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Paired Sample Statistical Evaluations of Performance of Stormwater Controls as Monitored during SERDP Project: *Development of Tools to Inform the Selection of Stormwater Controls at DoD Bases to Limit Potential Sediment Recontamination*

Contents

Abstract

This report evaluated stormwater treatment performance for the SERDP monitored sites (*Development of Tools to Inform the Selection of Stormwater Controls at DoD Bases to Limit Potential Sediment Recontamination*) grouped by treatment technologies. Prior evaluations for each site individually were limited by the amount of available data at each location. Paired influent and effluent concentrations were then re-examined when all of the site data became available using several graphical and statistical tools for data grouped into sedimentation, media filter, and bioinfiltration treatment categories. From five to eight data pairs for a variety of particulate, heavy metal, PFAS congener, and PAH compounds were available for these additional analyses reported in this report. This is still a relatively small amount of data, and the results are not as statistically robust as desired. However, the results are generally consistent, and the paired influent/effluent sample evaluations covered a wide range of site locations, rain characteristics, and pollutants.

Sedimentation resulted in high removals of the largest particulates, with less benefits for smaller particulates. Pollutants strongly associated with the larger particulates were therefore similarly removed at high rates, with poorer removals for pollutants associated with fines or filtered pollutant forms. Chromium, lead, nickel, and zinc had moderate to high removals, while copper had low removals. Sedimentation had no significant removals for PFAS compounds but had moderate to high removals for PAHs.

Media cartridge filter treatment (usually with hydrodynamic separator pretreatment) also had their best removals for large particulates but had mixed removals of heavy metals (highest removals for lead and zinc, and lowest removals for chromium, copper, and nickel). PFAS removals were generally poor and mixed, a few had low to moderate removals, but most had increased effluent concentrations. Media cartridge filters resulted in many moderate to high removals of PAHs, but some also had higher effluent concentrations.

Bioinfiltration had high removals for particulate solids with low constant effluent concentrations, except for the smallest particle sizes that had increased effluent concentrations likely due to media fines being washed out. Bioinfiltration had high removals of copper, nickel, and zinc, and moderate removals of chromium and lead (except for negative removals for filtered lead). Bioinfiltration had moderate to high removals of several PFAS congeners and moderate to high removals of many PAHs.

The bioinfiltration installations were relatively large compared to their drainage areas, in contrast to the media filter installations. The resulting treatment flow rates and media contact times were therefore different and likely the reason for the general increased relative performance for the bioinfiltration devices compared to the media filters. The bioinfiltration devices also included stormwater infiltration that would further decrease mass discharges of pollutants to the surface receiving waters, with some (estimated to be about 70% for the biofilter installation) infiltrated and retained in the vadose zone soils or directed to the groundwater, depending on the characteristics of the pollutants and soils. Therefore, based on these results, the most robust treatment controls for a wide range of constituents of concern would be large bioinfiltration systems, if space is available for their installation. The selection of suitable treatment media in the biofilters can also enhance their performance and can be selected to target specific constituents.

Summary

The purpose of this paper is to present the results of statistical and graphical evaluations of paired influent and effluent data from monitored stormwater controls from several locations in Lubbock, TX, San Diego, CA, and Bremerton, WA. These data were obtained during monitoring by the Texas Tech research group and local cooperators during the SERDP Project: *Development of Tools to Inform the Selection of Stormwater Controls at DoD Bases to Limit Potential Sediment Recontamination*. Prior reports presented the data with descriptions of the sites and monitoring programs and data evaluations for each location. This report is a final evaluation of the stormwater control evaluations using these combined data focusing on the main treatment technologies monitored.

Paired influent and effluent data from seven locations were used to calculate the statistical significance of the concentration changes associated with treatment. The data were combined into three technology categories to increase the number of data pairs available: sedimentation processes, media filtration, and bioinfiltration. The monitored constituents were also grouped into four groups: particulates by particle size, heavy metals, PFAS congeners, and PAH compounds. The data for the constituents were available for particulate and filtered forms, along with particle size ranges, when detected. Few data were available on treatment performance for the different particle sizes for the organic constituents due to low concentrations resulting in many non-detected observations.

Site Descriptions and Initial Performance Observations

This summary briefly describes the monitoring locations and sampling efforts, along with the preliminary observations relating to the stormwater treatment performance. Few data were available at each location so these initial observations were only apparent based on overall average influent and effluent concentrations with no statistical analyses possible.

The monitoring at the Reese Technology Center in Lubbock, TX, focused on influent stormwater (255 acres drainage area) to the 4-acre Picnic Lake and in-lake samples. Two events were monitored at the several locations at this location. The site report showed that the median size for the stormwater samples was about 100 µm, while it was only about 10 µm for the in-lake samples. There were very few in-lake particles greater than 64 µm, while about 75% of the stormwater samples were greater than 64 µm, indicating the preferential removal of the larger particles through sedimentation. The stormwater particulate solids average concentration was about 730 mg/L, while the average in-lake particulate solids concentration was about 50 mg/L, indicating large concentration reductions. The apparent concentration reductions for the heavy metals and PAHs were also high.

Two locations were monitored at Naval Base San Diego, the Commissary Bioinfiltration System and the Federal Credit Union Bioswale. These both had drainage areas of about 0.38 acres, and three events were monitored at each of these two locations. At the bioinfiltration site, many of the outlet metal concentrations for the smallest particle size range were greater than the influent concentrations, likely due to washout of media fines. In all cases, the apparent metal removals associated with particles greater than 20 µm were large. The overall total sample apparent reductions are low to moderate for most of the metals, while arsenic and mercury outlet concentrations for the total samples indicated increases after treatment. The median size associated with TSS was about 20 µm for the inlet samples, which was reduced to about 10 µm for the effluent samples. Overall, the Commissary bioinfiltration system was most effective in capturing the larger particles, while being less effective capturing the small particles. Many of the PAH removals associated with the smallest particle size ranges could not be calculated due to missing (non-detected) values. Overall, the apparent PAH concentration reductions were moderate to high. As with the metals, the removals for the individual PAHs were greatest for the large particles compared to the small particles, but there was substantial variability in the removals. PFAS data were only available for the total sample, filtered sample, and particulate sample fractions. The particulate bound concentrations were too small to be analyzed for different particle size ranges. The PFAS concentration removals were highly variable. At the Federal Credit Union Bioswale site, the influent median particle size was about 15 µm which was reduced to about 11 µm at the effluent location. Most of the heavy metals were associated with particles less than about 20 to 50 µm. There were no obvious patterns comparing the influent and effluent PAH concentrations at the bioswale location. Most of the PAH mass was associated with particles smaller than about 50 µm. No filterable PFAS concentrations or values associated with different particle size ranges were available due to the low concentrations.

The Naval Base Point Loma (adjacent to the Naval Base San Diego) site included monitoring of a media bed stormwater control. Three rains were monitored at this location, the average influent suspended solids concentration was about 70 mg/L, and the average outlet effluent concentration was reduced to about 3 mg/L. Particles larger than 20 µm were almost completely removed while the smallest size range particles had less removal. Overall, the treatment system had high removals of the total PAHs, while the filtered forms were not reduced, on the average. The only PFAS congener data available was for the bulk inlet and outlet samples. In all cases, the concentrations increased at the outlet location compared to the inlet location.

Three locations were monitored at the Puget Sound Naval Base which were treatment train systems; a hydrodynamic separator followed by cartridge media filters. Two events were sampled at the Pier B media filter (after the hydrodynamic separator), three events were sampled at the Recycled Metal Transfer Station (RMTS) hydrodynamic separator and media filter, and four events at the hydrodynamic separator at the Metals Yard. The median particle size after the hydrodynamic separator was about 30 µm and was reduced to about 12 µm after the media filters at Pier B. There were no patterns of apparent concentration reductions with the media filter treatment. Most of the PFAS compounds had large associations with the filtered samples in both the inlet and outlet samples. The TSS concentrations for the three events at the RMTS hydrodynamic separator/media filter treatment location were very low, with an average inlet concentration of only 17.5 mg/L and the treated effluent concentrations were only slightly reduced to an average of 13.6 mg/L. Most of the TSS mass was associated with the 5 to 63 µm particle size range in the influent and effluent samples, with average median particle sizes of about 15 µm. Lead had the most consistent positive removals for all particle sizes, while most of the other metals indicated concentration increases for many size ranges. The concentrations of the monitored PAHs were all very low. The particulate PAH concentrations had moderate reductions with treatment, while the filtered PAH concentrations indicated increased concentrations for many of the PAHs with treatment. The PFAS congener concentrations were also very low. The highest average influent PFAS concentration was for PFOA, followed by PFBA and PFOS. There were no likely concentration reductions of PFAS congeners with treatment. At the Metals Yard hydrodynamic separator site, most of the TSS mass was associated with particles between about 5 and 64 µm, with median sizes of about 15 µm for both influent and effluent samples. Most of the PAHs had apparent low to moderate concentration reductions associated with treatment by the hydrodynamic separator.

Paired Statistical and Graphical Analyses using Grouped Sites Data

The data available at each of the sites were only for a few events (2 to 4), which were not sufficient to calculate the statistical significance of the concentration changes observed. Therefore, paired sample evaluations of grouped sites for each of three treatment technologies (sedimentation, media filters, and bioinfiltration) were used to increase the confidence of the results. A total of five events were available for the sedimentation results (Reese Picnic Pond and NBPS metals yard hydrodynamic separator), eight events were available for the media filters (NBPS Pier B and RMTS cartridge filter systems and the NBPL media bed), and five events were available for bioinfiltration systems (NBSD Commissary and Federal Credit Union systems). These were further reduced due to missing information associated with non-detected influent constituent concentrations. Therefore, a set of complementary graphical and statistical tools were used to develop a set of evidence supporting the limited observations: summary statistics of influent and effluent concentrations, scatterplots of influent vs. effluent concentrations, regression analyses with analysis of variance calculations to identify significant regression parameters, grouped probability plots to compare and contrast data distributions and confidence intervals of influent and effluent concentrations, Mann-Whitney nonparametric comparison tests, and box and whisker plots to graphically compare all sets of influent and effluent concentrations. The results of these analyses are included in Appendices A through H.

As noted previously, relatively few conditions resulted in statistically significant differences ($p \leq 0.05$) comparing the influent and effluent concentrations, so the summary list was expanded to include "marginal" differences ($0.05 < p \leq 0.10$). There were many more significant regression relationships than significant Mann-Whitney differences test results. The "high reductions" generally had >70% reductions, the "moderate reductions" generally had 30 to 70% reductions, and "low reductions" generally had <30% reductions. Also noted are conditions resulting in negative removals (effluent concentrations greater than influent concentrations), and conditions resulting in generally low constant effluent concentrations. The following lists constituents and treatment technologies having significant (and "marginal") differences between the influent and effluent concentrations:

TSS and Particle Sizes

- Sedimentation resulted in high removals, best with TSS and large size, moderate removals with smaller sizes
- Media filters were best on larger size and TSS resulting in constant low effluent concentrations
- Bioinfiltration had high removals for particulate solids resulting in low constant effluent concentrations, but with some increases of concentration with small sizes due to media washout

Heavy Metals

Chromium

- Sedimentation resulted in high removals of total and particulate bound Cr, and less for filtered Cr and other particle sized Cr
- Media filters resulted in low removals of particulate Cr, while filtered Cr resulted in increased effluent Cr concentrations
- Bioinfiltration had moderate removals of total and particulate Cr, and low reductions of filtered Cr. Increases in fine particle bound Cr concentrations were noted, along with high removals of large particle bound Cr concentrations

Copper

- Sedimentation had low and negative removals of total and filtered Cu concentrations
- Media filters had no apparent effects on the removal of Cu
- Bioinfiltration had high removals of all forms of Cu evaluated

Lead

- Sedimentation had high removals of particulate Pb concentrations, but had increased effluent concentrations of filtered Pb and fine particle associated Pb
- Media filters had moderate total, filtered and mid-sized Pb concentration removals with low constant effluent concentrations of large particle bound Pb.
- Bioinfiltration had moderate removals for total and particulate Pb, increases in filtered Pb effluent concentrations, and high removals of large particle bound Pb with the largest particle bound Pb having constant low effluent concentrations

Nickel

- Sedimentation had high removals of total, particulate, and filtered Ni concentrations
- Media filters had no significant (or marginal) removals for Ni
- Bioinfiltration had relatively constant effluent concentrations for the largest nickel bound particulates

Zinc

- Sedimentation had increased effluent concentrations for total, particulate, and filtered Zn concentrations
- Media filters had moderate total and filtered Zn concentration removals and low removals of intermediate-sized Zn particles
- Bioinfiltration had high removals of total and particulate Zn concentrations, and moderate removals of small particle bound Zn. Effluent large particle bound Zn concentrations were consistently low

PFAS Congeners

- Sedimentation had no significant (or marginal) removals of PFAS compounds
- Media filter removals of PFAS compounds were mixed, with most showing effluent concentration increases with only a few having moderate and low reductions
- Bioinfiltration had moderate to high removals of several PFAS compounds, with one (particulate PFOS) having increased effluent concentrations, and one (particulate PFHpA) having constant low effluent concentrations

PAH Compounds

- Sedimentation resulted in many of the particulate and filtered PAH compounds having moderate to high concentration reductions, with several particulate PAHs having consistently low effluent concentrations
- Media filters resulted in many moderate to high particulate and filtered PAH removals, but also with many increased effluent concentrations. Particulate chrysene had generally constant low effluent concentrations
- Bioinfiltration resulted in moderate removals of many filtered PAHs with several particulate PAHs having constant low effluent concentrations

As expected, sedimentation was most effective for constituents mostly associated with larger particles, even though some filtered constituent removals were observed in the sedimentation group. The media cartridge filters, and the hydrodynamic separator, were part of treatment trains. The bioinfiltration installations were relatively large compared to the drainage areas, in contrast to the media filter installations. The resulting treatment flow rates and media contact times were therefore different and likely the reason for the general increased relative performance for the bioinfiltration devices compared to the media filters. The bioinfiltration devices also included stormwater infiltration that would decrease mass discharges of pollutants to the surface receiving waters, with some (estimated to be about 70% for the biofilter installation) infiltrated and retained in the vadose zone soils or directed to the groundwater, depending on the characteristics of the pollutants and soils.

Therefore, based on these results, the most robust treatment controls for a wide range of constituents of concern would be large bioinfiltration devices, if space is available for their installation. The selection of suitable treatment media would also enhance their performance and can be selected to target specific constituents.

Site and Monitoring Effort Descriptions and Site Data Evaluations

This section summarizes selected information previously presented in the individual site reports. Site characteristics, treatment system descriptions, and monitored events are briefly presented here, while the seven individual site reports also include detailed stormwater characteristic descriptions, comparisons with historical monitoring data (when available), preliminary WinSLAMM modeling, and characteristics affecting fate and transport of discharged stormwater pollutants. Initial stormwater treatment performance information is also presented in the site reports (and summarized in the following subsections). These performance calculations were mostly based on average influent and effluent concentration changes for all events combined. The few data pairs available for each site did not allow more robust statistical analyses. Later sections of this report focus on available paired data for combined sites having similar treatment technologies for more robust treatment performance results. Therefore, the performance comments in this section for the individual sites are apparent concentration changes due to the treatment but are not supported with statistical confidence analyses (as presented later in this report).

Reese Technology Center, Lubbock, TX

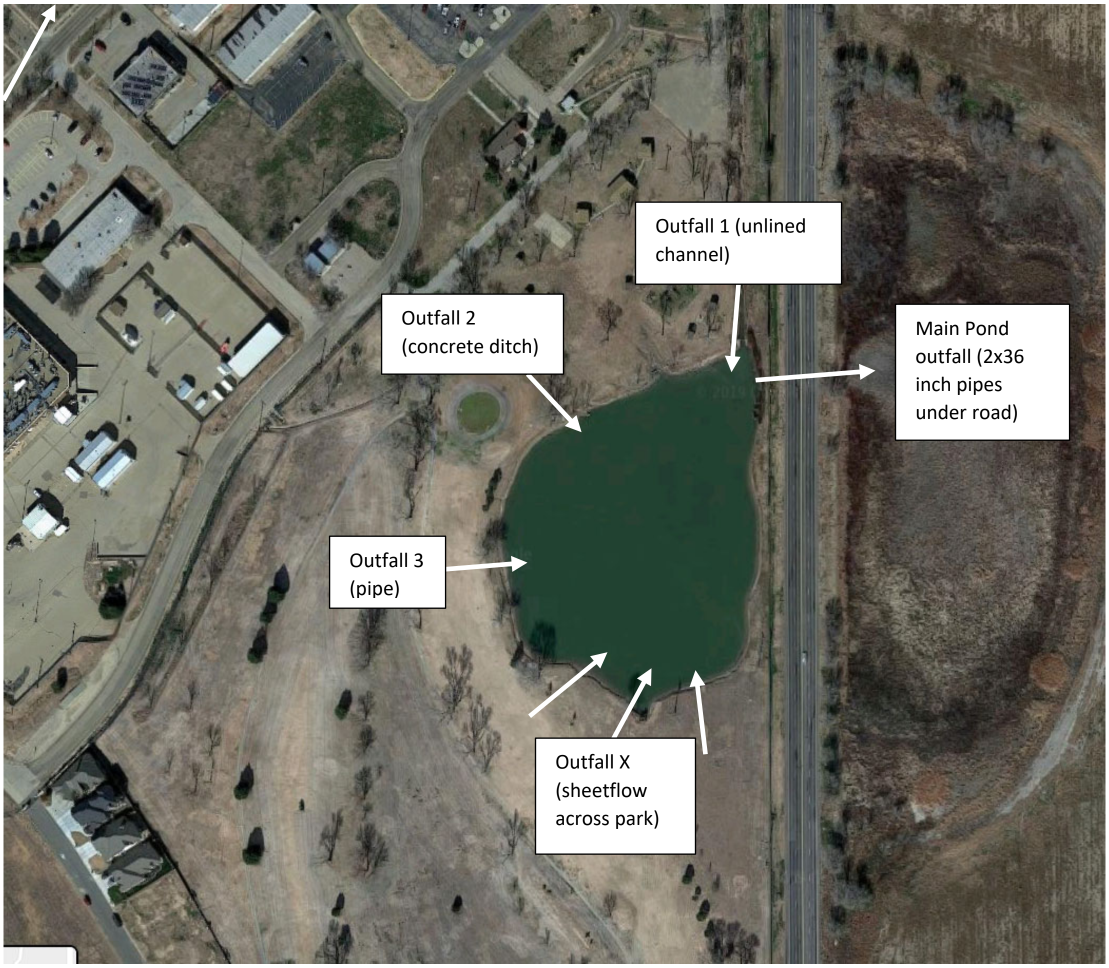
Stormwater and Picnic Lake water quality were monitored by researchers at Texas Tech University located near the site, the Reese Technology Center near Lubbock, Texas. The site is a decommissioned US Air Force base that is being converted to multiple uses and is shown on the following figure. The total drainage area to the 4-acre lake is about 255 acres. The lake is therefore about 1.6% of the drainage area. About half of the total area is comprised of directly connected paved areas (mainly parking areas and the old airfield apron, plus streets, roofs, and walkways).

Of the two events monitored, one had about a 25mm rainfall and was widespread over the Lubbock area, while the other event was very small and localized (with no rainfall recorded by the National Weather Service).

Picnic Lake

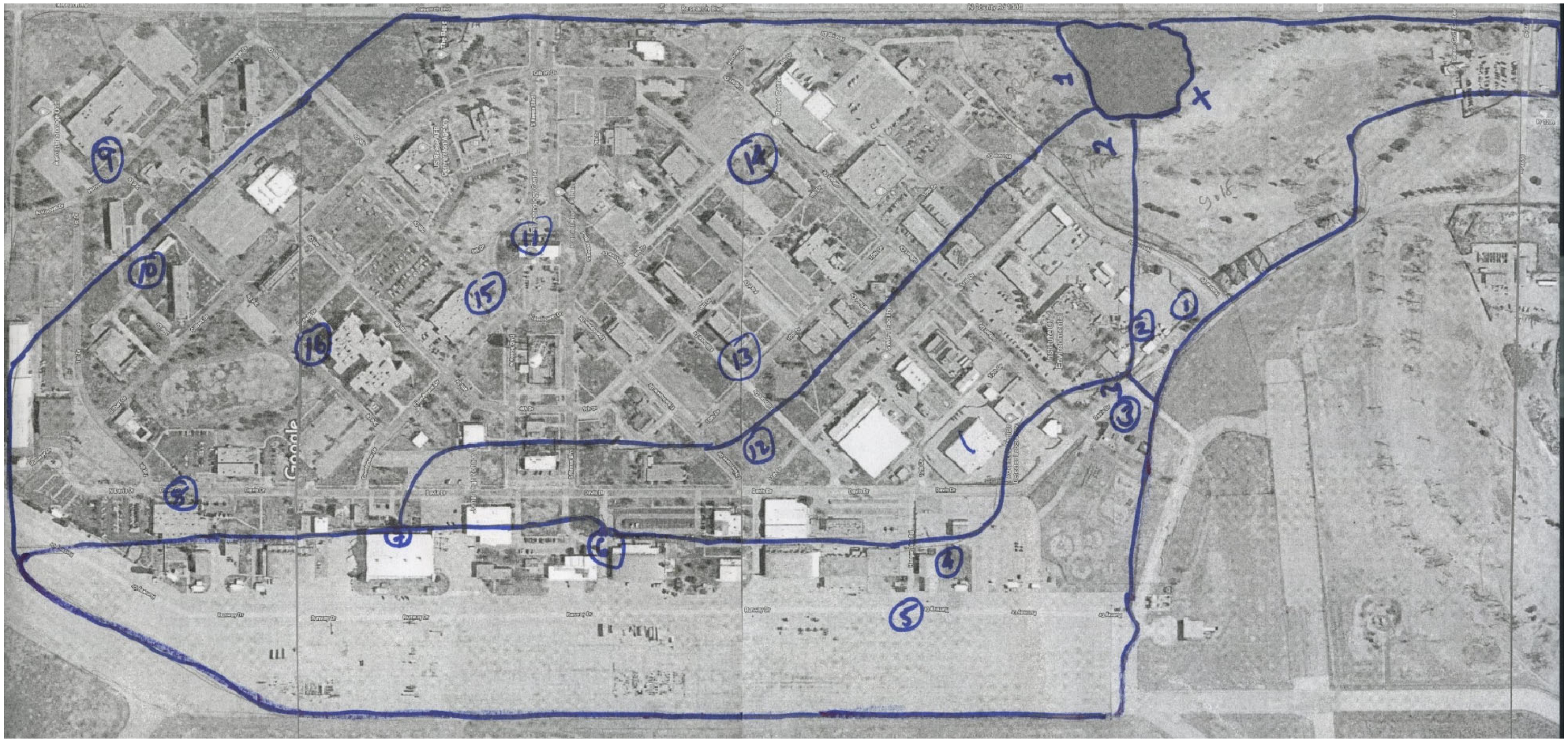
Reese Technology Center (Google Map image supplied by TT)

The following figure is an aerial image showing Picnic Lake and the stormwater discharge locations to the lake. The lake is a wet detention pond serving much of the developed Reese Technology Center area.



