Appendix B

Filtration Efficency Evaluation

APPENDIX B

Purpose

Per the Project Sampling and Analysis Plan (SAP) (King County 2013), water samples were collected representing pre- and post-filtration conditions for the filter solids sampling units. These samples were collected to better understand the relative filtration efficiency of the filtered solids units and to compare grain size distribution in the water passing through the filtered solids sampler and the solids retained on the filter. This effort was intended to provide ancillary information for a qualitative data evaluation.

Field Sampling Methods

At each site, one sampling event was targeted to assess filtration efficiency. Grab water samples were collected for two conditions: 1) prior to water passing through filtration units (influent); and 2) after water had passed through the filtration units (effluent). The samples were collected in high density polyethylene jars and placed in a cooler for transport to the King County Environmental Laboratory (KCEL). Upon receipt at KCEL, the samples were logged, separated into appropriate containers for total suspended solids (TSS) and particle size distribution (PSD) analyses, and stored per the project SAP until analysis. In most cases, grab sample pairs were collected within the first one to two hours of the filtered solids sample collection period and again at the end of the collection period. A sample was collected at each location during a storm event and at two locations during baseflow events (Table B-1).

Table B-1. Water sample collection information: dates, locators, and IDs.

Location (Locator)	Event Type	Collect Date	Sample Timing	Sample Type[1]	Sample ID
Green River – Flaming Geyser (FG319)	Storm	3/5/2014	Beginning of Event	Influent Effluent 1 Effluent 2	L59802-1 L59802-2 L59802-3
		3/6/2014	End of Event	Influent Effluent 1 Effluent 2	L59804-1 L59804-2 L59804-3
Newaukum Creek (0322)	Baseflow	10/22/2013	Beginning of Event	Influent Effluent 1 Effluent 2	L59037-1 L59037-2 L59037-3
		10/23/2013	End of Event	Influent Effluent 1 Effluent 2	L59039-1 L59039-2 L59039-3
	Storm	11/7/2013	Beginning of Event	Influent Effluent 1 Effluent 2	L59167-3 L59167-1 L59167-2
		11/8/2013	End of Event	Influent Effluent 1 Effluent 2	L59169-3 L59169-1 L59169-2

Location (Locator)	Event Type	Collect Date	Sample Timing	Sample Type[1]	Sample ID
Soos Creek (A320)	Baseflow	10/16/2013	Beginning of Event	Influent Effluent 1 Effluent 2	L58994-1 L58994-2 L58994-3
		10/17/2013	End of Event	Influent Effluent 1 Effluent 2	L58997-1 L58997-2 L58997-3
	Storm	11/7/2013	Beginning of Event	Influent Effluent 1 Effluent 2	L59168-3 L59168-1 L59168-2
		11/8/2013	End of Event	Influent Effluent 1 Effluent 2	L59170-3 L59170-1 L59170-2
Mill Creek (A315)	Storm	2/12/2014	Beginning of Event	Influent Effluent 1 Effluent 2	L59669-1 L59669-2 L59669-3
		2/12/2014	End of Event	Influent Effluent 1 Effluent 2	L59670-1 L59670-2 L59670-3
Springbrook Creek (P317)	Storm	4/17/2014	End of Event	Influent Effluent 1 Effluent 2	L60108-1 L60108-2 L60108-3
Green River – Foster Links (FL319)	Storm	3/5/2014	Beginning of Event	Influent Effluent 1 Effluent 2	L59793-1 L59793-2 L59793-3

[1] Two effluent samples are listed because filtered solids sampling equipment had two filter housing units for which water passed through independently.

Collecting TSS and PSD measurements at both the start and end of the sample collection period was important, because as solids collect on the 5 micron (µm) pore size filter, finer material is more likely retained, influencing the PSD of the sample and efficiency of the filtration unit. However, in most cases, the filters were so full of solids by the end of the sampling event and battery power was often low such that little to no water was reaching the filtration unit outlet. By replacing the partially-spent battery with a fully-charged battery, a slow trickle of water could be collected for the effluent sample. Unfortunately, changing the battery appeared to resuspend particles that had previously settled on the filter or in the hoses. This means the TSS and PSD results in these effluent samples are not likely to be representative of the effluent during most of the sampling event. Therefore, the data evaluation presented below does not include effluent results for the end of sampling events.

