Pre-Construction Suspended Sediment Monitoring for Big Harris Creek Restoration Project - Cleveland County Prepared by Division of Water Resources, Watershed Assessment Team February, 2014

Introduction

The NC Ecosystem Enhancement Program (NCEEP) is planning to restore and enhance several stream reaches in the upper portion of Big Harris Creek. The project involves 7.5 miles of stream, 144 acres of conservation easement and 11 landowners. The watershed is approximately 4 mi^2 of rural landscapes. Land uses are approximately 45% agriculture related to livestock production of mostly cattle, turkeys and pasture/hay, 41% forest, and the balance in residential and institutional land uses. Streams in the watershed are classified as Water Supply IV (WS-IV) and are fully supporting their uses. Big Harris Creek drains to the First Broad River, which is currently supporting its uses.

Staff with the NC Division of Water Resources Watershed Assessment Team (NC DWR-WAT) and Western Carolina University conducted pre-construction, stormwater monitoring for suspended sediment during September 2012 through December 2013 at 15 locations within the watershed. Figure 1 and Table 1 provide descriptions of the monitoring locations located throughout the watershed.

Methods

Monitoring and Analysis

Samples were collected using two different sampling methods. At four locations, staff installed portable, automated ISCO® samplers outfitted with marine batteries and actuators that triggered sampling upon a pre-set stream elevation ranging between five to ten centimeters. Once enabled, the machine pumped and distributed storm water samples every 15 minutes into 24 one-liter bottles (up to 24 samples over a 6 hour period) until the stream elevation receded below the actuator. Samples were collected, labeled and sent to WCU for analyses.

Single-stage U59B passive samplers (IACWR, 1961) were set-up at 15 monitoring locations including the four locations where automatic samplers were configured. Three 500 mL bottles with copper siphon tubes were attached to a pole set in-stream along the stream bank at 0.5, 1.0 and 1.5 feet above baseflow water level. The intent was to collect samples for back-up (in case of equipment failure), to provide additional baseline data from multiple locations for comparisons and to test whether the sampling method provided data that were comparable to automated collected samples.

Laboratory analyses were conducted using the suspended sediment concentration (SSC) method rather than the total suspended solids (TSS) method as described by Gray and others (2000).