Picnic Lake and outfalls (Google Map image supplied by TT)

The following figure is a composite of several Google Earth images showing the four drainage areas to Picnic Lake. These drainages are shown as area 1, 2, 3, and X. Drainage from the X watershed area enters the pond mostly as sheetflow across the park area around the pond. The drainage areas were determined using detailed stormwater drainage maps and topography maps from Reese Technology Center, supplemented by site surveys of the perimeters to verify drainage divides. The following table summarizes the main characteristics of the lake drainage areas.



Reese Technology Center drainage areas to Picnic Lake and locations of site surveys

Total Drainage Area to Picnic Pond Characteristics

	large pvd (old runway) - concrete, directly connected	pvd storage/parking areas. Directly connected	roofs - flat dir connected	roofs - pitched disconnected	streets, narrow (26 ft wide)	streets, wide (36 ft wide)	walkways, disconnected	large turf areas, silty soils, normal compaction	total area
acres	34.85	42.93	20.64	0.07	1.88	30.74	2.21	122.10	255.43
% of total area to pond	13.6	16.8	8.1	0.0	0.7	12.0	0.9	47.8	100.00

Many of the size-related PAH concentrations were not detected, especially for the in-lake samples. The stormwater PAH concentration trends with size were not as obvious as for the metals and particulates.

Pollutant particulate strengths associated with different particle sizes were also evaluated. The particulate strengths were similar for the stormwater and lake samples for each size range as they originate from the same source. The lake has fewer larger suspended particles compared to the stormwater, and the overall concentrations are much lower. This resulted in many non-detected concentration observations for the lake water. Ratios of pollutant strengths for the different particle sizes were compared to the total bulk particulate strength.

Total particulate solids size distributions from the stormwater samples are distinctly different from the in-lake samples. The median size for the stormwater samples was about 100 µm, while it was only about 10 µm for the in-lake samples. There were very few in-lake particles greater than 64 µm, while about 75% of the stormwater samples were greater than 64 µm, substantiating the preferential removal of the larger particles through sedimentation.

The stormwater particulate solids average concentration was about 730 mg/L (high for typical stormwater, but possible affected by erosion in the unlined stormwater channel conveyances). The average in-lake particulate solids concentration was about 50 mg/L, indicating an apparent 93% reduction. The apparent concentration reductions for the heavy metals ranged from about 60 to 90%. Most of the PAHs indicate large apparent reductions in concentrations between the stormwater and in-lake samples. Most of the apparent unfiltered PAH concentration reductions were very high >90%), with the filtered concentration reductions being less, but still high (80 and 90% apparent reductions).

Naval Base San Diego

NBSD Commissary Bioinfiltration System

The following is a summary of the site and data descriptions provided by the Texas Tech research group: "This spreadsheet contains the sampling and analytical data for NBSD - commissary site. The parking lot site has a drainage area of 0.38 acres and runoff enters the bioinfiltration system (storage capacity of ~ 600 cf) through two curb inlets under normal conditions. For the purpose of our sampling, we closed the inlet furthest away from the BMP device with landscape edging and foam sealant. The other inlet was provided with a H-flume for ease of sampling the incoming runoff. This also turned out to be useful for flow measurements as in some cases the area-velocity flow meter stopped working during sampling. In such cases, we estimated the flow values using the level and bioinfiltration capacity as detailed below. A total of 3 events were sampled for both flow and contaminant of concern (CoC) analysis."

As noted above, three events were sampled at this location. The PAHs and metals were evaluated by particle size range, while the PFAS were only evaluated for particulate bound and filtered fractions, due to low concentrations. The following table describes the three monitored events.

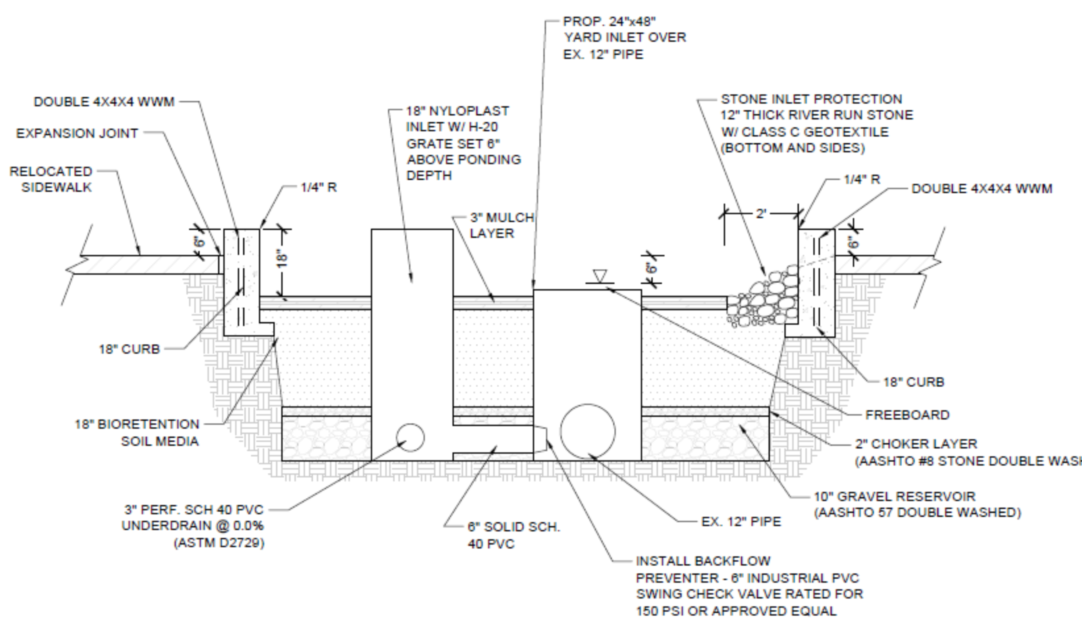
		Rain depth	Rain duration (hrs)
Event 1	February 22, 2020	0.29	1.25
Event 2	March 3, 2020	0.14	13.8
Event 3	March 10, 2020	n/a	n/a

Note: rain gauge for event 3 did not record the rain depth due to clogging

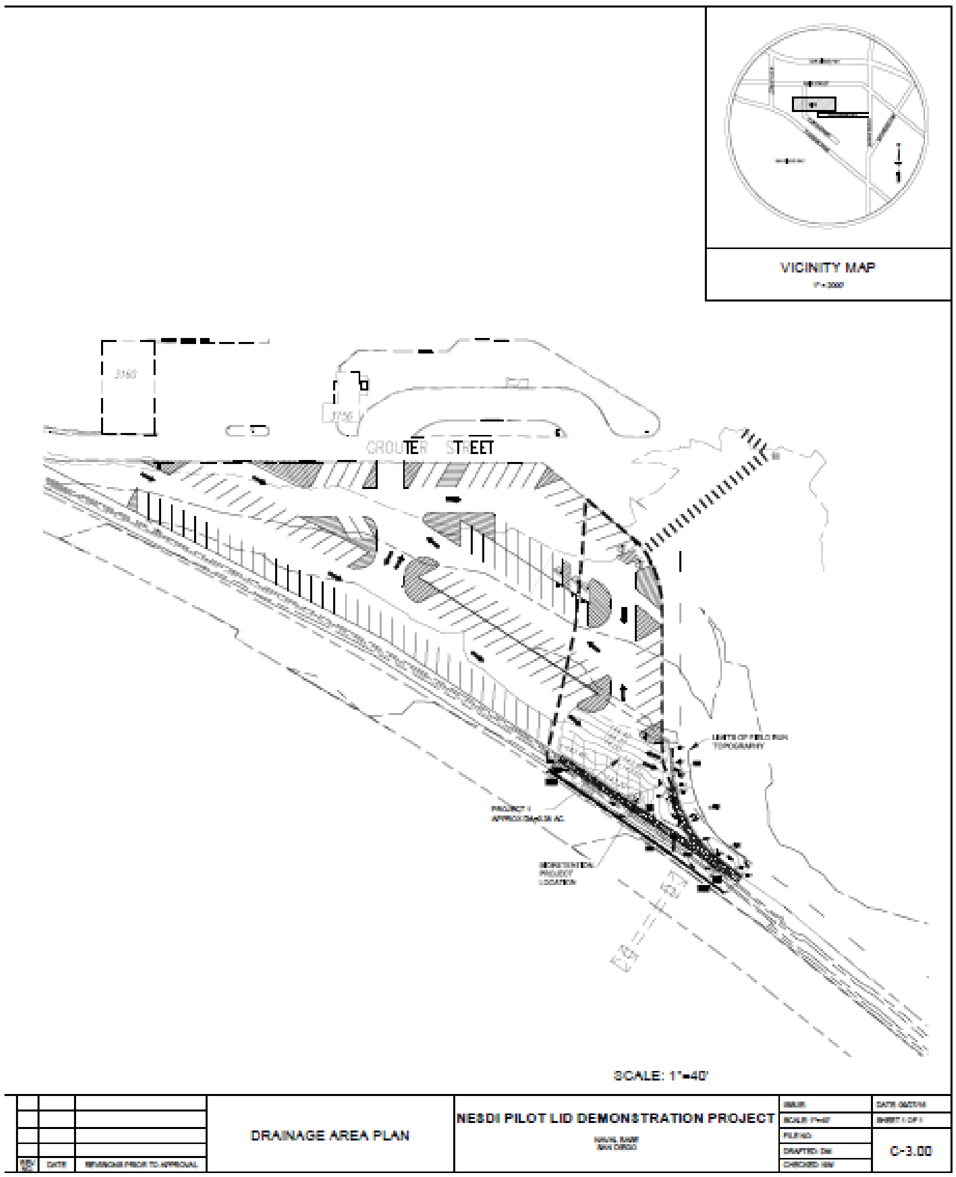
The following table and figures were provided by the Low Impact Development Center during the earlier project for the Navy that constructed the bioinfiltration system.

Drainage Area (ac)	Drainage Area (sf)	Surface Area (sf)	Ponding Depth (ft)	Ponding Storage (cf)	Mulch Depth (ft)
0.38	16,550	400	0.5	200	0.17

Mulch Storage (cf)	Media Depth (ft)	Media Storage (cf)	Gravel Depth (ft)	Gravel Storage (cf)	Total Storage (cf)
27	1.5	240	0.83	133	600



Bioinfiltration System Details (Low Impact Development Center).



Bioinfiltration System Drainage Area

The pollutant reductions reported were only for inlet vs. outlet concentrations and did not reflect mass reductions that would also be affected by runoff infiltration losses with the bioinfiltration system. The modeled system had an estimated 70% runoff volume reduction during long-term simulations.

Many of the outlet metal concentrations for the small particle size ranges show negative apparent removals (increasing concentrations) likely due to washout of media fines or previously captured material. In all cases, the metal removals associated with particles greater than 20 µm are large. The overall total sample apparent reductions are low to moderate for most of the metals, while arsenic and mercury outlet concentrations for the total samples indicate increases after the bioinfiltration system treatment.

The median size associated with TSS was about 20 µm for the inlet samples, which was reduced to about 10 µm for the effluent samples. Typical sizes associated with the inlet median metal concentrations ranged from about 15 to 50 µm, while the sizes associated with the outlet median concentrations ranged from about 2 to 15 µm. Overall, the Commissary bioinfiltration system was most effective in capturing the larger particles, while being less effective with capturing of the small particles. All of the metals, except for chromium and arsenic, had larger particulate strengths associated with the large particles (>63 µm) compared to the other size ranges.

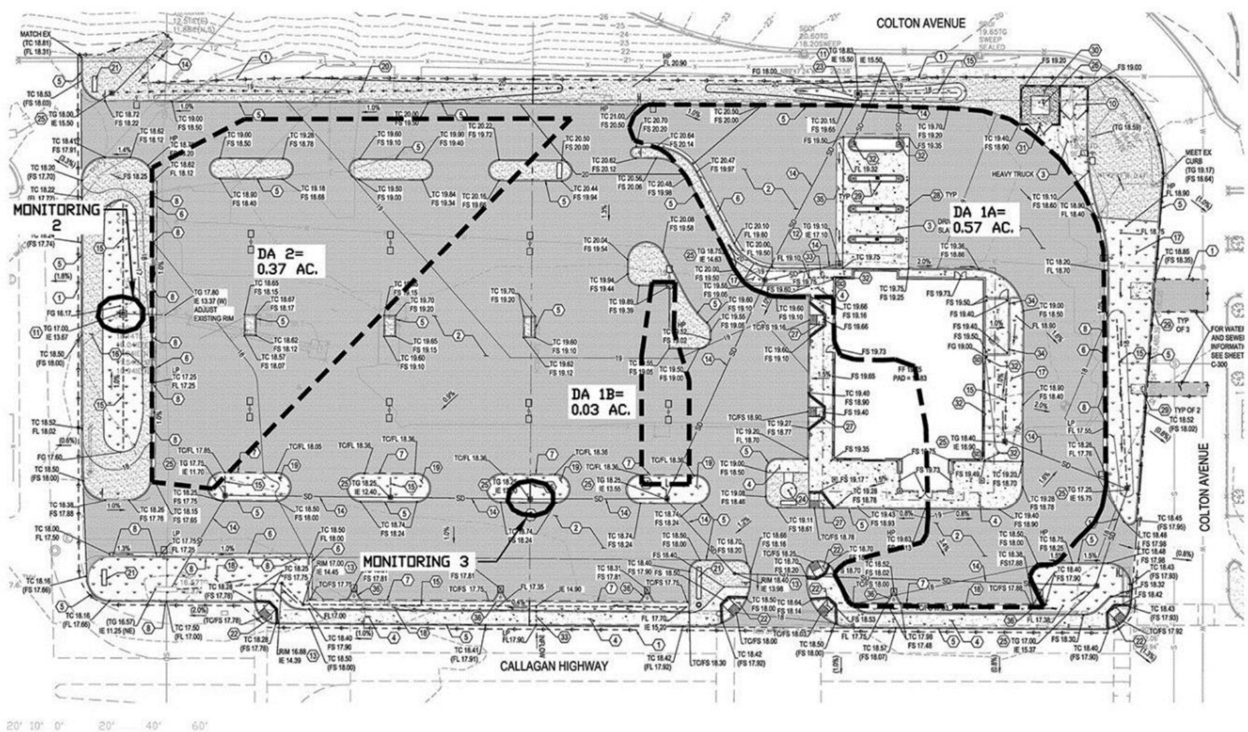
Many of the PAH removals associated with the smallest particle size range could not be calculated due to missing (non-detected) values. Overall, the apparent PAH concentration reductions were moderate to high. The total apparent PAH reductions were 91% for the total sample, 94% for the particulate bound sample fraction, and 60% for the filtered sample fraction. In general, the removals for the individual PAHs were greatest for the largest particles compared to the smallest particles, but there was substantial variability in the removals. In all cases, the inlet samples were associated with larger particle sizes (20 to >80 µm) associated with the median concentrations, compared to the outlet samples (7 to 20 µm). The bioinfiltration system preferentially removed the larger particles, with the smaller particles less effectively removed. In most cases, the PAH particulate strengths were highest for the largest (>63 µm) particle size range.

PFAS data were available for the total sample, filtered sample, and particulate sample fractions. The particulate bound concentrations were too small to be analyzed for different particle size ranges. The PFAS concentration removals were highly variable.

Credit Union Bioswale

This section contains the sampling and site descriptions for the NBSD Navy Federal Credit Union stormwater management site, as provided by information from the Texas Tech research group and from a prior stormwater report from NBSD. The drainage area was estimated as 0.37 acres and was comprised of an asphalt paved parking area with two small, vegetated islands. The runoff entered the bioswale/bioinfiltration system at several curb inlets. The outlet from the treatment system is an overflow grate in the middle of the bioswale which channels overflowing water into a 6-inch PVC pipe to the stormwater system. The curb inlet north of the inlet sampling location was closed with landscape edging and foam sealant to prevent short-circuiting of the inflowing waters at the sampling location.

The sampling inlet had an ISCO sampler and an H-flume for flow monitoring of the incoming runoff. The outlet was sampled at the end of the overflow/infiltration PVC pipe using another ISCO sampler. Three events were sampled for both flow and contaminants of concern (CoC) analysis. Only the inlet was sampled during the first event, while the 2nd and 3rd events both had inlet and outlet samples.



The earlier SPAWAR report (Katz, *et al.* 2018. *Demonstration of Low Impact (LID) to Mitigate Stormwater Metal Contaminants in Navy Commercial Areas*. Technical Report 3092) included additional information concerning the bioswale cells at this location. The bioswale cells at the Navy Federal Credit Union project site can be considered to be of representative size, configuration, and material that are used in the San Diego region. However, the media was not specifically selected to reduce the loads of the targeted metals. The specifications on the media are not very clear and construction details and materials are not known. There are also outfall issues as the discharge pipes are undersized and may affect the monitoring process as water backs up into the system.

The inlet samples were obtained during three events while the outlet samples were collected during two events. The average TSS and metal concentrations were reduced with the bioswale treatment. The influent median particle size was about 15 µm and reduced to about 11 µm at the effluent location. The patterns for the influent and effluent mass distributions for most of these constituents were similar. Most of the pollutants, by mass, were associated with particles less than about 20 to 50 µm. Chromium, manganese, nickel, copper, and zinc had their largest particulate strengths associated with the largest size range (>63 µm).

There were no obvious patterns comparing the influent and effluent PAH concentrations. For many of the PAHs, the patterns were similar and showed a general reduction of the median size associated with the 50th percentile of the mass, with most of the PAH mass associated with particles smaller than about 50 µm. Many of these PAHs have their greatest particulate strengths associated with the largest size range (>63 µm), although many had non-detected values for some of the size ranges.

No filterable PFAS concentrations or values associated with different particle size ranges were available due to the low concentrations observed.

Naval Base Point Loma

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)

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 by causing sheetflow to back up on the surrounding pavement. 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 the main features of the stormwater control.

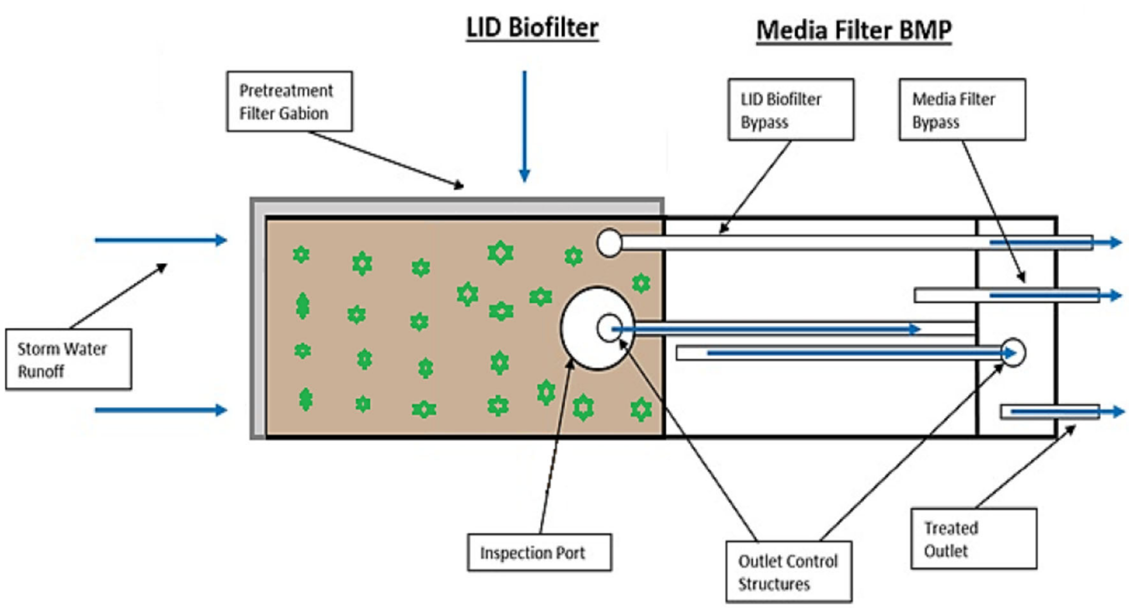
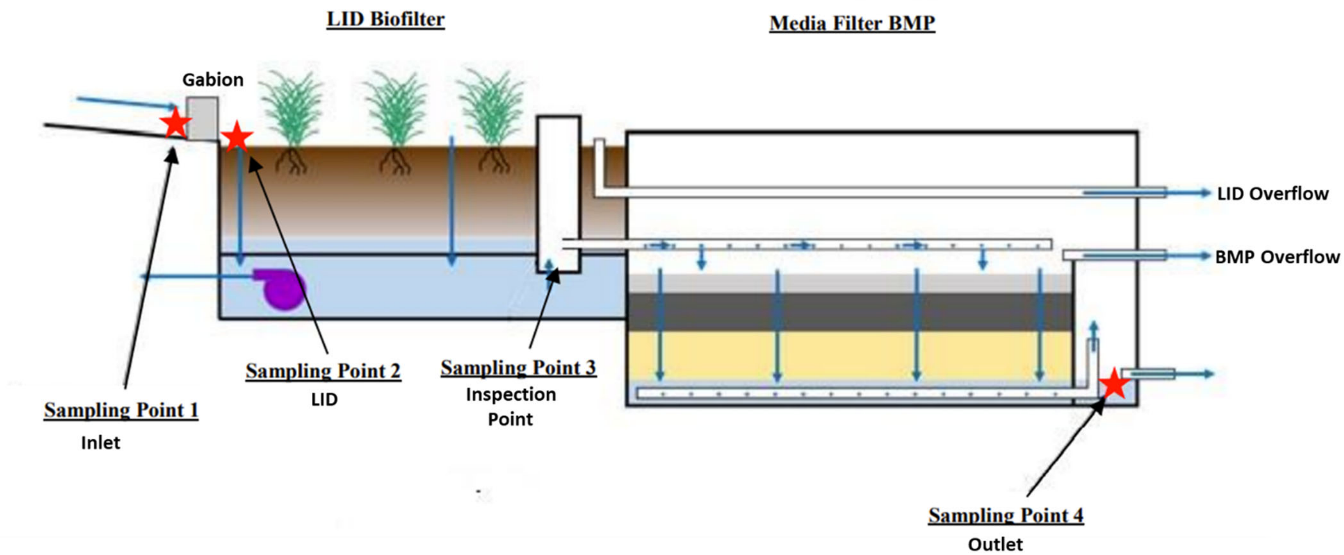


Figure 1-2. Conceptual Plan View Diagram for Hybrid LID / BMP System

Texas Tech researchers in conjunction with site 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 were not available for the PFAS congeners due to their low concentrations.