Laboratory Methods

The Standard Method 2540-D was followed for TSS analysis (APHA 1998). The TSS analysis uses a 0.45 µm glass fiber filter to trap suspended solids and results are reported in mg/L. PSD was analyzed using a combination of a sediment concentration method (PSD-SC; ASTM D422/D3977-97) followed by a laser diffraction method (PSD-LD; ISO 13320:2009[E]). The PSD-SC method separates solids into <250µm, 250-500µm, and >500µm. Then, 100mL of the sample that had passed through the 250µm sieve is analyzed using the PSD-LD method to determine the distribution between sand <500µm[1], silt, and clay. Particles >500µm were infrequently detected in the influent or effluent water, and made up less than 5% of the filtered solids samples collected during these targeted events. To simplify the results, the PSD presented below includes only the particle sizes <500µm. The PSD-SC reports results in mg/L and the PSD-LD results are reported as percent volume.

Results and Discussion

Figure B-1 presents influent and effluent TSS concentrations for samples collected at the beginning of each targeted sampling event. Each event utilized two filtration units; therefore, effluent concentrations are presented as the average between the two units with error bars depicting the minimum and maximum. The data labels in the figures display the percent decrease in TSS concentrations. These samples demonstrate the filtration units captured between 41% and 67% of solids on average at the beginning of sampling events (Figure B-1). The filter used in the filtered solids unit has a 5 µm pore size. This means not all the suspended solids measured by TSS, which uses 0.45 µm pore size filter, are expected to be captured by the unit. As the sampling period progresses, however, material that would normally pass through the filter (<5 µm), may be caught (retained on the filter) as trapped solids begin to build up on the filter. Therefore, the PSD distribution of the sample would influence the trapping efficiency of the filter. Because of the limitations in using the end of the sampling events (discussed in Field Sampling Methods), this analysis cannot sufficiently assess the filter efficiency during the entire sampling period.

[1] This size class includes all particles less than 500µm, because some particles are irregularly shaped and can pass through the 250µm sieve even though they are technically in the 500µm size class.