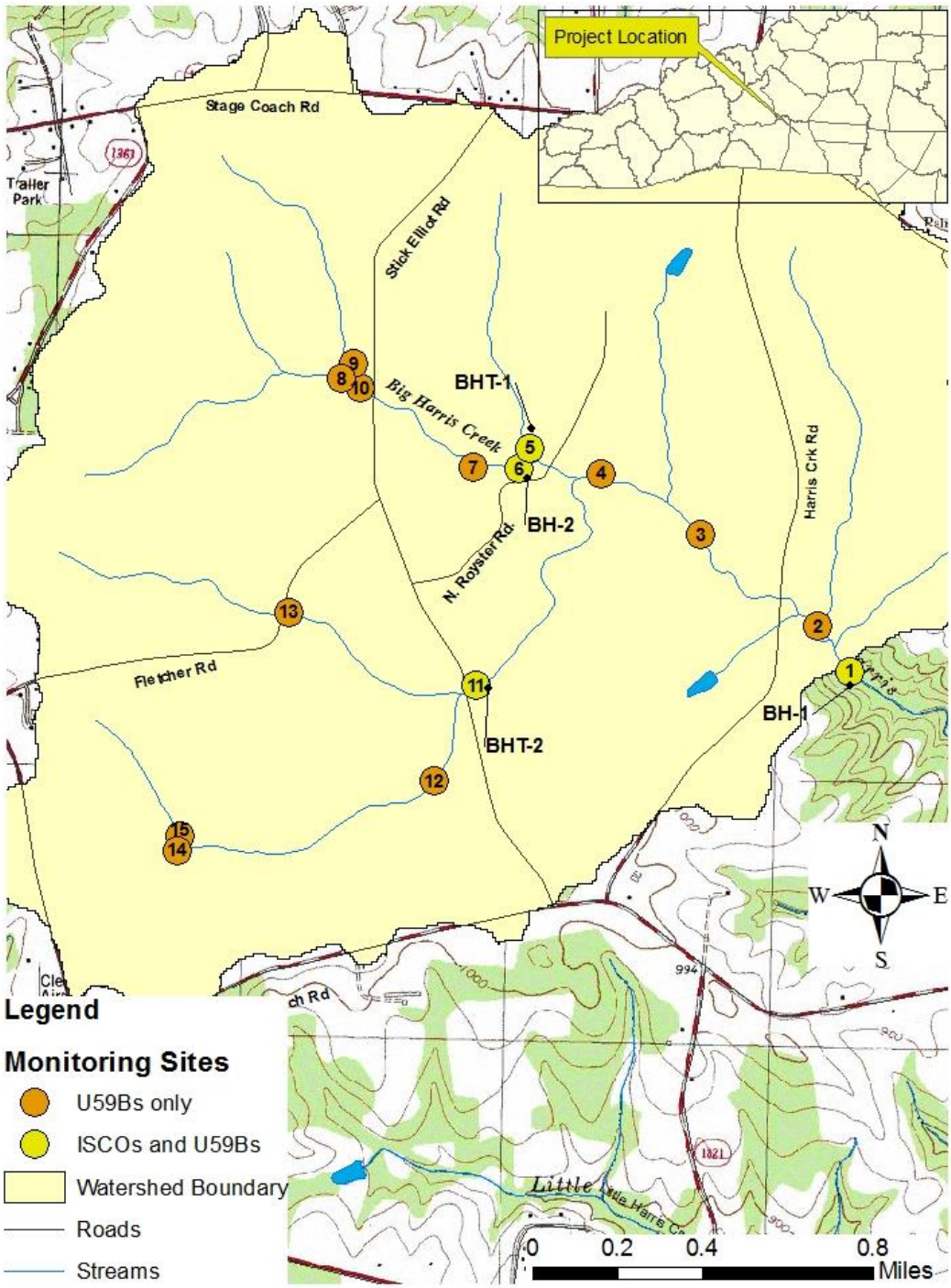

Figure 1. Suspended sediment concentration (SSC) monitoring locations, September 2012 through December 2013. BH and BHT codes are for ISCO locations.

Table 1. Pre-construction suspended sediment monitoring location discriptions in Big Harris Creek.

Site Number	Monitoring Reach and Descriptions	Latitude	Longitude	Drainage Area (sq. mi.)	U59Bs	ISCOs
1 (BH-1)	Big Harris Creek (Kernohan property)	35.4006	-81.5914	3.9	x	x
2	42 - Big Harris Creek along Kernohan property	35.4021	-81.5928	3.8	x	
3	14b - Big Harris Creek upstream of Harris Creek Rd	35.4051	-81.5978	3.4	x	
4	15b - UT to Big Harris Creek dowstream side of N. Royster Rd	35.4071	-81.6020	0.1	x	
5 (BHT-1)	UT to Big Harris off N. Royster Rd	35.4079	-81.6050	0.2	x	x
6 (BH-2)	Big Harris Creek off N. Royster Rd upstream of UT	35.4072	-81.6054	0.9	x	x
7	3c - UT to Big Harris Creek	35.4072	-81.6073	0.1	x	
8	25 - Big Harris Creek upstream side of Stick Elliot Rd	35.4098	-81.6121	0.4	x	
9	30d - UT to Big Harris Creek upstream side of Stick Elliot Rd	35.4106	-81.6124	0.2	x	
10	24b - UT to Big Harris Creek parallel to Stick Elliot Rd	35.4101	-81.6129	0.04	x	
11 (BHT-2)	UT to Big Harris-below culvert on Stick Elliott Rd	35.3998	-81.6070	1.3	x	x
12	32b - UT to Big Harris Creek near Stick Elliot Rd	35.3965	-81.6086	0.7	x	
13	31d - UT to Big Harris Creek at Fletcher Rd.	35.4021	-81.6148	0.4	x	
14	36c - UT to Big Harris Creek; near school	35.3939	-81.6192	0.2	x	
15	35b - UT to Big Harris Creek; near school	35.3944	-81.6191	0.1	x	

Notes: Reach numbers are based on Stantec Design, Fall 2011 provided by NCEEP. ISCO samples were time weighted. U59B samples were grab samples (see text for more discussion on sampling methods). BH and BHT codes are for ISCO locations.

Results and Discussion

As presented in Table 2, SSC in stormflow samples ranged from less than 10 to greater than 10,000 mg/L. Factors contributing to this variability may include differences in storm intensity, land use in the catchment, cattle access, stability of stream banks, and sampling method.

