Section 5. Lanesville Demonstration Restoration Project

Demonstration Project Report

Lanesville Stream Stabilization Project

Town of Hunter, Greene County, NY

December, 2003

Greene County Soil & Water Conservation District
907 Greene County Office Building, Cairo NY 12413
Phone (518) 622 – 3620 Fax (518) 622 – 0344
E-mail: **gcswcd@gcswcd.com**

Prepared By: Joel DuBois, CPESC, Stream Restoration Specialist

TABLE OF CONTENTS

1.0 Project Description

The project, as set forth in this design document, involves the stabilization of a severely eroded stream bank on the Stony Clove Creek. The bank is over sixty feet high, and composed largely of dispersive clay materials. The dispersive nature of the clay materials make this bank a priority for stabilization from a water quality standpoint. The bank has exhibited mass wasting as well as surficial hydraulic erosion. The bank failure will be addressed by adding a bankfull bench at the toe of the bank. The fill material in the bench will then be stabilized using rock structures design to minimize the erosive forces directed toward the bank. Natural Channel Design concepts will be applied to the stream reach approaching the bank. Addition of the bench in front of the bank results in a loss of channel length, and a resulting increase in channel slope in the area of the existing bank failure. Realignment of the reach upstream of the bank failure will compensate for the loss of channel length, and allow for the development of a stable channel slope through the reach. The Natural Channel Design component of this project will stabilize a ± 1700 linear foot stream reach. Stabilization of the approaching stream reach is critical to the success of the bank stabilization measures. The project reach is located in the Hamlet of Lanesville, in the Town of Hunter (see map).

2.0 Problem Assessment

The Stony Clove Creek, in the project reach, has been repeatedly modified, from its natural condition, in response to damaging flood events. Modifications made to the channel and adjacent riparian areas have disrupted the sediment transport function and flood plain dynamics of the reach. The site has exhibited localized zones of accelerated erosion and deposition. Undesirable trends of bed scour and aggradation have been observed on the site. These processes, coupled with lateral extension of the stream's belt width, have led to surface erosion and mass wasting of a 60+ ft. high slope. The length of the slope failure appears to be extending both upstream and downstream. Floodplain disconnectivity through the reach hampers natural recovery of the bank failure. The fine, clay-laden nature of the bank materials at the failure makes stabilization of the bank a priority from a water quality perspective.

Modifications made to the western floodplain have left the stream channel excessively confined. Aggradation of the streambed has been noted upstream of the channel confinement. Cycles of incisement and aggradation have developed along the length of confined channel. These cycles appear at a frequency that is not characteristically stable for the stream type and valley setting of the project reach.

Based on monitoring of the site and assessment of the stream's morphological condition, the following conclusions have been made:

1. Water quality is threatened by the bank failure due to the dispersive nature of the bank materials. The high-bank failure on the site has low potential for self-

recovery due to the confined state of the channel. Intervention is required to attain an acceptable rate of recovery.

2. Sediment transport through the reach is in a state of disequilibrium. Erosional and depositional processes have been accelerated to an unacceptable rate as a result of the sediment transport dysfunction of the reach.

3. Reaches both upstream and down stream of the project reach have been impacted by the instabilities that originate on the project site

3.0 Restoration Strategy

A stream stabilization strategy has been developed for this reach based upon reconnaissance within the watershed, history of the reach and assessment of the stream channel morphology. The stabilization strategy will provide a stable stream form, while physically stabilizing the bank failure. Sediment transport function will be restored to the reach in addition to enhancements to the flood plain and adjacent riparian areas.

The stabilization strategy includes the following design objectives:

1. Physical stabilization and revegetation of the bank must be achieved in order to mitigate the water quality threat posed by the failure.

2. Improvement of sediment transport continuity through the reach must be accomplished in order to ensure the success of bank stabilization measures. A channel planform, profile and cross-section must be developed to provide for conveyance of the systems flow and sediment supply without aggrading or degrading over time.

3. Reconnecting the active channel with a functioning flood-plain area, that is consistent with stream types that are characteristically stable in the valley setting of the reach, is a priority. A functioning flood plain will provide relief from the erosive forces of high flow events, enabling the channel to resist incision processes.

4. Ensure short-term stabilization of the planform and profile through installation of rock vanes to minimize bank erosion, and cross vanes to provide grade control.

5. Promote long-term stability of the reach through extensive planting of erosion resistant riparian vegetation.

4.0 Restoration Design

The following is a summary of the design calculations performed during development of stable channel planform, profile and cross-sectional dimensions.

4.1 Drainage Area (NYCDEP DEM) - Drainage area at the project site ranges from 14.4 mi^2, at the upper limits of the project reach, to 15.4 mi^2, at the lower limits of the project reach.

4.2 Project Reach Bankfull Discharge Calculations - Determination of the discharge (stream flow) associated with the bankfull channel is essential to the success of a stabilization design. Bankfull channel dimensions are a function of the flow and sediment regime. Therefore, bankfull discharge is the foundation of the calculations performed during development of the bankfull channel dimensions. Several methods were evaluated in order to quantify the bankfull flow.

From: Bankfull Discharge vs. drainage Area curve in The Reference Reach Field Book using the Southeast Pennsylvania data (Rosgen 1998).

