R. Pitt
December 23, 2021

Naval Base Point Loma Stormwater Treatment Facility SERDP Monitoring Data for Model Use

Contents

Summary

This report describes the stormwater treatment facility at the Naval Base Point Loma (NBPL) from the final report: *Hybrid Low Impact Development/Best Management Practice for DOD Industrial Site Storm Water Runoff*. Environmental Restoration Project ER-201634, April 15, 2020, by Anguiano, Foreman, and Pilkington and the monitoring data supplied by TT for the current SERDP project. The purpose of this summary is to characterize the monitoring data for use in extensions of the Source Loading and Management Model (WinSLAMM) considering pollutant characteristics and stormwater control performance by particle size increments.

Description of NBPL Monitored Site and Stormwater Treatment Facility

The following site descriptions are from the Anguiano, *et al*. (2020) report:
Location at Fleet Readiness Center Metal Finishing Complex (FRC MFC) located on Naval Base Point Loma (NBPL) in San Diego, California

Figure 4-2. NBPL FRC MFC Demonstration Site

Figure 4-5. Hybrid LID/BMP System Demonstration Site (Before and After)

Site Evaluation from Topographic Map

The following is a topographic map having 6-inch vertical resolution of the NBPL study site. Topographic analyses indicated a total area of 0.83 acres draining to the treatment system. The total roof area is about 0.18 acre (21.7%), the paved parking/storage area is about 0.62 acres (74.7%), and the unpaved/turf areas total is about 0.03 ac (3.6%). The roofs (all flat) are all directly connected and drain to the paved area.


Elevation
390
390.5
391
391.5
392
392.5
393
393.5
394
394.5
395
395.5
396
396.5
397
397.5
398
398.5
399
399.5
400
400.5
401
401.5
402
402.5
403
403.5
404
404.5
Point Loma
N
0 12.5 25 50 75 100
Feet
Source: NOAA Office for Coastal Management, Digital Globe

Description and Performance of NBPL Stormwater Treatment System

The following description is excerpted from the Anguiano, *et al.* (2020) report, which should be reviewed for additional information.

The stormwater treatment system is comprised of three main components, a pretreatment gabion wall, a biofilter (with a cistern), and a dual media filter. There are two overflow bypasses, one for the biofilter, and one for the media filter.

The gabion wall is 6 inches wide and 12 inches tall and surrounds the biofilter and acts as a sediment pretreatment unit for the inflowing sheetflow runoff from the site. Plastic-coated wire mesh contains ¾ to 3 inch rain ballast material.

The biofilter is a proprietary modular biofiltration product called FocalPoint purchased from California Filtration Specialists. The biofilter footprint is approximately 10 feet by 20 feet and has a design flow rate of approximately 1 gpm/ft^2 when clean, which equates to a 200-gpm maximum flow rate for the total unit. The top 3 inches is hardwood shredded mulch, then 15 inches of a sand with a small amount of peat on top of a 2-inch layer of 3/8 to ½ inch pea gravel and woven geotextile fabric act as a bridging layer to prevent the media from migrating to the underlying storage tank. The storage tank is a plastic modular unit 9 inches thick, holding about 1,100 gallons of filtered water. The tank has a pump that supplies water to the plants during dry periods. The tank discharges to the media filter, having a flow controlling valve to control the residence time in the biofilter. The biofilter is planted with southern Californian native vegetation (Cleveland Sage, Purple Sage) with very low water demands. The biofilter is lined to prevent infiltration losses.

The dual-media filter consists of a two-chamber concrete vault with external dimensions of 16’ long by 8’ 3” wide and 5’ 9” deep. The first chamber holds the adsorption media: (12 feet long and 7 feet 2 ¼ inch wide) filled with 6 inches of 8x30 mesh bone char on top of 9 inches of 28x48 mesh iron coated activates alumina (FS-50). The second chamber is a second clear well chamber (2 foot 7 ½ inch long by 7 feet 2 ¼ inch wide) for hydraulic controls and monitoring infrastructure.

The following are diagrams from the Anguiano, *et al.* (2020) report, illustrating these main features of the stormwater control.

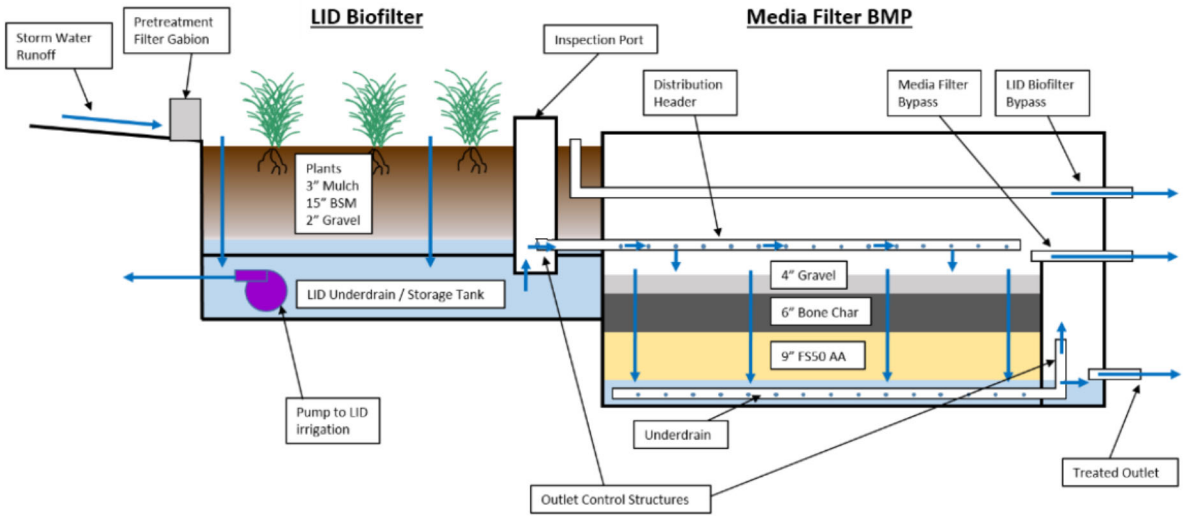


Figure 1-1. Conceptual Cross Section Diagram for Hybrid LID/BMP System

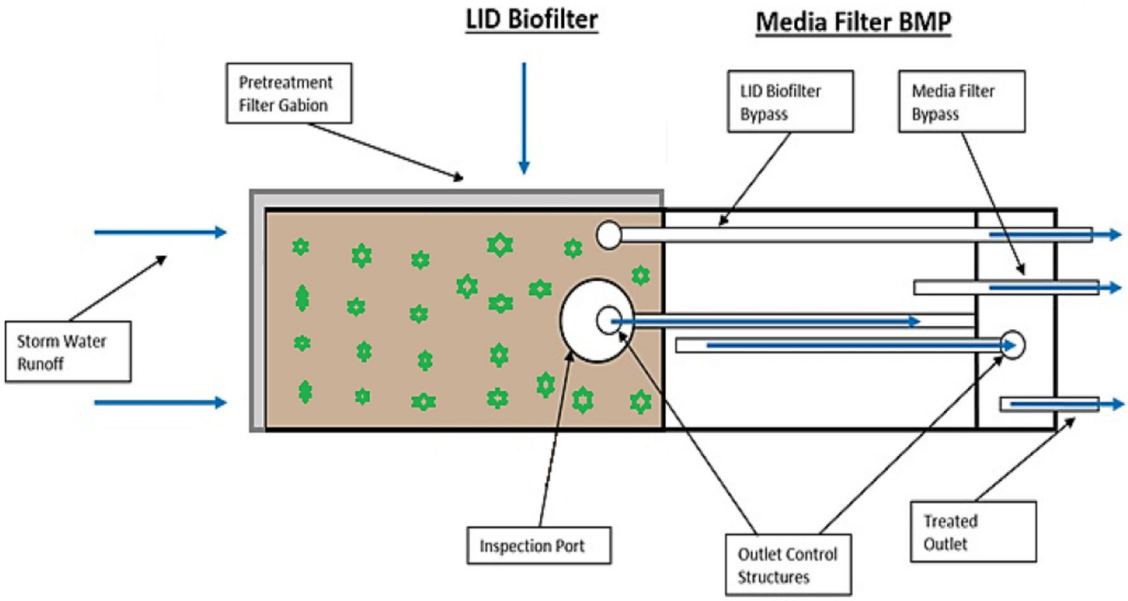


Figure 1-2. Conceptual Plan View Diagram for Hybrid LID / BMP System

The following table summarizes the influent and effluent concentrations of total suspended solids, total and filtered copper, and total and filtered zinc for the 14 monitored events from November 29, 2018, through May 19, 2019. These 14 events had rainfall ranges from 0.04 to 1.47 inches. These are all excellent removals.

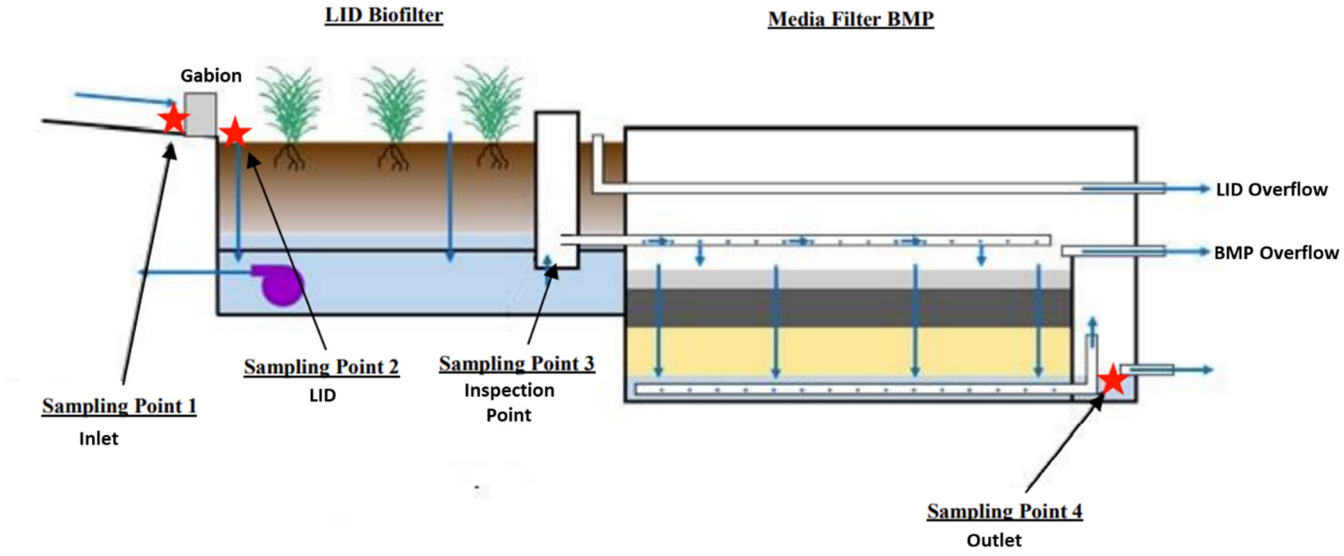
Performance Data for NBPL Stormwater Treatment System (Anguiano, *et al.* 2020)

	Influent (range and average)	Effluent (range and average)	Percentage removal (range and average)
Total copper (ug/L)	39 to 379 (153)	3.2 to 9.32 (5.2)	92 to 99 (97)
Filtered copper (ug/L)	31 to 116 (86)	0.8 to 6.14 (2.8)	92 to 99 (97)
Total zinc (ug/L)	156 to 769 (374)	2.5 to 13.2 (6.6)	94 to 99 (98)
Filtered zinc (ug/L)	94 to 539 (288)	1.9 to 14.7 (5.4)	93 to 99 (98)
Suspended Solids	4 to 280 (50.4)	<1 to 6.4 (2.6)	70 to 98 (95)

SERDP Characterization and Performance Monitoring

Texas Tech researchers in conjunction with Navy personnel conducted additional monitoring at the NBPL stormwater treatment system, focusing on particle size distributions for heavy metals, PAHs, and PFAS congeners. Particle size and filtered sample data are not available for the PFAS congeners due to their low concentrations.

