Hazen

NYC Environmental Protection

Protecting Our Drinking Water through Stream and Sewer Restoration

Southeast New York Stormwater Conference
October 14, 2015

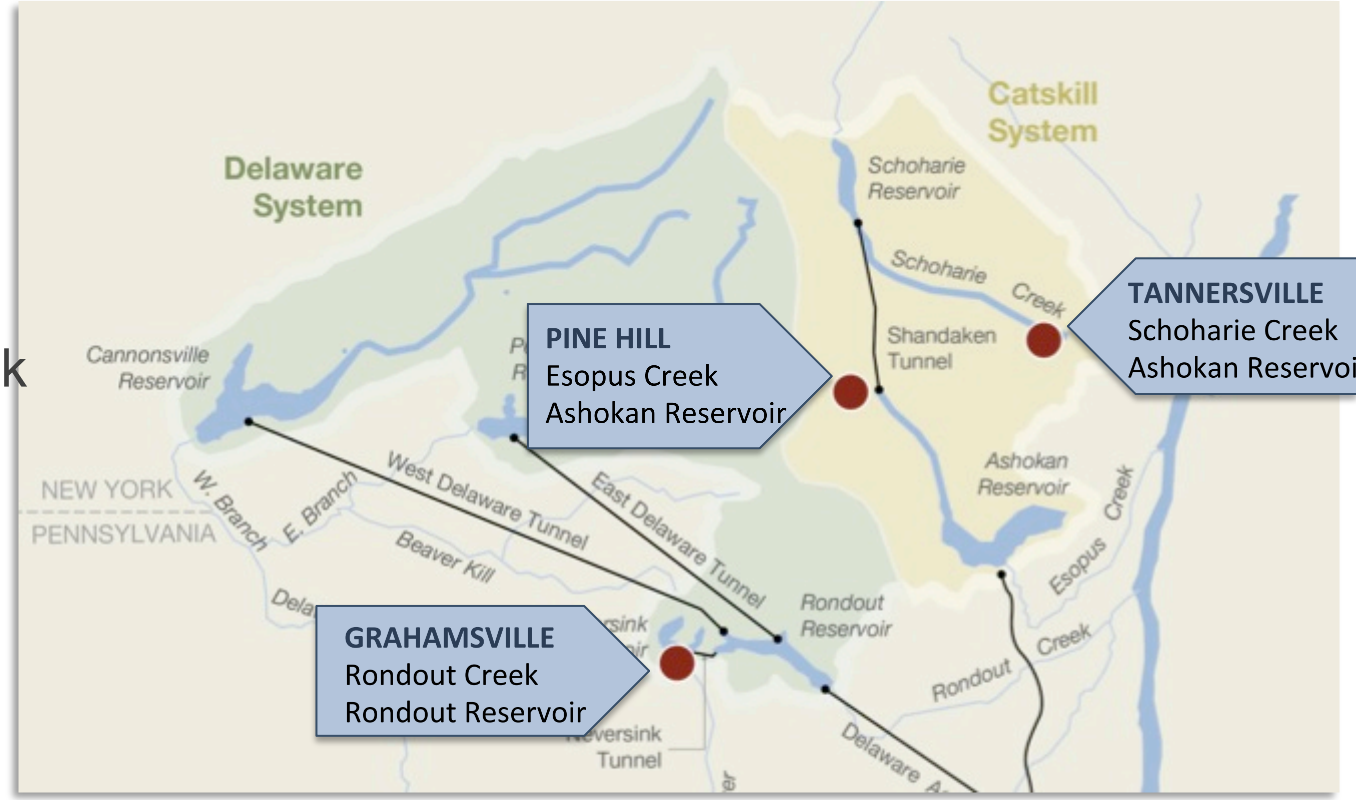
NYC Water Supply

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

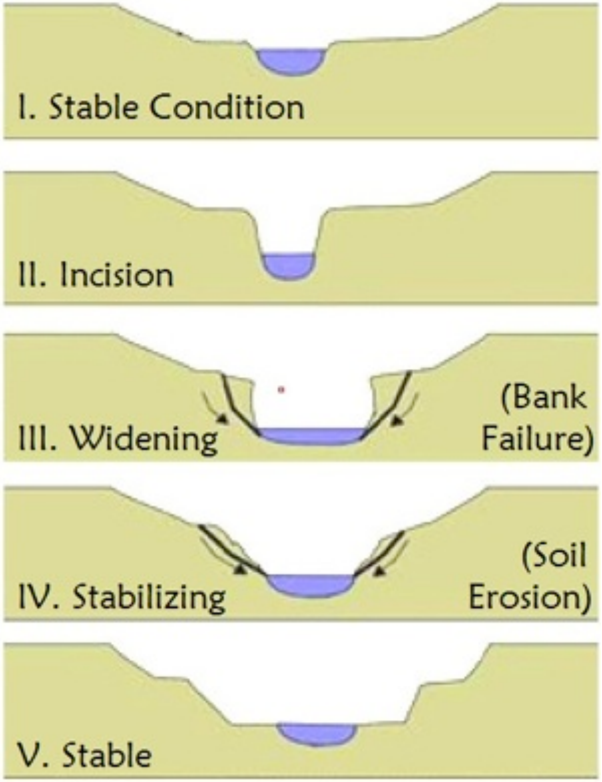


Project Elements

- 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?