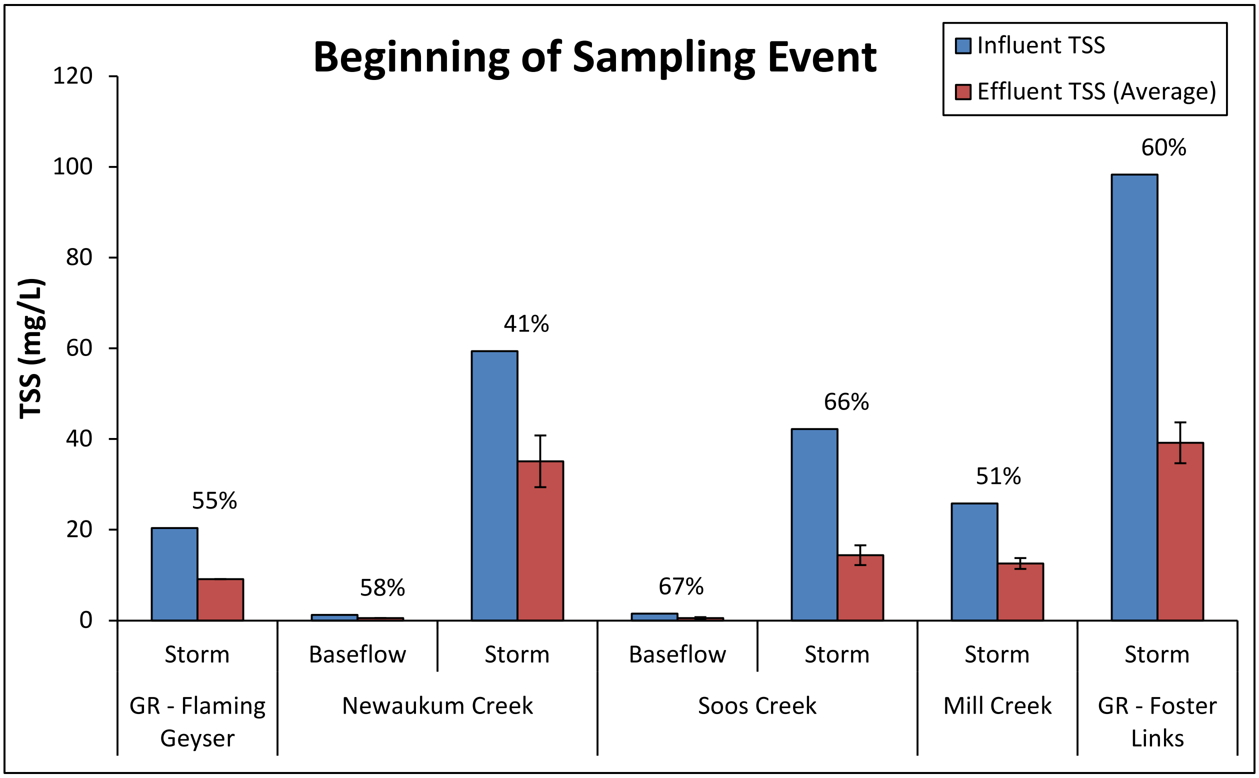

Figure B-1. TSS Results for Water Samples Collected at the Beginning of Select Filter Solids Sampling Periods

Figures B-2 through B-5 present a comparison of the PSD (<500µm) results for influent water samples collected at the beginning and end of the sampling event to the PSD (<500µm) results for the corresponding filtered solids sample. Generally, the filtered solids samples had a larger percentage of sand <500µm compared to the influent water samples. There are several factors that could potentially influence this observation. One is the grab sample water results are not necessarily representative of PSD over the entire filtered solids sampling period. Additionally, only a relatively small aliquot of the water sample (100 mL) is used for the PSD-LD analysis. Larger particles are likely not evenly mixed throughout the sample, and a single aliquot might not be representative. Furthermore, the solids retained on the filter could not be completely scraped into the sample, leaving behind a small amount of mass. Because smaller particles are harder to remove from the filters, the resulting PSD of the solids sample could have been affected. Finally, it is possible that the filtration units more effectively retained larger particles during the sampling period. Without reliable effluent PSD data and additional water samples during the filtered solids sampling period, it is hard to know which of these possibilities best explain the observed bias between the methods. No further assessment is possible with the available data.