Data are also available from four sampling locations, as shown on the following diagram:



Four sampling locations are noted: inlet, "LID" (gabion effluent and biofilter influent), inspection point (biofilter effluent/media filter influent), and outlet. The overflows were not sampled, so the outlet results only represent stormwater that passed through the complete system (only the first event had overflows). Flow monitoring was only conducted at the outlet, and overflows. No influent flows were monitored, being dispersed sheetflows entering the system along the gabion perimeter. Anguiano, *et al.* (2020) relied on rainfall monitoring to estimate influent flow amounts. They also assumed the site area to be 1.0 acres, but further topographic analyses resulted in a total area of about 0.82 acres, as shown previously.

The performance of the gabion barrier can be determined by comparing the inlet samples to the "LID" samples (influent to the biofilter). The biofilter performance can be determined by comparing the "LID" biofilter influent samples to the inspection point (biofilter effluent) samples. The media filter performance can be determined by comparing the inspection point (biofilter effluent/media filter influent) to the outlet. And, the overall system performance can be determined by comparing the inlet to the outlet samples.

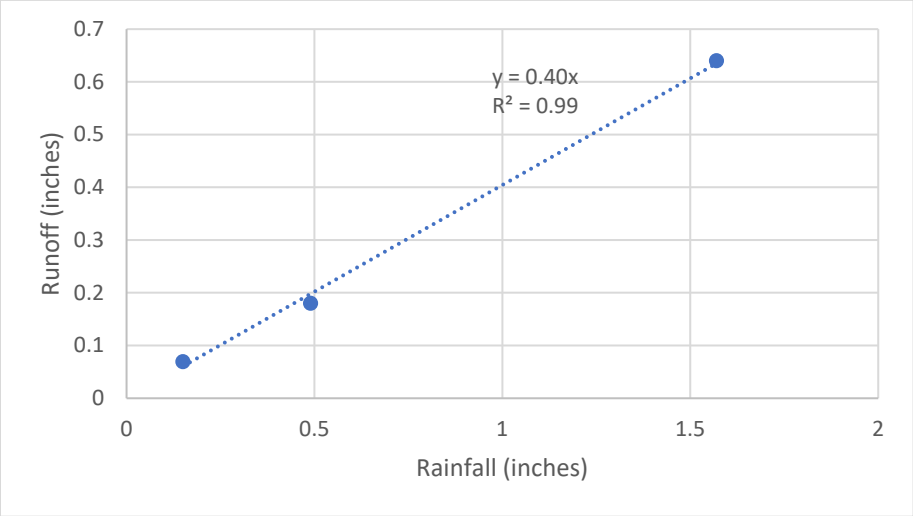
Flow Summary

Three events were monitored for this SERDP effort:

Rainfall and Flow Monitoring during SERDP NBPL Study

date	Rainfall (inches)	Total measured outflow (ft3)	Total measured overflows (ft3)	Calculated Rv (0.82 acre site)
February 9, 2020	1.57	1,948	232	0.41
February 22, 2020	0.15	210	0	0.46
December 29, 2020	0.49	553	0	0.37

The following scatterplot shows the relationship between rainfall and runoff (both expressed as inches) for these three events. Regression ANOVA did not indicate a significant intercept, so the plot only includes a slope term, which is equivalent to the overall Rv value (the ratio of runoff to rainfall). As noted by the other researchers, this value is lower than expected for the mostly paved site. Typically, the Rv for paved areas would be about 0.5 for small rains, increasing to about 0.85 for large rains. In this example, all three events have very similar, low, Rv values about half of the expected amount. The only flow loss in the treatment system would be associated with evapotranspiration of the plants, plus changes in soil moisture, but since these are individual rains of relatively short duration, these losses would not likely be significant. The greatest uncertainty is the unknown inflow runoff amount. It's also possible that the flow meters may not be accurate, as no calibration results were available.



Rainfall vs. runoff plot for three monitored events at NBPL.

Monitored Constituent Characteristics and Removal Performance

The Texas Tech monitoring data described the monitored concentrations for particulate solids, filterable solids, total and filtered heavy metals and PAHs, and total PFAS congeners. These data were available for each of the three events at the four sampling locations at the stormwater treatment facility. Only the inlet samples (before the gabion barrier) had data for several particle size categories, as the other sampling locations had low concentrations and were determined to be unlikely to result in accurate particle size data. Texas Tech also calculated the particulate strengths of the monitored constituents. This report summarizes and formats these data for later stormwater quality modeling with WinSLAMM. Appendices A through C include detailed tables, while the following discussion is a summary of the data. Processing these data included averaging the concentrations and particulate strengths for the three events at each of the four sampling locations.

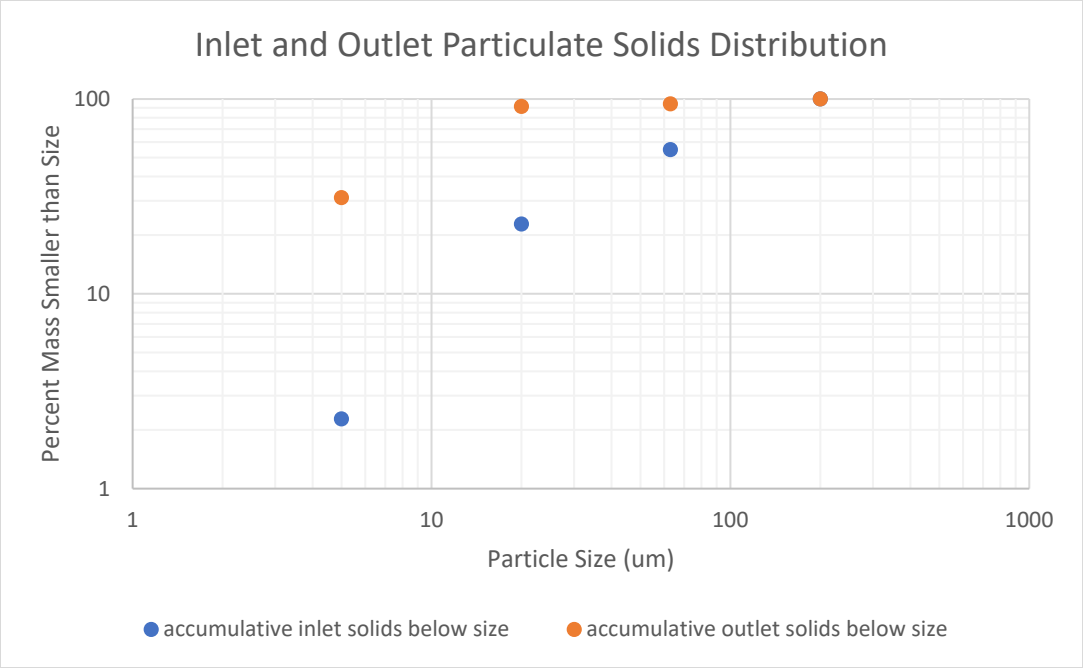
Particulate Solids Size Distributions and Removals

Particulate solids data are available at the inlet and outlet locations, by particle size, as shown in the following table. The 3-event inlet suspended solids concentration was about 70 mg/L, while the outlet concentration as reduced to about 3 mb/L. Particles larger than 20 µm were reduced by more than 99 percent, while the smallest size range (0.45 to 5 µm) had a reduction of about 40 percent.

Inlet and Outlet Particulate Solids Concentrations by Size Range and Overall Reductions

particle size range	average inlet particulate solids concentrations (mg/L)	average outlet particulate solids concentrations (mg/L)	overall percent reduction by size
0.45-5 µm	1.6	1.0	40.6
5-20 µm	14.4	1.8	87.2
20-63 µm	22.6	0.1	99.6
> 63 µm	31.7	0.2	99.4
total	70.4	3.1	95.6

The following plot illustrates the cumulative percentage of the total particulate solids by size. The median inlet particle size was about 60 µm, and the median outlet particle size was about 10 µm. Unfortunately, there is no particle size data at the intermediate sampling locations so it is not possible to examine the size reductions by unit process.



Note: The maximum particle size in the stormwater inlet samples was estimated to be 200 µm.

PAH Characteristics and Performance

Appendix A summarizes the substantial amount of PAH data from the site monitoring, by specific PAH compound. The following tables summarize the overall range of concentrations, removals, and particulate strengths, for all of the PAH compounds. The following table summarizes the concentrations by particle size (including the filtered fraction) for each sampling location. In general, PAHs are particulate bound, especially to particles having large surface areas (small particles) and/or large organic content (usually larger particles).

About 10 to 20 percent of most of the PAHs are associated with particulates. Naphthalene is the only PAH that was found to be more associated with filtered water samples than with the particulate fraction at the inlet. After the gabion barrier, many of the PAHs were associated with the filtered fraction.

