Post-Project Data Summary

“Middle Huron Sediment Reduction”

Tracking code: 2017-0019

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Contents

Introduction

This summary includes the results from monitoring since the beginning of the project titled "Middle Huron Sediment Reduction." Through its multi-year monitoring effort from 2019 to 2021, HRWC and partners measured a suite of water quality and flow parameters to assess water quality within the Glen. Pre and post construction monitoring data gauged the influence of best management practices (BMPs) in mitigating sediment and phosphorus loading and reducing stormwater runoff into the Huron River in Ann Arbor, Michigan.

Methods

The Huron River Watershed Council (HRWC) began conducting monitoring at School Girls Glen (the Glen) in April 2019 prior to the construction of BMPs. HRWC conducted sampling at two locations in the Glen during the pre-construction monitoring period: SGG01, at the top of the Glen near the University of Michigan's Reader Center, and SGG02, near the outlet to the Huron River just upstream of the Nichols Drive road crossing (see Figure 1). Twice monthly routine monitoring was conducted from April through September 2019 at the two sites assuming the presence of flowing water. During pre-construction monitoring visits, HRWC staff or volunteers measured in-stream chemistry using a YSI Multiparameter Instrument. Measurements were taken for temperature, dissolved oxygen, conductivity, total dissolved solids, and pH (see Tables 1 and 2). Grab samples were also collected and processed by the City of Ann Arbor Drinking Water Treatment Plant Lab for a suite of additional parameters, including total phosphorus, total suspended solids, *Escherichia coli*, sulfate, nitrate, nitrite, and chloride (see Tables 1 and 2).

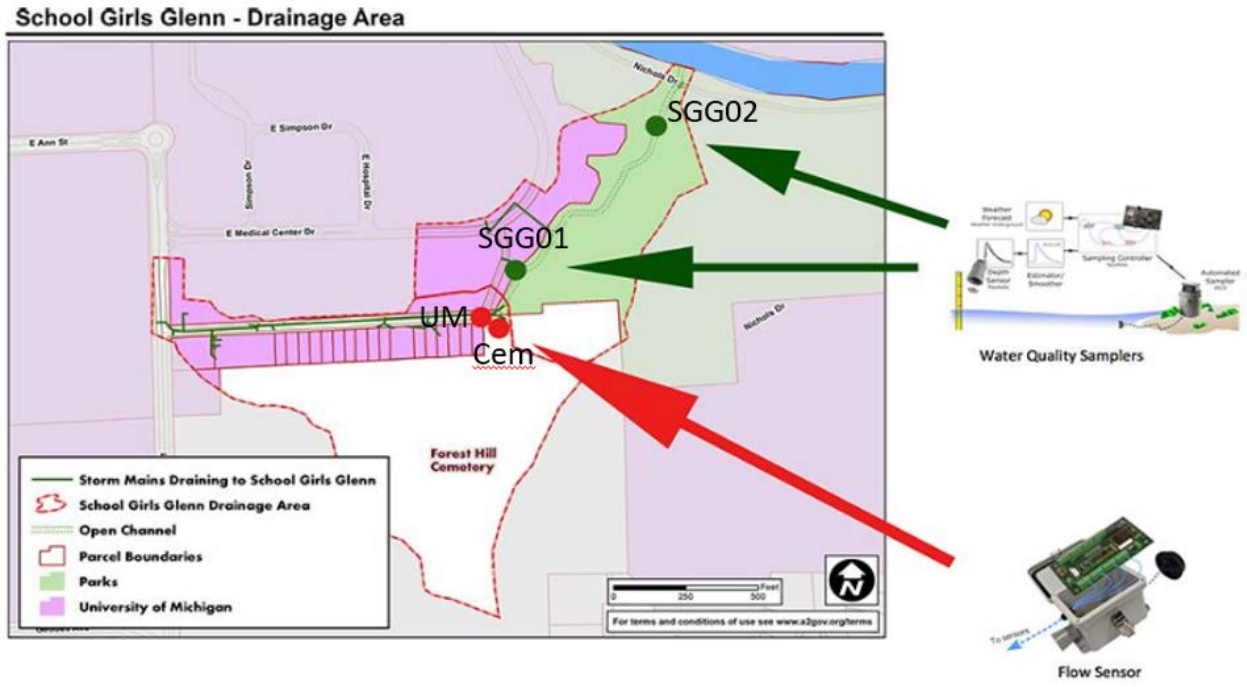

Figure 1. School Girls Glen monitoring sites during the sampling period. Sampling site ID number is shown.