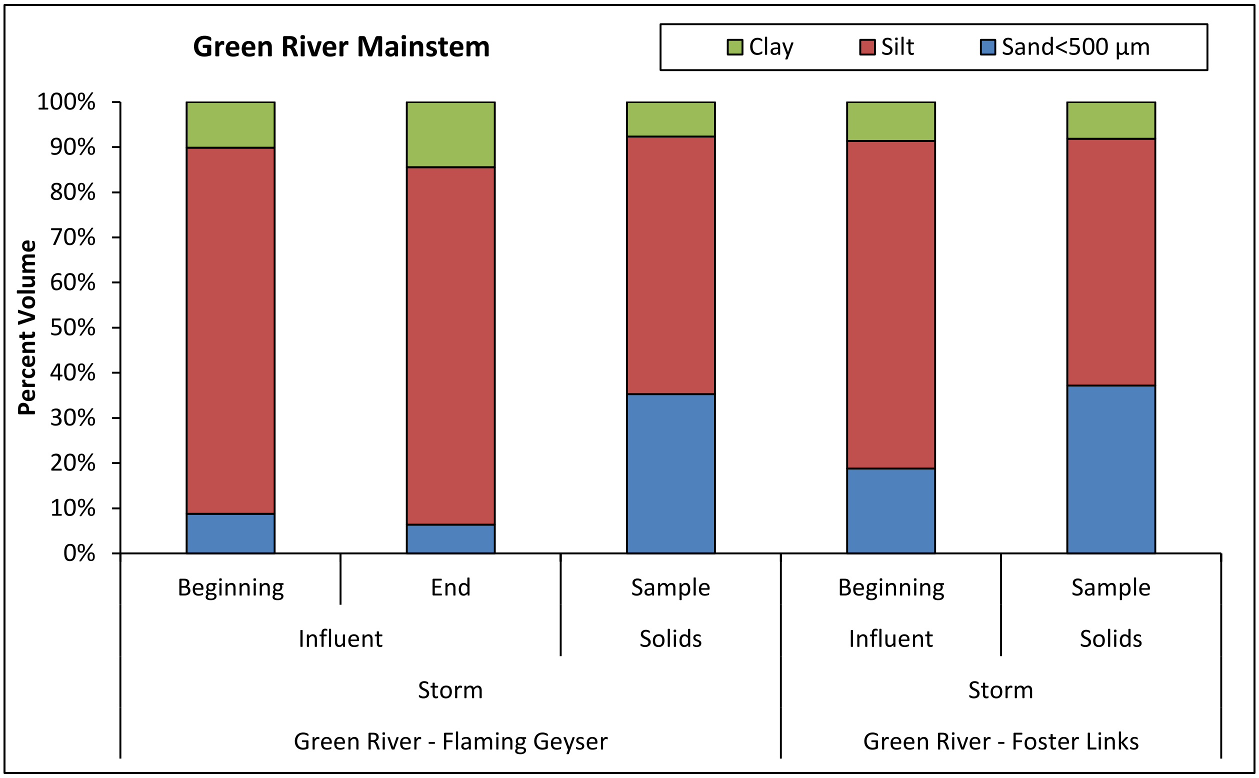

Figure B-2. PSD results for particles <500µm in influent water and corresponding filtered solids samples from the Green River mainstem locations (Flaming Geyser and Foster Links).