Data were 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.

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. The treatment system footprint was therefore about 1% of the paved drainage area.

Three events were monitored during 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 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.

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

About 10 to 20 percent of most of the PAHs were associated with particulates. Naphthalene was 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. 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. This pattern was consistent for all of the PAHs monitored. On the average, the particulate strength of the smallest size range was many times greater than for the bulk particle strength value. Overall, the treatment system averaged about 70 percent apparent reductions for the total PAHs, while the filtered forms were not reduced, on the average. The gabion barrier and backup of sheetflow on the pavement 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.

In contrast to the PAHs, the intermediate sizes (5 to 63 µm) generally had the largest 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.

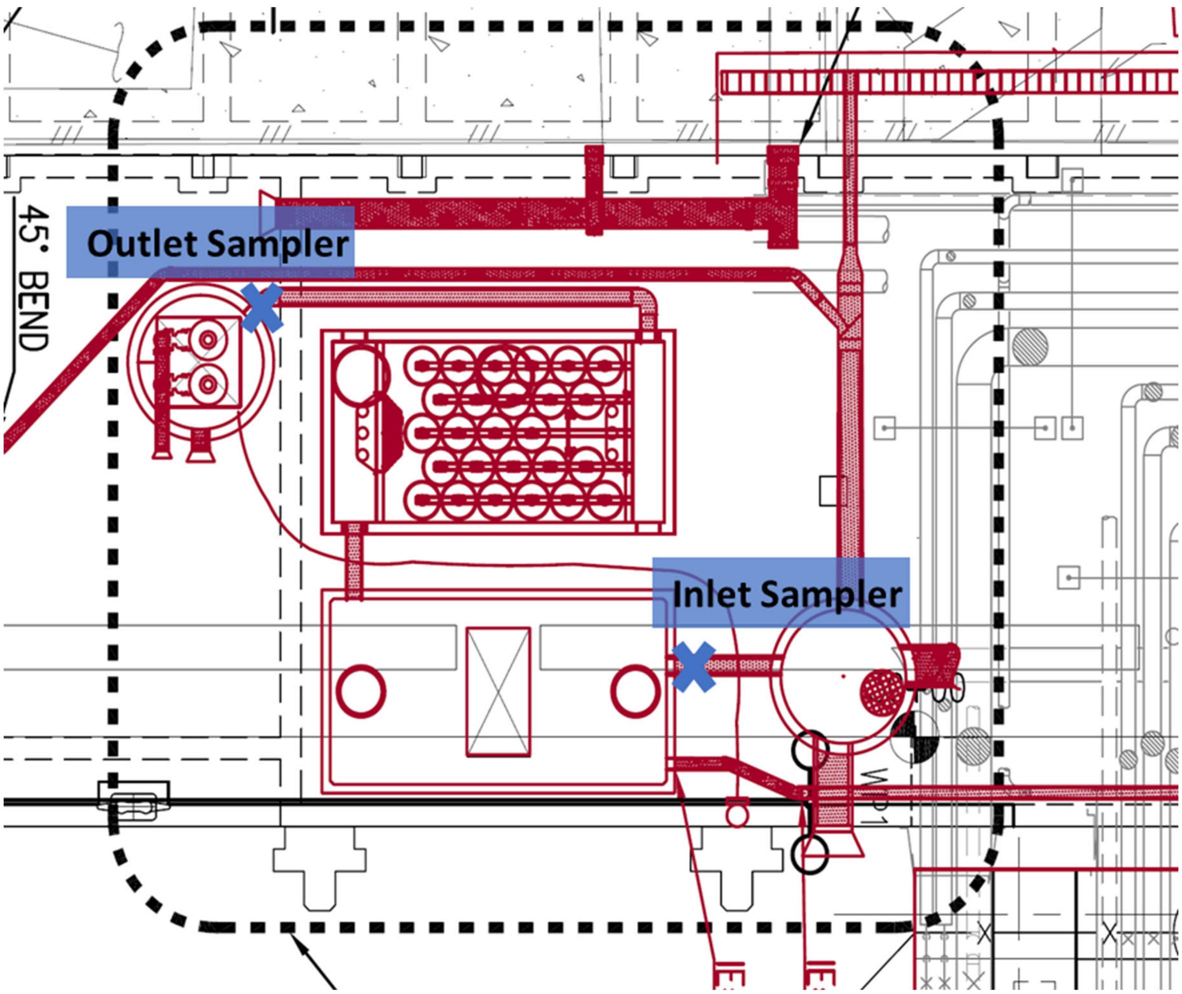
The available PFAS congener data was for the bulk inlet and outlet samples. In all cases, the concentrations increased at the outlet location.

Puget Sound Naval Shipyard and Intermediate Facility (PSNS & IMF), Bremerton, WA

Pier B

This section briefly summarizes the Pier B (Puget Sound Naval Shipyard and Intermediate Maintenance Facility, PSNS & IMF, Bremerton, WA) stormwater monitoring data supplied by the Texas Tech researchers, and the site description. The Pier B site stormwater entered a proprietary hydrodynamic separator (CONTECH CDS) for pretreatment to remove coarse solids, followed by an oil-water separator and finally into a cartridge type media filtration unit consisting of 23 zeolite, perlite, and granular activated carbon (ZPG) cartridges. These were sized for the peak 6-month storm (1.87”).

The outlet flow from the media filtration unit was directed into the receiving water using an underground pump system as shown in the figure below. Two ISCO samplers were installed with one at the outlet of the hydrodynamic separator and the other at the outlet of the cartridge filter. The monitoring data therefore represented the influent and effluent of the oil-water separator/cartridge filter system, after the hydrodynamic separator.



Layout of the stormwater control system and sample locations in Pier B. Note that the inlet was sampled after the hydrodynamic separator and the outlet after the oil/water separator and cartridge filters

Two events were sampled and analyzed for contaminants of concern (CoCs). However, flow data were not available due to flow sensor malfunctions. The underground pump in the outlet chamber was also not operating during the sampling period due to maintenance, resulting in mixing of the outlet stormwater with seawater, as indicated by high salinity and chloride results for the effluent samples.

The following aerial photograph shows Pier B and the drainage area outlined in yellow. The drainage area is about 3.1 acres from the Google Map scale for the site. The drainage area includes a short section of a frontage road and adjacent area, plus a portion of the pier. The following lists the approximate areas of the source areas on this map:

Road and adjacent areas:	0.4 acres
Sheds on pier:	0.6 acres
Laydown storage areas on pier:	0.6 acres
Remainder of pier:	1.5 acres

Aerial drainage map of Pier B site in PSNS with drainage represented by yellow lines

The metals with >70% of the total mass in the filtered inlet sample portion included manganese, nickel, zinc, arsenic, and cadmium, while the metals with >70% of the total mass in the filtered outlet sample portion included manganese, copper, arsenic, and lead. The outlet copper concentrations were much larger than the inlet copper concentrations, likely due to contamination of backflowing receiving waters in the sampling vault. Otherwise, the inlet and outlet concentrations did not show any expected pattern or much difference. The median particle size after the hydrodynamic separator was about 30 µm and was reduced to about 12 µm after the media filters, with few consistent patterns for the other pollutants. Metals with the highest particulate strengths in the largest size category (>63 µm) were chromium, arsenic, and lead. Manganese and zinc had their largest particulate strengths in the smallest size category (0.45 to 5 µm), while nickel, copper, and cadmium had their largest particulate strengths associated with intermediate size ranges.

None of the PAHs were seen to have >70% of the total mass in the filtered inlet sample portions, while naphthalene and 2-methylphthalene both had >70% of their mass in the filtered outlet sample portions. There were no patterns of apparent concentration reductions with the filter media treatment. Most of the PAHs had greater relative particulate strengths in the smallest size range (0.7 to 2.7 µm) compared to the other size ranges.

Most of the PFAS compounds had large associations with the filtered samples in both the inlet and outlet samples. Only FHxSA (inlet) had large (>70%) associations with particulate sample portions. All of the filtered and total sample PFAS concentrations had lower concentrations in the outlet samples compared to the inlet samples. PFOS had the largest concentrations and largest particulate strengths for the inlet and outlet samples.

Recycled Metal Transfer Station (RMTS)

The RMTS monitored area had a drainage area that contains metal and wiring staging activities. The runoff was treated by a Contech CDS separator followed by 23 ZPG (zeolite, perlite and granular activated carbon) Contech StormFilter cartridges in a vault. Two ISCO samplers were installed with one at the inlet of the hydrodynamic separator and other at the outlet of the cartridge filter. TSS concentrations were very low and had very small apparent reductions with treatment, with median particle sizes of about 15 µm. Heavy metal concentrations were moderate, with large fractions in filtered forms, and had low apparent treatment benefits. The PAHs and PFAS congeners had very low concentrations and little apparent treatment benefit.

The following summarizes the drainage system and shows an aerial image of the same area. The drainage area is comprised of only a few source area categories:

subarea	Approximate area
Wycott Way	0.3 acres (32 ft wide, with curb and gutters on both sides of the road)
Permanent roofs (metal roofing, slight pitch)	0.2 acres
Paved storage/staging areas	2.1 acres (about half designated with much galvanized metal exposure)
Total drainage area	2.6 acres

The aerial image also shows that there are many small storage bins and trailers parked on the paved area.


983
1110
1177
991
Wycoff Way
Wycoff Way
Wycoff Way
Wycoff Way
Google

Three events were sampled for flow and water quality by the Texas Tech and PSNS field teams. The three rains were sampled on the following dates, along with the approximate Rv (volumetric runoff coefficient, the ratio of the runoff depth to the rainfall depth over the drainage area):

date	rainfall	Approx. Rv
10/9/2020	0.41 inches	0.53
11/3/2020	0.38 inches	0.51
2/18/2021	0.12 inches	n/a

The TSS concentrations for the three events were very low, with an average inlet concentration of only 17.5 mg/L. The treated effluent TSS concentrations were only slightly reduced, to an average of 13.6 mg/L. Most of the TSS mass was associated with the 5 to 63 µm particle size range in the influent and effluent samples, with average median particle sizes of about 15 µm. The greatest TSS mass reductions were associated with the largest particle size monitored (>63 um), with the average inlet size fraction concentration of 4.1 mg/L reduced to 1.7 mg/L (both being very low values).

The heavy metal concentrations were generally of moderate concentrations, likely due to the site activities (being a recycled metal staging area, plus the presence of the metal roofing and building materials). The filtered forms of the metals were relatively high in the influent samples, with the filtered fraction slightly increased for most metals after treatment (preferential removal of particulate forms of the metals). Lead had the most consistent positive removals for all particle sizes, while most of the other metals indicated concentration increases for many size ranges. The particulate strengths for the metals indicated larger values for the largest particle size range (>63 µm) for Cr, Mn, Cu, and Pb common for metal material storage industrial areas, but that size range had lower pollutant masses than the smaller particles.

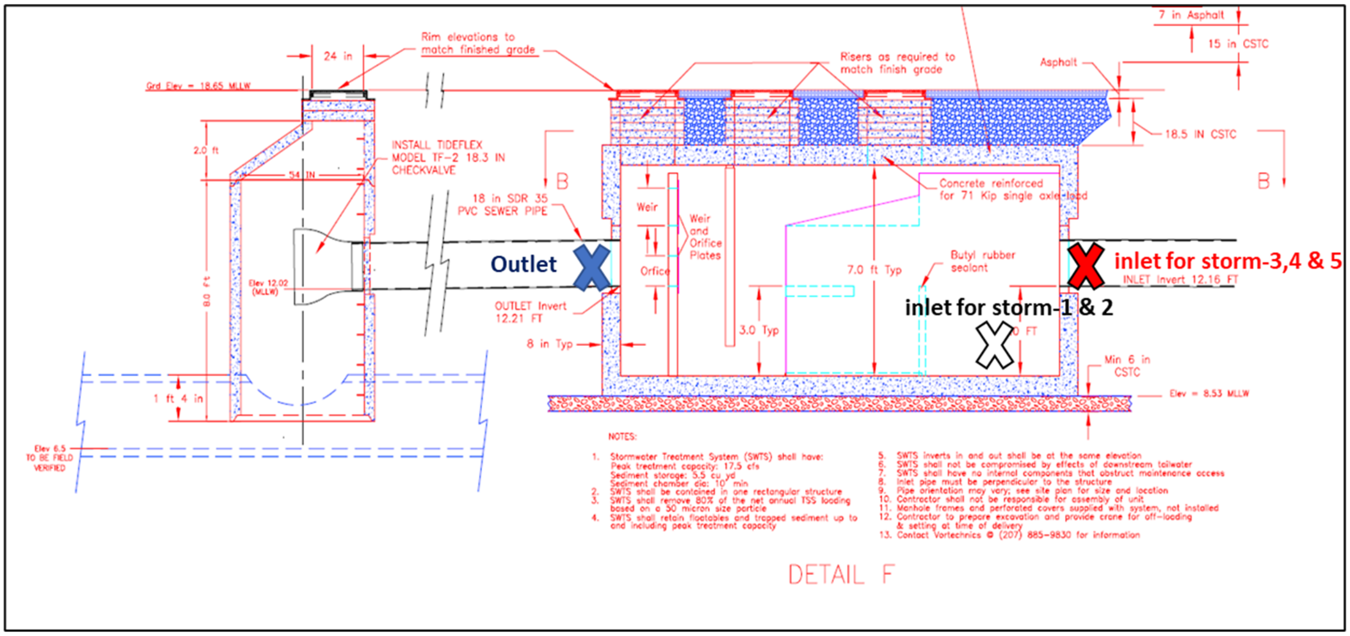
The concentrations of the monitored PAHs were all very low. The PAHs had an overall average filtered fraction of 43% in the influent which increased to 77% in the effluent. In general, stormwater PAHs are mostly particulate bound. The particulate concentrations had moderate apparent reductions with treatment (about 50% overall), while the filtered concentrations indicated increased concentrations for many of the PAHs with treatment.

The PFAS congener concentrations were also very low. The highest average influent PFAS concentration was for PFOA (17 ng/L), followed by PFBA and PFOS (both about 4 ng/L). The fraction of the PFAS congeners in filtered forms ranged from about 30 to 80%. There were no likely concentration reductions of PFAS congeners with treatment. PFOS had an average particulate strength of 0.8 mg/kg, and PFOA had an average particulate strength of 0.5 mg/kg, while the other PFAS congeners had much smaller particulate strengths (0.05 to 0.3 mg/kg).

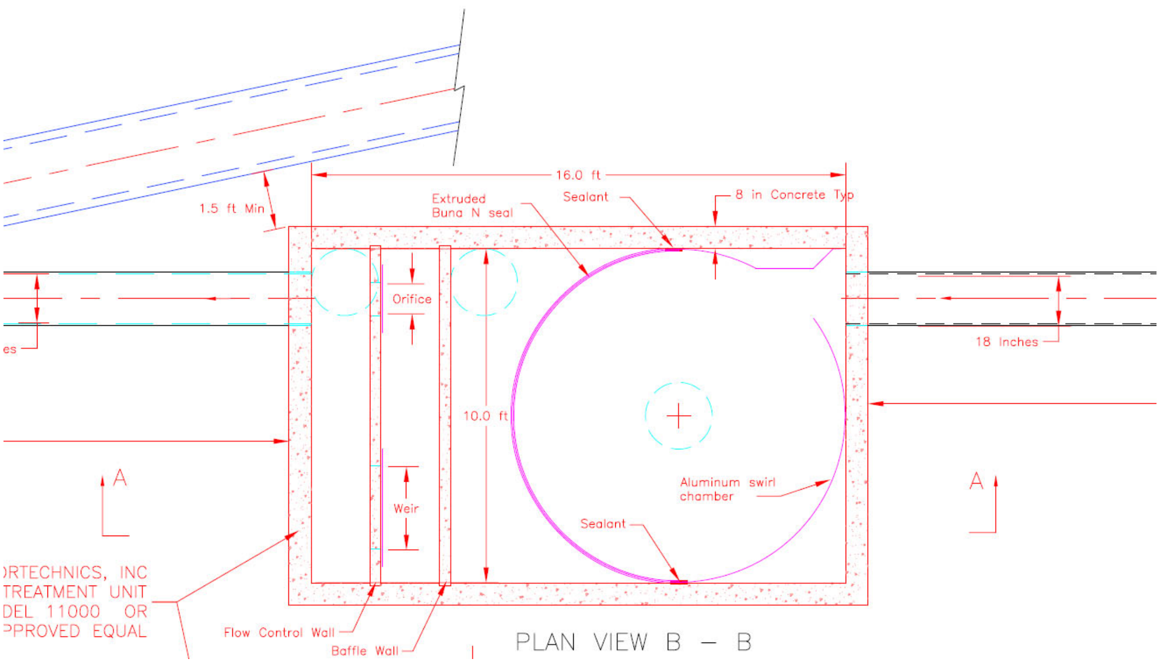
Metals Yard

The following information is summarized from material provided by the Texas Tech research group describing the site and the monitoring activity at the Puget Sound Naval Shipyard Metal Yards site. The estimated drainage area was 2.5 acres based on the drainage system diagram shown below. The area was used for laydown, supply and storage for large metal plating, steel and concrete pier blocks used for ship support in the dry docks. The site is adjacent to Harborside Fountain Park on one side and the Bremerton Puget Sound Naval Shipyard on the other side. The site contains temporary material storage covering about 1/3 of the paved site. Much of the material stored appeared to be galvanized (roofs of storage bins).

Drainage area of Metals Yard.



CDS hydrodynamic separator and sampling locations.



Five events were monitored at the Metals Yards site. The first four events had the following rain depths, start and end dates, and average intensities (no rainfall data available for the fifth event):

Total rain (in)	start date and time	End date and time	Rain duration (hrs)	Average intensity (in/hr)
3.97	2/27/2022 1:15	3/1/2022 7:35	54.3	0.073
0.14	4/9/2022 15:25	4/11/2022 6:35	39.2	0.0036
0.33	4/29/2022 22:20	4/30/2022 5:30	7.2	0.046
0.58	5/5/2022 1:45	5/7/2022 4:20	50.6	0.011

The stormwater was sampled at the inlet and outlet sides of a hydrodynamic separator. The outlet of the ten-foot diameter Vortech system drains to a separate discharge to the bay. A total of five events were sampled for flow and TSS, heavy metals, and PAHs. Few data were available for PFAS compounds. For some events, only inlet or outlet samples were obtained due to sampler trigger problems. Maintenance cleaning of the hydrodynamic separator swirl chamber was performed after the second storm event and before the third storm event. Prior to the maintenance, the inlet sampler tube was located inside the swirl chamber due to lack of proper access to the inlet pipe. During maintenance, the inlet sampler tube was re-located to the inlet pipe entering the swirl chamber. Approximate locations of the inlet and outlet samplers are provided in the figure below the drainage map.

Most of the inlet heavy metals (manganese, nickel, copper, zinc, and arsenic) were mostly associated with the filtered sample fraction, while chromium was mostly associated with the particulates and lead was about evenly divided between the particulate and filtered sample portions. After the hydrodynamic separator, there was a shift to greater abundance with the particulates for manganese, with smaller changes for the other metals. The apparent TSS reduction was about 44%. Other positive apparent reductions ranged from about 40% (Cd) to 63% (Ni), while Mn, Cu, Zn, and As all indicated increases in concentrations. The associations with the different particle size categories did not show any consistent patterns. Most of the TSS mass was associated with particles between about 5 and 64 µm, with median sizes of about 15 µm for both influent and effluent samples.

Many influent PAHs were mostly in filtered forms, with 2-methylnaphthalene, 1-methylnaphthalene, 2.6-dimethylnaphthalene, 1.3-dimethylnaphthalene, and fluorene having more than 70% of their concentrations associated with filtered forms of the samples. Only acenaphthene, phenanthrene, and 2-ethylanthracene had more than 70% of their concentrations associated with filtered samples for effluent samples (these were not shown to be predominately filtered in the inlet samples). In contrast, only inlet 2-ethylanthracene, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene had >70% of their concentrations associated with particulate fractions of the samples, while no effluent PAHs had large particulate fractions. Most of the PAHs had apparent low to moderate concentration reductions associated with treatment by the hydrodynamic separator.