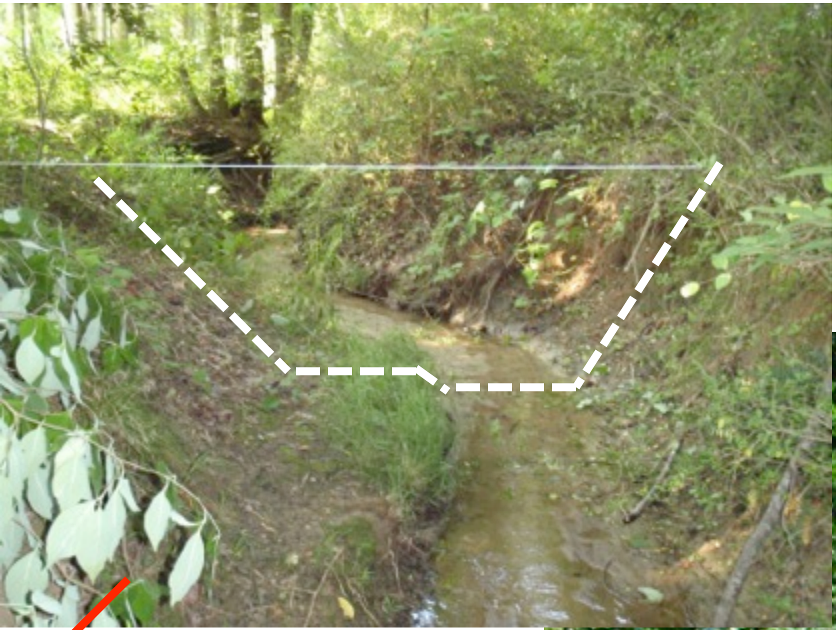


Fairfax County Watershed Management Plans - Stream Restoration

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

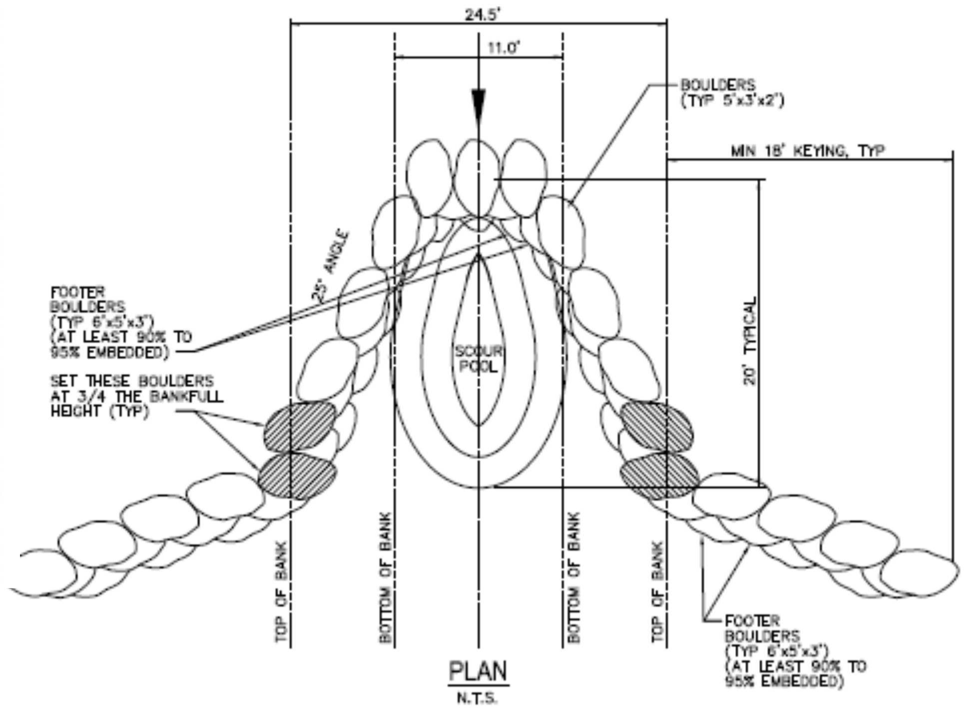
Post-restoration

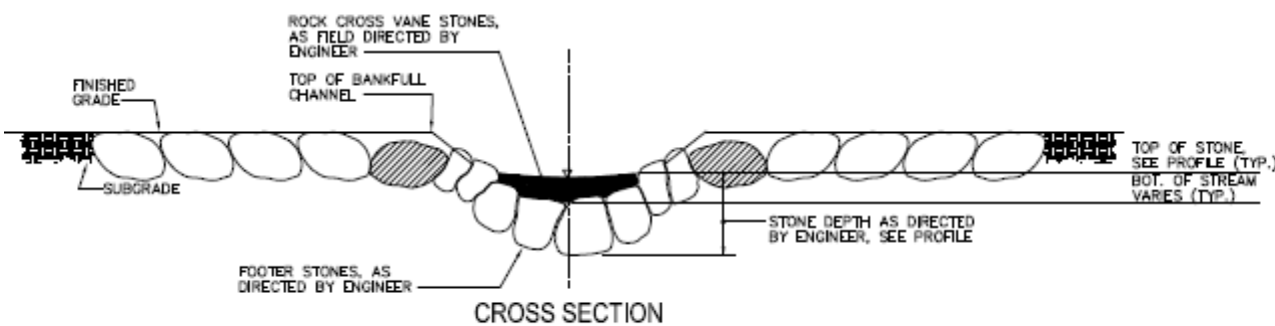
What does Natural Channel Design look like?