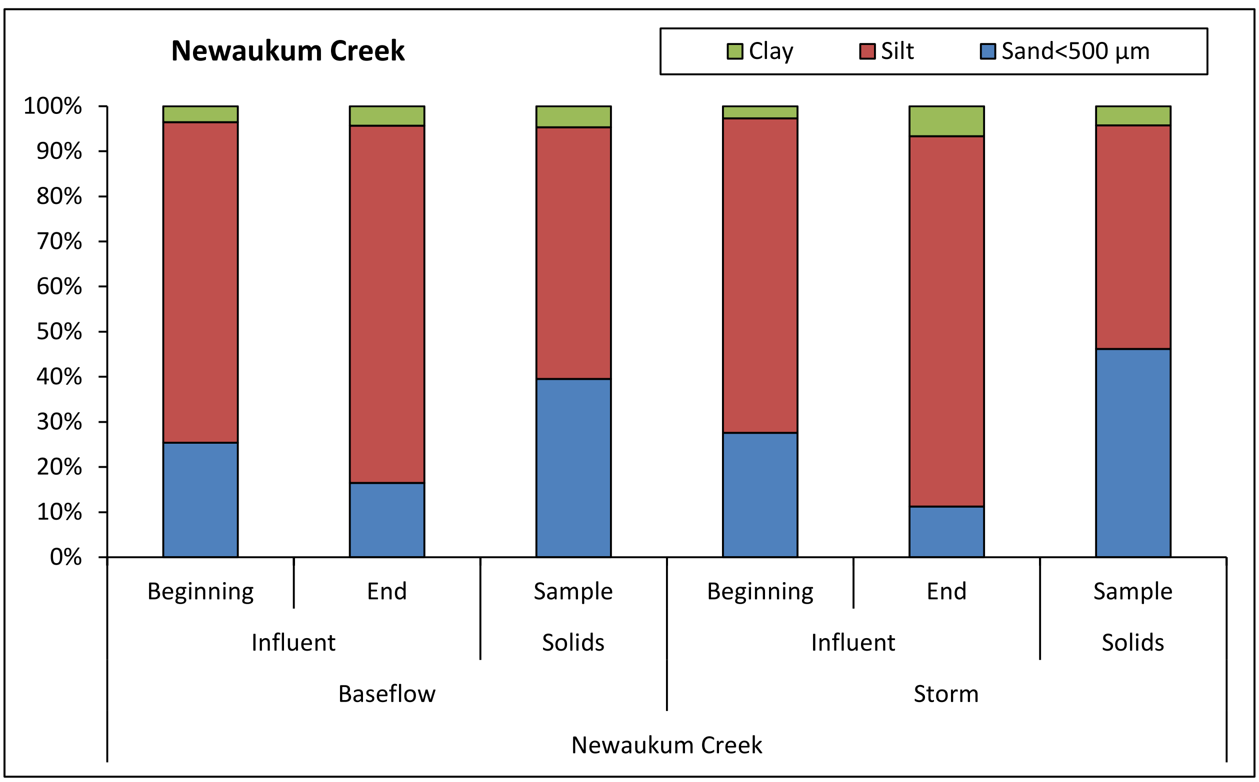

Figure B-3. PSD results for particles <500µm in influent water and corresponding filtered solids samples from Newaukum Creek.