The particulate strengths for all of the PAHs were highest for the smallest particle size range (0.7 to 2.7 µm), with the exception of naphthalene that also had a high particulate strength value for an intermediate particle size range. Most (>70%) of outlet acenaphthene, fluorene, and benzo(a)anthracene would be widely dispersed upon discharge, while none of the outlet PAHs would be associated with near-field sedimentation.

There were total and filtered PFAS data reported for some locations and events. Analyses weren't done by particle size and most of the PFAS congeners were ND. Therefore, analyses of PFAS data were not performed due to few detections and no particle size data.

Analytical Methods

Data Availability – Combining Site Observations

The initial stormwater treatment performance calculations noted above did not have any supporting statistical evaluations due to the few data available at each site (2 or 3 data pairs per site). This report therefore examined statistical analyses of paired performance data from combined sites having similar treatment technologies in order to increase the amount of available data for more supporting statistical analyses. The following tables show the three treatment categories and the associated sites for each.

Sedimentation

Location	Treatment component monitored	Treatment footprint	Drainage area	Treatment area percentage of drainage area	Number of paired events monitored
Reese Technology Center	Wet detention Pond	4 acres	255 acres	1.6%	2
NBPS – metals yard	Hydrodynamic separator	10 ft diameter	2.5 acres	n/a (part of treatment train)	3
total					5

Media Filters

Location	Treatment component monitored	Treatment footprint	Drainage area	Treatment area percentage of drainage area	Number of paired events monitored
NBPS – Pier B	Media cartridge filter	23 cartridges	3.1 acres	n/a (part of treatment train)	2
NBPS - RMTS	Media cartridge filter	23 cartridges	2.6 acres	n/a (part of treatment train)	3
NBPL	Media bed	220 ft^2	36,150 ft^2	0.6%	3
total					8

Bioinfiltration

Location	Treatment component monitored	Treatment footprint	Drainage area	Treatment area percentage of drainage area	Number of paired events monitored
NBSD - Commissary	Bioinfiltration	400 ft^2	16,550 ft^2	2.4%	3
NBSD – Federal Credit Union	Bioswale	1,500 ft^2	16,120 ft^2	9.3%	2
total					5

These tables list the locations combined for each category, the treatment component monitored, the treatment unit footprint (area of pond or bioinfiltration, for example), drainage area, percent of drainage area associated with the treatment footprint (larger relative areas of the treatment systems usually results in better treatment performance), and the number of paired events monitored. The three NBPS locations had stormwater treatment trains, with the monitoring locations isolating only single treatment components. Therefore, footprint calculations for these three locations are not comparable to the other locations. The number of paired events available for the analyses were further reduced due to non-detected influent constituent concentrations.

The sedimentation category includes two locations that mostly relied on physical sedimentation as the main treatment unit process: the wet pond at the Reese Technology Center, and the hydrodynamic separator at the NBPS metals yard location. The media filters included cartridge filters and a media bed all with specialized treatment media, with no runoff volume losses: NBPL, NBPS Pier B and RMTS. The bioinfiltration treatment systems had the largest treatment areas compared to the drainage areas and included standard media treatment in addition to infiltration: NBSD Commissary biofilter and Federal Credit Union bioswale.

The data were sorted into these three categories and separated into four constituent groupings: particulates by particle size, heavy metals, PFAS congeners, and PAH compounds. Only paired influent and effluent data were evaluated. As noted under the site and monitoring descriptions, there were periodic sampling issues that prevented complete sampling of both influent and effluent stormwater for each event. In addition, non-detection results were also common, especially for some of the filtered constituents and for the PFAS congeners. If an influent value was non-detected, the pair was eliminated for analyses. If the influent concentration was detected, but the effluent concentration was not detected, it was assumed that the treatment system resulted in the concentration reduction and those data pairs were included in the analyses. If necessary for some analyses, the non-detected effluent concentrations were substituted with half of the detection limit. As noted below in the discussion of the statistical analyses, non-parametric and graphical tools were emphasized that were less sensitive to these data substitutions.

Statistical Analyses

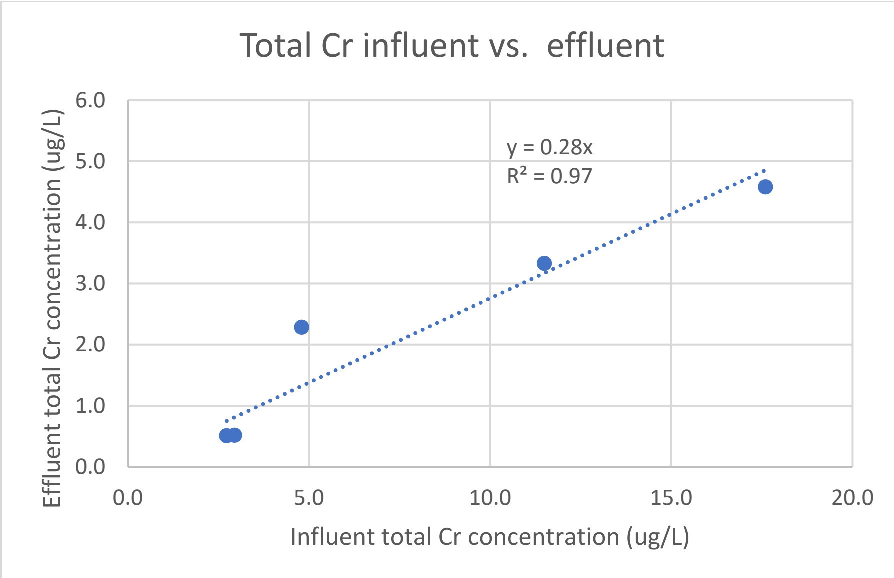
Several complementary statistical and graphical analyses were conducted to identify and quantify stormwater concentration changes associated with the use of different classes of stormwater controls. As noted previously, the first step was to combine the site data into three groups corresponding to major treatment technologies to increase the number of available data pairs for analyses. The initial performance evaluations noted previously were based on average influent and effluent concentrations for the few rain events observed at each site. These results rely on the concentrations being representative of the populations for all possible events. With just a few rain events, this assumption is not likely valid, and those performance estimates are considered apparent, with unknown levels of confidence. Therefore, additional analyses were conducted using paired observations. These results represent the rain conditions monitored and focus on the concurrent influent and effluent concentrations for each event, a more robust approach for performance calculations. The comparison tests are also more robust with increased numbers of observations. The following describe the statistical and graphical tools used for these evaluations, using Microsoft Excel and Minitab (version 21.4), with examples for the total chromium data set for the sedimentation treatment category.

1) Combining data from sites having similar treatment technologies and removing pairs having missing (non-detected) influent concentrations.
2) Calculating summary statistics for all influent and effluent data for each constituent for each treatment group (number of data observations, minimum, maximum, average, median, standard deviation, and coefficient of variation, the ratio of the standard deviation to the average).

	Cr total influent (µg/L)	Cr total effluent (µg/L)
Reese storm 1a	17.6	4.6
Reese storm 1b	11.5	3.3
Metals yard storm 1	3.0	0.5
Metals yard storm 4	2.7	0.5
Metals yard storm 5	4.8	2.3
count	5.0	5.0
minimum	2.7	0.5
maximum	17.6	4.6
average	7.9	2.2
median	4.8	2.3
Standard deviation	6.5	1.8
COV	0.82	0.79

The concentration units for the TSS and particle size data are mg/L, while the units for the heavy metals and PAHs are µg/L, and the units for the PFAS congeners are ng/L. These summary statistics are shown in the appendix summary tables.

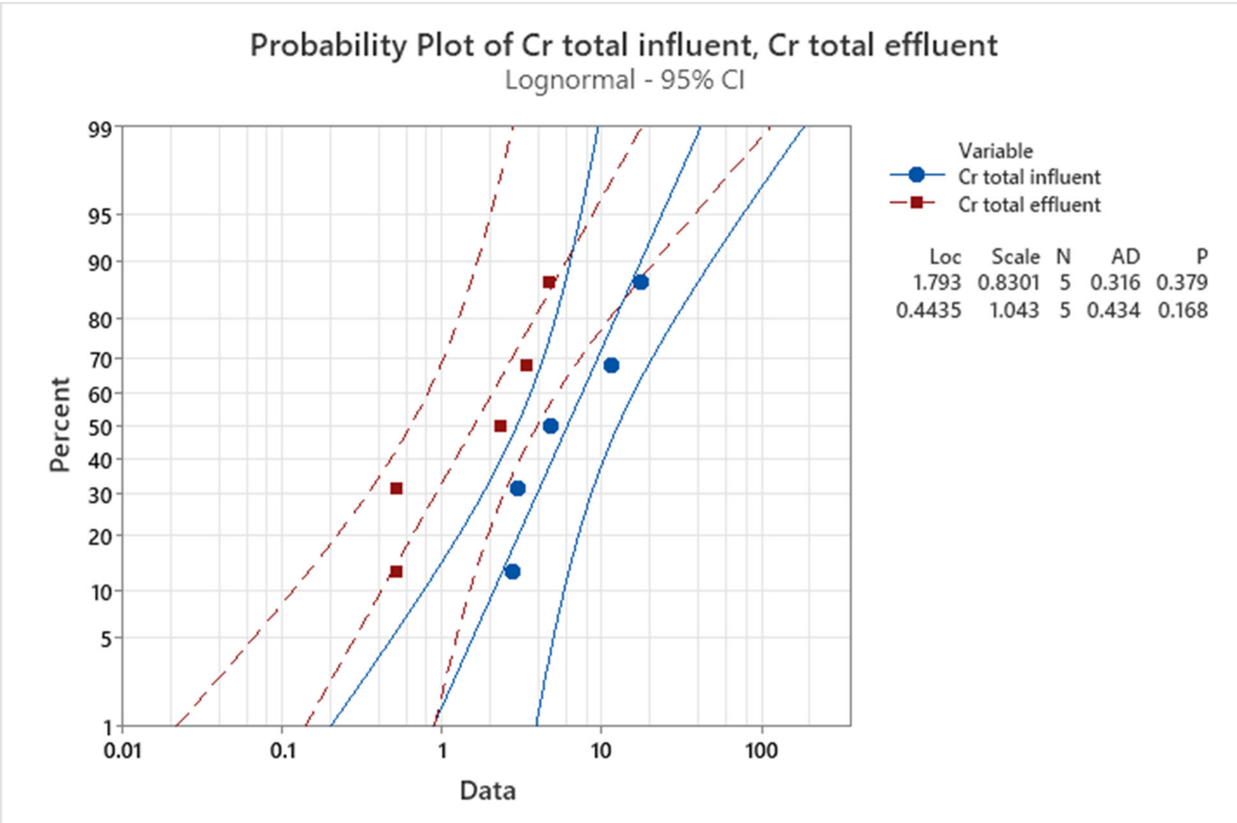
3) Regression analyses comparing influent and effluent concentrations with ANOVA to calculate significance of calculated regression parameters. The following is an example for total chromium for the sedimentation treatment category:



Regression Statistics						
Multiple R	0.984					
R Square	0.969					
Adjusted R Square	0.719					
Standard Error	0.541					
Observations	5					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	36.6	36.6	125.2	0.00153	
Residual	4	1.18	0.293			
Total	5	37.8				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable 1	0.276	0.025	11.2	0.000363	0.207	0.344

The regression scatterplots in the appendices do not have the axes labelled, but in all cases, the x-axis shows the influent, and the y-axis shows the effluent concentrations. The regression plots are included in the appendices for all constituents and treatment categories having sufficient data. The regressions were initially calculated with both y-intercept (Intercept) and slope (X Variable 1) terms. The ANOVA (analysis of variance) shows how well the data fit the regression equation. The Significance F value (0.00153 in this example) indicates if the overall regression equation is significant (a critical value of 0.05 is usually considered). The Coefficients column shows the calculated values for the y-intercept and the slope terms. The P-value column shows the significance of these coefficients, while the Lower 95% and Upper 95% columns show the 95% confidence range of the coefficient values. If the y-intercept value is not significant (>0.05), the regression was re-calculated setting the intercept to zero, forcing the regression equation through the zero value on the plot. This was the case for the data sets for this project. The resulting regression line and coefficients (along with the R^2 index of determination) are shown on the plot if the regression was significant. The data summaries in the appendices show the overall Significance F, the Coefficient and P values, and the R^2 values, along with the scatterplots.

4) Group probability plot and nonparametric comparison tests. Minitab was used to further evaluate the influent and effluent data pairs. A group probability plot was used to show the distribution of the concentrations and if they had similar variances.



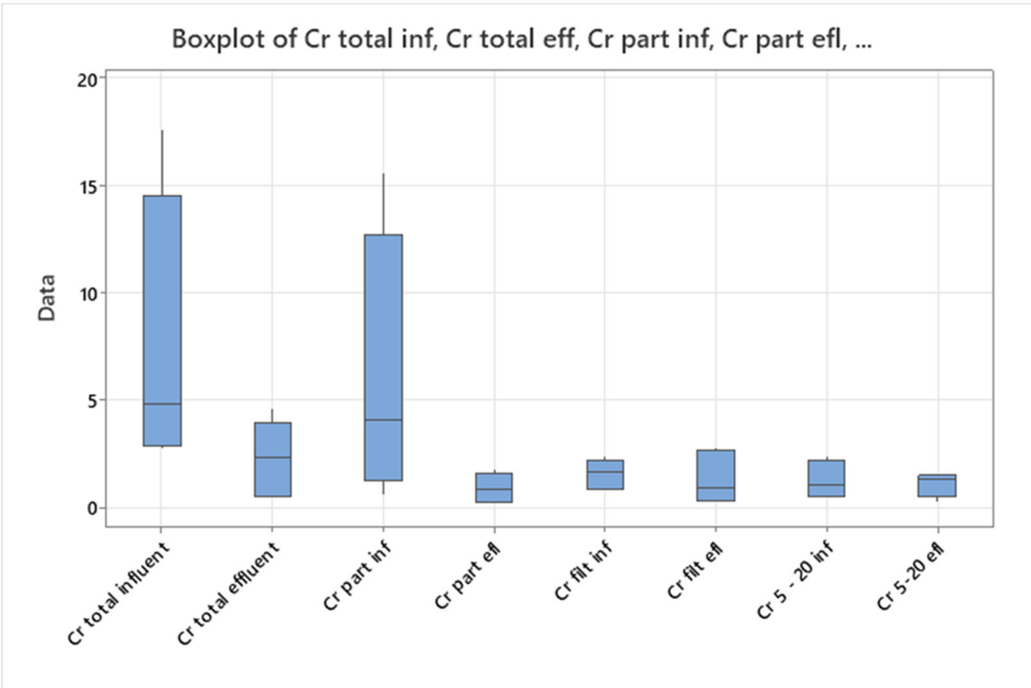
The probability plot also shows the 95 percent confidence intervals for the data sets. The above example shows separate distributions for the influent and effluent concentrations, but with overlaps of the confidence intervals. The probability lines are reasonably parallel indicating similar variances for the two data sets. The calculated Anderson-Darling (AD) test statistics and associated P values indicate if the data are significantly different from normal distributions. These plots are log-transformed, and the AD statistics indicate that the distributions are not significantly different (>0.05) from the fitted distributions for the number of data pairs available. The five data pairs show good fits from about the 10^{th} to 90^{th} percentiles, but the data lacks information for the more extreme percentile values. Fewer data pairs would have wider confidence intervals and narrower percentile coverages, while more data pairs would have narrower confidence intervals and more confidence of the extreme values (assuming similar data variances). These plots are included in the appendices for all constituents and treatment categories having sufficient data.

Minitab was also used to calculate significance of the differences in the influent and effluent concentrations using the Mann-Whitney non-parametric test. This test measures the significance of the differences between the medians of the two data sets, and requires that the distribution variabilities be similar, but they do not have to be normally distributed. The following table shows the output table for the comparison tests for total chromium for sedimentation treatment. In this example, the difference of the medians is 2.52 µg/L, with the confidence interval of the difference being -0.60 to 15 µg/L (with a confidence of 96% for the interval). The P value is shown to be 0.095, greater than the critical value of 0.05, so this is only marginally significant based on the number of observations available, also as indicated by the wide confidence interval of the median difference, and the negative value in the range of the differences. Several additional sample pairs would be needed to obtain a significant difference and a narrower confidence range for these conditions. The appendix summary tables also list the p values for all constituents and treatment groups tested.

Mann-Whitney: Cr total influent, Cr total effluent		
η_1: median of Cr total influent		
η_2: median of Cr total effluent		
Difference: $\eta_1 - \eta_2$		
Descriptive Statistics		
Sample	N	Median
Cr total influent	5	4.80
Cr total effluent	5	2.29
Estimation for Difference		
Difference	CI for Difference	Achieved
2.516	(-0.603, 15.31)	96.33%
Test		
Null hypothesis	H_0: $\eta_1 - \eta_2 = 0$	
Alternative hypothesis	H_1: $\eta_1 - \eta_2 \neq 0$	
W-Value	P-Value	
36	0.095	

5) Box plot comparing influent and effluent concentrations for all data in a constituent and treatment category. Minitab was also used to prepare a multiple box and whisker plot of the influent and effluent concentrations for the paired data for each constituent and treatment category as shown below for chromium in the sedimentation treatment category. The line inside the box is the median concentration, while the lower end of the box is the 25th percentile and the top of the box is the 75th percentile. The end of the top whisker is the 95th percentile and end of the bottom whisker is the 5th percentile. With such few data, no values are shown outside of these ranges. The greater the separation of the boxes, the more significant would be the differences in the data sets. For moderate numbers of data pairs (10 to 30 for example), if the median is above or below an adjacent box's 25th or 75th percentile ends, the differences are usually statistically significant. Due to the fewer data pairs for these analyses, this graphical separation is not statistically significant for this case. In this box plot, the total Cr influent vs. effluent boxes show a reasonable amount of separation, while the particulate Cr influent vs. effluent boxes show a greater amount of separation. The filtered Cr and the 5 to 20 µm Cr

fractions show much greater overlapping data sets. These plots are in the data appendices for each set of constituents and treatment groups.



Results

The previous methodology section discussed the statistical and graphical tools used to analyze the paired influent and effluent concentration data. The individual site reports included site and sampling descriptions, along with the basic stormwater characteristics and apparent treatment results. This report focuses on paired influent and effluent concentrations for site groups corresponding to treatment processes. Site groups were used to increase the number of available paired data for the statistical analyses. Even with the groupings, the number of data pairs per treatment category are small (5 to 8), challenging the ability to identify and measure significant benefits associated with the treatment efforts.

Appendices A through D are tabular summaries by constituent groupings, and E through H are similar groupings of the graphical results. Appendices A and E include results for TSS and individual particulate size ranges, Appendices B and F show the results for the heavy metals, Appendices C and G show the results for PFAS congeners, and Appendices D and H show the results for the PAHs. There are very many pages of results, and this section will summarize the main findings. The constituents examined in these paired analyses included (many more were analyzed by the Texas Tech team, but these were the most constituently observed above the detection limits):

Particulate Analyses

- TSS
- Particulate solids (>0.45 µm), 0.45 to 5 µm, 5 to 20 µm, 20 to 63 µm, and >63 µm)

Heavy Metal Analyses (total, particulate, filtered, 0.45 to 5 µm, 5 to 20 µm, 20 to 63 µm, and >63 µm, as available)

- Chromium
- Copper
- Lead
- Nickel
- Zinc

PFAS Congeners (particulate and filtered forms)

- PFBA
- PFPeA
- PFHxA
- PFHpA
- PFOA
- PFNA
- PFDA
- PFOS
- PFDoA

PAHs (particulate and filtered forms)

- Naphthalene
- Acenaphthene
- Fluorene
- Phenanthrene
- 2-methylphenanthrene
- 2-methylanthracene
- Benzo(a)anthracene
- Fluoranthene
- Pyrene
- Chrysene
- Benzo(b)fluoranthene
- Total PAHs

The following tables are excerpted from Appendices A through D and show the constituents and treatment technologies that had statistically significant (or marginal) concentration changes, and/or significant regression coefficients. Normally, regressions would only be examined if the influent and effluent concentrations are found to be significantly different. About 19 individual cases had Mann-Whitney P values of <0.05. This is a small fraction of the total number of evaluations conducted (about 150), so the high-lighted cases also include “marginal” notations when the P values are in the 0.05 to

0.10 range, which about doubled the "significant" cases to 36. There were substantially more cases with significant regression equations and coefficients with excellent data fits (116 cases, including "marginal" conditions).

The percent reduction values are calculated based on the slope term of the regression. As an example, a slope of 0.1 corresponds to a percentage reduction of 90% while a slope of 0.5 corresponds to a percentage reduction of 50%. The percentage reductions are constant for all influent concentrations if the y-intercept value is set to 0 (not significant) as found for these data sets. However, it must be emphasized that effluent quality is a more suitable performance measure for most stormwater evaluations, especially when the regression is not significant, but the Mann-Whitney test statistic is significant (implying a relatively constant effluent concentration over a wide range of influent concentrations). The summary tables below and the data appendices also include the Anderson Darling p values indicating how well the data fits the distribution. The Mann-Whitney test requires that the variances of the two data sets in the paired analysis are similar. The notes on the tables indicate if the probability plots are parallel (indicating similar variances). Also noted are the approximate overlaps of the 95% confidence ranges of the probability plots (more likely significantly different if well separated). The Mann-Whitney summary table also shows the resulting equations for predicting the effluent concentration. If the p value is significant (or "marginal" if desired), and the regression equation is not significant (no relationship between the influent and effluent), and the data plots reflect a relatively consistent effluent quality, the equation shown is just the average effluent concentration, along with the COV value to reflect the variation. If the regression equation is significant (or "marginal"), the resulting equation is a first order polynomial equation (effluent equals the influent times the slope factor, with no intercept term).