Newly Installed Cross Vane

Stream side Riparian Plantings

Rock Cross Vane Details



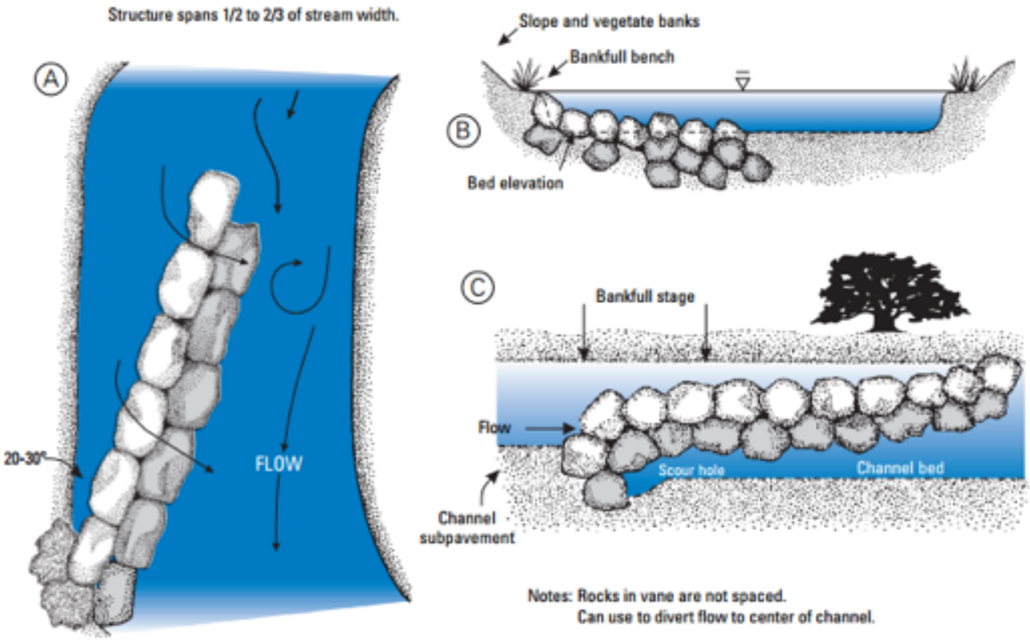


Holliday Brook Emergency Flood Response

- 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

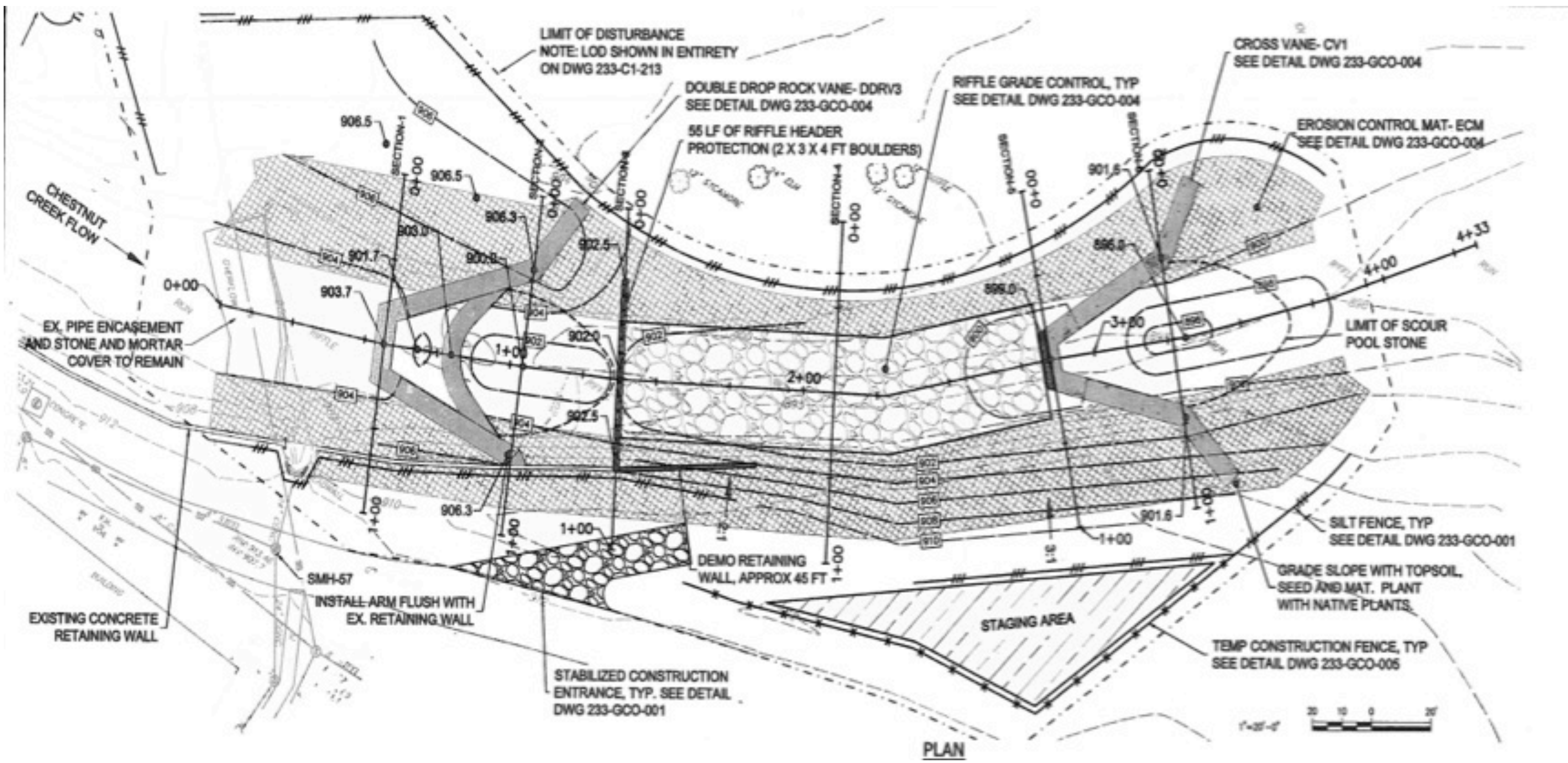
Sewer stream crossing at G-1

Stream restoration and point repair for sewer

Sewer stream crossing at G-3

