

## Hydrologic Description of Mill Creek of the Opequon Inwood, West Virginia

### Mill Creek at the mouth of the Opequon

Drainage Area = 32.6 mi<sup>2</sup>

$$W_{\text{bkf}} = 64.3 \text{ ft}$$

$$D_{\text{bkf}} = 2.8 \text{ ft}$$

$$A_{\text{bkf}} = 180 \text{ ft}^2$$

$$Q_{\text{bkf}} = 900 \text{ cfs}$$

Mill Creek is primary a C4-stream flowing through a terraced alluvial valley-type (Rosgen, 1994). Karst bedrock geology intermixed with a dark grey shale in the headwaters are the main lithologic units. In several locations, Mill Creek has downcut to bedrock. Springs are abundant in the area. The stream has been hydraulically disconnected in several areas due to transportation routes and historic Mills in the area. These hydrologic alterations cause several sites of instability including: unnatural storage of the sand and gravel bedload, improper sediment and nutrient fluxes, discontinuity of ground water and stream water interactions in the hyperheos, and fish or other aquatic ecosystem blockages. Housing Development is slated for a large area near all sites described.

### Conley Site (upper and lower)

Drainage Area = 1.8 mi<sup>2</sup>

$$W_{\text{bkf}} = 18 \text{ ft}$$

$$D_{\text{bkf}} = 1.14 \text{ ft}$$

$$A_{\text{bkf}} = 20.5 \text{ ft}^2$$

$$Q_{\text{bkf}} = 59 \text{ cfs}$$

### **Upper Conley Instability**

It is of utmost importance that cattle need to be removed from the active stream channel and floodplain as soon as possible from this site. Cattle are the primary cause of instability for the reach. The upper site is a reference reach and should be protected as one of the most intact references reaches (geomorphic and ecologic) observed in over 8 years in the field (RC Gaujot, 2008). Bedrock and several 300 – 400 year old Sycamore trees line the channel and help stabilize the stream and ‘anchor’ the thalweg. The stream proceeds down valley and meets a limestone bedrock outcrop and high yield spring on the river right. This spring seep created a colluvium of material and a seeping wetland. The reach does lack a solid understory and native grass species.

### **Upper Conley Restoration**

This reach could be easily enhanced by fencing out the livestock. Native plantings of understory and grass species would work well with the sycamore overstory and springs.

### **Lower Conley Instability**

The stream makes a left turn, flows about 300 feet and downcuts about 2 feet, about 1 average bankfull depth. Below this headcut, the stream has incised into valley and has been trampled and grazed. Both banks are primarily unvegetated and actively eroding vertically and laterally. Full cattle access and lack of vegetation are the main cause of instability.

**Lower Conley Restoration**

The headcut is severe, and must be stabilized soon in order to inhibit the upstream migration of the headcut into the reference reach. Dimension, pattern, and profile also need to be reestablished along with a native riparian buffer. Wood structures should be used in the restoration. See Conley cost estimates.

Conley Design, Oversight, and Monitoring Estimate: \$25.92/foot

Task 1	On-Site Review	\$	-
Task 2	Stream Morphology, Reference, and Functional Assessment	\$	5,998.30
Task 3	Morphological Data Development	\$	6,050.00
Task 4	Natural Stream Design and Engineering Evaluation	\$	3,880.00
Task 5	Restoration Plan and Permitting	\$	8,398.00
Task 6	Drawings and Construction Cost Estimate	\$	1,520.00
Task 7	Construction Bidding Conferences	\$	1,557.00
Task 8	Design Stakeout	\$	3,225.65
Task 9	Construction Oversight	\$	5,114.00
Task 10	As-Built Survey	\$	2,781.65
Task 11	Training	\$	-
	Supplies	\$	349.00
	Total	\$	38,873.60

Conley Construction Cost Estimate: \$ 75.15/foot

Equipment	Rate per hour	Total Hours	Units	Estimated Costs
Mobilization/Demobilization				\$2,000.00
Small Track Excavator (JD 490)	\$80.00	0		\$0.00
Med Track Excavator (JD690)	\$95.00	200		\$19,000.00
Excavator-Komatsu 200	\$95.00	0		\$0.00
Med Track Dozer (Case 1150)	\$70.00	200		\$14,000.00
Tandem Truck	\$60.00			\$0.00
Dump Truck	\$65.00	0		\$0.00
Dump Truck-short distance haul	\$40.00	0		\$0.00
Excavation	2,000	\$3.50	yd3	\$7,000.00
Labor	\$20.00	200		\$4,000.00
Supervision				\$2,000.00
				\$48,000.00 <b>Contractor</b>