The U59B method generally resulted in higher SSC at each location compared to the ISCO method and was statistically different (data not shown). However, no statistical difference was found in mean SSC when comparing U59B to U59B at the four sites where both methods were utilized (Figure 2A). This was true for ISCO to ISCO comparisons as well (Figure 2B).

Table 2. Descriptive SSC statistics by sampling method (mg/L).

ISCO and U59B data									
Map No.	**N**	**Min.**	**10%**	**25%**	**Median**	**Mean**	**75%**	**90%**	**Max.**
1	13	245	335	551	736	1748	1767	6327	6451
BH-1 (ISCO)	264	5	17	116	284	537	763	1168	6300
2	13	308	380	630	1160	1303	1924	2784	2962
3	13	370	466	905	1509	1703	1987	3927	3936
4	10	576	579	863	2138	2002	2686	3838	3945
5	13	605	637	1000	1685	2833	3631	8678	9474
BHT-1 (ISCO)	85	42	64	115	264	829	859	2226	9832
6	11	180	251	760	1611	1497	1734	3178	3407
BH-2 (ISCO)	151	9	26	49	98	790	743	2055	9586
8	2	1200	1200	1200	1310	1310	1419	1419	1419
9	8	233	233	343	848	831	1287	1412	1412
10	5	463	463	535	1416	1596	2746	3384	3384
11	11	360	412	928	1328	2205	3484	6063	6277
BHT-2 (ISCO)	133	43	108	245	624	894	1045	2335	7452
12	9	405	405	1026	1886	2906	2625	12815	12815
13	3	775	775	775	2452	3734	7976	7976	7976
14	20	500	636	1472	2059	3663	4677	10739	13234
15	8	80	80	829	1636	1780	2793	3824	3824

Note: The shaded rows correspond to sites where both sampling methods occurred at the corresponding map no.

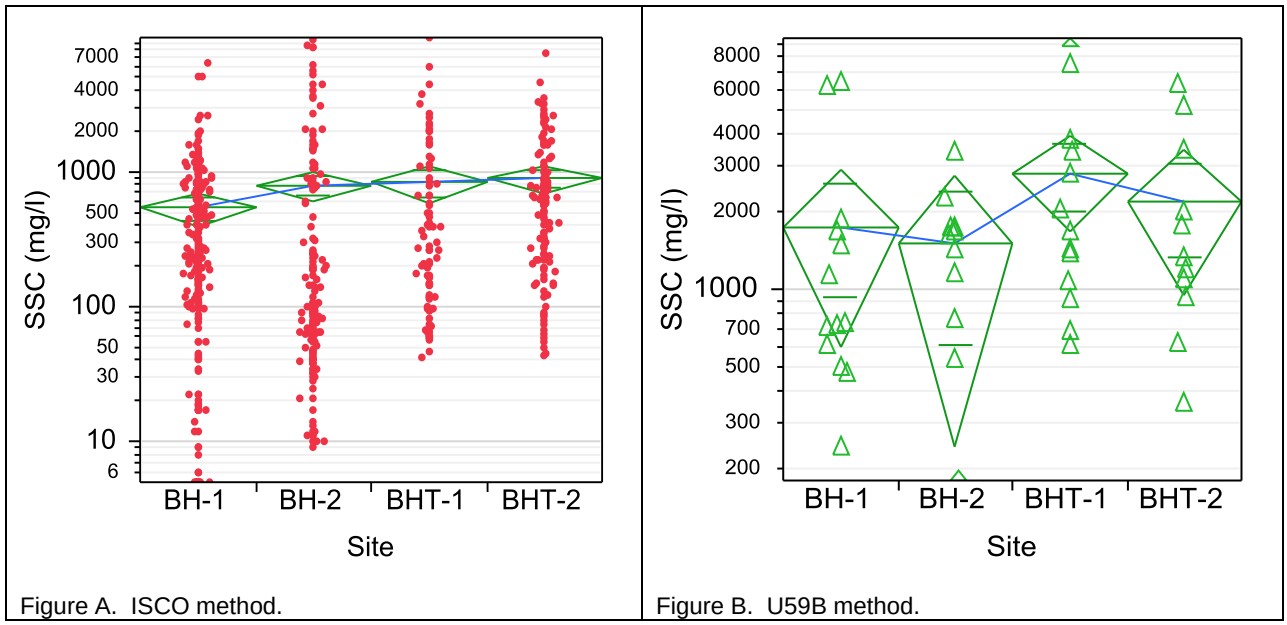

Figure A. ISCO method.