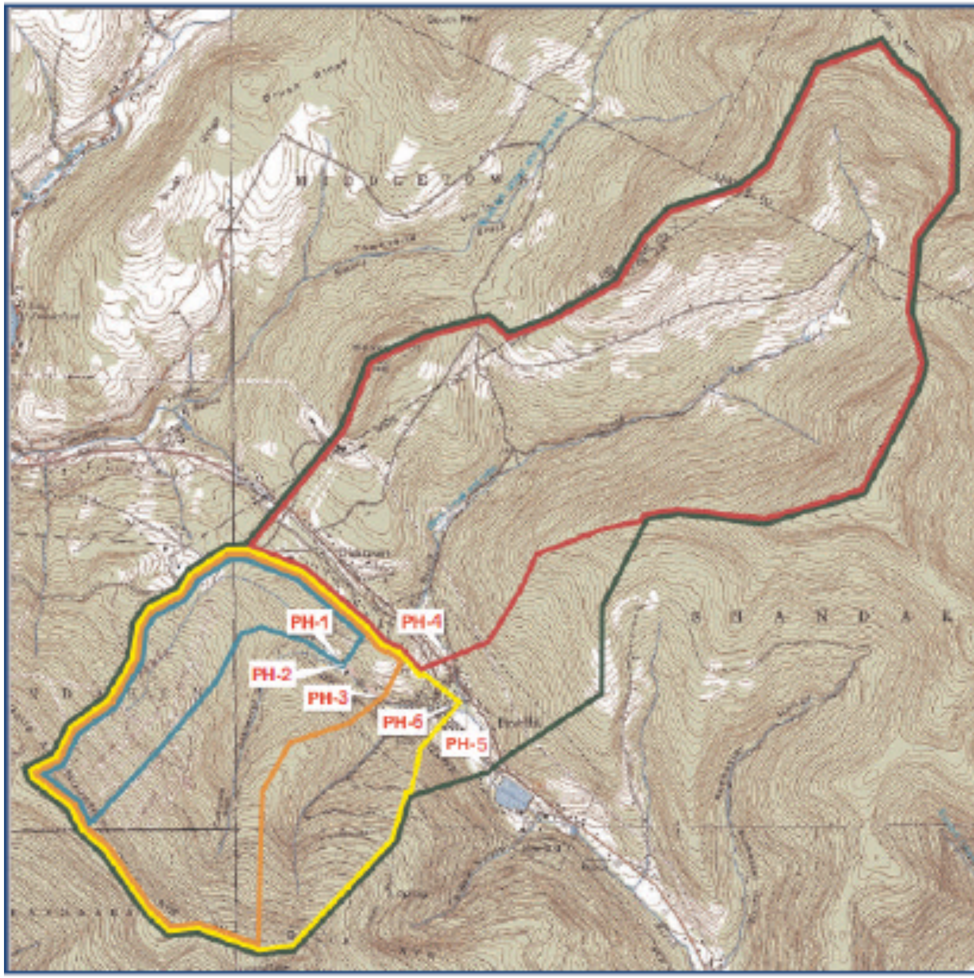
Sewer stream crossing at G-2

Stream restoration Design for G-3



- Double Drop Rock Vane + Cross Vane
- Riffle Grade Control

Detailed Pine Hill H&H Assessment



Pine Hill Drainage Areas

Site	Drainage Area (acres)	Drainage Area (square miles)
PH 1 PH 2 MH104A-MH103	489	0.8
PH-3 MH101-MH100	1155	1.8
PH-4 MH40-MH39	2941	4.6