PAH Concentration Summary at Sampling Locations

	minimum concentration	**maximum concentration**	**average concentration**	**median concentration**	**standard deviation of concentrations**	**COV of concentrations**
Inlet average (before gabion), ng/L						
Filtered (<0.7µm)	0.1	4.3	0.9	0.6	1.0	1.11
0.7-2.7 µm	0.0	1.2	0.1	0.0	0.2	1.76
2.7-20 µm	0.0	8.0	1.0	0.1	1.8	1.81
20-63 µm	0.1	80.5	5.2	0.7	14.2	2.75
>63 µm	0.0	124.8	12.1	2.3	24.3	2.01
Total Particulate (>0.7 µm)	0.3	139.9	18.4	3.5	33.2	1.81

Bulk	0.4	114.8	15.9	4.6	27.2	1.71
filtered fraction	0.0	0.6	0.2	0.1	0.1	0.87
particulate fraction	0.4	1.2	1.0	1.0	0.2	0.17
LID (after gabion), ng/L						
Filtered (<0.7µm)	0.0	20.4	2.2	0.5	4.2	1.93
Total Particulate (>0.7 µm)	0.0	12.1	1.1	0.2	2.4	2.15
Bulk	0.1	32.5	3.3	1.3	6.0	1.84
filtered fraction	0.0	1.0	0.7	0.8	0.3	0.51
particulate fraction	0.0	1.0	0.3	0.2	0.3	0.96
inspection port (after biofilter), ng/L						
Filtered (<0.7µm)	0.0	2.8	0.4	0.2	0.6	1.55
Total Particulate (>0.7 µm)	0.0	6.1	0.6	0.1	1.2	1.98
Bulk	0.0	8.3	1.0	0.4	1.5	1.59
filtered fraction	0.1	1.0	0.5	0.6	0.3	0.52
particulate fraction	0.0	0.9	0.5	0.4	0.3	0.63
outlet average, ng/L						
Filtered (<0.7µm)	0.0	8.3	1.1	0.4	1.8	1.71
Total Particulate (>0.7 µm)	0.0	3.5	0.7	0.4	0.8	1.13
Bulk	0.1	11.8	1.7	1.0	2.5	1.42
filtered fraction	0.1	0.9	0.5	0.4	0.2	0.46
particulate fraction	0.1	0.9	0.5	0.6	0.2	0.53

Particulate strengths of the PAH compounds varied by particle size. The smallest particle size range (0.7 to 2.7 µm) had much larger average particulate strengths than the other size ranges, as shown on the following table for inlet samples. This pattern was consistent for all of the PAHs monitored.

Particulate Strength Summary for PAHs

	minimum part. strengths	**maximum part. strengths**	**average part. strengths**	**median part. strengths**	**standard deviation of part. strengths**	**COV of part. strengths**
Avg inlet particulate strengths (mg/kg)						
0.7-2.7 µm	0.00	72.78	5.36	1.36	12.56	2.34
2.7-20 µm	0.00	1.50	0.13	0.01	0.27	2.14
20-63 µm	0.00	3.07	0.19	0.04	0.51	2.64
>63 µm	0.00	2.78	0.25	0.04	0.53	2.16
Total Particulate (>0.7 µm)	0.00	1.31	0.17	0.03	0.31	1.86
Avg LID/biofilter inlet particulate strengths (>0.7 µm)	0.00	0.15	0.01	0.00	0.03	2.04

Avg inspection port particulate strengths (>0.7 µm)	0.00	1.85	0.15	0.02	0.33	2.21
Avg outlet particulate strengths (>0.7 µm)	0.00	1.73	0.36	0.19	0.41	1.16

The following table shows the ratios of the particulate strengths for each size range compared to the bulk unfiltered particulates (>0.7 µm). On the average, the particulate strength of the smallest size range was many times greater than for the bulk particle strength value.

PAH Particle Strengths, Ratios of Averages by Size to total Particulate Solids (>0.7 µm) Particle Strength

ratio to >0.7um	**Minimum ratio**	**Maximum ratio**	**Average ratio**	**Median ratio**	**Standard deviation of ratios**	**Coefficient of Variation of ratios (COV)**
0.7-2.7 µm	0.00	4,022	213	41.7	660	3.10
2.7-20 µm	0.00	6.54	0.88	0.50	1.20	1.37
20-63 µm	0.25	2.99	1.12	1.06	0.65	0.58
>63 µm	0.00	2.13	1.32	1.52	0.60	0.45

The following table summaries the concentration reductions after each unit treatment process. Overall, the treatment system averaged about 70 percent reductions for the total PAHs, while the filtered forms were not reduced, on the average. The gabion barrier was responsible for most of the particulate PAH removals, while the biofilter had a minor effect on the filtered PAH concentrations, while the media filter resulted in increased PAH concentrations. The biofilter had substantial removals for some PAHs, but also had substantial additions for other PAHs.

PAH Reductions After Unit Treatment Processes

	minimum percent reduction	**maximum percent reduction**	**average percent reductions**	**median percent reductions**	**standard deviation of reductions**	**COV of reductions**
% gabion reduction (inlet vs. LID)						
Filtered (<0.7µm)	-93.1	1314.5	106.8	-24.6	338.5	3.17
Total Particulate (>0.7 µm)	81.4	100.0	93.5	94.4	5.4	0.06
Bulk	-25.4	98.7	63.9	74.9	32.1	0.50
% biofilter reduc (LID vs inspec port)						
Filtered (<0.7µm)	-1380.2	96.4	6.2	64.7	257.6	41.60
Total Particulate (>0.7 µm)	-7581.7	100.0	-512.1	-59.0	1451.8	-2.84
Bulk	-91.4	91.9	49.8	50.5	37.2	0.75
% media reduc (inspec port vs outlet)						
Filtered (<0.7µm)	-625.9	40.2	-157.0	-70.4	185.3	-1.18
Total Particulate (>0.7 µm)	-3457.5	84.3	-509.6	-133.5	899.0	-1.76
Bulk	-768.4	16.6	-141.1	-100.0	172.6	-1.22
overall percent reduction (inlet vs outlet)						

filtered	-492.9	85.8	-4.6	11.8	102.2	-22.36
total particulates	-43.7	99.0	82.4	95.9	29.9	0.36
bulk	-57.1	97.9	68.6	85.0	35.0	0.51

PFAS Characteristics

The only PFAS congener data available was for the bulk inlet and outlet samples, as shown on the following table. In all cases, the concentrations increased at the outlet location.

PFAS Congener Inlet and Outlet Concentrations and Removals.

PFAS congeners	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFOS	6:2 FTS
average inlet bulk (ng/L)	1.74	0.00	1.37	1.10	3.51	0.27	0.28	5.31	0.00
average outlet bulk (ng/L)	2.03	0.12	1.81	1.35	4.64	0.46	0.70	6.77	1.07
percent bulk reduction	-16.8	n/a	-32.1	-22.5	-32.2	-65.6	-150.5	-27.6	n/a

PFAS congeners analyzed but not detected in any NBPL stormwater samples: 4:2 FTS, 8:2 FTS, PFBS, PFDoA, PFDS, PFHpS, PFHxS, PFNS, PFOSA, PFPeS, PFTeA, PFTrA, and PFUdA.

Metals Characteristics and Performance

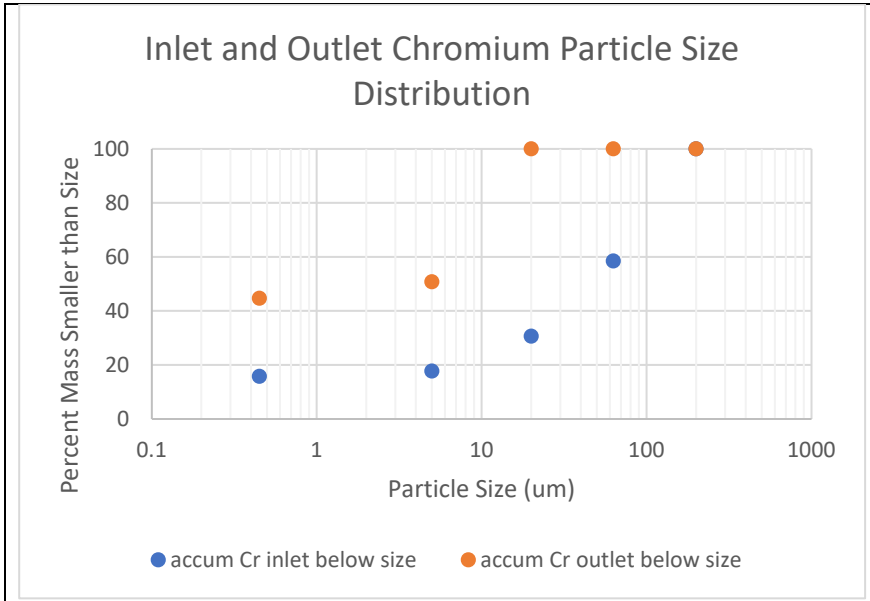
Appendix C includes the detained heavy metal average concentrations. The following table shows the average inlet and outlet concentrations, and their reductions, by particle size range for the heavy metals monitored. The removals were about 60 to >90% for these metals, with very low effluent concentrations.

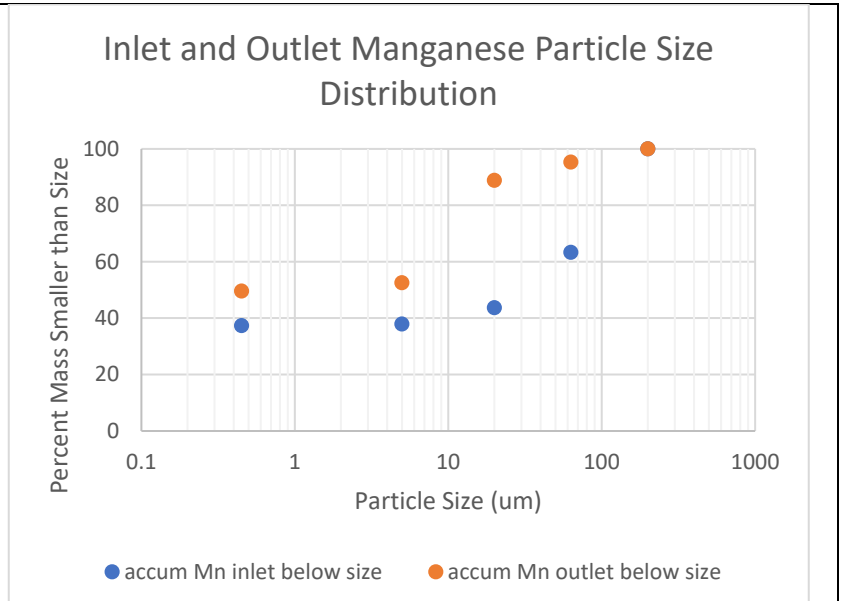
Average Inlet and Outlet Heavy Metal Concentrations and Reductions