In addition to routine monitoring at the two sites along the Glen, HRWC also performed targeted wet-weather monitoring during storm conditions, specifically events of 0.25 inches or greater within a 12-hour period or 0.5 inches within a 24-hour period. Using an automated ISCO sampler, HRWC collected samples throughout storm conditions to measure for changing total phosphorus and total suspended solids. Following challenges with the ISCO sampler, HRWC also conducted in-field flow monitoring and collected grab samples during storm events. HRWC conducted storm monitoring in July 2019, September 2019, May 2020, and in August 2021. In October 2019 and August 2021, HRWC sampled two storm outfalls above SGG01, labeled as UM and Cem on Figure 1. Those outfalls collect runoff from the Forest Hill Cemetery (Cem) and other University properties (UM). One additional outfall draining a smaller amount of university property was not sampled.

Finally, the team endeavored to measure storm event flow rates. In collaboration with partners from the University of Michigan Real Time Water Systems Lab, HRWC deployed two water level sensor nodes in the Glen—one at SGG01 and one at SGG02. These were used to measure real time stream flows. Subsequently, a small team was able to directly measure some flows from the two storm outfalls during the first cell of a 1.24", 24-hour storm. Flows were measured using a mix of direct area-velocity measurement and collecting a known volume over a measured period of time to calculate velocity since water levels were not sufficiently high enough to utilize a velocity meter.

Results and Discussion

Chemistry

Monitoring data reveals issues with sediment stabilization throughout the Glen both prior to and following the installation of BMPs. Pre-construction data validated preexisting conclusions of severe soil erosion and high stormwater runoff volumes within the Glen, predominantly during storm and high precipitation events.

Routine data collected during low flow, clear weather, and post-storm conditions from April through September 2019 indicates low sedimentation in the Glen, with low total suspended solids (TSS) concentrations at both SGG01 and SGG02. All routine samples except one were below the state municipal stormwater requirement for TSS of 80 mg/l, which is also used as a goal in TSS Total Maximum Daily Load (TMDL) evaluations in the watershed. In contrast, wet weather monitoring data shows high sedimentation in the Glen. During a storm of 1.31 inches in July 2019, TSS concentrations exceeded the 80 mg/l thresholds, with a maximum of 4100 mg/l and a median of 88.5 mg/l across eight samples. Even during a smaller storm of 0.38 inches in September 2019, TSS concentrations reached 460 mg/l with a median of 220 mg/l and a mean of 241 mg/l. On average, TSS concentrations were 4 times higher at the lower SGG02 station, though that was mostly due to a single extreme measure. A 0.20 inch storm in October 2019 generated enough flow to allow sampling of the two stormwater outfalls. TSS concentrations were 75 mg/l from the cemetery and 36 mg/ from the university outfall, which were both below the TSS guideline.

Following the installation of BMPs, TSS concentrations continued to exceed the state guideline during storm and high precipitation events. During post-construction monitoring conducted during a 0.67-inch

storm on August 29, 2021, samples collected from the cemetery outfall were up to 13 times higher than the university outflow. Samples from cemetery outflow reached up to 224 mg/l, indicating continued sediment loading from the cemetery into the Glen. Post-construction storm monitoring during the August 29th storm event also produced high TSS samples from SGG02, with concentrations reaching 263 mg/l. These high concentrations from the most downstream monitoring site in the Glen reveal continued sedimentation throughout the Glen and loading into the Huron River.