PH-5 MH143-MH19	4957	7.7
PH-6 MH30-MH29A	1595	2.5

Base Map: USGS 7.5 Minute Quadrangle Topographic Maps

0 0.25 0.5 1 Miles

N

Detailed Pine Hill H&H Assessment

Figure 1: Esopus Watershed boundary with scoped flooding sources and labeled sub-watersheds.

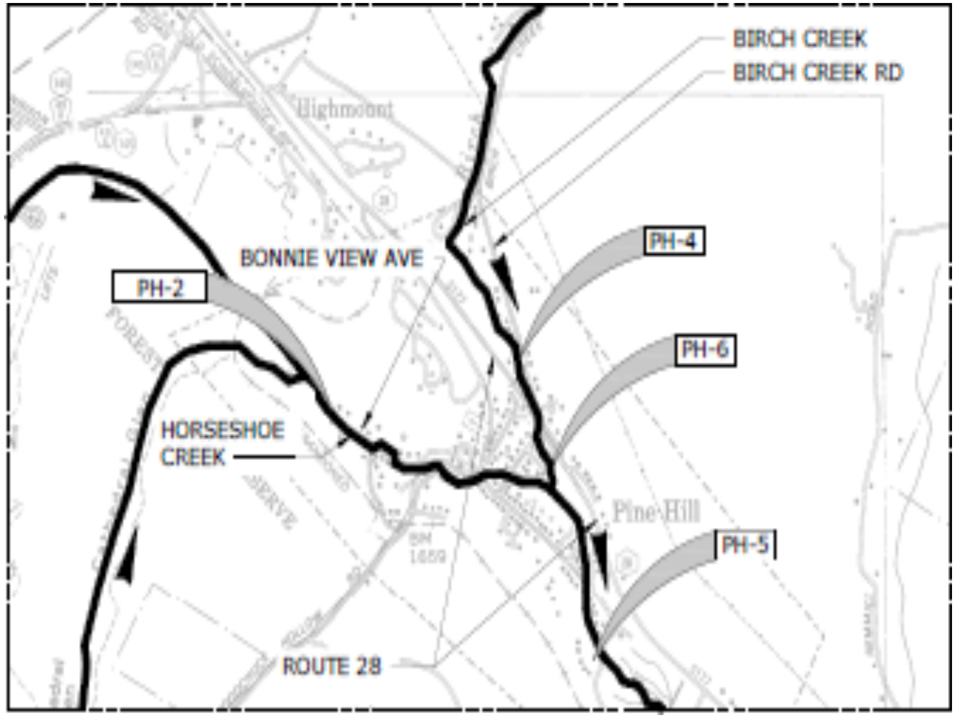
Extracted from FEMA Watershed Hydraulic Study, New York *June 2013*