Drainage Area (14.4 mi^2)$\Rightarrow$ Bankfull Q =500 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Bankfull Q =520 cfs

From: Regional Relationships of Bankfull Discharge to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY. (Provisional Data Provided by NYCDEP- May 1, 2001)

Drainage Area (14.4 mi^2)$\Rightarrow$ Bankfull Q =697 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Bankfull Q =736 cfs

From: Regional Relationships of Bankfull Discharge to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY, Stratified by Hydrologic Region for Hydrologic Region 4. (Provisional Data Provided by NYCDEP- May 1, 2001)

Drainage Area (14.4 mi^2)$\Rightarrow$ Bankfull Q =822 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Bankfull Q =869 cfs

From: Regional Relationships of Bankfull Discharge to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY, Stratified by Mean Annual Runoff (MAR> 2.3). (Provisional Data Provided by NYCDEP- May 1, 2001)

Drainage Area (14.4 mi^2)$\Rightarrow$ Bankfull Q =1171 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Bankfull Q =1234 cfs

From: Regional Relationships of Bankfull Discharge to Drainage Area for the Stony Clove Watershed in The Catskill Mountains, NY. (Provisional Data Provided by GCSWCD- 2001 Watershed Reconnaissance)

Drainage Area (14.4 mi^2)$\Rightarrow$ Bankfull Q =885 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Bankfull Q =946 cfs

From: USGS (90-4197, Lumia) Full Regression Equation for 2-year storm event

$$Q_2 = 14.1(A)^{0.880} (ST+1)^{-0.225} (P-20)^{0.614}$$

Where:
Q_2 = Peak discharge with 2 year return interval
A = Drainage area (mi^2)
ST = Basin storage (%) (From NYCDEP NWI and Water coverage) (.15% - .16%)
P = Mean Annual Precipitation (in.) (Project Site = 48 in.: from Distribution of Mean Annual Precipitation in New York (Excluding Long Island), USGS 1931-60)

Drainage Area (14.4 mi^2) $\Rightarrow$ Q_2 = 1105 cfs
Drainage Area (15.4 mi^2) $\Rightarrow$ Q_2 = 1170 cfs

Performed flow calculation for a 2-year return interval event using (USGS 90-4179, Lumia) full equation for hydrologic region 4.

From: USGS (90-4197, Lumia) Short Regression Equation for 2-year storm event

$$Q_2 = 68.3(A)^{.914}$$

Where:
Q_2 = Peak discharge with 2 year return interval
A = Drainage area (mi^2)

Drainage Area (14.4 mi^2)$\Rightarrow$ Q_2 = 782 cfs
Drainage Area (15.4 mi^2)$\Rightarrow$ Q_2 = 831 cfs

Performed flow calculation for a 2-year return interval event using (USGS 90-4179, Lumia) drainage area only equation for hydrologic region 4.

4.3 Bankfull Channel Dimensions – Bankfull channel dimensions are a function of the systems flow and sediment regime. Several regional resources have been evaluated to determine the appropriate bankfull channel dimensions. The following is a summary of the results of that evaluation.

From: Bankfull Channel Dimensions vs. Drainage Area in The Reference Reach Field Book using Eastern US curve (Rosgen 1998).

Bankfull Area

Drainage Area (14.4 mi^2)$\Rightarrow$ A_{bkf} = 130 ft^2
Drainage Area (15.4 mi^2)$\Rightarrow$ A_{bkf} = 140 ft^2

Bankfull Width

Drainage Area (14.4 mi^2)$\Rightarrow$ W_{bkf} = 40 ft
Drainage Area (15.4 mi^2)$\Rightarrow$ W_{bkf} = 42 ft

Bankfull Mean Depth

Drainage Area (14.4 mi^2)$\Rightarrow$ d_{bkf} = 3.2 ft
Drainage Area (15.4 mi^2)$\Rightarrow$ d_{bkf} = 3.3 ft

From: Regional Relationships of Bankfull Hydraulic Geometry to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY. (Provisional Data Provided by NYCDEP- May 1, 2001)

Bankfull Area

Drainage Area (14.4 mi^2)$\Rightarrow$ A_{bkf} = 106 ft^2
Drainage Area (15.4 mi^2)$\Rightarrow$ A_{bkf} = 112 ft^2

Bankfull Width

Drainage Area (14.4 mi^2)$\Rightarrow$ W_{bkf} = 49.1 ft
Drainage Area (15.4 mi^2)$\Rightarrow$ W_{bkf} = 50.8 ft

Bankfull Mean Depth

Drainage Area (14.4 mi^2)$\Rightarrow$ d_{bkf} = 2.16 ft
Drainage Area (15.4 mi^2)$\Rightarrow$ d_{bkf} = 2.20 ft

From: Regional Relationships of Bankfull Hydraulic Geometry to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY, Stratified by Mean Annual Runoff (MAR> 2.3) (Provisional Data Provided by NYCDEP- May 1, 2001)

Bankfull Area

Drainage Area (14.4 mi^2)$\Rightarrow$ A_{bkf} = 163 ft^2
Drainage Area (15.4 mi^2)$\Rightarrow$ A_{bkf} = 171 ft^2

