Protecting Our Drinking Water through Stream and Sewer Restoration

Southeast New York Stormwater Conference
October 14, 2015
NYC DEP Bureau of Water Supply (BWS)

- Responsible for management, operation, and protection of New York City’s water supply system
- Mission: to provide clean drinking water and protect the drinking water supply
Project Introduction and Background

- Grahamsville
  - Chestnut Creek
- Tannersville
  - Allen Brook
  - Gooseberry Creek
  - Saw Mill Creek
- Pine Hill
  - Birch Creek
  - Horseshoe Creek
Project Elements

- Evaluation of Potential Stream Restoration Techniques

- Stream Restoration and Erosion Control designs

- Additional hydrologic/hydraulic assessments at four sites (PH-2, PH-6, PH-4, and PH-5)
Stream restoration through Natural Channel Design

- Natural channel design attempts to restore a disturbed stream to imitate a natural stable channel.

  - Goal: final design causes neither erosion, excessive deposition of sediment nor flooding of nearby homes, businesses or roads

- What is a stable stream channel and how does it become unstable?

- Why did we use natural channel design for this project?
Stream Restoration Techniques: 101

• Types of Stream Restoration
  ➢ Channel modification
  ➢ Double drop rock cross vanes
  ➢ Cross vanes
  ➢ Bank stabilization
  ➢ Riffle
What does Natural Channel Design look like?

Pre-restoration

Post-restoration
What does Natural Channel Design look like?

Newly Installed Cross Vane

Stream side Riparian Plantings
Rock Cross Vane Details
Holliday Brook Emergency Flood Response

- Emergency response prompted by June 2007 flash flood around Pepacton Reservoir
- Constructed in-stream grade control structures:
  - rock-cross vanes
  - double rock-cross vanes
  - three straight
  - rock vane
How was Natural Channel Design Incorporated?

- Proposed measures include:
  - retrofitting existing sewer protection structures
  - implementing new stream structures (cross vanes and straight vanes)
  - armoring banks with riparian plantings

Typical Rock Vane: A) Plan B) Cross Section C) Profile
Evaluation of Crossings

• Evaluation based on
  ➢ GIS information
  ➢ Record drawings
  ➢ Field visits
  ➢ CCTV surveys of sewers (sewer and drain camera inspection)
  ➢ Topographic/Stream crossing surveys
CIPP Lining to Minimize Disturbance

Sewer stream crossing at T-8

CIPP Lining
Examples of DEP Watershed Streams in Good Condition

Sewer stream crossing at G-1
Stream restoration and point repair for sewer

Sewer stream crossing at G-3

Sewer stream crossing at G-2
Stream restoration Design for G-3

- Double Drop Rock Vane + Cross Vane
- Riffle Grade Control
Detailed Pine Hill H&H Assessment
Detailed Pine Hill H&H Assessment

Extracted from FEMA Watershed Hydraulic Study, New York June 2013
Detailed Pine Hill H&H Assessment

- Four Locations within Ulster County:
  - PH-2 and PH-6 on Horseshoe Creek (aka Alton Creek)
  - PH-4 and PH-5 are located on Birch Creek

- Cross section development/methodology
  - Comparison to FEMA cross sections
  - Modification to account for proposed improvements
Manning’s n Value Adjustment

- **Manning’s n Composite for Channel:**
  
  \[
  n = (n_b + n_1 + n_2 + n_3 + n_4)m
  \]

  - \(n_b\) = a base value of \(n\) for a straight, uniform, smooth channel in natural materials
  - \(n_1\) = a correction factor for the effect of surface irregularities
  - \(n_2\) = a value for variations in shape and size of the channel cross section
  - \(n_3\) = a value for obstructions
  - \(n_4\) = a value for vegetation and flow conditions
  - \(m\) = a correction factor for meandering of the channel

- **Manning’s n Composite for Floodplain:**
  
  \[
  n = (n_b + n_1 + n_2 + n_3 + n_4)m
  \]

  - \(n_b\) = a base value of \(n\) for the flood plain's natural bare soil surface
  - \(n_1\) = a correction factor for the effect of surface irregularities on the flood plain
  - \(n_2\) = a value for variations in shape and size of the flood-plain cross section, assumed to equal 0.0
  - \(n_3\) = a value for obstructions on the flood plain
  - \(n_4\) = a value for vegetation on the flood plain
  - \(m\) = a correction factor for sinuosity of the flood plain, equal to 1.0
Manning’s n Value Adjustment
Details of HEC-Ras Model Development

- Steady State Analysis Only

- Evaluation under two scenarios: Existing and Proposed

- Model outputs compared the impacts of the sewer improvement work in terms of four main parameters:
  - Water surface elevation
  - Floodplain limits
  - Velocity
  - Shear stress
A Closer Look at Hydraulic Structures in Pine Hill

- Detailed Bridge Assessment for PH-2
  - Velocity and shear increases during 100-year storm
  - Velocity under bridge is already elevated, and is likely to remain elevated during proposed condition

- Detailed Culvert Assessment for PH-4
  - Shear stress reduced or experiences a negligible increase
  - Velocity generally remains the same
PH-2 Crossing: Bonnie View Avenue Bridge