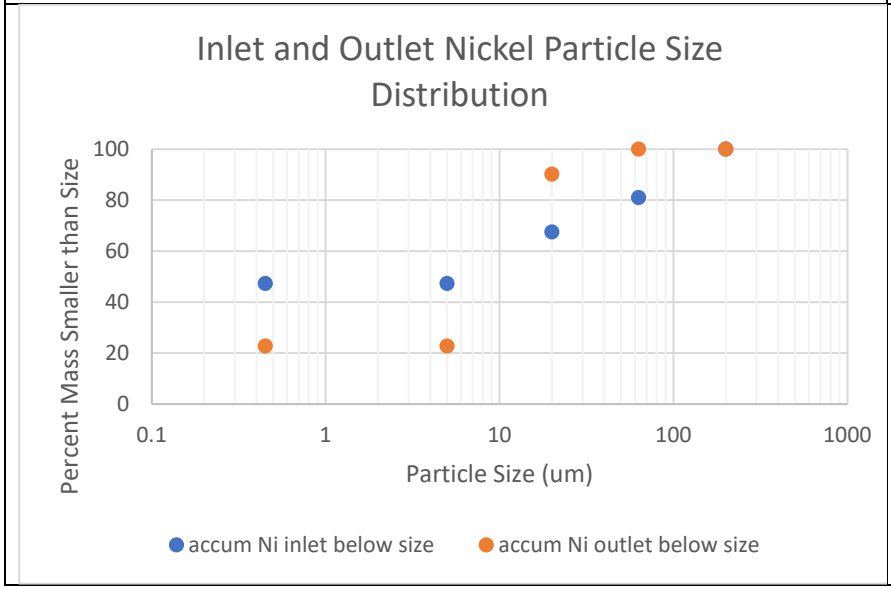
Particle size range	**Chromium, inlet (µg/L)**	**Chromium, outlet (µg/L)**	**Percent reduction**
<0.45 µm	1.493	0.806	46.0
0.45-5 µm	0.186	0.110	40.7
5-20 µm	1.221	0.888	27.3
20-63 µm	2.637	0.000	100.0
> 63 µm	3.929	0.000	100.0
sum	9.466	1.804	80.9
Particle size range	**Manganese, inlet (µg/L)**	**Manganese, outlet(µg/L)**	**Percent reduction**
<0.45 µm	14.756	2.626	82.2
0.45-5 µm	0.220	0.156	29.2
5-20 µm	2.291	1.921	16.2
20-63 µm	7.755	0.343	95.6
> 63 µm	14.517	0.251	98.3
sum	39.539	5.296	86.6
Particle size range	**Nickel, inlet (µg/L)**	**Nickel, outlet (µg/L)**	**Percent reduction**
<0.45 µm	3.213	0.622	80.6
0.45-5 µm	0.001	0.000	n/a
5-20 µm	1.371	1.843	-34.4
20-63 µm	0.916	0.270	70.5
> 63 µm	1.291	0.000	100.0
sum	6.792	2.735	59.7

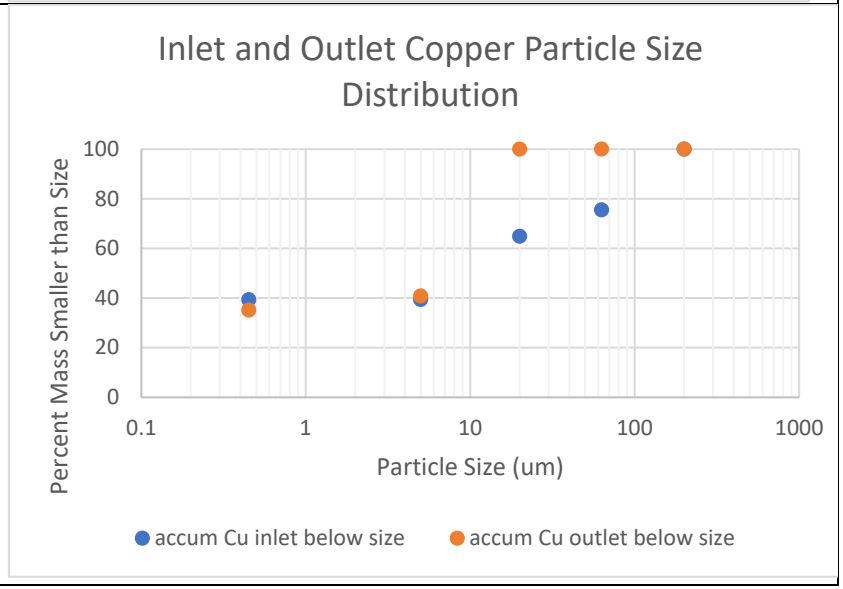
Particle size range	Copper, inlet (µg/L)	Copper, outlet (µg/L)	Percent reduction
<0.45 µm	73.704	5.409	92.7
0.45-5 µm	0.074	0.877	-1079.9
5-20 µm	47.744	9.110	80.9
20-63 µm	19.923	0.000	100.0
> 63 µm	45.819	0.000	100.0
sum	187.265	15.396	91.8
Particle size range	**Zinc, inlet (µg/L)**	**Zinc, outlet (µg/L)**	**Percent reduction**
<0.45 µm	238.918	8.382	96.5
0.45-5 µm	0.000	0.000	n/a
5-20 µm	0.074	2.497	-3289.1
20-63 µm	17.651	0.314	98.2
> 63 µm	87.084	0.000	100.0
sum	343.727	11.193	96.7
Particle size range	**Arsenic, inlet (µg/L)**	**Arsenic, outlet (µg/L)**	**Percent reduction**
<0.45 µm	0.484	0.266	44.9
0.45-5 µm	0.009	0.010	-14.5
5-20 µm	0.065	0.008	87.6
20-63 µm	0.110	0.012	88.8
> 63 µm	0.196	0.013	93.6
sum	0.864	0.309	64.2
Particle size range	**Cadmium, inlet (µg/L)**	**Cadmium, outlet (µg/L)**	**Percent reduction**
<0.45 µm	1.120	0.137	87.8
0.45-5 µm	0.000	0.001	n/a
5-20 µm	0.000	0.016	n/a
20-63 µm	0.097	0.003	96.7
> 63 µm	0.349	0.001	99.8
sum	1.566	0.157	89.9
Particle size range	**Lead, inlet (µg/L)**	**Lead, outlet (µg/L)**	**Percent reduction**
<0.45 µm	2.709	1.863	31.2
0.45-5 µm	0.000	0.015	n/a
5-20 µm	1.945	1.662	14.6
20-63 µm	2.811	0.041	98.6
> 63 µm	7.755	0.000	100.0
sum	15.221	3.581	76.5
Particle size range	**Total mercury, inlet (ng/L)**	**Total mercury, outlet (ng/L)**	**Percent reduction**
<0.45 µm	2.142	2.123	0.8
0.45-5 µm	0.055	0.000	100.0
5-20 µm	0.437	1.521	-248.0
20-63 µm	2.166	0.000	100.0
> 63 µm	4.326	0.000	100.0
sum	9.125	3.644	60.1

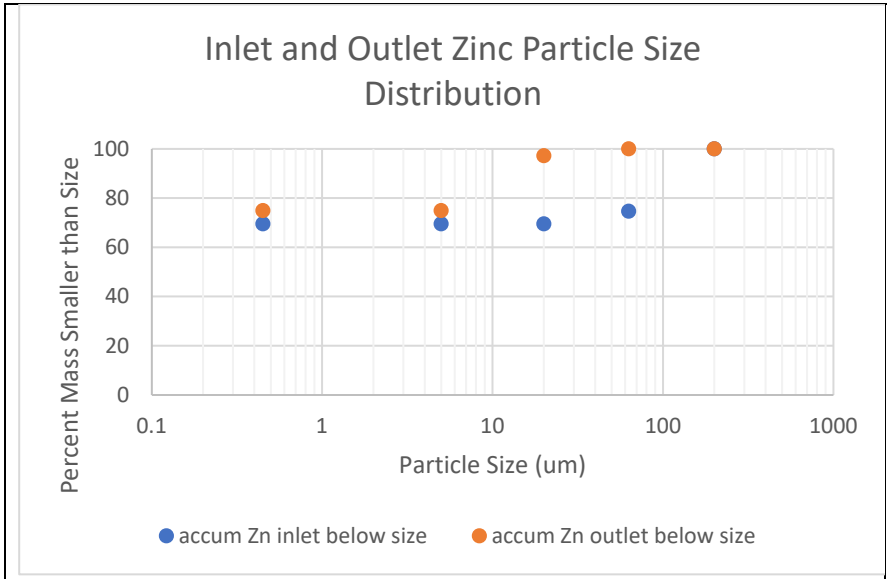
The following graphs show the inlet and outlet cumulative percent of mass plots by size for these metals. The upper particle size was assumed to about 200 µm for the inlet samples, as is common for most stormwater. The size associated with the 50th percentile of the metal masses is much smaller for the outlet samples compared to the inlet samples, reflecting the preferential removal of large particles in stormwater treatment systems.

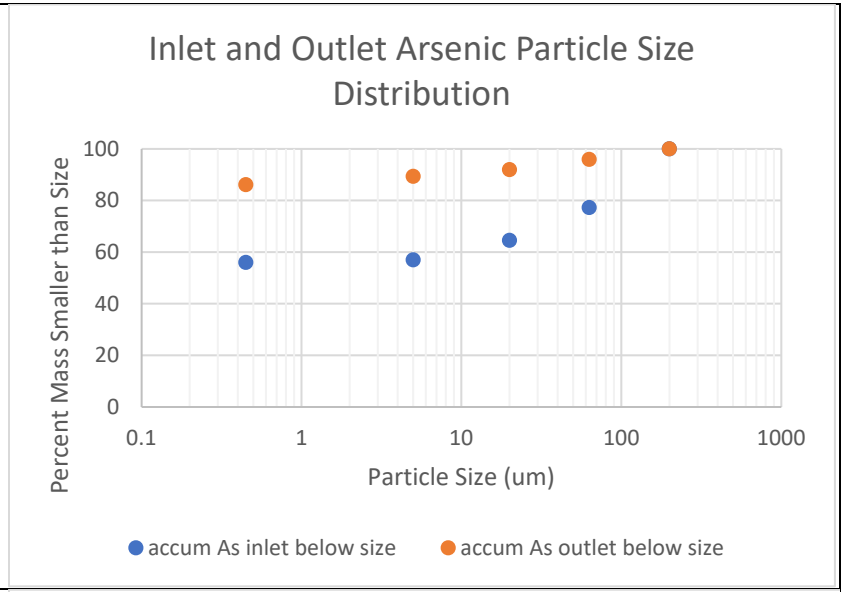

Inlet and Outlet Chromium Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Cr inlet below size
accum Cr outlet below size