Bankfull Width

Drainage Area (14.4 mi^2)⇒ W_{bkf} = 61.0 ft
Drainage Area (15.4 mi^2)⇒ W_{bkf} = 62.7 ft

Bankfull Mean Depth

Drainage Area (14.4 mi^2)⇒ d_{bkf} = 2.61 ft
Drainage Area (15.4 mi^2)⇒ d_{bkf} = 2.66 ft

From: Regional Relationships of Bankfull Hydraulic Geometry to Drainage Area for 14 USGS Stream Gages in The Catskill Mountains, NY, Stratified by Stream Type (B Stream Types) (Provisional Data Provided by NYCDEP- May 1, 2001)

Bankfull Area

Drainage Area (14.4 mi^2)⇒ A_{bkf} = 123 ft^2
Drainage Area (15.4 mi^2)⇒ A_{bkf} = 131 ft^2

From: Regional Relationships of Bankfull Discharge to Drainage Area for the Stony Clove Watershed in The Catskill Mountains, NY. (Provisional Data Provided by GCSWCD- 2001 Watershed Reconnaissance)

Bankfull Area

Drainage Area (14.4 mi^2)⇒ A_{bkf} = 108 ft^2
Drainage Area (15.4 mi^2)⇒ A_{bkf} = 116 ft^2

Bankfull Width

Drainage Area (14.4 mi^2)⇒ W_{bkf} = 52.1 ft
Drainage Area (15.4 mi^2)⇒ W_{bkf} = 53.6 ft

Bankfull Mean Depth

Drainage Area (14.4 mi^2)⇒ d_{bkf} = 2.00 ft
Drainage Area (15.4 mi^2)⇒ d_{bkf} = 2.06 ft

4.4 Stream Channel Planform – Stream Planform is a function of a streams slope, width, depth, sediment regime and boundary condition. Plan form design values have been developed based upon an evaluation of the design values for the channel dimension variables above, as well as a review of the planform geometry of nearby reference stream conditions. The following is a summary of the planform dimensions used for the stabilization design.

Radius of Curvature Range = 320 – 350 ft

Meander Wavelength = 1075 ft

Meander Amplitude = 275 ft

Sinuosity = thalweg length / valley distance
Sinuosity = 1697.36 / 1582.11 = 1.07

4.5 Sediment Transport Validation - Determination of the channel's competence to transport its bedload is critical to the development of stable channel geometry. Computing Critical Dimensionless Shear Stress (J_{ci}) is the first step in the Entrainment Analysis.

1. Critical Dimensionless Shear Stress is determined through a function of the ratio between the pavement and sub-pavement materials. The following is the procedure for this analysis:

   a. Collect and measure 4-5 of the largest particles resting on the lower third (tailout) of the point bar at an elevation half way between the point of maximum depth (thalweg) and bankfull. Calculate the average size (in feet) of the B-axis (median axis) of the particles collected.
   b. Collect a sediment sample from the point bar in the same location by pushing a two gallon bottomless bucket into the bar. Remove the bar material within the bucket to a depth twice the average size of the largest particles found in step "a." Process this sample through sieve analysis and determine the particle size distribution (i.e., D_{15}, D_{35}, D_{50}, etc.) of the bar material by weight.

   c. Conduct a Wolman Pebble Count (100 particles) and determine the particle size distribution (i.e., D_{15}, D_{35}, D_{50}, etc.) of the material on the bed of a narrow, stable riffle.

2. Using the following equations, determine the critical dimensionless shear stress.

   a. Determine ratio d_i / d_{50}

      Where: d_i = bed material D_{50} of riffle
      d_{50} = subpavement D_{50} of bar sample

   b. If ratio = 3.0 – 7.0 then determine Critical Dimensionless Shear Stress using:

$$T_{ci} = .0834 (d_i / d_{50})^{-0.872}$$

c. If ratio = 1.3 – 3.0 then determine Critical Dimensionless Shear Stress using:

$$T_{ci} = .0384\ (d_i / d_{50})^{-0.887}$$

3. Once Critical Dimensionless Shear Stress is determined, the minimum mean bankfull depth required to move the largest particles from the lower third of the bar is calculated using:

$$d = T_{ci}\ (Ss)(D_i) / s$$

Where: d = minimum bankfull mean depth (ft)
Ss = sediment density (1.65)
D_i = largest particle on lower third of point bar
s = proposed average bankfull slope

The sediment transport validation process was performed for both the project reach and the reference reach used for design development. The following figures summarize the sediment transport validation computations performed on the project site in its existing channel condition.