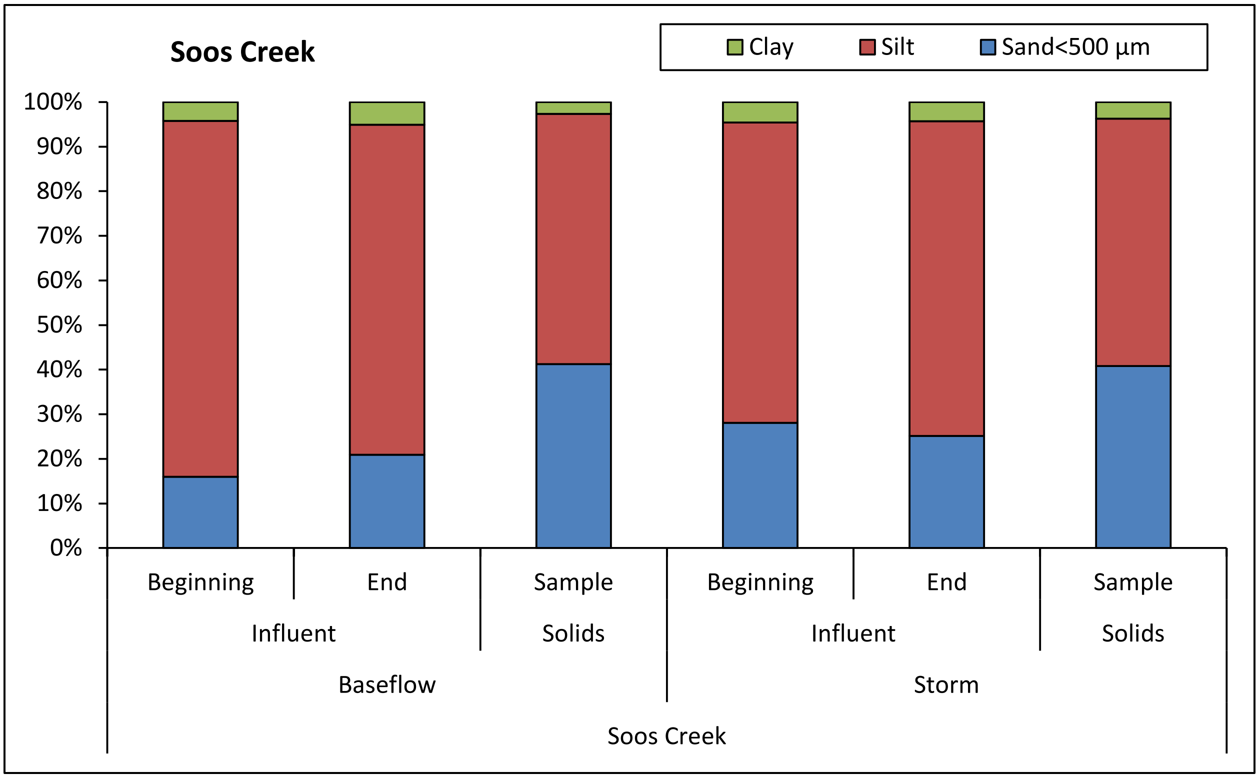

Figure B-4. PSD results for particles <500µm in influent water and corresponding filtered solids samples from Soos Creek.

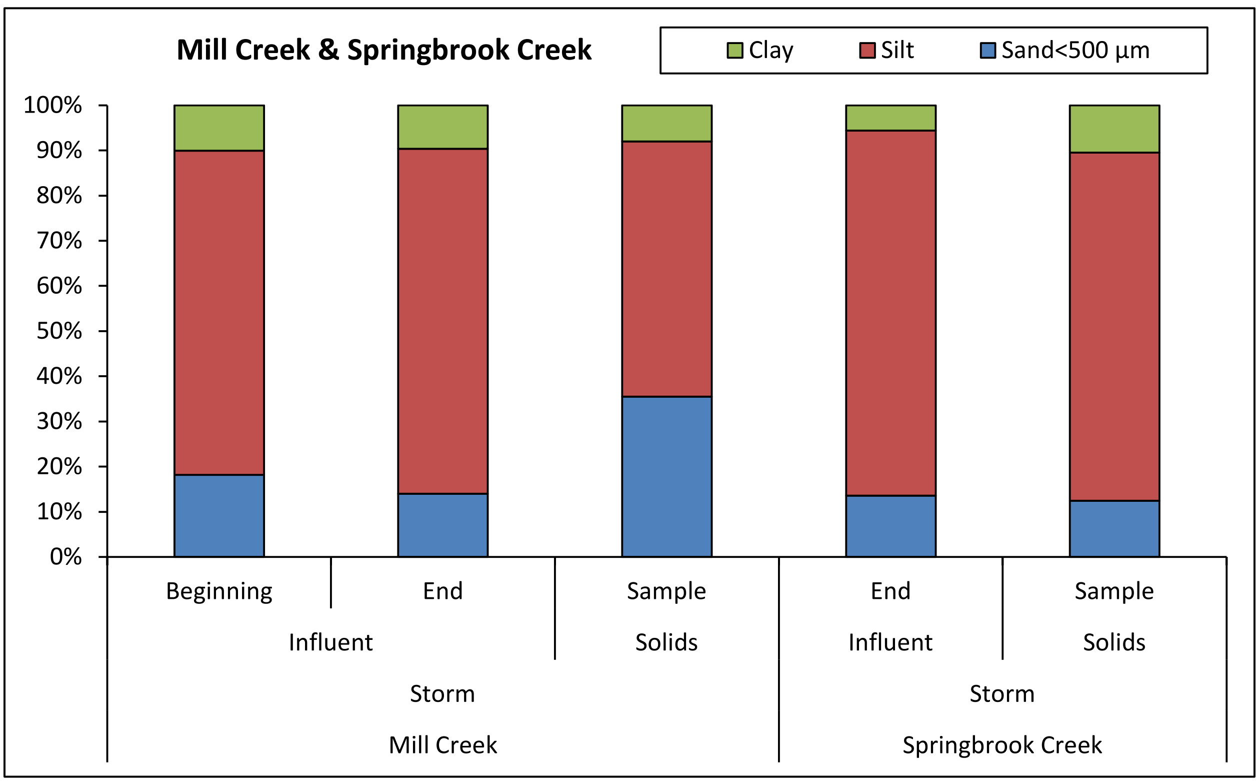

Figure B-5. PSD results for particles <500µm in influent water and corresponding filtered solids samples from Mill Creek and Springbrook Creek.