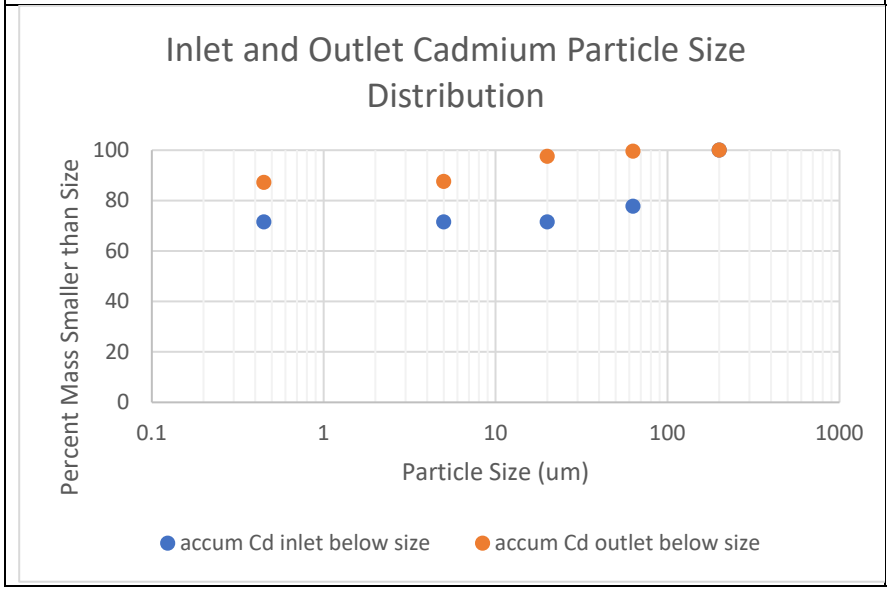

Inlet and Outlet Manganese Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Mn inlet below size
accum Mn outlet below size

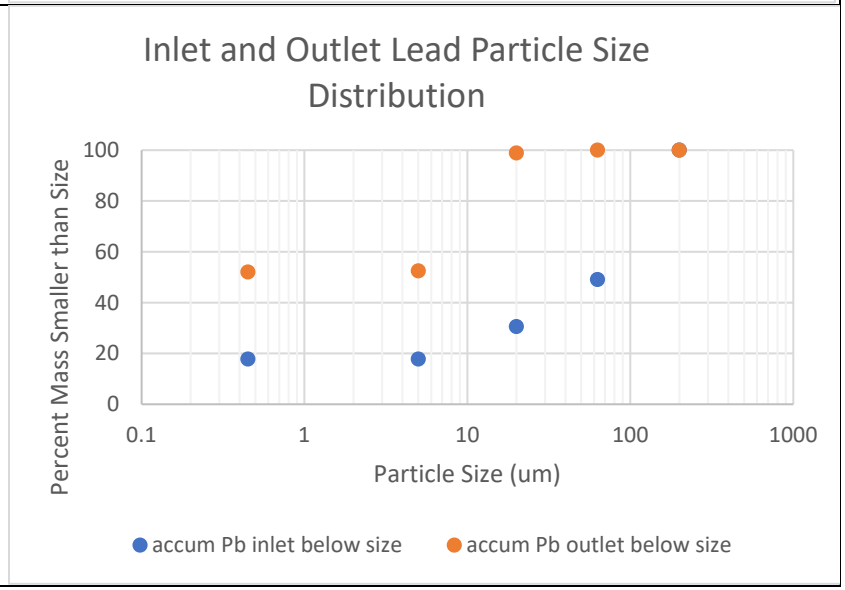

Inlet and Outlet Nickel Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Ni inlet below size
accum Ni outlet below size

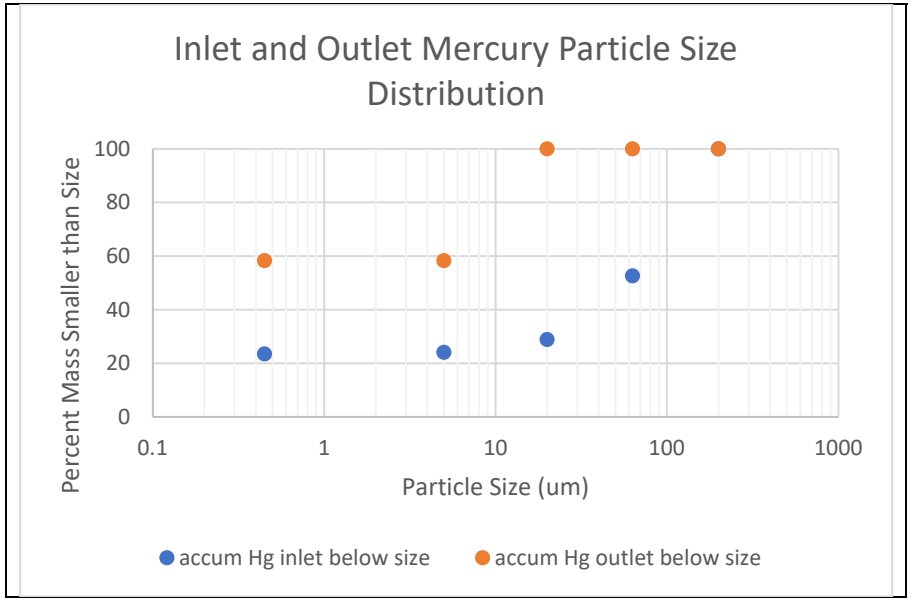

Inlet and Outlet Copper Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Cu inlet below size
accum Cu outlet below size


Inlet and Outlet Zinc Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Zn inlet below size
accum Zn outlet below size


Inlet and Outlet Arsenic Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum As inlet below size
accum As outlet below size


Inlet and Outlet Cadmium Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Cd inlet below size
accum Cd outlet below size


Inlet and Outlet Lead Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Pb inlet below size
accum Pb outlet below size


Inlet and Outlet Mercury Particle Size Distribution
Percent Mass Smaller than Size
100
80
60
40
20
0
0.1
1
10
100
1000
Particle Size (um)
accum Hg inlet below size
accum Hg outlet below size

Particulate strength data for the heavy metals is also shown in Appendix C. In contrast to the PAHs, the intermediate sizes (5 to 63 μm) generally had the highest particulate strengths for the heavy metals, with the largest size evaluated (>63 um) having the largest particulate strengths for several of the metals (manganese, zinc, cadmium, lead, and mercury). The inlet samples had most of chromium, lead, and mercury associated with the particulate samples, while zinc and cadmium were mostly associated with the filtered samples. The biofilter and media filter were responsible for most of the heavy metal concentration reductions, both in filtered and particulate forms.

Appendix A: PAH Characteristics and Performance

	Naphthalene	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene
Inlet average (before gabion), ng/L								
Filtered (<0.7µm)	4.1	1.8	1.2	0.4	0.5	0.6	0.2	0.1
0.7-2.7 µm	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2
2.7-20 µm	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0
20-63 µm	1.7	0.9	0.6	0.1	0.5	0.4	0.1	0.3
>63 µm	1.0	5.8	1.9	0.8	2.5	1.6	0.4	0.1
Total Particulate (>0.7 µm)	2.8	6.9	2.7	1.0	3.1	2.1	0.6	0.6
Bulk	6.3	7.3	3.4	1.1	3.0	2.3	0.7	0.7
filtered fraction	0.65	0.25	0.37	0.32	0.18	0.25	0.32	0.20
particulate fraction	0.44	0.94	0.79	0.85	1.03	0.94	0.84	0.80
LID (after gabion), ng/L								
Filtered (<0.7µm)	2.9	8.1	4.2	0.9	1.8	1.5	0.4	0.1
Total Particulate (>0.7 µm)	0.1	0.1	0.0	0.0	0.2	0.2	0.0	0.0
Bulk	2.9	8.2	4.2	0.9	2.0	1.6	0.4	0.1
filtered fraction	0.98	0.99	0.99	1.00	0.90	0.90	0.90	1.00
particulate fraction	0.02	0.01	0.01	0.00	0.10	0.10	0.10	0.00
inspection port (after biofilter), ng/L								
Filtered (<0.7µm)	0.6	0.3	0.3	0.1	0.1	0.2	0.0	0.0
Total Particulate (>0.7 µm)	1.2	2.5	0.8	0.3	0.9	0.6	0.2	0.0
Bulk	1.8	2.8	1.2	0.4	1.0	0.7	0.3	0.0
filtered fraction	0.34	0.11	0.29	0.21	0.12	0.25	0.16	0.78
particulate fraction	0.66	0.89	0.71	0.79	0.88	0.75	0.84	0.22
outlet average, ng/L								
Filtered (<0.7µm)	3.2	1.8	1.3	0.3	0.9	0.8	0.3	0.0
Total Particulate (>0.7 µm)	0.7	0.8	0.3	0.8	1.2	1.2	0.3	0.2
Bulk	4.0	2.6	1.6	1.0	2.1	2.0	0.5	0.3
filtered fraction	0.81	0.68	0.79	0.26	0.43	0.41	0.52	0.08
particulate fraction	0.19	0.32	0.21	0.74	0.57	0.59	0.48	0.92

	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene
Inlet average (before gabion), ng/L								
Filtered (<0.7µm)	0.3	0.2	1.0	0.6	4.3	0.1	1.1	0.1
0.7-2.7 µm	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
2.7-20 µm	0.0	0.0	0.0	0.1	1.6	0.1	0.3	0.0
20-63 µm	0.3	0.3	0.7	0.7	11.3	0.4	1.4	0.1
>63 µm	0.7	1.2	4.8	1.3	47.3	1.5	10.7	0.5
Total Particulate (>0.7 µm)	1.1	1.5	5.5	2.2	60.2	2.0	12.4	0.7
Bulk	1.2	1.4	5.4	2.5	52.5	1.7	11.0	0.6
filtered fraction	0.28	0.15	0.18	0.25	0.08	0.06	0.10	0.12
particulate fraction	0.90	1.07	1.02	0.91	1.15	1.15	1.12	1.07
LID (after gabion), ng/L								
Filtered (<0.7µm)	1.0	0.5	2.0	1.0	10.9	0.4	2.0	0.1
Total Particulate (>0.7 µm)	0.0	0.1	0.3	0.4	0.9	0.1	0.7	0.0
Bulk	1.1	0.6	2.3	1.4	11.8	0.5	2.7	0.1
filtered fraction	0.97	0.85	0.86	0.72	0.92	0.88	0.75	0.65
particulate fraction	0.03	0.15	0.14	0.28	0.08	0.12	0.25	0.35
inspection port (after biofilter), ng/L								
Filtered (<0.7µm)	0.1	0.1	0.3	0.5	2.2	0.1	0.7	0.1
Total Particulate (>0.7 µm)	0.2	0.3	1.7	0.6	6.1	0.0	1.3	0.0
Bulk	0.3	0.4	2.0	1.2	8.3	0.1	2.0	0.1
filtered fraction	0.39	0.25	0.15	0.45	0.26	0.62	0.33	0.97
particulate fraction	0.61	0.75	0.85	0.55	0.74	0.38	0.67	0.03
outlet average, ng/L								
Filtered (<0.7µm)	0.3	0.4	1.6	0.9	6.5	0.1	1.6	0.0
Total Particulate (>0.7 µm)	1.5	0.2	0.4	0.1	2.1	0.0	0.3	0.0
Bulk	1.8	0.6	2.0	1.0	8.5	0.1	1.9	0.1
filtered fraction	0.17	0.69	0.81	0.90	0.76	0.75	0.86	0.77
particulate fraction	0.83	0.31	0.19	0.10	0.24	0.25	0.14	0.23