Total phosphorus (TP) concentrations from routine and wet weather monitoring during the pre-construction monitoring phase were consistently high. All samples collected during routine and wet weather monitoring had TP concentrations above the TMDL target for Ford and Belleville Lakes of 0.03 mg/l. Routine monitoring produced an average TP concentration in the Glen of 0.07 mg/l and a median of 0.06 mg/l. TP concentrations during wet weather monitoring was on average 714 percent higher than during routine monitoring, with a mean concentration of 0.57 mg/l and a median concentration of 0.34 mg/l. There was only a small difference in TP concentrations between SGG01 and SGG02 overall. The small October 2019 storm generated TP concentrations of 0.80 mg/l from the cemetery and 0.12 mg/l from the university outfall. It appears that a larger load of phosphorus is coming from cemetery runoff, however, this is based on very limited data.

Post-construction monitoring data shows continued high TP concentrations in the Glen with no statistically significant difference in concentrations compared to pre-construction monitoring. Samples collected at SGG01, SGG02, and the two outflows still regularly exceed the TMDL target in wet weather conditions, with all samples in exceedance of the 0.03 mg/l target and a maximum value of 0.93 mg/l from the cemetery outflow.

Other chemical (and biological) concentrations were also noteworthy. Bacteria (E. coli) levels were high with mean MPN counts of 1,037 per 100 ml at SGG01 and 501 per 100 ml at SGG02, both above the state single sample standard of 300 per 100 ml[1]. Conductivity levels averaged 1,670 µS, exceeding an 800 µS comparative value and 501 µS respectively. This suggests that the source of high conductivity is likely above the top of the Glen. Conductivities in outfall flow during the small October 2019 storm were both very low at 130 and 240 µS, suggesting the source may not be due to runoff. Nitrate and chloride levels are also high at SGG01, but lower at SGG02. Dissolved oxygen was always measured above the 5.0 mg/l state standard for the warm water designated use, though several measures during low flow conditions were close to the standard.

[1] It should be noted that the state standard is based on triplicate sampling from different portions of the same site location. Sampling for this project consisted of a single sample from the center or deepest part of the creek.

*Table 1. Routine data collected from SGG01 during the 2019 monitoring season.**

	Cl	E. coli	NO3	NO2	SO4	TP	TSS	Cond	DO	pH	Temp	TDS
4/8/2019	800	16	1.2	0.033	60	0.06	12	1754	8.35		12.0	1508
4/24/2019	660	23	1.6	0.012	50	0.06	10	2272	9.18	7.69	10.9	2022
5/8/2019	1000	109	3.5	0.007	95	0.06	10	3051	7.45	7.66	12.5	2600
5/22/2019	240	411	1.1	0.015	27	0.06	8	1119	9.60	7.67	12.8	956
6/2/2019		2400	1.4	0.009		0.09	30	1410	9.55	7.79	15.6	1118
6/17/2019	413	3200	2.0	0.009	48	0.05	10	1826	9.46	7.86	15.9	1437
7/8/2019	819	399	2.6	0.007	220	0.08	2	2134	6.85	8.14	20.1	1534
7/24/2019	232	260	0.6	0.004	28	0.05	2	1427	5.40	7.89	19.9	1027
8/6/2019	261	2420	1.6	0.012	56	0.08	2	1446	6.15	7.68	21.3	1008
8/20/2019	282	210	1.2	0.005	61	0.15	28	1610	5.94	7.57	21.2	1131
9/4/2019	144	2420	0.8	0.003	40	0.08	2	1311	5.11	7.88	19.1	962
9/14/2019	236	576	0.5	0.002	48	0.07	2	678	6.67	7.77	21.0	481
Mean	462	1037	1.5	0.010	67	0.07	10	1670	7.48	7.78	16.9	1315
Minimum	144	16	0.5	0.002	27	0.05	2	678	5.11	7.57	10.9	481
Maximum	1000	3200	3.5	0.033	220	0.15	30	3051	9.60	8.14	21.3	2600
Median	282	405	1.3	0.008	50	0.06	9	1528	7.15	7.77	17.5	1125