Entrainment Calculation Form - Sample #1

Stream: STONY CLOVE	Reach: PROJECT REACH
Date: 10/29/02	Observers: JD, JB

Critical Dimensionless Shear Stress

$t_{ci} = 0.0834(d_i/d_{50})^{-0.872}$

Value	Variable	Definition
124.83	d_i (mm)	D_{50} Bed Material (D_{50} from riffle pebble count)
18.45	d_{50} (mm)	Bar Sample D_{50} or Sub-pavement D_{50}
0.016	t_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$d_r = (t_{ci} * 1.65 * D_i)/S_e$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.016	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
0.0187	S_e (ft/ft)	Existing Bankfull Water Surface Slope
0.8	d_r (ft)	**Bankfull Mean Depth Required**
1.5	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
1.8	d_e/d_r	Ratio of Existing Mean Depth to Required Mean Depth

Check one: ☐ Stable (de/dr = 1) ☐ Aggrading (de/dr < 1) ☑ Degrading (de/dr > 1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:

$S_r = (t_{ci} * 1.65 * D_i)/d_e$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.016	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
1.5	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.0102	Sr (ft/ft)	Bankfull Water Surface Slope Required
1.8	S_e/S_r	Ratio of Existing Slope to Required Slope

Check one: ☐ Stable (Se/Sr = 1) ☐ Aggrading (Se/Sr < 1) ☑ Degrading (Se/Sr > 1)

Sediment Transport Validation

180	Largest Particle in Bar Sample D_i (mm)
1.46	Hydraulic Radius (ft)
1.70	Bankfull Shear Stress $t_c = gRS$ (lb/ft^2) **g** = 62.4 R=Hydraulic Radius S=Slope
130	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
2.08	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

After Wildland Hydrology 2001

Entrainment Calculation Form - Sample #2

Stream: STONY CLOVE	Reach: PROJECT REACH
Date: 10/29/02	Observers: JD, JB

Critical Dimensionless Shear Stress

$$t_{ci} = 0.0834(d_i/d_{50})^{-0.872}$$

Value	Variable	Definition
124.83	d_i (mm)	D_{50} Bed Material (D_{50} from riffle pebble count)
30.87	d_{50} (mm)	Bar Sample D_{50} or Sub-pavement D_{50}
0.025	t_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$$d_r = (t_{ci} * 1.65 * D_i)/S_e$$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.025	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
0.0187	S_e (ft/ft)	Existing Bankfull Water Surface Slope
1.3	d_r (ft)	**Bankfull Mean Depth Required**
1.5	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
1.2	d_e/d_r	Ratio of Existing Mean Depth to Required Mean Depth

Check one: ☐ Stable (de/dr = 1) ☐ Aggrading (de/dr < 1) ☑ Degrading (de/dr > 1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:

$$S_r = (t_{ci} * 1.65 * D_i)/d_e$$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.025	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
1.5	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.0160	Sr (ft/ft)	Bankfull Water Surface Slope Required
1.2	S_e/S_r	Ratio of Existing Slope to Required Slope

Check one: ☐ Stable (Se/Sr = 1) ☐ Aggrading (Se/Sr < 1) ☑ Degrading (Se/Sr > 1)

Sediment Transport Validation

180	Largest Particle in Bar Sample D_i (mm)
1.46	Hydraulic Radius (ft)
1.70	Bankfull Shear Stress t_c=gRS (lb/ft^2) g = 62.4 R=Hydraulic Radius S=Slope
130	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
2.08	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

After Wildland Hydrology 2001

Entrainment Calculation Form - Composite Sample

Stream: STONY CLOVE	Reach: PROJECT REACH
Date: 10/29/02	Observers: JD, JB

Critical Dimensionless Shear Stress

$$t_{ci} = 0.0834(d_i/d_{50})^{-0.872}$$

Value	Variable	Definition
124.83	d_i (mm)	D_{50} Bed Material (D_{50} from riffle pebble count)
24.7	d_{50} (mm)	Bar Sample D_{50} or Sub-pavement D_{50}
0.020	t_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$$d_r = (t_{ci}*1.65*D_i)/S_e$$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.020	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
0.0187	S_e (ft/ft)	Existing Bankfull Water Surface Slope
1.1	d_r (ft)	**Bankfull Mean Depth Required**
1.5	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
1.4	d_e/d_r	Ratio of Existing Mean Depth to Required Mean Depth

Check one: ☐ Stable (de/dr = 1) ☐ Aggrading (de/dr < 1) ☑ Degrading (de/dr > 1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:

$$S_r = (t_{ci}*1.65*D_i)/d_e$$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.020	t_{ci}	Critical Dimensionless Shear Stress
0.59	D_i (ft)	Largest particle from bar sample
1.5	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.0132	Sr (ft/ft)	Bankfull Water Surface Slope Required
1.4	S_e/S_r	Ratio of Existing Slope to Required Slope

Check one: ☐ Stable (Se/Sr = 1) ☐ Aggrading (Se/Sr < 1) ☑ Degrading (Se/Sr > 1)

Sediment Transport Validation

180	Largest Particle in Bar Sample D_i (mm)
1.46	Hydraulic Radius (ft)
1.70	Bankfull Shear Stress $t_c = gRS$ (lb/ft^2) g = 62.4 R=Hydraulic Radius S=Slope
130	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
2.08	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

After Wildland Hydrology 2001

The following figure summarizes the sediment transport validation computations performed on the reference reach in its existing channel condition.