Figure B. U59B method.

Figure 2. The blue line connects the means. Means diamonds show no significant difference between sites where same method was utilized (95% confidence interval).

Among the locations sampled by U59Bs, #'s 5, 7, 13, 14, and 15 (Figure 3) had notably high SSC values. Location 14, on a UT downstream of the school, had consistently high SSC values.

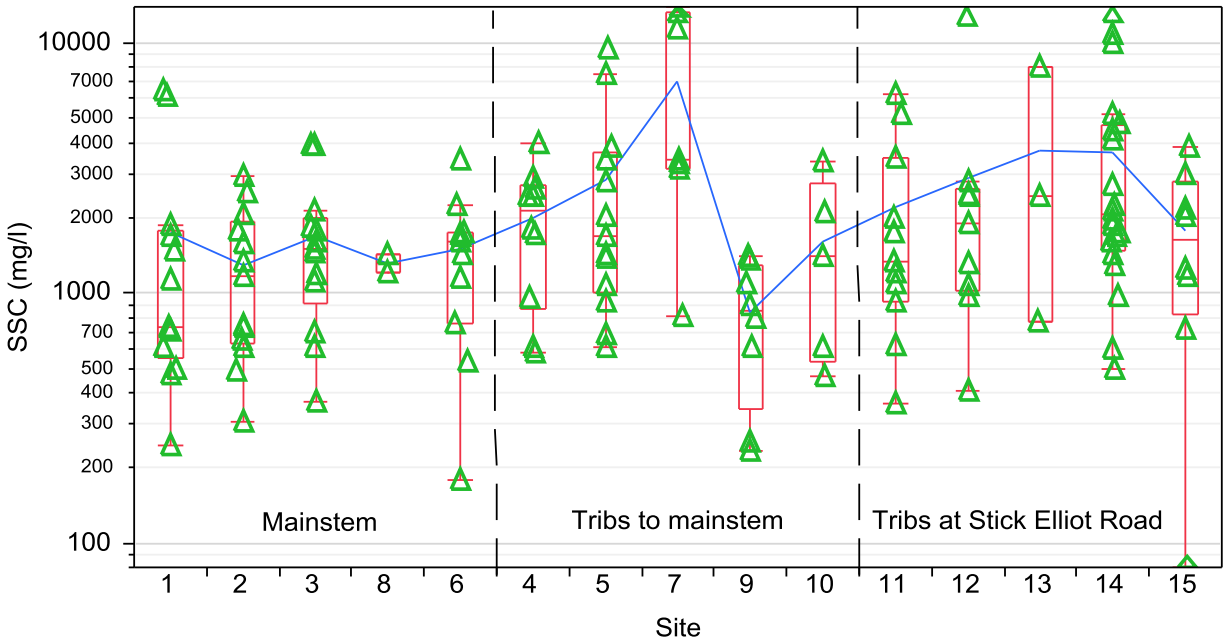

Figure 3. U59B SSC data. The blue line connects the means.

Within storm events, the ISCO method (which took up to 24 samples over a 6 hour period) often showed a pattern of rapidly rising SSC values within the first hour of the event, followed by a rapid decline during the next hour and a gradual decline to the end of the event (Figure 4). Contrast this with the U59B method which yielded much less detail about the SSC variability within any given storm event because it collected a maximum of three samples per storm event versus 24 and collected samples only during the rising limb of the hydrograph.

When data for individual storm events are examined, it is apparent that each storm event is unique in its intensity and duration. For example, ISCO data for September 18, 2012 at BH-1, indicated an event maximum of 260 mg/L, with most samples under 100 mg/L. While at the same location on June 7, 2013 there was an event maximum of 1901 mg/L, with most samples above 500 mg/L (Figure 4).