	1-methylphenanthrene	2-ethylanthracene	fluoranthene	pyrene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene
Inlet average (before gabion), ng/L								
Filtered (<0.7µm)	0.5	0.4	1.7	1.4	0.1	0.4	1.2	1.1
0.7-2.7 µm	0.0	0.1	0.5	1.2	0.0	0.1	0.3	0.3
2.7-20 µm	0.2	0.2	5.5	8.0	0.3	0.8	3.5	2.1
20-63 µm	0.7	0.5	9.0	80.5	0.2	3.4	11.8	5.2
>63 µm	5.8	0.5	124.8	26.8	2.0	5.3	47.8	25.8
Total Particulate (>0.7 µm)	6.7	1.3	139.9	116.6	2.5	9.6	63.4	33.5
Bulk	5.9	1.4	114.8	95.5	2.1	8.3	53.0	28.8
filtered fraction	0.08	0.27	0.01	0.01	0.02	0.05	0.02	0.04
particulate fraction	1.15	0.91	1.22	1.22	1.18	1.15	1.20	1.16
LID (after gabion), ng/L								
Filtered (<0.7µm)	0.9	0.4	6.9	20.4	0.0	0.4	0.8	0.4
Total Particulate (>0.7 µm)	0.3	0.2	1.5	12.1	0.2	1.8	6.0	3.4
Bulk	1.2	0.6	8.4	32.5	0.2	2.2	6.9	3.7
filtered fraction	0.77	0.65	0.82	0.63	0.02	0.18	0.12	0.10
particulate fraction	0.23	0.35	0.18	0.37	0.98	0.82	0.88	0.90
inspection port (after biofilter), ng/L								
Filtered (<0.7µm)	0.3	0.2	1.2	2.8	0.1	0.1	0.4	0.3
Total Particulate (>0.7 µm)	0.5	0.2	0.4	0.1	0.0	0.0	0.1	0.1
Bulk	0.7	0.4	1.5	2.9	0.1	0.2	0.6	0.4
filtered fraction	0.36	0.54	0.76	0.97	0.63	0.84	0.77	0.81
particulate fraction	0.64	0.46	0.24	0.03	0.37	0.16	0.23	0.19
outlet average, ng/L								
Filtered (<0.7µm)	0.7	0.4	1.7	8.3	0.0	0.3	0.5	0.4
Total Particulate (>0.7 µm)	0.1	0.0	2.3	3.5	0.1	0.4	0.6	0.8
Bulk	0.8	0.5	4.0	11.8	0.1	0.7	1.1	1.2
filtered fraction	0.85	0.91	0.42	0.70	0.34	0.37	0.45	0.32
particulate fraction	0.15	0.09	0.58	0.30	0.66	0.63	0.55	0.68

	7.12-methylbenz(a)anthracene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene
Inlet average (before gabion), ng/L								
Filtered (<0.7µm)	0.1	0.9	0.7	0.8	0.1	1.3	0.3	1.2
0.7-2.7 µm	0.0	0.2	0.2	0.2	0.0	0.2	0.2	0.1
2.7-20 µm	0.1	1.8	1.1	2.0	0.0	0.9	0.6	1.6
20-63 µm	0.2	4.9	13.2	5.8	0.3	4.2	1.2	4.8
>63 µm	0.3	26.6	5.2	19.4	0.0	7.1	1.9	4.8
Total Particulate (>0.7 µm)	0.6	33.5	19.6	27.4	0.3	12.3	3.9	11.3
Bulk	0.6	28.5	17.2	23.4	0.4	12.0	3.7	11.5
filtered fraction	0.16	0.03	0.04	0.03	0.23	0.11	0.07	0.10
particulate fraction	1.01	1.18	1.14	1.17	0.78	1.03	1.06	0.98
LID (after gabion), ng/L								
Filtered (<0.7µm)	0.1	0.4	0.2	0.3	0.1	0.1	0.2	0.1
Total Particulate (>0.7 µm)	0.1	2.9	0.1	3.1	0.0	0.6	0.5	0.0
Bulk	0.2	3.2	0.4	3.4	0.1	0.7	0.7	0.1
filtered fraction	0.45	0.11	0.63	0.09	0.85	0.16	0.28	0.77
particulate fraction	0.55	0.89	0.37	0.91	0.15	0.84	0.72	0.23
inspection port (after biofilter), ng/L								
Filtered (<0.7µm)	0.1	0.2	0.2	0.2	0.0	0.3	0.2	0.2
Total Particulate (>0.7 µm)	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1
Bulk	0.1	0.3	0.2	0.3	0.1	0.4	0.2	0.3
filtered fraction	1.00	0.66	0.85	0.70	0.59	0.73	1.00	0.66
particulate fraction	0.00	0.34	0.15	0.30	0.41	0.27	0.00	0.34
outlet average, ng/L								
Filtered (<0.7µm)	0.1	0.3	0.2	0.3	0.1	0.4	0.1	0.2
Total Particulate (>0.7 µm)	0.0	0.8	0.5	0.7	0.1	1.0	0.3	0.4
Bulk	0.1	1.1	0.7	1.0	0.1	1.4	0.4	0.6
filtered fraction	0.74	0.30	0.30	0.33	0.45	0.29	0.26	0.29
particulate fraction	0.26	0.70	0.70	0.67	0.55	0.71	0.74	0.71

	Naphthalene	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene
% gabion reduction								
(inlet vs LID)								
Filtered (<0.7µm)	43.3	-77.4	-70.4	-58.9	-70.9	-61.4	-39.9	149.1
Total Particulate (>0.7 µm)	98.0	98.4	98.4	99.6	93.7	92.7	92.6	100.0
Bulk	54.0	-12.1	-25.4	22.6	32.6	28.6	39.6	91.8
% biofilter reduc								
(LID vs insp port)								
Filtered (<0.7µm)	78.7	96.4	91.8	91.1	93.1	87.2	88.6	60.2
Total Particulate (>0.7 µm)	-2042.5	-2209.4	-1849.7	-7581.7	-376.0	-258.3	-435.2	#DIV/0!
Bulk	39.0	66.1	72.5	58.0	48.0	53.8	34.2	48.6
% media reduc								
(insp port vs outlet)								
Filtered (<0.7µm)	-431.3	-506.1	-274.1	-253.3	-625.9	-344.7	-556.5	11.3
Total Particulate (>0.7 µm)	37.0	66.4	57.2	-169.4	-30.6	-110.3	-12.9	-3457.5
Bulk	-123.2	5.9	-40.5	-187.1	-102.5	-168.9	-97.6	-768.4
overall percent reduction								
inlet vs outlet								
filtered	21.1	2.4	-3.6	23.7	-73.0	-47.2	-25.0	85.8
total particulates	73.5	87.8	86.9	19.0	60.8	44.6	55.1	58.0
bulk	37.3	64.2	51.6	6.7	29.0	11.4	21.5	63.4

	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene
% gabion reduction								
(inlet vs LID)								
Filtered (<0.7µm)	-68.1	-62.9	-50.1	-39.7	-60.7	-75.1	-44.5	34.0
Total Particulate (>0.7 µm)	97.2	93.4	94.2	82.1	98.5	97.2	94.6	95.5
Bulk	10.3	53.6	57.8	42.6	77.5	72.9	75.9	86.2
% biofilter reduc								
(LID vs insp port)								
Filtered (<0.7µm)	89.7	80.0	84.5	49.4	80.0	80.8	67.1	6.2
Total Particulate (>0.7 µm)	-467.9	-229.6	-440.3	-59.0	-577.0	14.4	-97.1	94.3
Bulk	74.2	33.0	10.6	18.7	30.0	72.8	25.6	37.3
% media reduc								
(insp port vs outlet)								
Filtered (<0.7µm)	-204.0	-265.6	-425.4	-67.3	-196.5	-39.8	-150.2	8.8
Total Particulate (>0.7 µm)	-815.4	43.4	78.1	84.3	65.9	21.6	80.4	-707.5
Bulk	-577.9	-34.7	3.3	16.6	-3.3	-16.5	4.0	-14.1
overall percent reduction								
inlet vs outlet								
filtered	1.6	-96.5	-62.7	-40.4	-50.7	-7.9	-48.5	36.2
total particulates	-43.7	87.7	93.1	95.5	96.6	98.1	97.9	97.9
bulk	-57.1	58.1	63.6	61.1	83.7	91.4	82.8	90.2

	1-methylphenanthrene	2-ethylanthracene	fluoranthene	pyrene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene
% gabion reduction								
(inlet vs LID)								
Filtered (<0.7µm)	-48.8	-9.4	-75.3	-93.1	1314.5	2.4	38.4	185.4
Total Particulate (>0.7 µm)	95.9	82.4	98.9	89.6	93.5	81.4	90.5	90.0
Bulk	79.4	53.8	92.7	66.0	92.2	73.9	87.0	87.0
% biofilter reduc								
(LID vs insp port)								
Filtered (<0.7µm)	71.1	46.7	83.1	86.2	-1380.2	62.3	47.5	12.3
Total Particulate (>0.7 µm)	-74.4	13.4	75.9	99.2	81.5	98.4	97.9	97.6
Bulk	38.1	35.2	81.8	91.0	50.6	91.9	91.7	88.8
% media reduc								
(insp port vs outlet)								
Filtered (<0.7µm)	-155.0	-84.9	-45.1	-194.7	40.2	-73.6	-13.4	-9.7
Total Particulate (>0.7 µm)	74.6	77.5	-525.4	-3340.7	-104.2	-1441.8	-374.7	-877.2
Bulk	-8.4	-9.9	-160.0	-304.6	-12.7	-296.5	-95.5	-176.1
overall percent reduction								
inlet vs outlet								
filtered	-44.1	-8.9	0.5	-492.9	37.4	36.1	57.0	66.3
total particulates	98.2	96.6	98.4	97.0	97.6	95.4	99.0	97.6
bulk	86.2	67.1	96.5	87.6	95.6	91.6	97.9	96.0

	7.12-methylbenz(a)anthracene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene
% gabion reduction								
(inlet vs LID)								
Filtered (<0.7µm)	32.5	165.5	201.1	153.6	103.8	1034.1	23.9	943.1
Total Particulate (>0.7 µm)	85.1	91.5	99.3	88.8	97.5	95.1	86.6	99.7
Bulk	72.6	88.7	97.9	85.7	86.7	94.0	80.2	98.7
% biofilter reduc								
(LID vs insp port)								
Filtered (<0.7µm)	10.7	41.2	21.4	28.0	19.5	-129.4	16.6	-63.4
Total Particulate (>0.7 µm)	100.0	96.3	75.4	97.0	-218.4	84.3	100.0	-183.8
Bulk	60.0	90.2	41.2	90.9	-15.4	50.4	76.5	-91.4
% media reduc								
(insp port vs outlet)								
Filtered (<0.7µm)	13.6	-64.2	-13.8	-49.0	-42.2	-53.6	33.2	9.0
Total Particulate (>0.7 µm)	#DIV/0!	-634.2	-1352.0	-620.4	-156.6	-914.7	#DIV/0!	-329.2
Bulk	-16.0	-256.7	-219.7	-220.0	-88.6	-284.0	-154.7	-107.5
overall percent reduction								
inlet vs outlet								
filtered	41.8	63.6	70.3	57.7	43.8	68.9	55.1	85.7
total particulates	96.8	97.7	97.5	97.6	79.6	92.1	91.8	96.3
bulk	87.3	96.1	96.0	95.8	71.0	88.6	88.2	94.9