Entrainment Calculation Form - Sample #1

Stream: STONY CLOVE	Reach: REFERENCE REACH
Date: 10/29/02	Observers: JD, JB

Critical Dimensionless Shear Stress

$t_{ci} = 0.0834(d_i/d_{50})^{-0.872}$

Value	Variable	Definition
124.83	d_i (mm)	D_{50} Bed Material (D_{50} from riffle pebble count)
32.39	d_{50} (mm)	Bar Sample D_{50} or Sub-pavement D_{50}
0.026	t_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$d_r = (t_{ci}*1.65*D_i)/S_e$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.026	t_{ci}	Critical Dimensionless Shear Stress
0.53	D_i (ft)	Largest particle from bar sample
0.0138	S_e (ft/ft)	Existing Bankfull Water Surface Slope
1.6	d_r (ft)	**Bankfull Mean Depth Required**
2.22	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
1.4	d_e/d_r	Ratio of Existing Mean Depth to Required Mean Depth

Check one: ☐ Stable (de/dr = 1) ☐ Aggrading (de/dr < 1) ☑ Degrading (de/dr > 1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:

$S_r = (t_{ci}*1.65*D_i)/d_e$

1.65 = submerged specific weight of sediment

Value	Variable	Definition
0.026	t_{ci}	Critical Dimensionless Shear Stress
0.53	D_i (ft)	Largest particle from bar sample
2.22	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
0.0101	Sr (ft/ft)	Bankfull Water Surface Slope Required
1.4	S_e/S_r	Ratio of Existing Slope to Required Slope

Check one: ☐ Stable (Se/Sr = 1) ☐ Aggrading (Se/Sr < 1) ☑ Degrading (Se/Sr > 1)

Sediment Transport Validation

162	Largest Particle in Bar Sample D_i (mm)
2.16	Hydraulic Radius (ft)
1.86	Bankfull Shear Stress $t_c = gRS$ (lb/ft^2) **g** = 62.4 R=Hydraulic Radius S=Slope
150	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book: p238, Red field book: p190)
1.9	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book: p238, Red field book: p190)

After Wildland Hydrology 2001

4.6 Design Channel Dimensions – Final channel dimensions were developed through an evaluation of the morphological parameters presented above. The dimensions calculated represent values for the bankfull channel.

Mean Depth – Mean depth for the stream stabilization design was based on the sediment transport validation computations performed for the project reach. The mean depth is designed to develop the critical shear stress required to mobilize sediments commonly mobile in the project reach at the bankfull stage.

Cross-sectional Area – channel cross-sectional area was developed from empirically derived regional curves for cross-sectional area as a function of drainage area.

Channel Width – Channel width was developed as a function of cross-sectional area and mean depth. (A_{xs} / d_{mean} = W_{bkf})

Reference Conditions – Stable channel dimensions were field collected from a reference reach exhibiting valley morphology, channel morphology and hydrology similar to that of the project reach. The reference reach exhibited a stable, desirable form capable of conveying its flow and sediment without significant aggradation, degradation, or lateral migration over time.

Channel dimensions including maximum depths, feature spacing, feature lengths, feature slopes, radii of curvature, meander wavelength and meander amplitude were extracted from data collected on the reference reach.

Below is a summary table of the channel dimensions extracted from the reference reach for the Lanesville Stream Stabilization Project.

Lanesville - Stream Stabilization Project	
Reference Reach Summary	
Stream Type	B3c
Drainage Area (mi^2)	14.2 - 14.3
Bankfull Width (Ft)	62.9 - 73.2
Bankfull d_{mean} (Ft)	1.8 - 2.5
Mobile Particle (mm)	133 - 168
Existing Shear (Lbs./ Ft^2)	1.1 - 3.2
Width / Depth (Ft.)	26.5 - 41.4
Bankfull A_{xs} (Ft^2)	129 - 171
Bankfull V_{mean} (Ft/ Sec.)	5.6 - 10.3
bankfull Q (Ft^3/Sec.)	719 - 1548
Ratio D_{riff} / d_{mean}	1.2 - 1.5
Ratio D_{pool} / d_{mean}	1.5 - 2.3
Entrenchment	1.5 - 2.1

Spacing		
P-P / W_{bkf}	**R-R / W_{bkf}**	
8.7	10.7	**upper**
8.5	9.6	**mean**
8.3	8.5	**lower**

Lengths		
$Length_{pool}$ /W_{bkf}	**$Length_{riff}$ /W_{bkf}**	
3.2	4.9	**upper**
2.9	3.5	**mean**
2.3	2.5	**lower**

Those values were then reduced to dimensionless ratios normalized by mean depth, channel width or mean slope of the reference reach. Using those ratios, combined with the values for mean depth, channel width or mean slope for the stabilization design, the reference data can be applied to the project site.

Below is a summary table of the channel dimensions applied to the stabilization design for the Lanesville Stream Stabilization Project.