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:

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

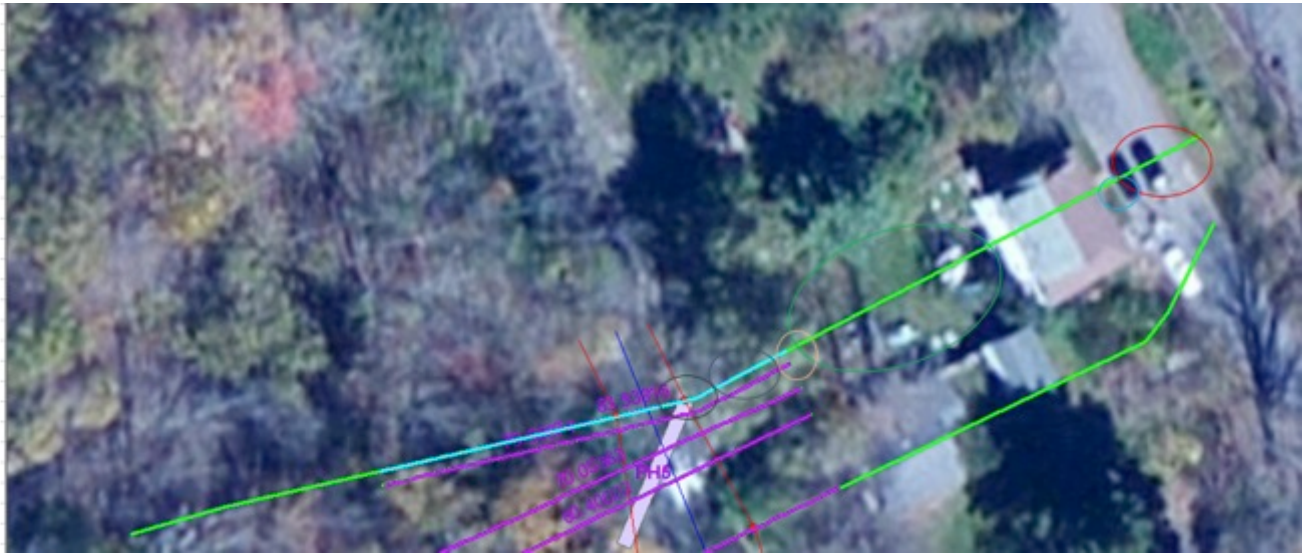
n_b =a base value of n for a straight, uniform, smooth channel in natural materials
n_1 =a correction factor for the effect of surface irregularities
n_2 = a value for variations in shape and size of the channel cross section
n_3 =a value for obstructions
n_4 =a value for vegetation and flow conditions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

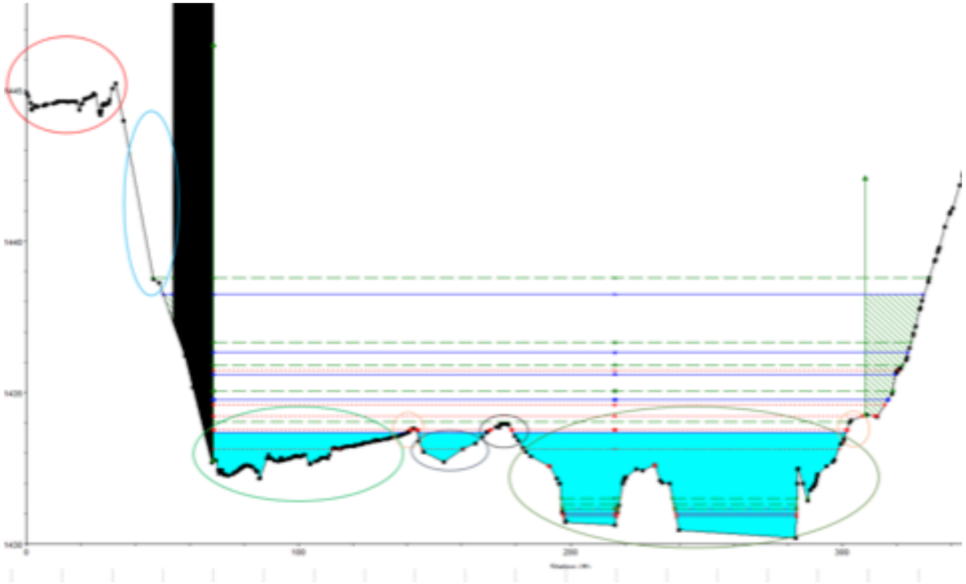
- Manning's n Composite for Floodplain:

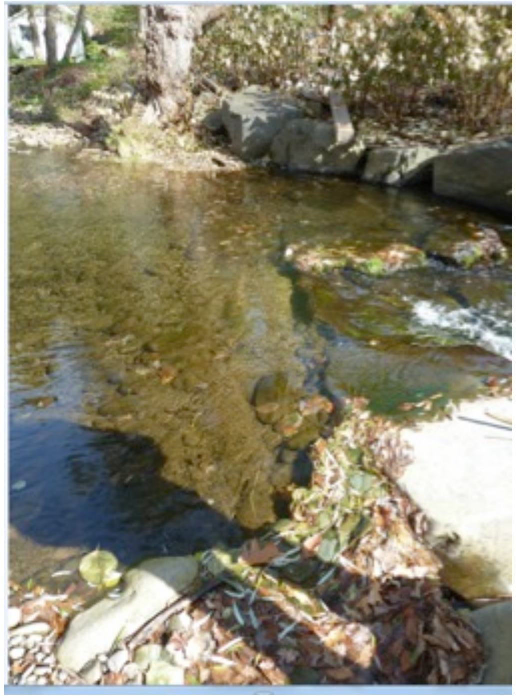
$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

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

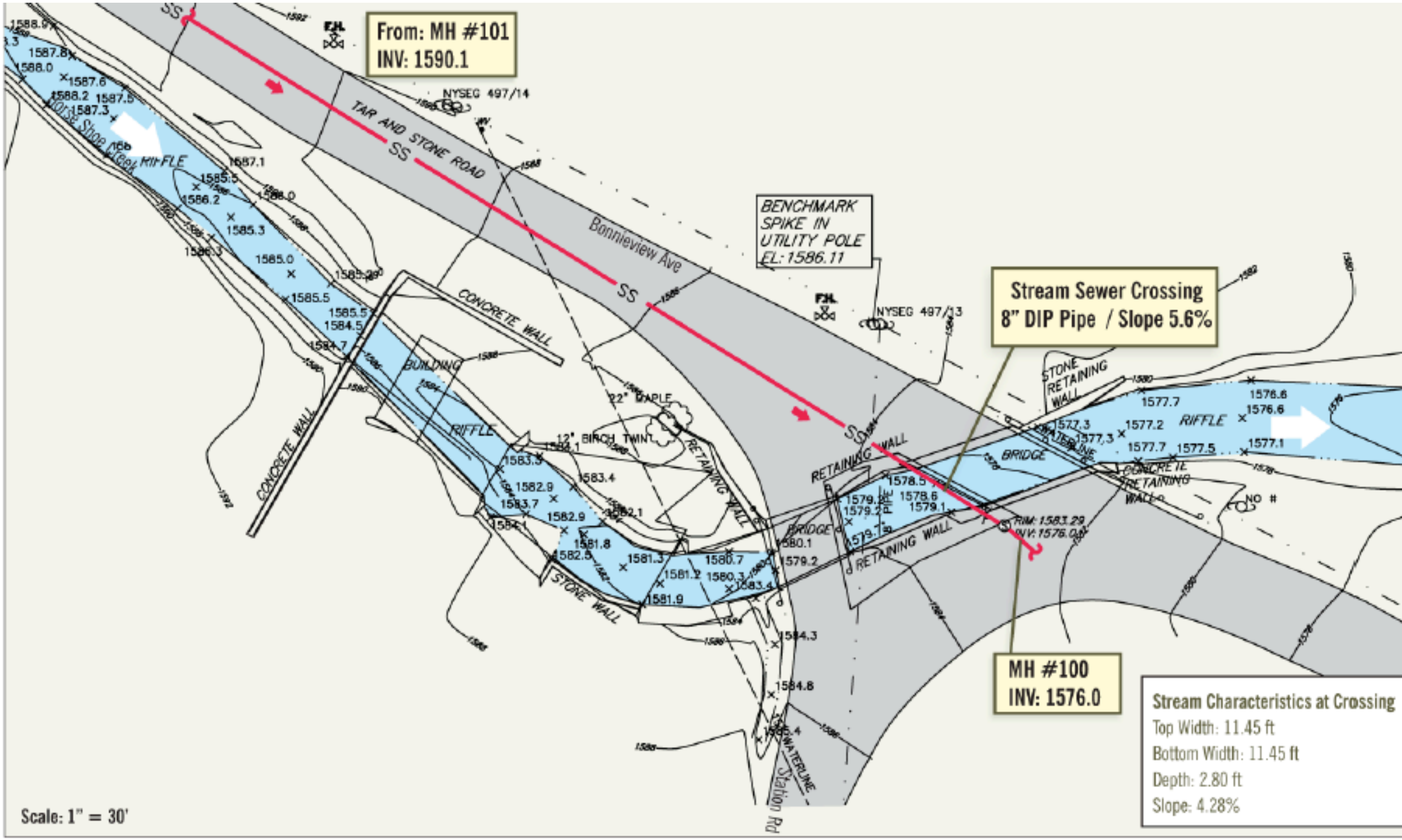
PH-2 Crossing: Bonnie View Avenue Bridge