**All results in mg/l except E. coli (MPN/100 ml), Cond(µS), pH(no units), Temp (°C). E. coli results were from single grab samples.*

*Table 2. Routine data collected from SGG02 during the 2019 monitoring season.**

	Cl	E. coli	NO3	NO2	SO4 2-	TP	TSS	Cond	DO	pH	Temp	TDS
4/24/2019	340	2	0.2	0.001	25	0.04	13	1309	7.45	7.72	12.4	1118
5/8/2019	140	17	0.2	0.001	21	0.03	2	798	5.02	7.44	10.7	715
5/22/2019	96	866	0.3	0.006	15	0.05	9	522	8.82	7.93	12.3	449
6/2/2019		1120	0.2	0.001		0.13	140	870	9.88	7.71	16.2	676
Mean	192	501	0.23	0.002	20	0.06	41	1234	7.46	7.76	15.46	995
Minimum	96	2	0.2	0.001	15	0.03	2	522	5.02	7.44	10.7	449
Maximum	340	1120	0.3	0.006	25	0.13	140	3051	9.88	8.14	21.3	2600
Median	140	442	0.2	0.001	21	0.04	11	870	7.45	7.77	16.2	715

**All results in mg/l except E. coli (MPN/100 ml), Cond(µS), pH(no units), Temp (°C). E. coli results were from single grab samples.*