The following tables show the constituent/treatment combinations that had significant (or "marginal") p values for the Mann-Whitney tests and/or significant overall regression and slope terms. These significant factors are highlighted in yellow.

TSS and Particle Sizes Removal Summary Statistics

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Part (>0.45 µm)	5	0.96	0.0024	0.0006	0.075	92.5	0.45	close	mostly overlap
5-20 µm	4	0.99	0.0410	0.0041	0.450	55.0	0.25	yes	mostly overlap
20-63 µm	4	0.99	0.0350	0.0031	0.061	93.9	0.26	yes	50% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Part (>0.45 µm)	marginal 0.083	marginal y = 7.7 (COV = 0.74)	overall regression and slope terms are not significant
> 63 µm	marginal 0.09	marginal y = 1.3 (COV = 0.98)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Part (>0.45 µm)	5.0	0.79	0.0300	0.0180	0.600	40.0	0.17	yes	overlap
5-20 µm	5.0	0.94	0.0040	0.0010	1.140	-14.0	0.15	yes	overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
> 63 µm	0.012	y = 1.1 (COV = 0.70)	overall regression and slope terms are not significant

Heavy Metals Removal Summary Statistics

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr total	5	0.97	0.002	0.000	0.27	73.0	0.17	yes	50% overlap
Cr part	5	0.84	0.019	0.010	0.12	88.0	0.41	yes	50% overlap
Cr filt	5	0.63	marginal 0.081	marginal 0.06	0.83	17.0	0.36	no	overlap
Cr 5-20 µm	4	0.77	marginal 0.085	marginal 0.049	0.72	28.0	0.03	yes	overlap

	Mann Whitney, a rank sum non-parametric paired test		
Sedimentation	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cr part	marginal 0.06	marginal. use regression slope	y = 0.12x (88% reduction)

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr part	8	0.46	0.075	0.070	-0.33	n/a	0.32	yes	50% overlap
Cr filt	8	0.87	0.001	0.000	1.07	-6.8	0.63	yes	overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr total	5	0.73	0.047	0.031	0.64	36.2	0.12	yes	overlap
Cr part	5	0.65	0.073	0.053	0.60	39.8	0.23	yes	overlap
Cr filt	5	0.93	0.005	0.002	0.75	25.5	0.76	yes	overlap
Cr 5-20 µm	5	0.94	0.005	0.002	2.30	-129	0.05	yes	overlap
Cr 20-63 µm	5	0.63	0.078	0.058	0.04	96.3	0.03	no	50% overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total	7	0.50	marginal 0.057	0.050	0.89	11.0	0.37	yes	overlap
Cu filt	5	0.93	0.006	0.002	1.10	-9.8	0.60	yes	overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total	8	0.64	0.018	0.020	-0.75	n/a	0.09	close	75% overlap
Cu part	8	0.47	marginal 0.060	marginal 0.060	-0.39	n/a	0.41	yes	50% overlap
Cu filt	8	0.46	<0.0001	marginal 0.060	-1.20	n/a	0.28	close	mostly overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total	5	0.63	marginal 0.081	marginal 0.061	0.08	91.7	0.42	no	separate
Cu filt	5	0.77	0.035	0.022	0.13	86.9	0.83	close	mostly separate
Cu 0.45 - 5 µm	4	0.96	0.015	0.004	0.16	84.1	0.37	yes	25% overlap
Cu 5-20 µm	4	0.88	0.044	0.019	0.21	79.1	0.51	close	25% overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cu total	0.012	use regression slope	marginal y = 0.08x (92% reduction)
Cu filt	0.012	use regression slope	y = 0.13x (87% reduction)
Cu 5-20 µm	0.030	use regression slope	y=0.21x (79% reduction)
Cu 20-63 µm	marginal 0.055	marginal y = 3.3 (COV = 1.7)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total	5	0.86	0.016	0.008	0.15	84.9	0.53	close	overlap
Pb part	4	0.95	0.018	0.005	0.11	88.7	0.07	yes	overlap
Pb filt	5	0.73	0.047	0.031	1.42	-42.0	0.13	no	overlap
Pb 5-20 µm	3	0.96	marginal 0.095	0.022	1.48	-47.7	0.25	close	overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total	8	0.56	0.020	0.020	0.28	72.0	0.28	close	75% overlap
Pb filt	7	0.53	0.049	0.042	0.48	52.0	0.30	yes	overlap
Pb 5-20 µm	4	0.97	0.009	0.002	0.47	53.0	0.05	yes	50% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Pb >63 µm	0.037	y = 0.13 (COV = 0.4)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total	5	0.84	0.019	0.010	0.39	61.2	0.53	no	75% overlap
Pb part	5	0.87	0.014	0.007	0.33	67.0	0.31	no	50% overlap
Pb filt	5	0.82	0.024	0.013	1.00	-0.2	0.06	close	overlap
Pb 5-20 µm	5	0.95	0.003	0.001	0.57	43.4	0.71	close	overlap
Pb 20-63 µm	4	0.79	marginal 0.079	0.044	0.04	96.0	0.69	no	50% overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Pb >63 µm	marginal 0.059	marginal y = 0.1 (COV = 0.9)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Ni total	5	0.81	0.026	0.014	0.25	75.2	0.57	yes	separate
Ni part	5	0.39	marginal 0.0743	marginal 0.0545	0.13	87.3	0.51	yes	50% overlap
Ni filt	5	0.36	marginal 0.08875	marginal 0.0677	0.23	76.8	0.42	no	overlap

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Ni total	0.012	use regression slope	y = 0.25x (75.2% reduction)
Ni part	0.037	use regression slope	marginal y = 0.13x (87.3% reduction)

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Ni total	5	0.74	0.043	0.029	0.28	71.7	0.39	yes	mostly separated
Ni part	5	0.61	marginal 0.086	marginal 0.065	0.36	64.0	0.73	yes	overlap
Ni filt	5	0.89	0.010	0.004	0.23	77.0	0.25	close	separate
Ni 5-20 µm	5	0.95	0.004	0.001	1.13	-13.0	0.39	yes	overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Ni total	0.022	use regression slope	y = 0.28x (72% reduction)
Ni filt	0.013	use regression slope	y = 0.23x (77% reduction)
Ni 20-63 µm	marginal 0.081	marginal y = 0.1 (COV = 0.5)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total	7	0.82	0.003	0.002	1.53	-52.9	0.58	yes	overlap
Zn part	7	0.55	0.043	0.035	1.31	-30.6	0.43	yes	overlap
Zn filt	5	0.93	0.005	0.002	1.40	-40.4	0.04	close	overlap

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total	8	0.45	marginal 0.053	0.047	0.49	51.2	0.04	no	50% overlap
Zn filt	8	0.42	marginal 0.067	marginal 0.061	0.36	63.8	0.23	close	50% overlap
Zn 20-63	6	0.57	marginal 0.063	marginal 0.051	0.99	1.1	0.04	no	50% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Zn filt	marginal 0.066	marginal, use regression slope	marginal y = 0.36x (64% reduction)

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total	5	0.81	0.025	0.014	0.09	91.1	0.48	no	mostly separated
Zn part	5	0.96	0.002	0.001	0.19	81.4	0.89	close	25% overlap
Zn 5-20 µm	4	0.83	marginal 0.060	0.030	0.70	30.1	0.32	yes	overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Zn total	0.012	use regression slope	y = 0.09x (91% reduction)
Zn filt	0.012	y = 14 (COV = 0.6)	overall regression and slope terms are not significant
Zn 20-63 µm	<0.05	y = 0.6 (COV = 0.4)	overall regression and slope terms are not significant

PFAS Removal Summary Statistics

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
PFBA filt	5	0.87	0.014	0.007	0.785	21.5	0.51	yes	75% overlap
PFBA part	7	0.75	0.008	0.006	1.058	-5.8	0.79	yes	overlap
PFPeA filt	4	0.99	0.007	0.007	0.456	54.4	0.11	no	overlap
PFHxA part	6	0.97	0.000	<0.001	1.360	-36.0	0.08	yes	overlap
PFOA filt	6	0.99	<0.001	<0.001	1.070	-7.0	0.14	yes	overlap
PFOA part	8	0.98	<0.001	<0.001	1.270	-27.0	0.37	yes	overlap
PFNA part	5	0.81	0.026	0.015	1.250	-25.0	0.02	yes	50% overlap
PFDA filt	3	0.92	marginal 0.130	0.038	1.040	-4.0	0.21	yes	overlap
PFDA part	6	0.89	0.003	0.002	1.012	-1.2	0.91	yes	overlap
PFOS filt	6	0.68	0.040	0.021	0.779	22.1	0.46	yes	overlap
PFOS part	8	0.80	0.002	0.001	0.973	2.7	0.08	yes	overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
PFHpA part	0.013	y = 2.0x (COV = 0.28)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
PFHxA part	4	0.67	0.134	marginal 0.092	0.353	64.7	0.50	close	overlap
PFHpA filt	3	0.96	marginal 0.086	0.018	0.295	70.5	0.57	yes	overlap
PFOA part	4	0.93	0.024	0.008	0.469	53.1	0.48	yes	75% overlap
PFNA filt	3	0.93	0.118	0.034	0.691	30.9	0.24	close	overlap
PFNA part	3	0.96	marginal 0.091	0.020	0.606	39.4	0.20	yes	overlap
PFDA filt	3	0.99	marginal 0.053	0.007	0.586	41.4	0.26	yes	75% overlap
PFOS part	3	1.00	0.029	0.002	1.029	-2.9	0.40	yes	overlap
PFDoA part	3	0.95	0.103	0.026	0.179	82.1	0.44	close	overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
PFHpA part	marginal 0.08	marginal y = 1.6 (COV = 0.1)	overall regression and slope terms are not significant

PAH Removal Summary Statistics

	Summary Statistics	Regression Statistics					log-normal probability plot		
Sedimentation	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene filt	5	0.59	marginal 0.096	marginal 0.077	0.483	51.7	0.34	yes	overlap
acenaphthene filt	5	0.68	marginal 0.060	0.042	0.214	78.6	0.74	close	25% overlap
fluorene filt	5	0.76	0.039	0.024	0.288	71.2	0.51	close	mostly overlap
phenanthrene filt	5	0.80	0.027	0.016	0.467	53.3	0.43	close	75% overlap
2-methylphenanthrene filt	5	0.90	0.008	0.004	0.661	33.8	0.03	close	mostly overlap
2-methylanthracene filt	5	0.93	0.005	0.002	0.800	20	0.81	yes	overlap
benz(a)anthracene part	5	0.89	0.010	0.005	0.006	99.3	0.76	close	50% overlap
fluoranthene filt	5	0.89	0.009	0.004	0.269	73.1	0.17	yes	mostly overlap
fluoranthene part	5	0.91	0.008	0.003	0.002	99.8	0.13	yes	50% overlap
pyrene filt	5	0.97	0.001	0.000	0.313	68.7	0.84	yes	overlap
chrysene filt	5	0.67	marginal 0.064	0.046	0.058	94.2	0.3	close	mostly overlap
chrysene part	5	0.98	0.001	0.000	0.021	97.9	0.9	close	75% overlap
benzo(b)fluoranthene filt	5	0.61	marginal 0.088	marginal 0.067	0.042	95.8	0.82	close	overlap
benzo(b)fluoranthene part	5	1.00	<0.001	<0.001	0.018	98.1	0.64	yes	mostly overlap
Total PAH filt	5	0.78	0.032	0.019	0.188	81.2	0.79	close	75% overlap
Total PAH part	5	0.93	0.006	0.002	0.012	98.7	0.93	close	25% overlap

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
acenaphthene filt	marginal 0.095	marginal use slope term	marginal y = 0.21x (79% reduction)
acenaphthene part	0.03	y = 0.30 (COV = 0.79)	overall regression and slope terms are not significant
fluorene part	0.037	y = 0.60 (COV = 1.0)	overall regression and slope terms are not significant
phenanthrene part	0.037	y = 4.4 (COV = 0.70)	overall regression and slope terms are not significant
2-methylphenanthrene part	0.012	y = 0.6 (COV = 0.68)	overall regression and slope terms are not significant
2-methylanthracene part	0.012	y = 0.1 (COV = 0.74)	overall regression and slope terms are not significant
pyrene part	marginal 0.06	marginal y = 8.8 (COV = 1.08)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Media Filters	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene part	7	0.51	marginal 0.054	0.046	0.253	74.7	0.1	yes	25% overlap
acenaphthene filt	8	0.50	0.037	0.033	2.890	-189	0.4	close	75% overlap
fluorene filt	8	0.59	0.019	0.015	1.932	-93.2	0.54	close	75% overlap
fluorene part	5	0.86	0.016	0.008	0.507	49.3	0.46	close	75% overlap
phenanthrene filt	8	0.55	0.025	0.022	1.764	-76.4	0.33	yes	overlap
phenanthrene part	6	0.86	0.005	0.003	0.313	68.7	0.028	yes	50% overlap
2-methylphenanthrene filt	8	0.53	0.030	0.025	1.650	-65	0.79	yes	mostly overlap
2-methylphenanthrene part	7	0.86	0.002	0.001	0.343	65.7	0.24	yes	50% overlap
2-methylanthracene filt	8	1.00	<0.001	<0.001	0.572	42.8	0.06	yes	overlap
2-methylanthracene part	7	0.98	<0.001	<0.001	0.427	57.3	0.19	yes	mostly overlap
benz(a)anthracene filt	8	0.86	0.001	0.000	0.626	37.4	0.68	yes	overlap
fluoranthene filt	8	0.51	0.036	marginal 0.061	1.320	-32	0.55	yes	overlap
pyrene filt	8	0.39	marginal 0.078	marginal 0.072	1.570	-57	0.82	yes	50% overlap
pyrene part	7	0.84	0.002	0.001	0.287	71.3	0.096	yes	50% overlap
chrysene filt	8	0.73	0.005	0.003	0.542	45.8	0.58	yes	25% overlap
benzo(b)fluoranthene filt	8	0.62	0.016	0.012	0.361	63.9	0.42	yes	mostly overlap
Total PAH filt	8	0.44	marginal 0.057	marginal 0.052	1.474	-47.4	0.54	close	75% overlap
Total PAH part	7	0.76	0.007	0.004	0.243	75.7	<0.005	yes	50% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
2-methylphenanthrene part	marginal 0.097	marginal, use slope terms	y = 0.34x (66% increase)
pyrene filt	marginal 0.1	marginal, use slope terms	marginal y = 1.57x (57% increase)
chrysene part	marginal 0.097	marginal, y = 2.5 (COV = 0.78)	overall regression and slope terms are not significant

	Summary Statistics	Regression Statistics					log-normal probability plot		
Bioinfiltration	count	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene filt	5	0.61	marginal 0.086	marginal 0.065	0.335	66.5	0.56	yes	50% overlap
fluorene filt	5	0.85	0.017	0.008	0.529	47.1	0.42	yes	50% overlap
phenanthrene filt	5	0.84	0.019	0.010	0.511	48.9	0.55	close	mostly overlap
2-methylphenanthrene filt	5	0.97	0.001	0.000	0.594	40.6	0.61	yes	overlap
2-methylanthracene filt	5	0.89	0.018	0.005	0.688	31.2	<0.005	yes	50% overlap
benz(a)anthracene filt	5	0.78	0.034	0.021	0.391	60.9	0.02	yes	overlap
fluoranthene filt	5	0.79	0.031	0.019	0.367	63.3	0.35	close	50% overlap
chrysene filt	5	0.90	0.009	0.004	0.384	61.6	0.26	close	mostly separate
benzo(b)fluoranthene filt	5	0.91	0.009	0.004	0.374	62.6	0.24	yes	50% overlap
Total PAH filt	4	0.86	0.048	0.022	0.514	48.6	0.15	close	mostly overlap

Bioinfiltration	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
2-methylanthracene part	marginal 0.08	marginal y = 0.1 (COV = 0.3)	overall regression and slope terms are not significant
fluoranthene part	marginal 0.095	marginal y = 6.8 (COV = 0.4)	overall regression and slope terms are not significant
pyrene part	0.037	y = 6.6 (COV = 0.3)	overall regression and slope terms are not significant
chrysene filt	0.012	use slope terms	y = 0.38x (62% reduction)
chrysene part	marginal 0.06	marginal y = 5.7 (COV = 0.4)	overall regression and slope terms are not significant
benzo(b)fluoranthene filt	marginal 0.074	marginal, use slope term	y = 0.37x (63% reduction)
benzo(b)fluoranthene part	marginal 0.095	marginal y = 2.7 (COV = 0.5)	overall regression and slope terms are not significant

Conclusions

The following lists the stormwater treatment results based on the paired influent and effluent concentration data. These are for the high-lighted conditions shown previously representing significant or marginal concentration changes based on the Mann-Whitney tests and/or the regression analyses. As noted previously, relatively few conditions resulted in statistically significant differences ($p \leq 0.05$) comparing the influent and effluent concentrations, so the list was expanded to include marginal differences (>0.05 to ≤ 0.10). There were many more significant regression relationships than significant Mann-Whitney differences test results. The “high reductions” generally had >70% reductions, the “moderate reductions” generally had 30 to 70% reductions, and “low reductions” generally had <30% reductions. Also noted are conditions resulting in negative removals (effluent concentrations greater than influent concentrations), and conditions resulting in generally low constant effluent concentrations.

TSS and Particle Sizes

	Low "constant" effluent concentrations	High reductions	Moderate reductions	Low reductions	Effluent concentrations greater than influent concentrations
Sedimentation		20-63 µm Part (>0.45 µm)	5-20 µm		
Media Filters	> 63 µm Part (>0.45 µm)				
Bioinfiltration	> 63 µm		Part (>0.45 µm)		5-20 µm

- Sedimentation resulted in high removals, best with TSS and large size, moderate removals with smaller sizes
- Media filters best on larger size and TSS resulting in constant low effluent concentrations
- Bioinfiltration best removal for particulate solids resulting in low constant effluent concentrations, but with some increases of concentration with small sizes due to media washout

Heavy Metals

	Low "constant" effluent concentrations	High reductions	Moderate reductions	Low reductions	Effluent concentrations greater than influent concentrations
Sedimentation		Cr part Cr total Ni filt Ni part Ni total Pb part Pb total		Cr 5-20 µm Cr filt Cu total	Cu filt Pb 5-20 µm Pb filt Zn filt Zn part Zn total
Media Filters	Pb >63 µm	Pb total	Pb 5-20 µm Pb filt Zn filt Zn total	Zn 20-63	Cr filt
Bioinfiltration	Cu 20-63 µm Ni 20-63 µm Pb >63 µm Zn 20-63 µm Zn filt	Cr 20-63 µm Cu 0.45 - 5 µm Cu 5-20 µm Cu filt Cu total Pb 20-63 µm Zn part Zn total	Cr part Cr total Pb 5-20 µm Pb part Pb total Zn 5-20 µm	Cr filt	Cr 5-20 µm Pb filt

Chromium

- Sedimentation resulted in high removals of total and particulate bound Cr, and less for filtered Cr and other particle sized Cr
- Media filters resulted in low removals of particulate Cr, while filtered Cr resulted in increased effluent Cr concentrations
- Bioinfiltration had moderate removals of total and particulate Cr, and low reductions of filtered Cr. Increases in fine particle bound Cr concentrations were noted, along with high removals of large particle bound Cr concentrations

Copper

- Sedimentation had low and negative removals of total and filtered Cu concentrations
- Media filters had no apparent effects on the removal of Cu
- Bioinfiltration had high removals of all forms of Cu evaluated

Lead

- Sedimentation had high removals of particulate Pb concentrations, but had increased effluent concentrations of filtered Pb and fine particle associated Pb
- Media filters had moderate total, filtered and mid-sized Pb concentrations removals with low constant effluent concentrations of large particle bound Pb.
- Bioinfiltration had moderate removals for total and particulate Pb, increases in filtered Pb effluent concentrations, and high removals of large particle bound Pb with the largest particle bound Pb resulting in constant low effluent concentrations

Nickel

- Sedimentation had high removals of total, particulate, and filtered Ni concentrations
- Media filters had no significant (or marginal) removals for Ni
- Bioinfiltration had relatively constant effluent concentrations for the largest nickel bound particulates

Zinc

- Sedimentation had increased effluent concentrations for total, particulate, and filtered Zn concentrations
- Media filters had moderate total and filtered Zn concentration removals and low removals of intermediate-sized Zn particles
- Bioinfiltration had high removals of total and particulate Zn concentrations, and moderate removals of small particle bound Zn. Effluent large particle bound Zn concentrations were consistently low

PFAS Congeners

	Low "constant" effluent concentrations	High reductions	Moderate reductions	Low reductions	Effluent concentrations greater than influent concentrations
Sedimentation					
Media Filters			PFPeA filt	PFBA filt PFOS filt PFOS part	PFBA part PFDA filt PFDA part PFHpA part PFHxA part PFNA part PFOA filt PFOA part
Bioinfiltration	PFHpA part	PFDoA part PFHpA filt	PFDA filt PFHxA part PFNA filt PFNA part PFOA part		PFOS part

- Sedimentation had no significant (or marginal) removals of PFAS compounds
- Media filter removals of PFAS compounds were mixed, with most showing effluent concentration increases with only a few having moderate and low reductions
- Bioinfiltration had moderate to high removals of several PFAS compounds, with one (particulate PFOS) having increased effluent concentrations, and one (particulate PFHpA) having constant low effluent concentrations

PAH Compounds

	Low "constant" effluent concentrations	High reductions	Moderate reductions	Low reductions	Effluent concentrations greater than influent concentrations
Sedimentation	2-methylanthracene part 2-methylphenanthrene part acenaphthene part fluorene part phenanthrene part pyrene part	acenaphthene filt benz(a)anthracene part benzo(b)fluoranthene filt benzo(b)fluoranthene part chrysene filt chrysene part fluoranthene filt fluoranthene part fluorene filt Total PAHs filt Total PAHs part	2-methylphenanthrene filt Naphthalene filt phenanthrene filt pyrene filt	2-methylanthracene filt	
Media Filters	chrysene part	Naphthalene part pyrene part Total PAHs part	2-methylanthracene filt 2-methylanthracene part 2-methylphenanthrene part benzo(a)anthracene filt benzo(b)fluoranthene filt chrysene filt fluorene part phenanthrene part		2-methylphenanthrene filt acenaphthene filt fluoranthene filt fluorene filt phenanthrene filt pyrene filt Total PAHs filt
Bioinfiltration	2-methylanthracene part benzo(b)fluoranthene part chrysene part fluoranthene part pyrene part		2-methylanthracene filt 2-methylphenanthrene filt benzo(a)anthracene filt benzo(b)fluoranthene filt chrysene filt fluoranthene filt fluorene filt Naphthalene filt phenanthrene filt Total PAHs filt		

- Sedimentation resulted in many of the particulate and filtered PAH compounds having moderate to high concentration reductions, with several particulate PAHs having consistently low effluent concentrations
- Media filters resulted in many moderate to high particulate and filtered PAH removals, but also with many increased effluent concentrations. Particulate chrysene had generally constant low effluent concentrations
- Bioinfiltration resulted in moderate removals of many filtered PAHs with several particulate PAHs having constant low effluent concentrations

The above summaries illustrate some general patterns of treatment performance observed during these monitoring activities. As expected, sedimentation was most effective for constituents mostly associated with larger particles, even though some filtered constituent removals were observed in the sedimentation group. The media cartridge filters, and the hydrodynamic separator, were part of treatment trains. The cartridge filters received partially treated water from the hydrodynamic separators upstream of the filters, so the largest particles had already been removed from the stormwater. The monitored hydrodynamic separator was a pretreatment device before an unmonitored cartridge filter so the effluent quality was not the same as the final stormwater quality discharged from the treatment train. The biofilter and bioswale installations were relatively large bioinfiltration systems compared to their drainage areas, in contrast to the media filter installations. The resulting treatment flow rates and media contact times were therefore different and likely the reason for the general increased relative performance for the biofilters and bioswales compared to the media filters. The biofilter and bioswale also included stormwater infiltration that would decrease mass discharges of pollutants to the surface receiving waters, with some (estimated to be about 70% for the biofilter installation) infiltrated and retained in the vadose zone soils or directed to the groundwater, depending on the characteristics of the pollutants and soils.