Lanesville - Stream Stabilization Project	
Channel Design Summary	
Stream Type	B3c
Drainage Area (mi^2)	15.3
Bankfull Width (Ft)	58.5
Bankfull d_{mean} (Ft)	1.97
Mobile Particle (mm)	180
Min. Design Shear (Lbs./ Ft^2)	2.08
Width / Depth (Ft.)	30
Bankfull A_{xs} (Ft^2)	115
Bankfull V_{mean} (Ft/ Sec.)	7.49
bankfull Q (Ft^3/Sec.)	861
Ratio D_{riff} / d_{mean}	1.31
Ratio D_{pool} / d_{mean}	2.01
Entrenchment	1.7

Spacing		
P-P / W_{bkf}	R-R / W_{bkf}	
8.7	10.7	upper
8.5	9.6	mean
8.3	8.5	lower

Lengths		
$Length_{pool}$ /W_{bkf}	$Length_{riff}$ /W_{bkf}	
3.2	4.9	upper
2.9	3.5	mean
2.3	2.5	lower

5.0 Summary of Final Design Features

In addition to the information presented above for the proposed channel dimensions, the following is a summary of the key features of the stabilization design.

5.1 Cut/Fill Volumes – The proposed cross-sections and proposed final grade lines indicate there will be a net of $\pm$ 20000 yds^3 of material removed from the project area. The materials will be disposed of at an upland location. The materials in the upland location will be contoured to an acceptable grade, and stabilized through seeding and mulching.

5.2 Rock Volumes – The stream stabilization will involve the placement of heavy rock materials used to construct in-stream structures. The design will include construction of Cross Vanes intended to provide grade control, and reduce velocity in the near-bank region, while promoting diversity of bedform. The design will also include the installation of rock vanes. Rock Vanes are intended to reduce velocities in the near-bank region, while also promoting bedform diversity. Both of these structure types also help to dissipate stream energy during flood conditions through internal distortion resistance. The following is a summary of the instream structures proposed for the project, and the estimated rock mass required for each type of structure.

Cross Vanes	4 vanes @ 250 tons/Cross Vane	= 1000 tons
Rock Vanes	5 vanes @ 100 tons/Rock Vane	= 500 tons
	Total Rock	= 1500 tons

5.3 Vegetation Plantings – establishment of an effective riparian buffer zone is critical to the success of a stream stabilization design. A combination of dormant plant materials, conservation seed mixtures, and plantings of live trees and shrubs will be employed to initiate the development of a functioning riparian community. Native willow and dogwood species will be planted on the streambanks, with brush layering techniques installed immediately downstream each rock structure arm. Single or double rows of live fascines will be applied to flood plain benches, along side each vane, on outside bends and to other areas of special concern. All other areas of disturbance will be treated with conservation seed mixtures and mulched to minimize soil losses. Various species of woody trees and shrubs, appropriate for the riparian zone, shall be planted in the disturbed upland areas.

6.0 Project Specifications

This project will be constructed in accordance with stream restoration specifications developed by Greene County Soil and Water Conservation District. These specifications are provided in **Appendix A** to this document.

7.0 Project Estimates

The stream stabilization cost estimates for the Lanesville Stream Stabilization Project were based upon previous projects of a very similar nature. The projects were completed within the past 4 years in the NYC Watershed area. It is estimated that the stream stabilization project will cost $150.00 per linear foot, for a total of 1700 linear feet, yielding a total cost of **$255,000.00**.

8.0 Project Bidding

A project bid package was developed to include drawings and specifications for the proposed project. The project was publicly bid using a competitive sealed bid process to select a contractor. Eight complete bids were received with Total Primary Bid Prices ranging from $183,317.00 to $438,760.00. The bid was awarded to Fastracs Rentals, Inc. with a Total Primary Bid Price of $183,317.00. The winning bid is summarized in the table below.

Primary Bid Items				
Bid Item				
No.		Units	Estimated Units [1]	Fastracs
1	Mobilization & Demobilization	LS		$9,100.00
2	Clearing & Grubbing	LS		$2,500.00
3	De-watering	LS		$21,000.00
4	Stream Channel Excavation	LS		$66,500.00
5	Rock Structures	Ton	2,200	$57,750.00
6	Live Fascines	LF	1,900	$7,125.00
7	Brush Layering	LF	200	$1,600.00
8	Live Posts	Each	1,500	$6,000.00
9	Seeding & Mulching - Permanent Seeding	SqFt	206,000	$11,742.00
			Total Primary Bid Price	$183,317.00

Alternate Bid Items				
Alt. Bid				
Item No.		Units		Fastracs
Alt. #1	Root Wads	Ea		$700.00
Alt #2	Live Material Transplants - shrubs/trees	Ea		$50.00
Alt #3	Clay Removal and Disposal	CuYd		$9.00

9.0 Project Construction

9.1 Construction Schedule – Construction of this project is expected to commence during the first week of August, 2003. Construction duration has been estimated at 5-7 weeks for primary channel construction activities, including rock structures. The bioengineering component of the project will be installed beginning in mid-October, 2003. Bioengineering installation is expected to be complete by mid-November, 2003.

9.2 Project Dewatering – Preliminary de-watering schematics have been presented in the attached **Design Drawings** for this project. De-watering of all work areas will be required to divert clean water around the work site. The site presents limited opportunity for passive diversion of clean water. Therefore, de-watering operations will require use of pumps and pipeline. For further information about project de-watering, see the attached **Construction Specification CS-04, Project De-watering**.