Avg inlet particulate strengths	filtered and particulate solids (mg/L)	Naphthalene (mg/kg)	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	1-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene
0.7-2.7 µm	3.20	0.00	1.51	1.58	1.77	0.58	0.00	0.00
2.7-20 µm	14.04	0.00	0.01	0.00	0.00	0.00	0.01	0.01
20-63 µm	26.14	0.16	0.09	0.05	0.01	0.00	0.04	0.04
>63 µm	32.23	0.02	0.16	0.05	0.02	0.00	0.07	0.04
Total Particulate (>0.7 µm)	64.28	0.05	0.09	0.03	0.01	0.00	0.04	0.03
ratio to >0.7um								
0.7-2.7 µm	0.05	0.04	17.21	46.66	175.20	307.54	0.00	0.00
2.7-20 µm	0.22	0.07	0.12	0.08	0.49	0.20	0.20	0.20
20-63 µm	0.41	2.99	0.97	1.59	0.63	1.53	1.11	1.42
>63 µm	0.50	0.40	1.87	1.37	1.96	1.22	1.80	1.54
Avg outlet particulate strengths	filtered and particulate solids (mg/L)	Naphthalene (mg/kg)	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	1-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene
Total Particulate (>0.7 µm)	2.31	0.41	0.46	0.20	0.25	0.06	0.38	0.37

Avg LID/biofilter inlet particulate strengths	filtered and particulate solids (mg/L)	Naphthalene (mg/kg)	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	1-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene
Total Particulate (>0.7 µm)	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avg inspection port particulate strengths	filtered and particulate solids (mg/L)	Naphthalene (mg/kg)	2-methylnaphthalene	1-methylnaphthalene	2-ethylnaphthalene	1-ethylnaphthalene	2.6-dimethylnaphthalene	1.3-dimethylnaphthalene
Total Particulate (>0.7 µm)	4.08	0.36	0.81	0.26	0.09	0.01	0.30	0.18

Avg inlet particulate strengths	2-isopropylnaphthalene	acenaphthylene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene
0.7-2.7 µm	0.16	1.83	0.05	10.08	0.63	0.11	0.00	10.29
2.7-20 µm	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
20-63 µm	0.00	0.00	0.01	0.01	0.02	0.02	0.06	0.04
>63 µm	0.00	0.01	0.01	0.00	0.01	0.03	0.13	0.03
Total Particulate (>0.7 µm)	0.00	0.00	0.01	0.01	0.01	0.02	0.07	0.03
ratio to >0.7um								
0.7-2.7 µm	134.95	497.15	6.17	916.44	49.10	5.71	0.03	358.57
2.7-20 µm	1.81	0.03	0.05	0.15	0.08	0.28	0.04	0.60
20-63 µm	0.31	0.44	1.41	1.15	1.89	1.19	0.95	1.36
>63 µm	1.96	1.50	1.57	0.08	1.17	1.73	1.94	1.03
Avg outlet particulate strengths	2-isopropylnaphthalene	acenaphthylene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene
Total Particulate (>0.7 µm)	0.01	0.01	0.08	0.11	0.47	0.06	0.18	0.06
Avg LID/biofilter inlet particulate strengths	2-isopropylnaphthalene	acenaphthylene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene
Total Particulate (>0.7 µm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Avg inspection port particulate strengths	2-isopropylnaphthalene	acenaphthylene	1.2-dimethylnaphthalene	1.8-dimethylnaphthalene	acenaphthene	2.3.5-trimethylnaphthalene	fluorene	1-methylfluorene
Total Particulate (>0.7 µm)	0.00	0.01	0.07	0.00	0.05	0.10	0.56	0.20

Avg inlet particulate strengths	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene	1-methylphenanthrene	9-methylanthracene	2-ethylanthracene	fluoranthene
0.7-2.7 µm	0.00	0.93	0.00	0.52	0.98	0.66	2.91	29.28
2.7-20 µm	0.42	0.02	0.06	0.00	0.03	0.00	0.03	1.50
20-63 µm	0.85	0.02	0.09	0.01	0.04	0.00	0.03	0.33
>63 µm	0.96	0.04	0.25	0.01	0.13	0.00	0.02	2.78
Total Particulate (>0.7 µm)	0.66	0.03	0.12	0.01	0.07	0.00	0.02	1.31
ratio to >0.7um								
0.7-2.7 µm	0.00	36.71	0.00	73.22	15.08	333.91	183.23	22.43
2.7-20 µm	0.64	0.69	0.51	0.43	0.47	0.00	1.82	1.15
20-63 µm	1.29	0.82	0.73	1.00	0.64	0.78	1.73	0.25
>63 µm	1.47	1.75	1.99	1.77	2.01	1.60	1.15	2.13
Avg outlet particulate strengths	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene	1-methylphenanthrene	9-methylanthracene	2-ethylanthracene	fluoranthene

Total Particulate (>0.7 µm)	1.16	0.02	0.14	0.01	0.07	0.00	0.04	1.12
Avg LID/biofilter inlet particulate strengths	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene	1-methylphenanthrene	9-methylanthracene	2-ethylanthracene	fluoranthene
Total Particulate (>0.7 µm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avg inspection port particulate strengths	phenanthrene	anthracene	2-methylphenanthrene	2-methylanthracene	1-methylphenanthrene	9-methylanthracene	2-ethylanthracene	fluoranthene
Total Particulate (>0.7 µm)	1.85	0.02	0.40	0.00	0.15	0.00	0.05	0.10

Avg inlet particulate strengths	pyrene	9.10-dimethylanthracene	2-tertbutylanthracene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene	7.12-methylbenz(a)anthracene
0.7-2.7 µm	72.78	1.35	0.31	1.38	3.28	14.93	9.07	0.34
2.7-20 µm	0.44	0.00	0.00	0.08	0.12	0.48	0.27	0.01
20-63 µm	3.07	0.00	0.00	0.01	0.14	0.46	0.23	0.01
>63 µm	0.86	0.00	0.00	0.04	0.11	1.47	0.58	0.01
Total Particulate (>0.7 µm)	1.18	0.00	0.00	0.03	0.10	0.76	0.36	0.01
ratio to >0.7um								
0.7-2.7 µm	61.93	4022.45	402.03	53.18	31.80	19.67	25.31	48.49
2.7-20 µm	0.37	2.30	6.54	3.20	1.15	0.63	0.76	1.36
20-63 µm	2.61	0.32	0.29	0.30	1.39	0.60	0.64	1.22
>63 µm	0.73	0.00	1.10	1.60	1.09	1.93	1.63	1.20
Avg outlet particulate strengths	pyrene	9.10-dimethylanthracene	2-tertbutylanthracene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene	7.12-methylbenz(a)anthracene
Total Particulate (>0.7 µm)	1.73	0.01	0.00	0.03	0.48	0.61	0.87	0.01

Avg LID/biofilter inlet particulate strengths	pyrene	9.10-dimethylanthracene	2-tertbutylanthracene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene	7.12-methylbenz(a)anthracene
Total Particulate (>0.7 µm)	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Avg inspection port particulate strengths	pyrene	9.10-dimethylanthracene	2-tertbutylanthracene	1-methylpyrene	benz(a)anthracene	chrysene	benzo(b)fluoranthene	7.12-methylbenz(a)anthracene
Total Particulate (>0.7 µm)	0.03	0.00	0.00	0.01	0.01	0.02	0.02	0.00

Avg inlet particulate strengths	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene	Total corrected PAH
0.7-2.7 µm	6.65	4.90	6.50	0.47	8.47	4.07	5.28	152.62
2.7-20 µm	0.22	0.06	0.28	0.00	0.17	0.09	0.42	0.71
20-63 µm	0.21	0.56	0.23	0.02	0.19	0.05	0.26	4.94
>63 µm	0.61	0.08	0.45	0.00	0.15	0.05	0.11	5.97
Total Particulate (>0.7 µm)	0.35	0.22	0.29	0.01	0.17	0.06	0.20	3.65
ratio to >0.7um								
0.7-2.7 µm	19.25	21.85	22.39	55.48	50.23	71.86	26.23	41.83
2.7-20 µm	0.64	0.27	0.98	0.29	1.02	1.61	2.07	0.19
20-63 µm	0.60	2.51	0.78	1.97	1.12	0.90	1.29	1.35
>63 µm	1.77	0.37	1.54	0.01	0.91	0.89	0.53	1.64
Avg outlet particulate strengths	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene	Total corrected PAH
Total Particulate (>0.7 µm)	0.83	0.57	0.70	0.09	1.07	0.33	0.51	0.00

Avg LID/biofilter inlet particulate strengths	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene	Total corrected PAH
Total Particulate (>0.7 µm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avg inspection port particulate strengths	benzo(k)fluoranthene	benzo(a)pyrene	benzo(e)pyrene	perylene	Indeno(123-cd)pyrene	Dibenzo(ah)anthracene	benzo(ghi)perylene	Total corrected PAH
Total Particulate (>0.7 µm)	0.02	0.01	0.02	0.01	0.02	0.00	0.02	0.00

Appendix B: PFAS Congeners Characteristics and Performance

PFAS congeners	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFOS	6:2 FTS
average inlet bulk (ng/L)	1.74	0.00	1.37	1.10	3.51	0.27	0.28	5.31	0.00
average outlet bulk (ng/L)	2.03	0.12	1.81	1.35	4.64	0.46	0.70	6.77	1.07
percent bulk reduction	-16.8262	n/a	-32.0735	-22.542	-32.1534	-65.6074	-150.504	-27.5736	n/a

analyzed but not detected: 4:2 FTS 8:2 FTS PFBS PFDoA PFDS PFHpS PFHxS PFNS PFOSA PFPeS PFTeA PFTrA PFUdA