PH-2, view looking upstream from Bonnie View Ave

PH-2, view looking downstream from headwall

Eroded conditions at Bonnie View Avenue Bridge
PH-2 Crossing: Bonnie View Avenue Bridge

From: MH #101
INV: 1590.1

Stream Sewer Crossing
8” DIP Pipe / Slope 5.6%

MH #100
INV: 1576.0

Stream Characteristics at Crossing
Top Width: 11.45 ft
Bottom Width: 11.45 ft
Depth: 2.80 ft
Slope: 4.28%

Scale: 1” = 30’
PH-2: Replacement of sanitary sewer pipe and concrete encasement

PH-2 Existing Pipe and Concrete Encasement

Raising concrete encasement changes stream channel topography
PH-4 Crossing: Academy Street Culvert

PH-4, view looking upstream from sewer crossing

PH-4, view looking downstream at sewer crossing
PH-6 Crossing

PH-6, view looking upstream from sewer crossing, steep eroded banks visible

PH-6, view looking downstream from sewer crossing
PH-5 Crossing

PH-5, view looking upstream at sewer crossing

PH-5, view looking downstream from sewer crossing
## Comparison of WSEL for Bankfull Storm Events

<table>
<thead>
<tr>
<th>Stream</th>
<th>Cross Section Location</th>
<th>Representation</th>
<th>Storm Event</th>
<th>Water Surface Elevation</th>
<th>Existing Conditions (ft)</th>
<th>Proposed Conditions (ft)</th>
<th>Δ Proposed - Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alton Creek</td>
<td>3686.482</td>
<td>Bonnie View Avenue Bridge; PH-2 improvements occur at the downstream end of the bridge</td>
<td>1.25-year</td>
<td>1614.09</td>
<td>1614.51</td>
<td>0.42</td>
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<td></td>
<td>2-year</td>
<td>1614.34</td>
<td>1614.76</td>
<td>0.42</td>
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<tr>
<td></td>
<td>281.5337</td>
<td>PH-6 sewer crossing</td>
<td>1.25-year</td>
<td>1472.66</td>
<td>1473.16</td>
<td>0.5</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-year</td>
<td>1472.84</td>
<td>1473.33</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Birch Creek</td>
<td>17925.96</td>
<td>Academy Street Culvert; PH-4 improvements occur at the upstream end</td>
<td>1.25-year</td>
<td>1505.77</td>
<td>1505.77</td>
<td>0.00</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-year</td>
<td>1506.66</td>
<td>1506.66</td>
<td>0.00</td>
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</tr>
<tr>
<td></td>
<td>14821.95</td>
<td>PH-5 sewer crossing</td>
<td>1.25-year</td>
<td>1431.24</td>
<td>1431.56</td>
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<tr>
<td></td>
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<td>2-year</td>
<td>1431.85</td>
<td>1432.12</td>
<td>0.27</td>
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</tbody>
</table>
Comparison of Water Surface Elevations for 10-year, 25-year, and 50-year Storms

- In general, either negligible increases or decreases. In the case of increases, generally less than 1 foot lateral increase.

- PH:4
Comparison of WSEL: 100-year Storm Floodplain Analysis

• PH-2
  - WSEL increase of about 0.11 ft at downstream end of bridge
  - Equates to approximately 1 foot lateral increase; this impact is considered negligible

• PH-6
  - WSEL increase of about 0.40 ft at location of improvement
  - Equates to approximately 1 foot lateral increase; this impact is considered negligible
Shear Stress and Velocity Analysis

- PH-2 and PH-6
  - minor increases in velocity and shear during the 2-year storm

- PH-4 and PH-5
  - localized minor increases during all storm events

- Conclusion:
  - Majority increases negligible based on particle entrainment analysis
Particle Entrainment Analysis

Modified Shield’s Curve

Additional Resources: Stability Thresholds for Stream Restoration Materials (Fischenich 2001)
## Results of Particle Entrainment Analysis

<table>
<thead>
<tr>
<th>Stream</th>
<th>Location</th>
<th>Summary of Results</th>
</tr>
</thead>
</table>
| Alton Creek | PH-2     | - Shear: No notable change  
            |           | - Velocity: No notable change                           |
|             | PH-6     | - Shear: No notable change  
            |           | - Velocity: Velocities exceed permissible range (5 ft/s) under 2-year existing and proposed conditions |
| Birch Creek | PH-4     | - Shear: No notable change  
            |           | - Velocity: No notable change                           |
|             | PH-5     | - Shear: No notable change  
            |           | - Velocity: No notable change                           |
Conclusions and Current Project Status

- Minor floodplain impacts at PH-2, PH-6, and PH-5; considered negligible
- With the exception of PH-6, all water surface increases are confined to channel banks
- Based on results of particle entrainment, only PH-6 is likely to require additional bank stabilization
- The Bonnie View Bridge at the location of PH-2 is currently experiencing erosion and the predicted velocity increases may exacerbate erosion
- Additional stream design at PH-6 and PH-5 to commence shortly