9.3 Sediment Control – Sediment control during construction will be accomplished through collection of all turbid water within the work area, and pumping the sediment-laden water to designated grassy filter areas. In the event that adequate sediment control cannot be accomplished using existing filter areas, the Contractor will be required to develop open sediment basins constructed of hay bales lined with filter fabric. These constructed basins would be placed near the locations of the existing filter areas and will pre-treat the discharge before it enters the existing filter areas. All disturbed areas will be temporarily stabilized as soon as possible to minimize soil erosion. The sediment control measures will ensure that no turbid water discharges from the work area. See the attached **Construction Specification CS-03, Pollution Control.**

10.0 Current Project Status

Construction commenced at the project site on July 28, 2003. Work continued, weather and flow permitting, until September 15, 2003. Due to inclement weather and high flow conditions, the site was shutdown for a substantial portion of the construction window. As a result of the shutdown periods the Contractor, Fastracs Rentals, Inc. was unable to complete the entire scope of the contract.

To date, 850 feet of the overall 1700 foot project length have been graded and rock structures installed. Two of the four cross vanes and two of the five rock vanes proposed for the project have been completed. Roughly 30% of the cut & fill work has been completed from a volumetric stand point.

Sections of the job that have been completed are scheduled for seed and mulch, bio-engineering installation, and planting of potted plant materials.

The seed and mulch application on the completed areas will be permanent, while seed and mulch applied to the incomplete sections of the project will be temporary. Different seed mixtures may be applied to the respective areas. The temporary seeding areas should be treated with a less expensive, faster growing mix. The areas that have been completed will be treated with a seed mix that, while more expensive, better correlates to the native vegetative community expected in this area.

The bio-engineering installation will commence as plant materials begin to enter winter dormancy. This is expected to occur by the end of October, allow harvesting and installation by mid-November. The materials harvested will be fashioned into fascines, and brush layers to be installed as vegetative bank erosion protection. Bio-engineering will not be installed on any areas that are not complete at this time.

The contractor is expected to remobilize to the site in June of 2004 to commence construction on the portions of the project that were not completed in the 2003 construction window.

Below are photographs of the project site, taken shortly after the contractors de-mobilization from the site.

Figure 1: top of project are looking down stream. This section has been completed and is scheduled for bio engineering this fall.

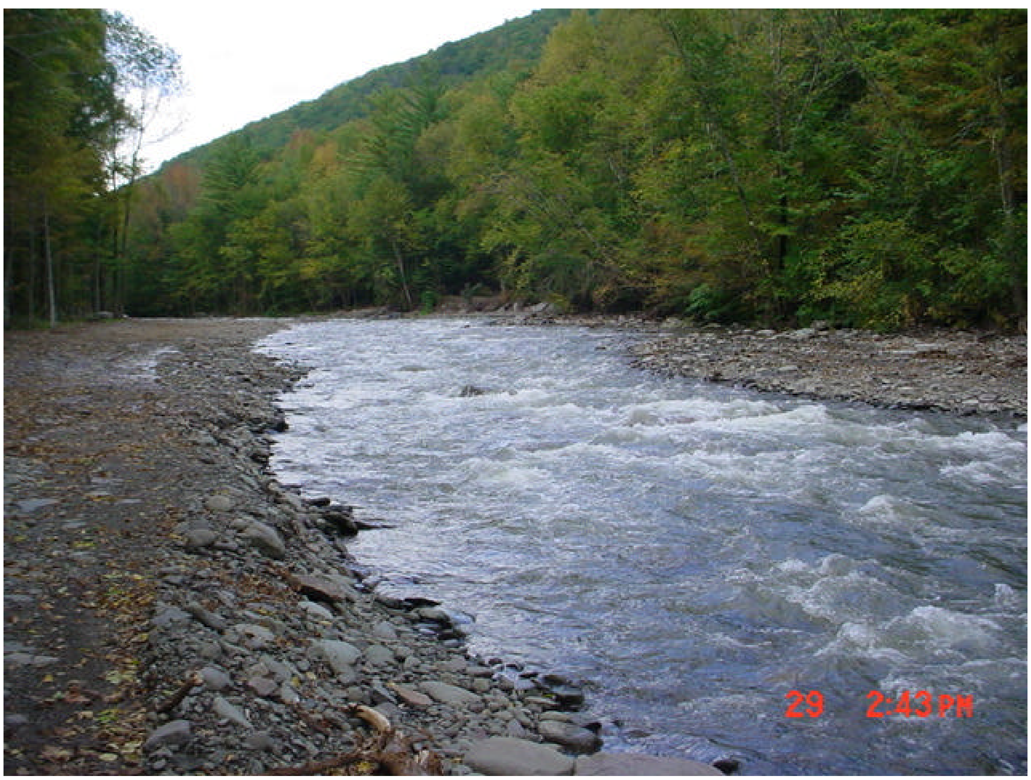

Figure 2: Project area looking upstream from near station 7+50. This section is complete.