Appendix C: Heavy Metals Characteristics and Performance

avg inlet before gabions	Filtered and Particulate Solids (mg/L)	Chromium (µg/L)	Manganese(µg/L)	Nickel (µg/L)	Copper (µg/L)	Zinc (µg/L)	Arsenic (µg/L)	Cadmium (µg/L)	Lead (µg/L)	Total mercury (ng/L)
Bulk	n/a	8.1	33.7	5.7	162.1	306.3	0.8	1.4	12.6	8.0
Total (>0.45 µm)	59.0	6.8	21.2	3.0	98.1	93.1	0.3	0.4	10.2	6.1
<0.45 µm	n/a	1.5	14.8	3.2	73.7	238.9	0.5	1.1	2.7	2.1
0.45-5 µm	1.6	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1
5-20 µm	14.4	1.2	2.3	1.4	47.7	0.1	0.1	0.0	1.9	0.4
20-63 µm	22.6	2.6	7.8	0.9	19.9	17.7	0.1	0.1	2.8	2.2
> 63 µm	31.7	3.9	14.5	1.3	45.8	87.1	0.2	0.3	7.8	4.3
fraction of >0.45 to bulk	n/a	0.84	0.63	0.53	0.60	0.30	0.43	0.29	0.81	0.76
fraction of <0.45 to bulk	n/a	0.18	0.44	0.56	0.45	0.78	0.63	0.83	0.21	0.27

avg outlet after all processes	Filtered and Particulate Solids (mg/L)	Chromium (µg/L)	Manganese(µg/L)	Nickel (µg/L)	Copper (µg/L)	Zinc (µg/L)	Arsenic (µg/L)	Cadmium (µg/L)	Lead (µg/L)	Total mercury (ng/L)
Bulk	n/a	1.3	5.0	1.5	10.6	9.9	0.3	0.1	2.6	2.8
Total (>0.45 µm)	2.2	0.4	2.4	0.9	5.2	1.5	0.0	0.0	0.7	0.7
<0.45 µm	n/a	0.8	2.6	0.6	5.4	8.4	0.3	0.1	1.9	2.1
0.45-5 µm	1.0	0.1	0.2	0.0	0.9	0.0	0.0	0.0	0.0	0.0
5-20 µm	1.8	0.9	1.9	1.8	9.1	2.5	0.0	0.0	1.7	1.5
20-63 µm	0.1	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	0.0
> 63 µm	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
fraction of >0.45 to bulk	n/a	0.36	0.48	0.58	0.49	0.15	0.09	0.08	0.28	0.24
fraction of <0.45 to bulk	n/a	0.64	0.52	0.42	0.51	0.85	0.91	0.92	0.72	0.76

avg inspection port after biofilter	Filtered and Particulate Solids (mg/L)	Chromium (µg/L)	Manganese(µg/L)	Nickel (µg/L)	Copper (µg/L)	Zinc (µg/L)	Arsenic (µg/L)	Cadmium (µg/L)	Lead (µg/L)	Total mercury (ng/L)
Bulk	n/a	1.6	357.7	2.2	22.3	63.5	1.2	0.4	1.9	2.8
Total (>0.45 µm)	3.1	0.2	104.2	0.1	5.0	17.5	0.1	0.1	0.4	0.8
<0.45 µm	n/a	1.4	253.5	2.0	17.4	46.0	1.1	0.3	1.5	2.0
fraction of >0.45 to bulk	n/a	0.13	0.29	0.06	0.22	0.28	0.06	0.21	0.21	0.28
fraction of <0.45 to bulk	n/a	0.87	0.71	0.94	0.78	0.72	0.94	0.79	0.79	0.72

avg LID after gabion before biofilter	Filtered and Particulate Solids (mg/L)	Chromium (µg/L)	Manganese(µg/L)	Nickel (µg/L)	Copper (µg/L)	Zinc (µg/L)	Arsenic (µg/L)	Cadmium (µg/L)	Lead (µg/L)	Total mercury (ng/L)
Bulk	n/a	5.6	64.8	5.5	160.8	409.1	1.2	1.6	11.5	7.5
Total (>0.45 µm)	45.9	3.3	9.9	2.0	124.0	191.1	0.2	0.7	3.9	4.3
<0.45 µm	n/a	2.3	54.9	3.4	71.6	218.0	0.9	0.9	7.6	3.2
fraction of >0.45 to bulk	n/a	0.60	0.15	0.37	0.77	0.47	0.20	0.41	0.34	0.57
fraction of <0.45 to bulk	n/a	0.40	0.85	0.63	0.45	0.53	0.80	0.59	0.66	0.43

percentage gabion reduction										
(inlet vs LID)	Filtered and Particulate Solids	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	Mercury
Filtered (<0.45µm)	n/a	-51.6	-271.7	-7.0	2.8	8.8	-91.1	16.2	-181.0	-50.1
Total Particulate (>0.45 µm)	22.2	51.2	53.2	32.2	-26.5	-105.2	28.7	-64.7	62.1	29.8
Bulk	n/a	30.9	-92.2	4.4	0.8	-33.6	-50.4	-17.8	9.2	6.9
percentage biofilter reduc										
(LID vs insp port)	Filtered and Particulate Solids	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	Mercury
Filtered (<0.45µm)	n/a	39.5	-362.1	40.7	75.8	78.9	-21.8	67.1	80.1	36.9
Total Particulate (>0.45 µm)	93.2	93.7	-951.4	93.7	96.0	90.8	71.8	87.5	89.7	81.5
Bulk	n/a	71.7	-452.3	60.5	86.1	84.5	-2.9	75.5	83.3	62.3
percentage media reduc										
(insp port vs outlet)	Filtered and Particulate Solids	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	Mercury
Filtered (<0.45µm)	n/a	41.1	99.0	69.5	68.8	81.8	76.4	55.6	-22.8	-4.7
Total Particulate (>0.45 µm)	28.9	-111.7	97.7	-577.2	-4.3	91.5	59.6	85.8	-83.4	14.7
Bulk	n/a	20.7	98.6	31.2	52.5	84.5	75.4	61.9	-35.4	0.8
overall percentage reduction										
inlet vs outlet	Filtered and Particulate Solids	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	Mercury
Filtered (<0.45µm)	n/a	46.0	82.2	80.6	92.7	96.5	44.9	87.8	31.2	0.8
Total Particulate (>0.45 µm)	96.2	93.4	88.7	71.2	94.7	98.4	91.9	97.1	92.8	89.0
bulk	n/a	84.5	85.1	74.0	93.5	96.8	62.0	89.0	79.5	65.2
0.45-5 µm reduction	40.6	40.7	29.2	100.0	-1079.9	n/a	-14.5	n/a	n/a	100.0
5-20 µm reduction	87.2	27.3	16.2	-34.4	80.9	-3289.1	87.6	n/a	14.6	-248.0
20-63 µm reduction	99.6	100.0	95.6	70.5	100.0	98.2	88.8	96.7	98.6	100.0
> 63 µm reduction	99.4	100.0	98.3	100.0	100.0	100.0	93.6	99.8	100.0	100.0

Average inlet particulate strengths	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	units	Total mercury	units
Bulk-water	8.1	33.7	5.7	162.1	306.3	0.8	1.4	12.6	µg/L	8.0	ng/L
Filtered water (< 0.45 µm)	1.3	12.5	2.7	64.0	213.1	0.4	1.0	2.1	µg/L	2.0	ng/L
Total Particulate (> 0.45 µm)	127.3	421.7	66.4	1620.1	1664.1	6.4	7.5	157.6	mg/kg	117.0	ug/kg
Particulate (0.45 -5 µm)	114.3	133.4	0.5	45.1	0.0	4.7	0.0	0.0	mg/kg	33.2	ug/kg
Particulate (5-20 µm)	89.4	169.1	97.0	2952.8	6.0	5.1	0.0	166.6	mg/kg	38.6	ug/kg
Particulate (20-63 µm)	155.8	455.2	78.5	1221.6	1158.1	5.4	7.5	79.5	mg/kg	118.4	ug/kg
Particulate (> 63 µm)	112.6	703.1	33.8	1505.0	4222.7	5.6	17.4	209.4	mg/kg	191.2	ug/kg
ratio of size value to total part	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead		Total mercury	
Particulate (0.45 -5 µm)	0.9	0.3	0.0	0.0	0.0	0.7	0.0	0.0		0.3	
Particulate (5-20 µm)	0.7	0.4	1.5	1.8	0.0	0.8	0.0	1.1		0.3	
Particulate (20-63 µm)	1.2	1.1	1.2	0.8	0.7	0.8	1.0	0.5		1.0	
Particulate (> 63 µm)	0.9	1.7	0.5	0.9	2.5	0.9	2.3	1.3		1.6	
average outlet particulate strengths	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	units	Total mercury	units
Bulk-water	1.3	5.0	1.5	10.6	9.9	0.3	0.1	2.6	µg/L	2.8	ng/L
Filtered water (< 0.45 µm)	0.8	2.6	0.6	5.4	8.4	0.3	0.1	1.9	µg/L	2.1	ng/L
Total Particulate (> 0.45 µm)	154.4	1091.5	281.1	1894.8	531.0	14.3	5.5	367.3	mg/kg	188.3	ug/kg
Particulate (0.45 -5 µm)	76.9	131.4	0.0	809.1	0.0	1.8	0.0	0.0	mg/kg	0.0	ug/kg
Particulate (5-20 µm)	509.1	1104.4	1065.9	5206.3	1446.0	4.4	8.9	822.1	mg/kg	906.5	ug/kg
Particulate (20-63 µm)	0.0	0.0	0.0	0.0	0.0	33.5	0.0	461.2	mg/kg	0.0	ug/kg
Particulate (> 63 µm)	0.0	3188.2	0.0	0.0	0.0	165.0	3.8	0.0	mg/kg	0.0	ug/kg
ratio of size value to total part	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead		Total mercury	
Particulate (0.45 -5 µm)	0.5	0.1	0.0	0.4	0.0	0.1	0.0	0.0		0.0	
Particulate (5-20 µm)	3.3	1.0	3.8	2.7	2.7	0.3	1.6	2.2		4.8	
Particulate (20-63 µm)	0.0	0.0	0.0	0.0	0.0	2.3	0.0	1.3		0.0	
Particulate (> 63 µm)	0.0	2.9	0.0	0.0	0.0	11.6	0.7	0.0		0.0	
average LID/biofilter inlet particulate strength	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	units	Total mercury	units
Bulk-water	5.6	64.8	5.5	160.8	409.1	1.2	1.6	11.5	µg/L	7.5	ng/L
Filtered water (< 0.45 µm)	2.3	54.9	3.4	71.6	218.0	0.9	0.9	7.6	µg/L	3.2	ng/L
Total Particulate (> 0.45 µm)	82.2	250.0	62.3	3919.1	6582.0	6.5	21.7	91.2	mg/kg	109.5	ug/kg
average inspection port particulate solids	Chromium	Manganese	Nickel	Copper	Zinc	Arsenic	Cadmium	Lead	units	Total mercury	units
Bulk-water	1.6	357.7	2.2	22.3	63.5	1.2	0.4	1.9	µg/L	2.8	ng/L
Filtered water (< 0.45 µm)	1.4	253.5	2.0	17.4	46.0	1.1	0.3	1.5	µg/L	2.0	ng/L
Total Particulate (> 0.45 µm)	76.6	50417.5	56.9	2166.3	6792.9	28.6	33.7	66.7	mg/kg	427.8	ug/kg