Therefore, the most robust treatment controls of those monitored for a wide range of constituents of concern would be large bioinfiltration systems, if space is available for their installation. The selection of suitable treatment media would also enhance their performance and can be selected to target specific constituents.

Appendix A: TSS and Particle Sizes Removal Summary Statistics

	Summary Statistics							Regression Statistics					log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Part (>0.45 µm) inf	5	5.5	728.7	176.2	21.1	312.1	1.77						0.55		
Part (>0.45 µm) efl	5	4.0	53.7	17.3	9.0	20.9	1.21	0.96	0.0024	0.0006	0.075	92.5	0.45	close	mostly overlap
0.45-5 µm inf	4	0.1	5.3	2.5	2.2	2.3	0.92						n/a		
0.45-5 µm efl	1			9.9		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5-20 µm inf	4	5.5	79.6	37.2	31.9	35.4	0.95						0.33		
5-20 µm efl	4	3.4	35.8	12.1	4.5	15.9	1.32	0.99	0.0410	0.0041	0.450	55.0	0.25	yes	mostly overlap
20-63 µm inf	4	3.6	98.7	32.7	14.1	45.1	1.38						0.06		
20-63 µm efl	4	0.4	6.0	2.4	1.6	2.6	1.07	0.99	0.0350	0.0031	0.061	93.9	0.26	yes	50% overlap
> 63 µm inf	5	0.4	550.4	118.4	4.4	241.9	2.04						0.48		
> 63 µm efl	3	0.4	2.0	1.1	1.0	0.8	0.76	0.80	0.2200	0.1100	not significant	not significant	0.59	no	mostly overlap

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Part (>0.45 µm) inf			
Part (>0.45 µm) efl	0.21	no significant difference based on the number of sample pairs (y = x)	y = 0.075x (92.5% reduction)
0.45-5 µm inf			
0.45-5 µm efl	n.a	n/a	n/a
5-20 µm inf			
5-20 µm efl	0.38	no significant difference based on the number of sample pairs (y = x)	y = 0.45x (55% reduction)
20-63 µm inf			
20-63 µm efl	0.38	no significant difference based on the number of sample pairs (y = x)	y = 0.061x (93.9% reduction)
> 63 µm inf			
> 63 µm efl	0.38	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Part (>0.45 µm) inf	8	8.0	81.9	30.1	18.6	28.0	0.93						0.16		
Part (>0.45 µm) efl	8	1.9	15.9	7.7	7.3	5.7	0.74	0.18	0.2600	0.2500	not significant	not significant	0.15	yes	mostly separate
0.45-5 µm inf	3	0.4	2.1	1.1	0.7	0.9	0.85						0.44		
0.45-5 µm efl	3	0.1	0.7	0.3	0.1	0.3	1.13	0.22	0.5900	0.5300	not significant	not significant	0.06	yes	mostly separate
5-20 µm inf	6	1.0	21.4	8.3	5.5	8.0	0.96						0.92		
5-20 µm efl	6	1.8	8.7	5.2	5.1	2.3	0.44	0.35	0.1700	0.1600	not significant	not significant	0.27	yes	mostly overlap
20-63 µm inf	5	1.8	26.4	9.1	3.7	10.3	1.14						0.53		
20-63 µm efl	5	0.1	6.7	2.2	1.1	2.8	1.24	0.18	0.4200	0.4000	not significant	not significant	0.58	close	50% overlap
> 63 µm inf	5	1.6	45.6	12.1	5.0	18.8	1.55						0.32		
> 63 µm efl	5	0.1	3.0	1.3	1.0	1.3	0.98	0.05	0.6800	0.6800	not significant	not significant	0.35	yes	mostly separate

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Part (>0.45 µm) inf			
Part (>0.45 µm) efl	marginal 0.083	marginal y = 7.7 (COV = 0.74)	overall regression and slope terms are not significant
0.45-5 µm inf			
0.45-5 µm efl	0.18	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
5-20 µm inf			
5-20 µm efl	0.94	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
20-63 µm inf			
20-63 µm efl	0.14	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
> 63 µm inf			
> 63 µm efl	marginal 0.09	marginal y = 1.3 (COV = 0.98)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics						log-normal probability plot		
Biofilters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Part (>0.45 µm) inf	5.0	13.2	194.2	75.9	59.6	74.2	1.0						0.58		
Part (>0.45 µm) efl	5.0	13.3	110.9	56.4	62.0	42.4	0.8	0.79	0.0300	0.0180	0.600	40.0	0.17	yes	overlap
0.45-5 µm inf	3.0	1.2	3.4	2.2	2.0	1.1	0.5						0.62		
0.45-5 µm efl	3.0	0.5	14.8	5.3	0.7	8.2	1.5	0.12	0.6900	0.6500	not significant	not significant	0.12	no	overlap
5-20 µm inf	5.0	5.7	83.8	39.1	33.4	35.0	0.9						0.24		
5-20 µm efl	5.0	5.8	92.7	48.0	56.1	39.0	0.8	0.94	0.0040	0.0010	1.140	-14.0	0.15	yes	overlap
20-63 µm inf	5.0	2.4	83.2	26.4	19.6	33.2	1.3						0.35		
20-63 µm efl	5.0	0.9	5.0	3.0	3.5	1.6	0.5	0.11	0.5300	0.5200	not significant	not significant	0.37	no	50% overlap
> 63 µm inf	5.0	3.1	27.1	9.1	4.4	10.2	1.1						0.10		
> 63 µm efl	5.0	0.5	2.5	1.1	0.9	0.8	0.7	0.29	0.2900	0.2700	not significant	not significant	0.29	yes	mostly separate

Biofilters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Part (>0.45 µm) inf			
Part (>0.45 µm) efl	1	no significant difference based on the number of sample pairs (y = x)	y = 0.60x (40% reduction)
0.45-5 µm inf			
0.45-5 µm efl	0.66	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
5-20 µm inf			
5-20 µm efl	0.68	no significant difference based on the number of sample pairs (y = x)	y = 1.14x (14% increase)
20-63 µm inf			
20-63 µm efl	0.21	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
> 63 µm inf			
> 63 µm efl	0.012	y = 1.1 (COV = 0.70)	overall regression and slope terms are not significant

Appendix B: Heavy Metals Removal Summary Statistics

	Summary Statistics							Regression Statistics					log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr total influent	5	2.7	17.6	7.9	4.8	6.5	0.82						0.38		
Cr total effluent	5	0.5	4.6	2.2	2.3	1.8	0.79	0.97	0.002	0.000	0.27	73.0	0.17	yes	50% overlap
Cr part inf	5	0.6	15.6	6.4	4.0	6.2	0.98						0.83		
Cr part efl	5	0.2	1.8	0.9	0.8	0.7	0.80	0.84	0.019	0.010	0.12	88.0	0.41	yes	50% overlap
Cr filt inf	5	0.8	2.4	1.5	1.6	0.7	0.46						0.38		
Cr filt efl	5	0.3	2.8	1.4	0.9	1.2	0.88	0.63	marginal 0.081	marginal 0.06	0.83	17.0	0.36	no	overlap
Cr 0.45 - 5 inf	1			0.4											
Cr 0.45 - 5 efl	1			0.1											
Cr 5 - 20 inf	4	0.5	2.4	1.2	1.1	0.9	0.71						0.51		
Cr 5-20 efl	4	0.2	1.5	1.1	1.3	0.6	0.54	0.77	marginal 0.085	marginal 0.049	0.72	28.0	0.03	yes	overlap
Cr 20 - 63 inf	2	0.1	1.9	1.0	1.0	1.3	1.34								
Cr 20-63 efl	2	0.1	0.2	0.1	0.1	0.0	0.20								
Cr >63 inf	1			11.7											
Cr >63 efl	1			0.4											

	Mann Whitney, a rank sum non-parametric paired test		
Sedimentation	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cr total influent			
Cr total effluent	0.095	no significant difference based on the number of sample pairs (y = x)	y = 0.27x (73% reduction)
Cr part inf			
Cr part efl	marginal 0.06	marginal. use regression slope	y = 0.12x (88% reduction)
Cr filt inf			
Cr filt efl	1.000	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.83s (17% reduction)
Cr 0.45 - 5 inf			
Cr 0.45 - 5 efl	n/a	n/a	n/a
Cr 5 - 20 inf			
Cr 5-20 efl	0.890	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.72x (28% reduction)
Cr 20 - 63 inf			
Cr 20-63 efl	n/a	n/a	n/a
Cr >63 inf			
Cr >63 efl	n/a	n/a	n/a

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr total influent	8	1.20	11.89	6.05	6.39	4.19	0.69						0.20		
Cr total effluent	8	0.67	7.45	4.08	3.75	2.74	0.67	0.31	0.450	0.450	not significant	not significant	0.32	yes	75% overlap
Cr part inf	8	0.50	9.89	4.26	3.20	3.73	0.87						0.43		
Cr part efl	8	0.10	5.90	1.87	1.53	1.90	1.01	0.46	0.075	0.070	-0.33	n/a	0.32	yes	50% overlap
Cr filt inf	8	0.20	5.03	1.78	0.94	1.81	1.01						0.48		
Cr filt efl	8	0.36	5.10	2.20	1.77	1.89	0.86	0.87	0.001	0.000	1.07	-6.8	0.63	yes	overlap
Cr 0.45 - 5 inf	3	0.10	0.29	0.20	0.20	0.10	0.50						0.50		
Cr 0.45 - 5 efl	3	0.10	0.75	0.35	0.20	0.35	1.00	0.49	0.570	0.510	not significant	not significant	0.50	yes	overlap
Cr 5 - 20 inf	6	0.21	3.30	0.92	0.49	1.18	1.28						0.09		
Cr 5-20 efl	6	0.10	1.40	0.71	0.73	0.55	0.78	0.54	0.260	0.260	not significant	not significant	0.10	yes	overlap
Cr 20 - 63 inf	5	0.10	3.13	1.43	0.63	1.54	1.08						0.41		
Cr 20-63 efl	5	0.02	1.02	0.30	0.04	0.43	1.45	0.04	0.720	0.720	not significant	not significant	0.21	yes	50% overlap
Cr >63 inf	6	0.08	5.15	1.48	0.59	1.95	1.31						0.91		
Cr >63 efl	6	0.10	5.90	1.41	0.48	2.23	1.59	0.15	0.750	0.750	not significant	not significant	0.73	yes	overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cr total influent			
Cr total effluent	0.320	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cr part inf			
Cr part efl	0.230	no significant difference based on the number of sample pairs (y = x)	marginal y = -0.33x (adverse slope)
Cr filt inf			
Cr filt efl	0.500	no significant difference based on the number of sample pairs (y = x)	y = 1.07 x (7% increase)
Cr 0.45 - 5 inf			
Cr 0.45 - 5 efl	0.830	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cr 5 - 20 inf			
Cr 5-20 efl	0.940	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cr 20 - 63 inf			
Cr 20-63 efl	0.140	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cr >63 inf			
Cr >63 efl	1.000	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cr total influent	5	1.4	16.2	6.2	5.1	6.0	1.0						0.64		
Cr total effluent	5	1.7	8.7	5.4	7.1	3.2	0.6	0.73	0.047	0.031	0.64	36.2	0.12	yes	overlap
Cr part inf	5	0.4	13.3	4.4	3.2	5.2	1.2						0.71		
Cr part efl	5	0.6	7.8	3.9	4.7	3.1	0.8	0.65	0.073	0.053	0.60	39.8	0.23	yes	overlap
Cr filt inf	5	0.8	3.0	1.8	1.1	1.1	0.6						0.12		
Cr filt efl	5	1.0	2.4	1.5	1.4	0.6	0.4	0.93	0.005	0.002	0.75	25.5	0.76	yes	overlap
Cr 0.45 - 5 inf															
Cr 0.45 - 5 efl															
Cr 5 - 20 inf	5	0.3	2.4	1.5	2.1	1.1	0.7						0.03		
Cr 5-20 efl	5	0.2	7.0	3.3	4.6	3.0	0.9	0.94	0.005	0.002	2.30	-129.5	0.05	yes	overlap
Cr 20 - 63 inf	5	0.0	8.6	2.1	0.9	3.6	1.7						0.77		
Cr 20-63 efl	5	0.1	0.3	0.1	0.1	0.1	0.9	0.63	0.078	0.058	0.04	96.3	0.03	no	50% overlap
Cr >63 inf	3	0.2	2.2	1.2	1.2	1.0	0.9						0.38		
Cr >63 efl	3	0.1	0.8	0.3	0.1	0.4	1.4	0.03	0.850	0.830	not significant	not significant	0.06	yes	50% overlap

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cr total influent			
Cr total effluent	0.680	no significant difference based on the number of sample pairs (y = x)	y = 0.64x (36% reduction)
Cr part inf			
Cr part efl	0.680	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.6x (40% reduction)
Cr filt inf			
Cr filt efl	1.000	no significant difference based on the number of sample pairs (y = x)	y = 0.75x (26% reduction)
Cr 0.45 - 5 inf			
Cr 0.45 - 5 efl	n/a	n/a	n/a
Cr 5 - 20 inf			
Cr 5-20 efl	0.680	no significant difference based on the number of sample pairs (y = x)	y = 2.3x (130% increase)
Cr 20 - 63 inf			
Cr 20-63 efl	0.290	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.04x (96% reduction)
Cr >63 inf			
Cr >63 efl	0.180	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total influent	7	5.4	23.7	13.6	12.6	6.6	0.49						0.24		
Cu total effluent	7	3.3	44.8	13.3	8.9	14.3	1.07	0.50	marginal 0.057	0.050	0.89	11.0	0.37	yes	overlap
Cu part inf	6	0.9	20.7	7.6	5.3	7.2	0.95						0.94		
Cu part efl	6	1.6	27.5	8.4	5.0	9.8	1.16	0.13	0.430	0.420	not significant	not significant	0.80	yes	overlap
Cu filt inf	5	2.0	12.8	7.0	7.1	4.6	0.65						0.51		
Cu filt efl	5	3.0	17.3	7.7	6.9	5.7	0.74	0.93	0.006	0.002	1.10	-9.8	0.60	yes	overlap
Cu 0.45 - 5 inf	0														
Cu 0.45 - 5 efl	0														
Cu 5 - 20 inf	3	0.5	10.7	4.4	2.1	5.5	1.24						0.63		
Cu 5-20 efl	3	5.6	10.7	7.4	5.9	2.9	0.38	0.30	0.520	0.450	not significant	not significant	0.11	no	mostly overlap
Cu 20 - 63 inf	1			1.5											
Cu 20-63 efl	1			0.4											
Cu >63 inf	1			2.7											
Cu >63 efl	1			16.7											

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cu total influent			
Cu total effluent	0.370	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.89x (11% reduction)
Cu part inf			
Cu part efl	1.000	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cu filt inf			
Cu filt efl	1.000	no significant difference based on the number of sample pairs (y = x)	y = 1.10x (9.8% increase)
Cu 0.45 - 5 inf			
Cu 0.45 - 5 efl	n/a	n/a	n/a
Cu 5 - 20 inf			
Cu 5-20 efl	0.380	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cu 20 - 63 inf			
Cu 20-63 efl	n/a	n/a	n/a
Cu >63 inf			
Cu >63 efl	n/a	n/a	n/a

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total influent	8	20.40	283.77	107.67	107.27	86.47	0.80						0.39		
Cu total effluent	8	6.06	216.90	92.96	94.70	81.95	0.88	0.64	0.018	0.020	-0.75	n/a	0.09	close	75% overlap
Cu part inf	8	7.30	169.52	59.91	37.88	57.40	0.96						0.77		
Cu part efl	8	1.20	92.09	31.19	21.67	33.15	1.06	0.47	0.060	0.060	-0.39	n/a	0.41	yes	50% overlap
Cu filt inf	8	11.70	114.25	47.77	37.26	36.59	0.77						0.61		
Cu filt efl	8	4.51	177.20	61.76	46.59	64.76	1.05	0.46	<0.0001	0.060	-1.20	n/a	0.28	close	mostly overlap
Cu 0.45 - 5 inf	3	0.13	0.60	0.34	0.30	0.24	0.69						0.62		
Cu 0.45 - 5 efl	3	0.10	20.94	10.31	9.90	10.43	1.01	0.30	0.520	0.450	not significant	not significant	0.17	no	mostly overlap
Cu 5 - 20 inf	5	2.96	33.11	12.53	5.90	12.71	1.01						0.52		
Cu 5-20 efl	5	6.05	53.30	19.62	12.72	19.26	0.98	0.12	0.520	0.510	not significant	not significant	0.26	yes	overlap
Cu 20 - 63 inf															
Cu 20-63 efl															
Cu >63 inf	3	1.00	88.67	31.42	4.60	49.61	1.58						0.50		
Cu >63 efl	3	0.10	0.10	0.10	0.10	0.00	0.00	1.00	n/a	n/a	0.00	100.0	n/a	no	separate

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cu total influent			
Cu total effluent	0.495	no significant difference based on the number of sample pairs (y = x)	y = -0.75x (adverse slope)
Cu part inf			
Cu part efl	0.160	no significant difference based on the number of sample pairs (y = x)	marginal y = -0.39x (adverse slope)
Cu filt inf			
Cu filt efl	0.880	no significant difference based on the number of sample pairs (y = x)	y = -1.2x (adverse slope)
Cu 0.45 - 5 inf			
Cu 0.45 - 5 efl	0.660	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cu 5 - 20 inf			
Cu 5-20 efl	0.300	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cu 20 - 63 inf			
Cu 20-63 efl	n/a	n/a	n/a
Cu >63 inf			
Cu >63 efl	n/a (efl constant)	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Cu total influent	5	146.9	1121.8	392.9	221.5	411.6	1.0						0.14		
Cu total effluent	5	38.3	68.7	55.7	53.3	12.1	0.2	0.63	0.081	0.061	0.08	91.7	0.42	no	separate
Cu part inf	5	14.7	618.5	178.0	81.5	251.5	1.4						0.89		
Cu part efl	5	14.5	22.6	17.7	16.0	3.7	0.2	0.49	0.150	0.120	not significant	not significant	0.22	no	separate
Cu filt inf	5	76.5	503.4	215.0	160.0	169.6	0.8						0.81		
Cu filt efl	5	23.5	52.7	38.0	38.8	11.6	0.3	0.77	0.035	0.022	0.13	86.9	0.83	close	mostly separate
Cu 0.45 - 5 inf	4	0.5	7.0	4.8	5.8	3.0	0.6						0.03		
Cu 0.45 - 5 efl	4	0.1	1.3	0.8	0.8	0.5	0.7	0.96	0.015	0.004	0.16	84.1	0.37	yes	25% overlap
Cu 5 - 20 inf	4	23.4	132.8	65.8	53.5	49.5	0.8						0.67		
Cu 5-20 efl	4	10.2	22.4	17.0	17.6	5.2	0.3	0.88	0.044	0.019	0.21	79.1	0.51	close	25% overlap
Cu 20 - 63 inf	4	6.6	291.1	84.8	20.8	137.8	1.6						0.41		
Cu 20-63 efl	4	0.5	11.7	3.3	0.5	5.6	1.7	0.01	0.910	0.910	not significant	not significant	0.01	yes	25% overlap
Cu >63 inf	3	3.1	247.2	89.4	17.9	136.8	1.5						0.56		
Cu >63 efl	3	0.5	0.5	0.5	0.5	0.0	0.0	0.39	0.460	0.380	not significant	not significant	n/a	no	75% separate