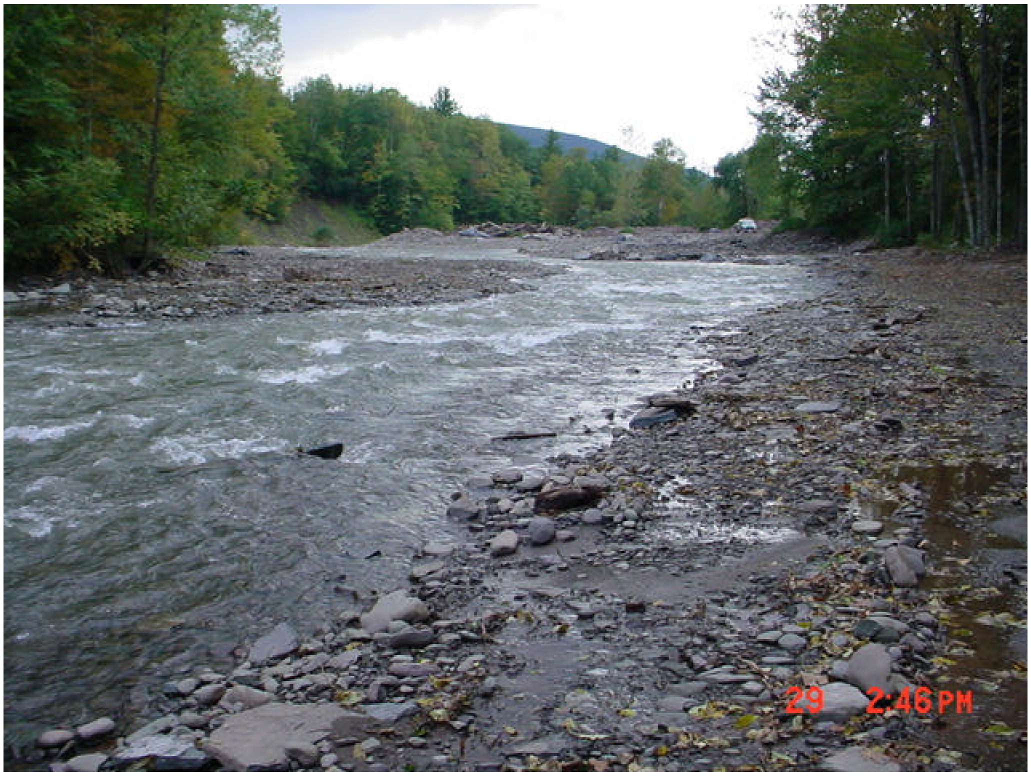

Figure 3: Looking downstream from near station 6+50. Completed section ends at the apex of the bend and flow continues into the incomplete portion of the project area.

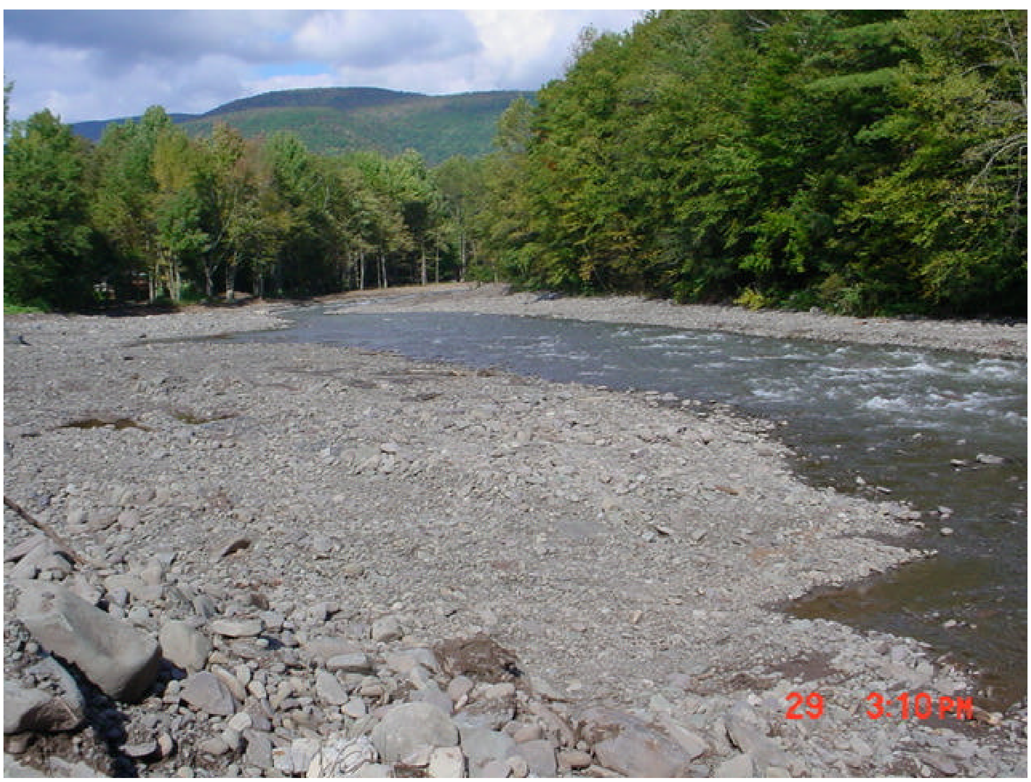

Figure 4: Looking upstream from near station 14+00. this section is incomplete, and scheduled for temporary seeding and mulching.

Figure 5: Problem bank near bottom of project area. This section has not been completed. Temporary flood conveyance has been provided on the opposite bank to relieve stress on the problem bank. This area will be treated with temporary seed and mulch.