6	9/18/12 14:14	221
7	9/18/12 14:44	260
8	9/18/12 15:14	186
9	9/18/12 15:44	115
10	9/18/12 16:14	99
11	9/18/12 16:44	97
12	9/18/12 17:14	73
13	9/18/12 17:44	70
14	9/18/12 18:14	55
15	9/18/12 18:44	54
16	9/18/12 19:14	45
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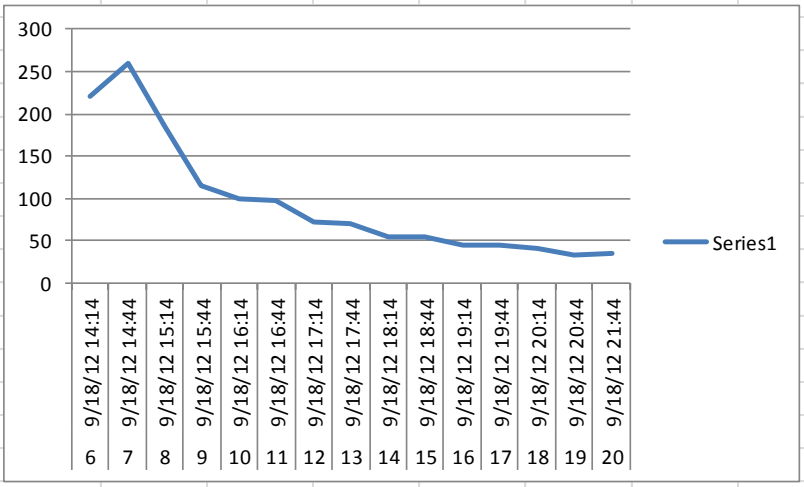
18	9/18/12 20:14	41
19	9/18/12 20:44	33
20	9/18/12 21:44	34



1	6/7/13 21:49	1888
2	6/7/13 22:04	1901
3	6/7/13 22:19	1048
4	6/7/13 22:34	878
5	6/7/13 22:49	879
6	6/7/13 23:04	614
7	6/7/13 23:19	461
8	6/7/13 23:34	384
9	6/7/13 23:49	308
10	6/8/13 0:04	267
11	6/8/13 0:19	251

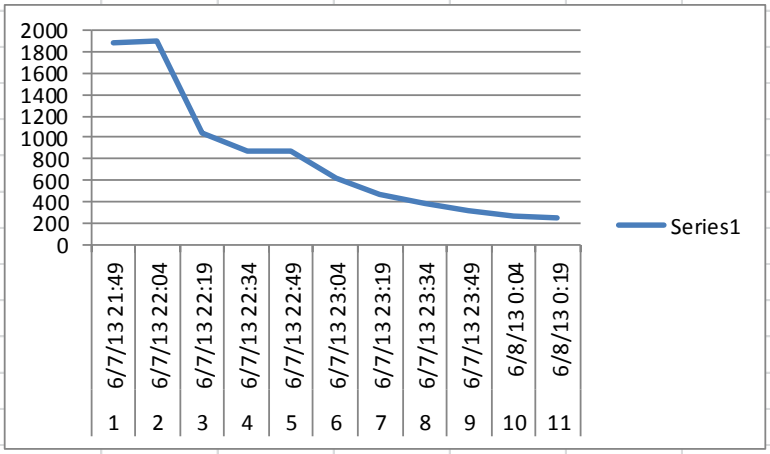


Figure 4. ISCO SSC data for two storm events at BH-1.

Summary and Conclusions

Stormwater sampling for suspended sediment was conducted by DWR-WAT in collaboration with staff from Western Carolina University during September 2012 through December 2013 at 15 locations with the Big Harris Creek watershed in Cleveland County as part of a planned stream restoration project managed by NCEEP.

Automated sampling equipment was deployed at four locations and single stage U59B passive samplers were deployed at 15 locations, four of which were paired with ISCO locations.

Western Carolina performed the laboratory analyses using a method developed by Gray and others (2000).

The data were variable ranging from 10 to greater than 10,000 mg/L. The U59B method collected three grab samples during the rising limb of the hydrograph at 0.5 foot intervals above base flow and tended to collect higher concentrations than ISCOs. ISCOs collected 24 time-weighted samples over a 6-hour period which included both the rising and falling limb of the hydrograph along with concomitant lower SSC concentrations. There was a statistical difference between sampling methods at paired locations. No statistical difference was evident between the four locations where the same method was utilized.

The U59Bs provided good data for remote locations but likely over estimate SSC. Post-construction results should only compare those data collected by similar methods (ISCO to ISCO and U59B to U59B).

References

Gray, R. J., G.D. Glysson, L.M. Turcios and G.E. Schwarz, 2000. USGS Water Resources Investigations Report 00-4191. *Comparability of suspended-sediment concentration and total suspended solids data.* Reston VA. August.

Inter-Agency Committee on Water Resources. 1961. The Single Stage Sampler for Suspended Sediment. Report No. 13. (Available from Federal Interagency Sedimentation Project, Waterways Experiment Station, Vicksburg, MS).