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Cu total influent			
Cu total effluent	0.012	use regression slope	marginal y = 0.08x (92% reduction)
Cu part inf			
Cu part efl	0.095	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Cu filt inf			
Cu filt efl	0.012	use regression slope	y = 0.13x (87% reduction)
Cu 0.45 - 5 inf			
Cu 0.45 - 5 efl	0.110	no significant difference based on the number of sample pairs (y = x)	y = 0.16x (84% reduction)
Cu 5 - 20 inf			
Cu 5-20 efl	0.030	use regression slope	y=0.21x (79% reduction)
Cu 20 - 63 inf			
Cu 20-63 efl	0.055	marginal y = 3.3 (COV = 1.7)	overall regression and slope terms are not significant
Cu >63 inf			
Cu >63 efl	effluent all constant	n/a	Y = 0.5 (COV = n/a)

	Summary Statistics							Regression Statistics						log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total influent	5	1.0	24.3	8.5	1.3	10.6	1.26						0.06		
Pb total effluent	5	0.6	3.3	1.8	1.7	1.2	0.66	0.86	0.016	0.008	0.15	84.9	0.53	close	overlap
Pb part inf	4	0.5	24.0	9.8	7.3	11.4	1.17						0.12		
Pb part efl	4	0.2	2.4	1.2	1.2	1.2	0.95	0.95	0.018	0.005	0.11	88.7	0.07	yes	overlap
Pb filt inf	5	0.3	0.7	0.5	0.6	0.1	0.26						0.51		
Pb filt efl	5	0.4	1.7	0.8	0.5	0.6	0.71	0.73	0.047	0.031	1.42	-42.0	0.13	no	overlap
Pb 0.45 - 5 inf	2	0.2	0.2	0.2	0.2	0.0	0.23								
Pb 0.45 - 5 efl	2	0.1	0.2	0.1	0.1	0.1	0.82								
Pb 5 - 20 inf	3	0.5	3.3	2.1	2.3	1.4	0.69						0.23		
Pb 5-20 efl	3	0.1	5.6	2.8	2.6	2.7	0.99	0.96	marginal 0.0946	0.022	1.48	-47.7	0.25	close	overlap
Pb 20 - 63 inf															
Pb 20-63 efl															
Pb >63 inf	1			18.3											
Pb >63 efl	1			0.1											

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Pb total influent			
Pb total effluent	0.530	no significant difference based on the number of sample pairs (y = x)	y = 0.14x (84.9% reduction)
Pb part inf			
Pb part efl	0.310	no significant difference based on the number of sample pairs (y = x)	y = 0.11x (88.7% reduction)
Pb filt inf			
Pb filt efl	1.000	no significant difference based on the number of sample pairs (y = x)	y = 1.42x (42% increase)
Pb 0.45 - 5 inf			
Pb 0.45 - 5 efl	n/a	n/a	n/a
Pb 5 - 20 inf			
Pb 5-20 efl	1.000	no significant difference based on the number of sample pairs (y = x)	marginal y = 1.48x (48% increase)
Pb 20 - 63 inf			
Pb 20-63 efl	n/a	n/a	n/a
Pb >63 inf			
Pb >63 efl	n/a	n/a	n/a

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total influent	8	1.40	17.45	7.57	6.73	6.24	0.82						0.22		
Pb total effluent	8	1.26	5.84	3.13	2.62	1.91	0.61	0.56	0.020	0.020	0.28	72.0	0.28	close	75% overlap
Pb part inf	6	0.33	11.38	5.27	4.62	5.07	0.96						0.14		
Pb part efl	6	0.10	2.97	1.21	0.71	1.28	1.06	0.30	0.210	0.200	not significant	not significant	0.20	yes	50% overlap
Pb filt inf	7	0.50	6.08	2.14	1.51	2.07	0.97						0.63		
Pb filt efl	7	0.70	3.43	1.63	1.26	1.07	0.66	0.53	0.049	0.042	0.48	52.0	0.30	yes	overlap
Pb 0.45 - 5 inf															
Pb 0.45 - 5 efl															
Pb 5 - 20 inf	4	0.20	3.76	1.85	1.71	1.77	0.96						0.36		
Pb 5-20 efl	4	0.10	1.66	0.86	0.84	0.88	1.02	0.97	0.009	0.002	0.47	53.0	0.05	yes	50% overlap
Pb 20 - 63 inf	5	0.10	2.43	1.02	0.33	1.08	1.06						0.36		
Pb 20-63 efl	5	0.10	1.49	0.60	0.10	0.69	1.15	0.49	0.140	0.120	not significant	not significant	0.02	yes	50% overlap
Pb >63 inf	4	0.20	8.25	2.71	1.20	3.78	1.39						0.65		
Pb >63 efl	4	0.10	0.20	0.13	0.10	0.05	0.40	0.24	0.430	0.400	not significant	not significant	0.01	no	25% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Pb total influent			
Pb total effluent	0.230	no significant difference based on the number of sample pairs (y = x)	y = 0.28x (72% reduction)
Pb part inf			
Pb part efl	0.170	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Pb filt inf			
Pb filt efl	0.900	no significant difference based on the number of sample pairs (y = x)	y = 0.48x (52% reduction)
Pb 0.45 - 5 inf			
Pb 0.45 - 5 efl	n/a	n/a	n/a
Pb 5 - 20 inf			
Pb 5-20 efl	0.310	no significant difference based on the number of sample pairs (y = x)	y = 0.47x (53% reduction)
Pb 20 - 63 inf			
Pb 20-63 efl	0.330	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Pb >63 inf			
Pb >63 efl	0.037	y = 0.13 (COV = 0.4)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Pb total influent	5	1.3	17.9	8.0	7.3	7.1	0.9						0.51		
Pb total effluent	5	1.6	6.9	3.9	4.2	2.2	0.6	0.84	0.019	0.010	0.39	61.2	0.53	no	75% overlap
Pb part inf	5	0.9	17.0	7.2	6.1	6.8	1.0						0.49		
Pb part efl	5	1.3	5.0	3.0	3.4	1.7	0.6	0.87	0.014	0.007	0.33	67.0	0.31	no	50% overlap
Pb filt inf	5	0.4	1.2	0.8	0.9	0.4	0.5						0.21		
Pb filt efl	5	0.4	1.9	0.8	0.6	0.6	0.8	0.82	0.024	0.013	1.00	-0.2	0.06	close	overlap
Pb 0.45 - 5 inf															
Pb 0.45 - 5 efl															
Pb 5 - 20 inf	5	0.7	9.9	4.1	3.8	3.8	0.9						0.45		
Pb 5-20 efl	5	0.8	5.0	2.7	3.0	1.7	0.6	0.95	0.003	0.001	0.57	43.4	0.71	close	overlap
Pb 20 - 63 inf	4	0.1	7.5	2.3	0.8	3.5	1.5						0.05		
Pb 20-63 efl	4	0.1	0.3	0.2	0.1	0.1	0.6	0.79	0.079	0.044	0.04	96.0	0.69	no	50% overlap
Pb >63 inf	4	0.1	3.7	1.4	0.9	1.6	1.1						0.10		
Pb >63 efl	4	0.0	0.2	0.1	0.1	0.1	0.9	0.11	0.600	0.580	not significant	not significant	0.01	no	50% overlap

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Pb total influent			
Pb total effluent	0.680	no significant difference based on the number of sample pairs (y = x)	y = 0.39x (61% reduction)
Pb part inf			
Pb part efl	0.680	no significant difference based on the number of sample pairs (y = x)	y = 0.33x (67% reduction)
Pb filt inf			
Pb filt efl	0.840	no significant difference based on the number of sample pairs (y = x)	y = 1.00x (-0.2% increase)
Pb 0.45 - 5 inf			
Pb 0.45 - 5 efl	n/a	n/a	n/a
Pb 5 - 20 inf			
Pb 5-20 efl	0.840	no significant difference based on the number of sample pairs (y = x)	y = 0.57x (43% reduction)
Pb 20 - 63 inf			
Pb 20-63 efl	0.310	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.04x (96% reduction)
Pb >63 inf			
Pb >63 efl	0.059	marginal y = 0.1 (COV = 0.9)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics						log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Ni total influent	5	7.0	16.5	11.4	11.1	3.4	0.30						0.25		
Ni total effluent	5	1.9	5.0	3.1	3.0	1.2	0.40	0.81	0.026	0.014	0.25	75.2	0.57	yes	separate
Ni part inf	5	0.6	10.3	5.1	4.2	3.6	0.70						0.19		
Ni part efl	5	0.3	1.7	0.8	0.5	0.6	0.78	0.39	marginal 0.0743	marginal 0.0545	0.13	87.3	0.51	yes	50% overlap
Ni filt inf	5	0.5	12.7	6.3	7.2	5.6	0.89						0.09		
Ni filt efl	5	1.5	3.4	2.3	1.9	0.8	0.35	0.36	marginal 0.08875	marginal 0.0677	0.23	76.8	0.42	no	overlap
Ni 0.45 - 5 inf	1			2.0											
Ni 0.45 - 5 efl	1			0.2											
Ni 5 - 20 inf	4	0.3	1.8	1.3	1.5	0.7	0.54						0.02		
Ni 5-20 efl	4	0.5	2.7	1.5	1.4	0.9	0.60	0.33	0.134	0.092	not significant	not significant	0.29	yes	overlap
Ni 20 - 63 inf	1			1.1											
Ni 20-63 efl	1			0.1											
Ni >63 inf															
Ni >63 efl															

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Ni total influent			
Ni total effluent	0.012	use regression slope	y = 0.25x (75.2% reduction)
Ni part inf			
Ni part efl	0.037	use regression slope	marginal y = 0.13x (87.3% reduction)
Ni filt inf			
Ni filt efl	0.680	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.23x (76.8% reduction)
Ni 0.45 - 5 inf			
Ni 0.45 - 5 efl	n/a	n/a	n/a
Ni 5 - 20 inf			
Ni 5-20 efl	0.890	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni 20 - 63 inf			
Ni 20-63 efl	n/a	n/a	n/a
Ni >63 inf			
Ni >63 efl	n/a	n/a	n/a

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Ni total influent	8	11.16	283.77	98.70	88.99	92.88	0.94						0.34		
Ni total effluent	8	6.06	216.90	81.68	49.60	85.64	1.05	0.34	0.130	0.130	not significant	not significant	0.23	yes	25% overlap
Ni part inf	8	2.29	169.52	55.77	28.54	60.53	1.09						0.76		
Ni part efl	8	1.20	92.09	27.03	6.49	34.47	1.28	0.26	0.200	0.200	not significant	not significant	0.36	yes	50% overlap
Ni filt inf	8	8.88	114.25	42.94	32.98	39.09	0.91						0.53		
Ni filt efl	8	4.51	177.20	54.65	18.15	66.57	1.22	0.29	0.170	0.170	not significant	not significant	0.43	close	overlap
Ni 0.45 - 5 inf	4	0.01	0.60	0.26	0.22	0.26	0.98						0.39		
Ni 0.45 - 5 efl	4	0.10	20.94	7.80	5.08	9.89	1.27	0.30	0.370	0.330	not significant	not significant	0.28	yes	25% overlap
Ni 5 - 20 inf	6	1.60	33.11	10.71	5.00	12.22	1.14						0.76		
Ni 5-20 efl	6	1.45	53.30	16.59	10.91	18.76	1.13	0.12	0.460	0.450	not significant	not significant	0.76	yes	75% overlap
Ni 20 - 63 inf	3	0.30	30.55	11.12	2.50	16.87	1.52						0.62		
Ni 20-63 efl	3	0.10	0.51	0.24	0.10	0.24	1.00	0.04	0.810	0.790	not significant	not significant	0.06	no	50% overlap
Ni >63 inf	3	1.00	88.67	31.42	4.60	49.61	1.58						0.50		
Ni >63 efl	3	0.10	0.10	0.10	0.10	0.00	0.00	1.00	n/a	n/a	0.00	100.0	n/a	no	separate

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Ni total influent			
Ni total effluent	0.500	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni part inf			
Ni part efl	0.160	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni filt inf			
Ni filt efl	0.710	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni 0.45 - 5 inf			
Ni 0.45 - 5 efl	0.470	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni 5 - 20 inf			
Ni 5-20 efl	0.470	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni 20 - 63 inf			
Ni 20-63 efl	0.180	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni >63 inf			
Ni >63 efl	n/a (efl constant)	y = 0.1 (all constant)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Ni total influent	5	5.9	23.5	10.9	8.3	7.1	0.7						0.08		
Ni total effluent	5	2.4	6.1	3.9	4.2	1.5	0.4	0.74	0.043	0.029	0.28	71.7	0.39	yes	mostly separated
Ni part inf	5	0.9	11.7	4.4	3.0	4.5	1.0						0.49		
Ni part efl	5	0.7	5.2	2.2	2.0	1.8	0.8	0.61	0.086	0.065	0.36	64.0	0.73	yes	overlap
Ni filt inf	5	2.7	11.8	6.5	6.1	3.3	0.5						0.71		
Ni filt efl	5	0.9	2.3	1.7	1.7	0.5	0.3	0.89	0.010	0.004	0.23	77.0	0.25	close	separate
Ni 0.45 - 5 inf	3	0.1	0.7	0.3	0.1	0.3	1.2						0.08		
Ni 0.45 - 5 efl	3	0.1	0.3	0.2	0.1	0.1	0.8	0.27	0.550	0.480	not significant	not significant	0.63	yes	overlap
Ni 5 - 20 inf	5	0.3	3.5	1.8	1.9	1.3	0.7						0.47		
Ni 5-20 efl	5	0.6	4.9	2.0	1.9	1.7	0.9	0.95	0.004	0.001	1.13	-13.0	0.39	yes	overlap
Ni 20 - 63 inf	3	0.3	6.0	2.4	0.9	3.1	1.3						0.53		
Ni 20-63 efl	3	0.1	0.1	0.1	0.1	0.0	0.5	0.81	0.210	0.102	not significant	not significant	0.62	close	mostly separated
Ni >63 inf	3	0.1	3.0	1.6	1.7	1.5	0.9						0.23		
Ni >63 efl	3	0.1	0.1	0.1	0.1	0.0	0.0	0.64	0.310	0.200	not significant	not significant	n/a	no	mostly separated

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Ni total influent			
Ni total effluent	0.022	use regression slope	y = 0.28x (72% reduction)
Ni part inf			
Ni part efl	0.296	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.36x (64% reduction)
Ni filt inf			
Ni filt efl	0.013	use regression slope	y = 0.23x (77% reduction)
Ni 0.45 - 5 inf			
Ni 0.45 - 5 efl	1.000	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Ni 5 - 20 inf			
Ni 5-20 efl	1.000	no significant difference based on the number of sample pairs (y = x)	y = 1.13x (13% increase)
Ni 20 - 63 inf			
Ni 20-63 efl	0.081	marginal y = 0.1 (COV = 0.5)	overall regression and slope terms are not significant
Ni >63 inf			
Ni >63 efl	n/a (efl constant)	y = 0.1 (all constant)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total influent	7	6.7	325.2	125.0	73.1	124.3	0.99						0.24		
Zn total effluent	7	7.4	655.0	187.1	61.1	235.0	1.26	0.82	0.003	0.002	1.53	-52.9	0.58	yes	overlap
Zn part inf	7	6.7	158.6	58.9	27.3	64.5	1.10						0.52		
Zn part efl	7	5.3	378.7	80.6	40.1	133.9	1.66	0.55	0.043	0.035	1.31	-30.6	0.43	yes	overlap
Zn filt inf	5	4.0	242.4	92.7	45.8	106.9	1.15						0.26		
Zn filt efl	5	0.7	293.4	146.3	159.9	142.3	0.97	0.93	0.005	0.002	1.40	-40.4	0.04	close	overlap
Zn 0.45 - 5 inf															
Zn 0.45 - 5 efl															
Zn 5 - 20 inf	2	17.4	27.3	22.4	22.4	7.0	0.31								
Zn 5-20 efl	2	10.2	23.9	17.0	17.0	9.7	0.57								
Zn 20 - 63 inf															
Zn 20-63 efl															
Zn >63 inf	1			54.1											
Zn >63 efl	1			378.7											

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Zn total influent			
Zn total effluent	0.898	no significant difference based on the number of sample pairs (y = x)	y = 1.53x (52.9% increase)
Zn part inf			
Zn part efl	0.898	no significant difference based on the number of sample pairs (y = x)	y = 1.31x (30.6% increase)
Zn filt inf			
Zn filt efl	1.000	no significant difference based on the number of sample pairs (y = x)	y = 1.40x (40.4% increase)
Zn 0.45 - 5 inf			
Zn 0.45 - 5 efl	n/a	n/a	n/a
Zn 5 - 20 inf			
Zn 5-20 efl	n/a	n/a	n/a
Zn 20 - 63 inf			
Zn 20-63 efl	n/a	n/a	n/a
Zn >63 inf			
Zn >63 efl	n/a	n/a	n/a

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total influent	8	86.05	429.55	273.16	287.16	111.76	0.41						0.14		
Zn total effluent	8	4.30	346.40	168.47	192.54	138.22	0.82	0.45	0.053	0.047	0.49	51.2	0.04	no	50% overlap
Zn part inf	8	43.42	196.66	93.98	91.03	50.83	0.54						0.56		
Zn part efl	8	0.10	217.92	80.65	61.38	84.81	1.05	0.32	0.120	0.120	not significant	not significant	0.08	no	50% overlap
Zn filt inf	8	42.64	300.56	179.18	186.32	97.51	0.54						0.09		
Zn filt efl	8	2.41	212.83	87.82	80.89	75.93	0.86	0.42	0.067	0.061	0.36	63.8	0.23	close	50% overlap
Zn 0.45 - 5 inf															
Zn 0.45 - 5 efl															
Zn 5 - 20 inf	3	2.36	62.06	29.91	25.30	30.12	1.01						0.38		
Zn 5-20 efl	3	10.37	28.50	19.63	20.01	9.07	0.46	0.67	0.300	0.180	not significant	not significant	0.51	close	overlap
Zn 20 - 63 inf	6	3.13	28.32	17.34	16.50	8.93	0.52						0.06		
Zn 20-63 efl	6	0.10	43.61	17.59	13.97	19.75	1.12	0.57	0.063	0.051	0.99	1.1	0.04	no	50% overlap
Zn >63 inf	6	6.95	104.33	42.13	38.59	34.19	0.81						0.68		
Zn >63 efl	6	0.10	161.96	64.68	33.12	72.99	1.13	0.14	0.420	0.410	not significant	not significant	0.15	no	overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Zn total influent			
Zn total effluent	0.160	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.49x (51% reduction)
Zn part inf			
Zn part efl	0.640	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Zn filt inf			
Zn filt efl	0.066	marginal, use regression slope	marginal y = 0.36x (64% reduction)
Zn 0.45 - 5 inf			
Zn 0.45 - 5 efl	n/a	n/a	n/a
Zn 5 - 20 inf			
Zn 5-20 efl	1.000	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Zn 20 - 63 inf			
Zn 20-63 efl	0.940	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.99x (1% reduction)
Zn >63 inf			
Zn >63 efl	1.000	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Zn total influent	5	90.1	935.3	365.8	313.6	339.7	0.9						0.66		
Zn total effluent	5	31.9	68.0	45.5	41.2	13.6	0.3	0.81	0.025	0.014	0.09	91.1	0.48	no	mostly separated
Zn part inf	5	20.4	383.4	143.9	100.8	150.6	1.0						0.52		
Zn part efl	5	11.6	68.0	31.6	23.4	22.5	0.7	0.96	0.002	0.001	0.19	81.4	0.89	close	25% overlap
Zn filt inf	5	69.7	551.9	221.9	124.0	199.1	0.9						0.58		
Zn filt efl	5	0.5	22.4	14.0	17.7	9.1	0.6	0.18	0.420	0.400	not significant	not significant	0.02	close	mostly separated
Zn 0.45 - 5 inf	4	7.2	16.1	11.1	10.6	4.0	0.4						0.74		
Zn 0.45 - 5 efl	4	0.4	30.3	8.0	0.6	14.9	1.9	0.31	0.370	0.330	not significant	not significant	0.02	no	75% overlap
Zn 5 - 20 inf	4	6.4	59.9	30.0	26.8	24.8	0.8						0.56		
Zn 5-20 efl	4	11.0	37.7	26.3	28.3	11.8	0.4	0.83	0.060	0.030	0.70	30.1	0.32	yes	overlap
Zn 20 - 63 inf	4	8.3	169.9	75.0	60.9	68.0	0.9						0.30		
Zn 20-63 efl	4	0.5	1.1	0.6	0.5	0.3	0.4	0.50	0.220	0.180	not significant	not significant	0.01	no	separate
Zn >63 inf	4	0.7	160.7	63.7	46.7	68.7	1.1						0.17		
Zn >63 efl	4	0.5	9.4	3.3	1.6	4.2	1.3	0.02	0.814	0.807	not significant	not significant	0.25	close	25% overla[

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Zn total influent			
Zn total effluent	0.012	use regression slope	y = 0.09x (91% reduction)
Zn part inf			
Zn part efl	0.140	no significant difference based on the number of sample pairs (y = x)	y = 0.19x (81% reduction)
Zn filt inf			
Zn filt efl	0.012	y = 14 (COV = 0.6)	overall regression and slope terms are not significant
Zn 0.45 - 5 inf			
Zn 0.45 - 5 efl	>0.05	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Zn 5 - 20 inf			
Zn 5-20 efl	>0.05	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.70x (30% reduction)
Zn 20 - 63 inf			
Zn 20-63 efl	<0.05	y = 0.6 (COV = 0.4)	overall regression and slope terms are not significant
Zn >63 inf			
Zn >63 efl	>0.05	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