PH-2, view looking upstream from Bonnie View Ave

PH-2, view looking downstream from headwall

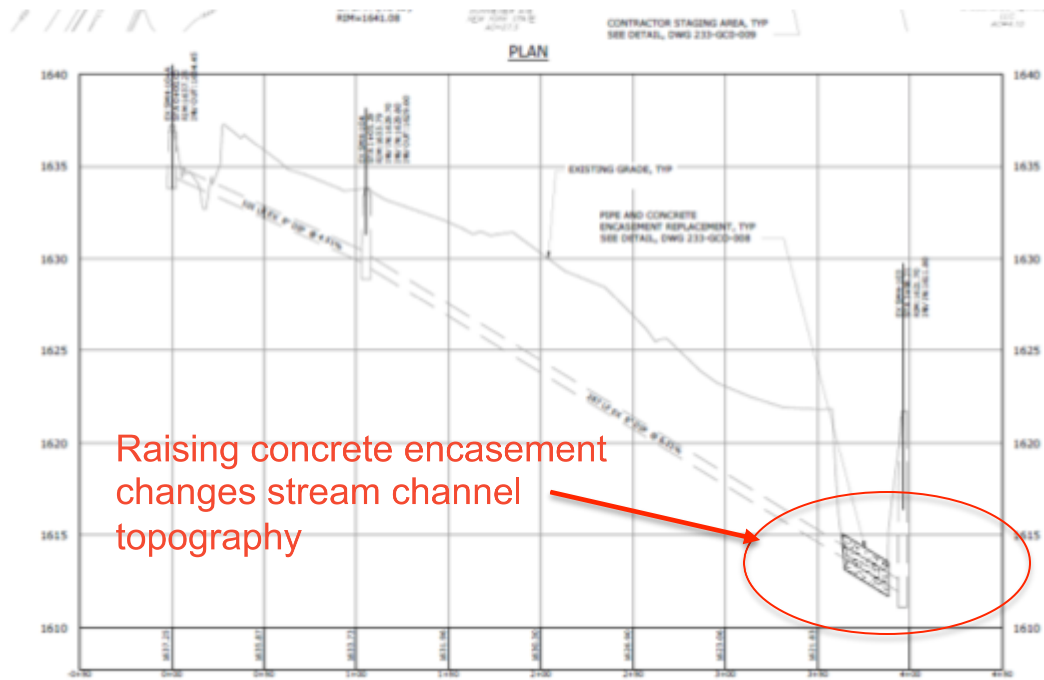
Eroded conditions at Bonnie View Avenue Bridge

PH-2 Crossing: Bonnie View Avenue Bridge



PH-2: Replacement of sanitary sewer pipe and concrete encasement

PH-2 Existing Pipe and Concrete Encasement



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

Stream	Cross Section Location	Representation	Storm Event	Water Surface Elevation		
				Existing Conditions (ft)	Proposed Conditions (ft)	Δ Proposed - Existing
Alton Creek	3686.482	Bonnie View Avenue Bridge; PH-2 improvements occur at the downstream end of the bridge	1.25-year	1614.09	1614.51	0.42
			2-year	1614.34	1614.76	0.42
	281.5337	PH-6 sewer crossing	1.25-year	1472.66	1473.16	0.5
			2-year	1472.84	1473.33	0.49
Birch Creek	17925.96	Academy Street Culvert; PH-4 improvements occur at the upstream end	1.25-year	1505.77	1505.77	0.00
			2-year	1506.66	1506.66	0.00
	14821.95	PH-5 sewer crossing	1.25-year	1431.24	1431.56	0.32
			2-year	1431.85	1432.12	0.27

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

Stream	Location	Summary of Results
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