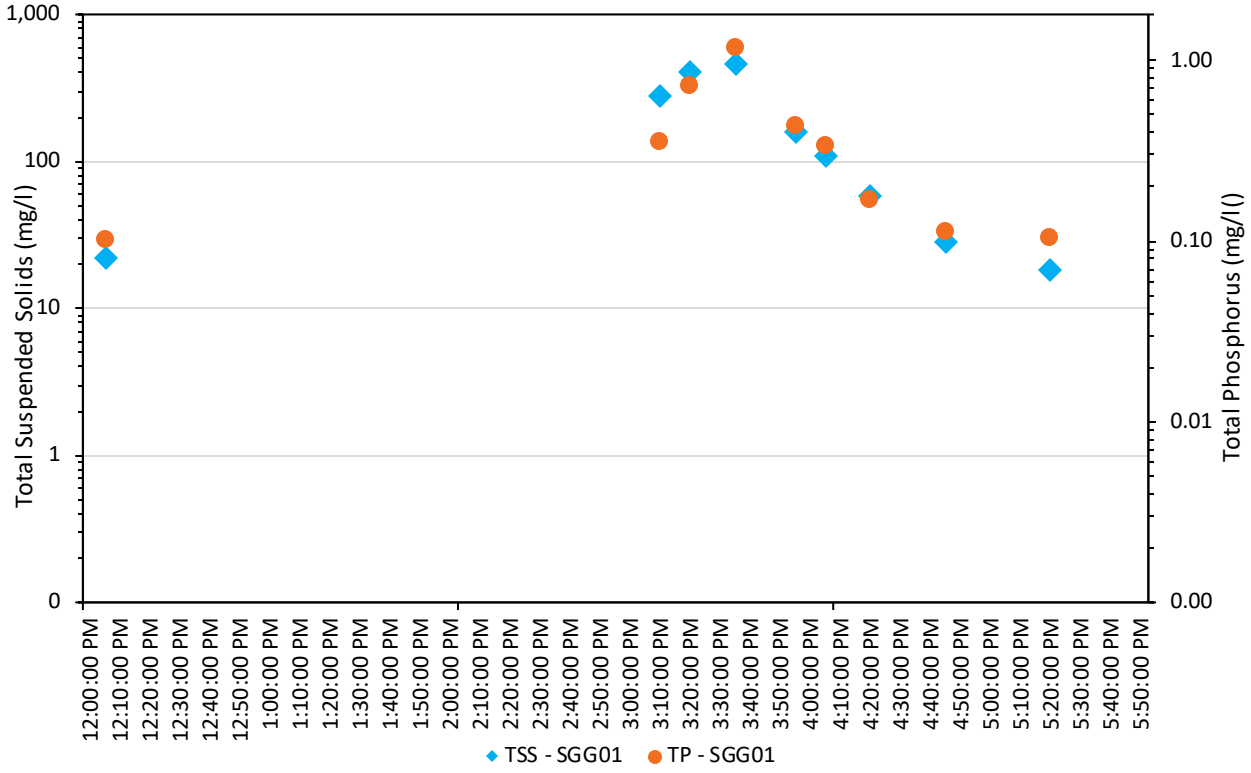

Figure 2. Total suspended solids and total phosphorus concentrations of a 0.38-inch storm monitored on September 13, 2019.

Table 3. Storm data collected from School Girls Glen during a 0.67-inch rain event on August 29, 2021.

Site	Collection Time	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Discharge (Est. in cfs)
Cemetery Outflow	20:00	0.93	224	2.2
University Outflow	20:05	0.11	17	2.0
SGG01	20:07	0.33	82	4.2
SGG02	20:15	0.47	263	2.9
Cemetery Outflow	20:40	0.52	80	0.15
University Outflow	20:43	0.12	13	0.24
SGG01	20:45	0.15	21	0.39
SGG02	20:50	0.32	125	0.39

Flow

Due to the ephemerality of stream flow through the Glen, inconsistent stream substrate, and the transport of sediments and heavy material during storm events, water level data collected by the nodes was largely unusable. Collected data was noisy, making it difficult to decipher a true water level or even

a reasonable range of levels. In attempt to characterize storm flows, HRWC directly measured flow during a single event prior to installation of best management practices.

HRWC employed several alternative techniques in an attempt to accurately measure flow rates in the Glen. A known volume-fill time "bucket" method was employed but was only feasible at the University of Michigan storm sewer outlet. A stream location with a natural weir was discovered just a few feet down from the cemetery outlet where more accurate velocities could be measured. A flow measure downstream of both outflows was possible, and the total flow there was compared to combined values from the two outfalls. The methods produced reasonably similar flow rates. Crude rating curves were developed and frequent levels were measured throughout the event. Event precipitation was interpolated from two City of Ann Arbor stations and one Weather Underground station, resulting in a measurement of 1.23 inches over a 24-hour period, consisting of two distinct rain falls.

The flow data was used to generate precipitation rate to discharge estimations (using best-fit linear regression) that could be used to model storm events. Below are the resulting rainfall rate-discharge equations. All discharge and precipitation data are included in an Excel spreadsheet file that accompanies this report.

Cemetery: *Discharge (cfs) = 3.54 * (lag 15-30 min rate (in)) + 0.039 (R^2=0.91)*,
where the precipitation value is a 30-minute total summed 15 minutes prior to the discharge measure.

University outfall: *Discharge (cfs) = 3.06 * (30 min rate (in)) + 0.15 (R^2=0.62),*
Where the precipitation value is a 30-minute total summed up to the time of the discharge measure.

Mean flows during the storm event were 0.17 cfs from the cemetery and 0.24 cfs from the university outfall.

Conclusion

According to monitoring data, best management practices installed within the Forest Hill Cemetery, including slope stabilization, bioswales, rain gardens and a sediment separator have not yet produced promising results in mitigating sedimentation throughout School Girls Glen. It is important to note that, at the time of "post-construction" sampling, the paving had yet to be completed in the cemetery. Due to this, storm flow was allowed to bypass several of the BMPs. Further, plants had not yet established on exposed soils along BMP borders and within the drop pool section. There was evidence of soil erosion under existing asphalt that additionally covered the water quality separator, blocking its effectiveness. Therefore, this monitoring should be considered preliminary at best. Monitoring data indicates continued issues with sediment loading, high total phosphorus concentrations, and flashy flows in the Glen, suggesting continued efforts may be necessary to slow stormwater runoff, sedimentation, and phosphorus loading. It is recommended that continued post-construction monitoring take place after the best management practices have been in place for a reasonable amount of time (e.g. two or three years) to evaluate their effectiveness.