Materials	Quantity	Price per unit	Units	Estimated Costs
Fencing				\$10,000.00
Bridge				\$0.00
Bridge Installation			Included	
Abutment & Wingwalls				\$0.00
Trees with root bole	20		EACH	\$0.00 delivered
Boulders for Structures	1800	\$21.00	TONS	\$37,800.00
Sandstone-4-8" Riprap	0.0	\$12.75	TONS	\$0.00
Gravel	200.0	\$12.75	TONS	\$2,550.00
Geotextile	2,000.0	\$0.80	SY	\$1,600.00
Temporary Seeding	5.0	\$50.00	AC	\$250.00
Permanent Plantings	0.0	\$400.00	AC	\$0.00
Seed Mix				\$2,500.00
Live Stakes				\$4,000.00
Mulch (hay)	0.0	\$2.50	BALE	\$0.00
Mulch (straw)	500	\$4.50	BALE	\$2,250.00
-Mulch hauling fee	0.0		JOB	
Button Cap Nails	2	\$13.18	5LB	\$26.36
Silt Fence	3000	\$1.25	FOOT	\$3,750.00
				\$64,726.36 <b>Materials</b>

**TOTAL ESTIMATED COSTS=** \$112,726.36

Stream Length 1,500.0 feet  
\$ per foot \$75.15 per foot

**Webber Site**

Drainage Area = 3.9 mi<sup>2</sup>

W<sub>bkf</sub> = 25.2 ft

D<sub>bkf</sub> = 1.45 ft

A<sub>bkf</sub> = 36.5 ft<sup>2</sup>

Q<sub>bkf</sub> = 122 cfs

**Instability**

This site includes about 982 feet of stream, much of it flowing through limestone bedrock. A small tributary enters the reach above the Webber house. The stream has incised slightly and is laterally eroding a new floodplain. The floodplain and first terrace are overgrown with nonnative vegetation. BEHI and NBS measurements indicated about 88 tons per year of streambank erosion from the site. Nonnative vegetation is the primary geomorphic stabilizer.

**Restoration**

Priority II restoration should be performed minimizing changes in the dimension pattern and profile. A well vegetated bankfull bench would work well for several ‘high’ banks. Wood structures should be used in the restoration. See Webber cost estimates.

Webber Design, Oversight, and Monitoring Estimate: \$39.69/foot

Task 1	On-Site Review	\$	-
Task 2	Stream Morphology, Reference, and Functional Assessment	\$	5,998.30
Task 3	Morphological Data Development	\$	7,200.00
Task 4	Natural Stream Design and Engineering Evaluation	\$	4,730.00
Task 5	Restoration Plan and Permitting	\$	8,398.00
Task 6	Drawings and Construction Cost Estimate	\$	1,520.00
Task 7	Construction Bidding Conferences	\$	1,557.00
Task 8	Design Stakeout	\$	3,225.65
Task 9	Construction Oversight	\$	3,214.00
Task 10	As-Built Survey	\$	2,781.65
Task 11	Training	\$	-
	Supplies	\$	349.00
	Total	\$	38,973.60

Webber Construction Cost Estimate: \$ 85.74/foot

Equipment	Rate per hour	Total Hours	Units	Estimated Costs
Mobilization/Demobilization				\$2,000.00
Small Track Excavator (JD 490)	\$80.00	0		\$0.00
Med Track Excavator (JD690)	\$95.00	200		\$19,000.00
Excavator-Komatsu 200	\$95.00	0		\$0.00
Med Track Dozer (Case 1150)	\$70.00	200		\$14,000.00
Tandem Truck	\$60.00			\$0.00
Dump Truck	\$65.00	0		\$0.00
Dump Truck-short distance haul	\$40.00	0		\$0.00
Excavation	2,000	\$3.50	yd3	\$7,000.00
Labor	\$20.00	200		\$4,000.00
Supervision				\$2,000.00
				\$48,000.00 <b>Contractor</b>

Materials	Quantity	Price per unit	Units	Estimated Costs
Fencing				\$0.00
Bridge				\$0.00
Bridge Installation			Included	
Abutment & Wingwalls				\$0.00
Trees with root bole	20		EACH	\$0.00 delivered
Boulders for Structures	1200	\$21.00	TONS	\$25,200.00
Sandstone-4-8" Riprap	0.0	\$12.75	TONS	\$0.00
Gravel	100.0	\$12.75	TONS	\$1,275.00
Geotextile	2,500.0	\$0.80	SY	\$2,000.00
Temporary Seeding	5.0	\$50.00	AC	\$250.00
Permanent Plantings	0.0	\$400.00	AC	\$0.00
Seed Mix				\$2,500.00
Live Stakes				\$2,000.00
Mulch (hay)	0.0	\$2.50	BALE	\$0.00
Mulch (straw)	100	\$4.50	BALE	\$450.00
-Mulch hauling fee	0.0		JOB	
Button Cap Nails	2	\$13.18	5LB	\$26.36
Silt Fence	2000	\$1.25	FOOT	\$2,500.00
				\$36,201.36 <b>Materials</b>

**TOTAL ESTIMATED COSTS=** \$84,201.36

Stream Length 982.0 feet  
\$ per foot \$85.74 per foot