Appendix C: PFAS Removal Summary Statistics

	Summary Statistics			
Sedimentation	count	average	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
PFBA filt inf	2	5.61		
PFBA filt efl	2	6.42	n/a too few data pairs	n/a too few data pairs
PFPeA filt inf	2	4.53		
PFPeA filt efl	2	12.22	n/a too few data pairs	n/a too few data pairs
PFHxA filt inf	2	19.02		
PFHxA filt efl	2	54.28	n/a too few data pairs	n/a too few data pairs
PFHxA total inf	2	5.13		
PFHxA total efl	2	4.20	n/a too few data pairs	n/a too few data pairs
PFHpA filt inf	2	2.72		
PFHpA filt efl	2	8.50	n/a too few data pairs	n/a too few data pairs
PFOA filt inf	2	1.55		
PFOA filt efl	2	522.54	n/a too few data pairs	n/a too few data pairs
PFHxS filt inf	2	32.32		
PFHxS filt efl	2	1559.29	n/a too few data pairs	n/a too few data pairs
PFOS filt inf	2	78.14		
PFOS filt efl	2	224.00	n/a too few data pairs	n/a too few data pairs

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
PFBA filt inf	5	1.00	5.71	3.27	3.14	1.79	0.55						0.64		
PFBA filt efl	5	0.50	4.66	2.57	2.30	1.87	0.73	0.87	0.014	0.007	0.785	21.5	0.51	yes	75% overlap
PFBA part inf	7	0.24	5.32	2.97	2.83	1.97	0.66						0.17		
PFBA part eff	7	0.19	8.34	3.11	2.35	3.15	1.01	0.75	0.008	0.006	1.058	-5.8	0.79	yes	overlap
PFPeA filt inf	4	0.17	6.66	2.19	0.96	3.00	1.37						0.41		
PFPeA filt efl	4	1.22	4.12	2.07	1.47	1.38	0.67	0.99	0.007	0.007	0.456	54.4	0.11	no	overlap
PFPeA part inf	4	0.32	3.48	1.28	0.66	1.49	1.16						0.40		
PFPeA part efl	4	1.00	2.23	1.58	1.54	0.66	0.42	0.30	0.370	0.380	not significant	not significant	0.10	close	overlap
PFHxA filt inf	5	2.28	11.92	4.87	3.61	4.03	0.83						0.19		
PFHxA filt efl	5	0.94	5.19	3.10	3.51	1.59	0.51	0.56	0.143	0.140	not significant	not significant	0.31	yes	50% overlap
PFHxA part inf	6	0.53	4.17	2.51	2.49	1.52	0.61						0.01		
PFHxA part efl	6	0.06	6.35	3.34	2.95	2.34	0.70	0.97	0.000	<0.001	1.360	-36.0	0.08	yes	overlap
PFHpA filt inf	5	0.86	12.16	3.48	1.65	4.87	1.40						0.08		
PFHpA filt efl	5	1.02	1.90	1.46	1.45	0.37	0.25	0.24	0.400	0.400	not significant	not significant	0.78	no	mostly overlap
PFHpA part inf	6	0.83	1.75	1.10	0.97	0.35	0.32						0.25		
PFHpA part efl	6	1.50	3.03	2.00	1.81	0.56	0.28	0.12	0.500	0.500	not significant	not significant	0.42	yes	separate
PFOA filt inf	6	1.64	18.66	10.11	10.24	7.84	0.78						0.20		
PFOA filt efl	6	0.40	19.20	10.62	11.88	8.87	0.84	0.99	<0.001	<0.001	1.070	-7.0	0.14	yes	overlap
PFOA part inf	8	0.73	23.42	8.75	4.52	8.36	0.95						0.47		
PFOA part efl	8	0.34	28.78	10.89	7.39	11.19	1.03	0.98	<0.001	<0.001	1.270	-27.0	0.37	yes	overlap
PFNA filt inf	3	0.62	0.93	0.80	0.84	0.16	0.20						0.36		
PFNA filt efl	3	0.50	2.00	1.01	0.52	0.86	0.85	0.69	0.280	0.170	not significant	not significant	0.07	close	overlap
PFNA part inf	5	0.55	1.71	1.26	1.37	0.47	0.37						0.22		
PFNA part efl	5	0.54	2.40	1.74	2.00	0.71	0.41	0.81	0.026	0.015	1.250	-25.0	0.02	yes	50% overlap
PFDA filt inf	3	0.60	1.06	0.78	0.68	0.25	0.32						0.30		
PFDA filt efl	3	0.66	1.00	0.86	0.93	0.18	0.20	0.92	0.130	0.038	1.040	-4.0	0.21	yes	overlap
PFDA part inf	6	0.30	1.85	1.19	1.38	0.60	0.50						0.09		
PFDA part efl	6	0.73	2.00	1.34	1.34	0.46	0.34	0.89	0.003	0.002	1.012	-1.2	0.91	yes	overlap
PFOS filt inf	6	3.37	24.53	11.65	7.45	9.96	0.86						0.21		
PFOS filt efl	6	1.13	31.12	9.78	6.67	10.81	1.11	0.68	0.040	0.021	0.779	22.1	0.46	yes	overlap
PFOS part inf	8	2.05	28.12	12.44	11.38	8.19	0.66						0.32		
PFOS part efl	8	1.34	23.62	13.81	14.79	8.32	0.60	0.80	0.002	0.001	0.973	2.7	0.08	yes	overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
PFBA filt inf			
PFBA filt efl	0.68	no significant difference based on the number of sample pairs (y = x)	y = 0.78x (21% reduction)
PFBA part inf			
PFBA part eff	0.9	no significant difference based on the number of sample pairs (y = x)	y = 1.06x (6% increase)
PFPeA filt inf			
PFPeA filt efl	0.31	no significant difference based on the number of sample pairs (y = x)	y = 0.45x (54% reduction)
PFPeA part inf			
PFPeA part efl	0.31	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
PFHxA filt inf			
PFHxA filt efl	0.4	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
PFHxA part inf			
PFHxA part efl	0.68	no significant difference based on the number of sample pairs (y = x)	y = 1.4x (36% increase)
PFHpA filt inf			
PFHpA filt efl	1	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
PFHpA part inf			
PFHpA part efl	0.013	y = 2.0x (COV = 0.28)	overall regression and slope terms are not significant
PFOA filt inf			
PFOA filt efl	0.81	no significant difference based on the number of sample pairs (y = x)	y = 1.07x (7% increase)
PFOA part inf			
PFOA part efl	1	no significant difference based on the number of sample pairs (y = x)	y = 1.27x (27% increase)
PFNA filt inf			
PFNA filt efl	0.66	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
PFNA part inf			
PFNA part efl	0.21	no significant difference based on the number of sample pairs (y = x)	y = 1.25x (25% increase)
PFDA filt inf			
PFDA filt efl	1	no significant difference based on the number of sample pairs (y = x)	marginal y = 1.04x (4 % increase)
PFDA part inf			
PFDA part efl	0.69	no significant difference based on the number of sample pairs (y = x)	y = 1.01x (1% increase)
PFOS filt inf			
PFOS filt efl	0.94	no significant difference based on the number of sample pairs (y = x)	y = 0.78x (22% reduction)
PFOS part inf			
PFOS part efl	0.71	no significant difference based on the number of sample pairs (y = x)	y = 0.97x (3 % reduction)

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters and bioswales	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
PFHxA part inf	4	0.6	14.6	6.6	5.6	6.0	0.9						0.48		
PFHxA part efl	4	2.4	4.9	3.5	3.3	1.2	0.3	0.67	0.134	0.092	0.353	64.7	0.50	close	overlap
PFHpA filt inf	3	0.7	6.7	3.4	2.9	3.0	0.9						0.53		
PFHpA filt efl	3	0.5	1.8	1.1	1.1	0.7	0.6	0.96	0.086	0.018	0.295	70.5	0.57	yes	overlap
PFHpA part inf	3	1.8	8.9	4.6	3.2	3.7	0.8						0.54		
PFHpA part efl	3	1.4	1.7	1.6	1.6	0.1	0.1	0.73	0.259	0.146	not significant	not significant	0.31	no	50% overlap
PFOA part inf	4	2.3	45.5	17.0	10.1	19.8	1.2						0.76		
PFOA part efl	4	1.0	19.5	9.0	7.7	8.8	1.0	0.93	0.024	0.008	0.469	53.1	0.48	yes	75% overlap
PFNA filt inf	3	0.0	3.5	1.7	1.5	1.8	1.0						0.19		
PFNA filt efl	3	0.4	2.2	1.4	1.6	0.9	0.6	0.93	0.118	0.034	0.691	30.9	0.24	close	overlap
PFNA part inf	3	1.0	5.1	2.7	1.8	2.2	0.8						0.53		
PFNA part efl	3	1.2	2.9	1.8	1.4	0.9	0.5	0.96	0.091	0.020	0.606	39.4	0.20	yes	overlap
PFDA filt inf	3	0.8	3.1	1.9	1.8	1.1	0.6						0.52		
PFDA filt efl	3	0.5	1.7	1.1	1.3	0.6	0.5	0.99	0.053	0.007	0.586	41.4	0.26	yes	75% overlap
PFDA part inf	3	1.5	6.3	3.4	2.4	2.5	0.8						0.48		
PFDA part efl	3	1.5	3.0	2.4	2.9	0.8	0.3	0.74	0.253	0.140	not significant	not significant	0.08	yes	overlap
PFOS part inf	3	8.6	60.2	26.1	9.3	29.6	1.1						0.08		
PFOS part efl	3	5.0	62.5	25.9	10.3	31.8	1.2	1.00	0.029	0.002	1.029	-2.9	0.40	yes	overlap
PFDoA part inf	3	0.0	49.0	21.1	14.2	25.2	1.2						0.20		
PFDoA part efl	3	1.0	8.2	4.5	4.3	3.6	0.8	0.95	0.103	0.026	0.179	82.1	0.44	close	overlap

Biofilters and bioswales	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
PFHxA part inf			
PFHxA part efl	0.47	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.35x (65% reduction)
PFHpA filt inf			
PFHpA filt efl	0.38	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.30x (71% reduction)
PFHpA part inf			
PFHpA part efl	0.08	marginal y = 1.6 (COV = 0.1)	overall regression and slope terms are not significant
PFOA part inf			
PFOA part efl	0.67	no significant difference based on the number of sample pairs (y = x)	y = 0.47x (53% reduction)
PFNA filt inf			
PFNA filt efl	1	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.69x (31% reduction)
PFNA part inf			
PFNA part efl	1	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.61x (41% reduction)
PFDA filt inf			
PFDA filt efl	0.38	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.59x (41% reduction)
PFDA part inf			
PFDA part efl	1	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
PFOS part inf			
PFOS part efl	1	no significant difference based on the number of sample pairs (y = x)	y = 1.03x (3% increase)
PFDoA part inf			
PFDoA part efl	0.66	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.18x (82% reduction)

Appendix D: PAH Removal Summary Statistics

	Summary Statistics							Regression Statistics					log-normal probability plot		
Sedimentation	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene filt inf	5	3.1	13.6	7.5	4.8	4.8	0.64						0.31		
Naphthalene filt efl	5	2.9	9.1	5.0	4.0	2.4	0.48	0.59	0.096	0.077	0.483	51.7	0.34	yes	overlap
Naphthalene part inf	3	2.0	25.4	13.2	12.1	11.7	0.89						0.41		
Naphthalene part efl	3	0.1	6.0	2.2	0.5	3.3	1.51	0.02	0.860	0.850	not significant	not significant	0.54	yes	50% overlap
acenaphthene filt inf	5	0.7	6.3	2.5	1.2	2.4	0.94						0.41		
acenaphthene filt efl	5	0.4	1.5	0.7	0.6	0.4	0.58	0.68	0.060	0.042	0.214	78.6	0.74	close	25% overlap
acenaphthene part inf	4	1.1	23.5	10.4	8.5	10.9	1.04						0.29		
acenaphthene part efl	4	0.1	0.7	0.3	0.2	0.3	0.79	0.14	0.559	0.537	not significant	not significant	0.2	close	mostly separate
fluorene filt inf	5	1.5	13.5	5.6	2.2	5.3	0.95						0.17		
fluorene filt efl	5	1.6	3.7	2.3	2.1	0.8	0.37	0.76	0.039	0.024	0.288	71.2	0.51	close	mostly overlap
fluorene part inf	5	1.0	17.9	6.9	3.1	7.4	1.08						0.38		
fluorene part efl	5	0.1	1.6	0.6	0.3	0.6	1.02	0.05	0.680	0.680	not significant	not significant	0.8	yes	50% overlap
phenanthrene filt inf	5	8.8	47.2	21.8	20.1	15.3	0.70						0.61		
phenanthrene filt efl	5	9.4	16.1	12.3	10.9	2.8	0.23	0.80	0.027	0.016	0.467	53.3	0.43	close	75% overlap
phenanthrene part inf	5	5.1	726.1	210.6	13.5	314.3	1.49						0.19		
phenanthrene part efl	5	0.1	8.4	4.4	4.6	3.1	0.70	0.20	0.390	0.370	not significant	not significant	0.03	yes	50% overlap
2-methylphenanthrene filt inf	5	1.1	3.7	2.2	2.0	1.0	0.47						0.94		
2-methylphenanthrene filt efl	5	1.1	1.9	1.6	1.7	0.3	0.20	0.90	0.008	0.004	0.661	33.86	0.03	close	mostly overlap
2-methylphenanthrene part inf	5	1.1	95.6	27.8	3.2	40.9	1.47						0.27		
2-methylphenanthrene part efl	5	0.2	1.1	0.6	0.6	0.4	0.68	0.12	0.510	0.490	not significant	not significant	0.63	close	25% overlap
2-methylanthracene filt inf	5	0.3	0.7	0.4	0.3	0.2	0.44						0.27		
2-methylanthracene filt efl	5	0.2	0.5	0.3	0.3	0.1	0.43	0.93	0.005	0.002	0.800	20	0.81	yes	overlap
2-methylanthracene part inf	5	0.4	18.6	5.7	2.8	7.6	1.32						0.68		

2-methylanthracene part efl	5	0.1	0.3	0.1	0.1	0.1	0.74	0.16	0.450	0.430	not significant	not significant	0.08	close	separate
benz(a)anthracene filt inf	5	0.1	73.7	16.0	0.2	32.4	2.02						0.16		
benz(a)anthracene filt efl	5	0.1	0.4	0.3	0.3	0.1	0.45	0.30	0.270	0.260	not significant	not significant	0.2	no	mostly overlap
benz(a)anthracene part inf	5	1.2	938.5	232.6	3.9	405.5	1.74						0.18		
benz(a)anthracene part efl	5	0.2	5.3	2.0	0.8	2.2	1.11	0.89	0.010	0.005	0.006	99.39	0.76	close	50% overlap
fluoranthene filt inf	5	2.8	95.5	29.0	4.8	40.2	1.39						0.15		
fluoranthene filt efl	5	2.5	27.8	9.1	4.6	10.6	1.17	0.89	0.009	0.004	0.269	73.1	0.17	yes	mostly overlap
fluoranthene part inf	5	6.2	1782.5	524.9	11.1	785.4	1.50						0.06		
fluoranthene part efl	5	0.1	30.4	13.1	8.4	12.9	0.98	0.91	0.008	0.003	0.002	99.82	0.13	yes	50% overlap
pyrene filt inf	5	1.6	93.4	30.5	3.9	41.0	1.34						0.19		
pyrene filt efl	5	1.4	29.3	11.0	6.0	11.6	1.05	0.97	0.001	0.000	0.313	68.7	0.84	yes	overlap
pyrene part inf	5	7.0	1513.1	511.3	12.6	710.0	1.39						0.05		
pyrene part efl	5	1.0	25.4	8.8	5.8	9.5	1.08	0.48	0.149	0.125	not significant	not significant	0.22	close	50% overlap
chrysene filt inf	5	0.5	92.5	22.3	1.2	39.8	1.78						0.26		
chrysene filt efl	5	1.0	4.8	2.6	2.0	1.8	0.69	0.67	0.064	0.046	0.058	94.2	0.3	close	mostly overlap
chrysene part inf	5	3.2	1748.3	520.6	8.3	775.1	1.49						0.09		
chrysene part efl	5	0.8	37.1	12.1	4.8	15.1	1.25	0.98	0.001	0.000	0.021	97.93	0.9	close	75% overlap
benzo(b)fluoranthene filt inf	5	0.1	37.1	10.3	0.3	16.1	1.57						0.14		
benzo(b)fluoranthene filt efl	5	0.2	1.6	0.8	0.6	0.6	0.78	0.61	0.088	0.067	0.042	95.81	0.82	close	overlap
benzo(b)fluoranthene part inf	5	1.4	1817.9	527.3	3.0	802.2	1.52						0.06		
benzo(b)fluoranthene part efl	5	0.3	32.8	10.3	2.1	14.0	1.35	1.00	<0.001	<0.001	0.018	98.18	0.64	yes	mostly overlap
Total PAH filt inf	5	37.7	627.7	199.8	79.9	249.6	1.25						0.43		
Total PAH filt efl	5	32.1	99.4	59.2	57.0	27.2	0.46	0.78	0.032	0.019	0.188	81.2	0.79	close	75% overlap
Total PAH part inf	5	50.4	22291.0	5873.5	60.9	9646.2	1.64						0.04		
Total PAH part efl	5	11.8	259.1	97.6	59.8	99.9	1.02	0.93	0.006	0.002	0.012	98.78	0.93	close	25% overlap

Sedimentation	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Naphthalene filt inf			
Naphthalene filt efl	0.4	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.48x (52% reduction)
Naphthalene part inf			
Naphthalene part efl	0.19	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
acenaphthene filt inf			
acenaphthene filt efl	0.095	marginal use slope term	marginal y = 0.21x (79% reduction)
acenaphthene part inf			
acenaphthene part efl	0.03	y = 0.30 (COV = 0.79)	overall regression and slope terms are not significant
fluorene filt inf			
fluorene filt efl	0.53	no significant difference based on the number of sample pairs (y = x)	y = 0.29x (71% reduction)
fluorene part inf			
fluorene part efl	0.037	y = 0.60 (COV = 1.0)	overall regression and slope terms are not significant
phenanthrene filt inf			
phenanthrene filt efl	0.3	no significant difference based on the number of sample pairs (y = x)	y = 0.47x (53% reduction)
phenanthrene part inf			
phenanthrene part efl	0.037	y = 4.4 (COV = 0.70)	overall regression and slope terms are not significant
2-methylphenanthrene filt inf			
2-methylphenanthrene filt efl	0.4	no significant difference based on the number of sample pairs (y = x)	y = 0.66x (34% reduction)
2-methylphenanthrene part inf			
2-methylphenanthrene part efl	0.012	y = 0.6 (COV = 0.68)	overall regression and slope terms are not significant
2-methylanthracene filt inf			
2-methylanthracene filt efl	0.53	no significant difference based on the number of sample pairs (y = x)	y = 0.80x (20% reduction)
2-methylanthracene part inf			
2-methylanthracene part efl	0.012	y = 0.1 (COV = 0.74)	overall regression and slope terms are not significant
benz(a)anthracene filt inf			
benz(a)anthracene filt efl	0.84	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
benz(a)anthracene part inf			
benz(a)anthracene part efl	0.14	no significant difference based on the number of sample pairs (y = x)	y = 0.006x (99% reduction)
fluoranthene filt inf			
fluoranthene filt efl	0.68	no significant difference based on the number of sample pairs (y = x)	y = 0.27x (73% reduction)
fluoranthene part inf			
fluoranthene part efl	0.4	no significant difference based on the number of sample pairs (y = x)	y = 0.002x (99% reduction)
pyrene filt inf			
pyrene filt efl	0.84	no significant difference based on the number of sample pairs (y = x)	y = 0.31x (69% reduction)
pyrene part inf			
pyrene part efl	0.06	marginal y = 8.8 (COV = 1.08)	overall regression and slope terms are not significant
chrysene filt inf			
chrysene filt efl	1	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.058x (94% reduction)

chrysene part inf			
chrysene part efl	0.3	no significant difference based on the number of sample pairs (y = x)	y = 0.021x (98% reduction)
benzo(b)fluoranthene filt inf			
benzo(b)fluoranthene filt efl	0.84	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.042x (96% reduction)
benzo(b)fluoranthene part inf			
benzo(b)fluoranthene part efl	0.4	no significant difference based on the number of sample pairs (y = x)	y = 0.018x (98% reduction)
Total PAH filt inf			
Total PAH filt efl	0.3	no significant difference based on the number of sample pairs (y = x)	y = 0.19x (81% reduction)
Total PAH part inf			
Total PAH part efl	0.4	no significant difference based on the number of sample pairs (y = x)	y = 0.012x (99% reduction)

	Summary Statistics							Regression Statistics					log-normal probability plot		
Media Filters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene filt inf	8	1.65	8.41	5.09	4.83	2.92	0.57						0.1		
Naphthalene filt efl	8	0.05	59.88	10.99	3.80	19.99	1.82	0.38	0.110	0.110	not significant	not significant	0.2	no	overlap
Naphthalene part inf	7	0.18	12.43	5.66	4.33	4.65	0.82						0.2		
Naphthalene part efl	7	0.03	4.28	1.79	1.12	1.91	1.06	0.51	0.054	0.046	0.253	74.7	0.1	yes	25% overlap
acenaphthene filt inf	8	0.17	0.73	0.41	0.35	0.23	0.55						0.6		
acenaphthene filt efl	8	0.07	5.23	1.00	0.37	1.72	1.72	0.50	0.037	0.033	2.890	-189.0	0.4	close	75% overlap
acenaphthene part inf	5	0.09	0.99	0.52	0.62	0.37	0.70						0.34		
acenaphthene part efl	5	0.01	2.69	0.65	0.10	1.15	1.76	0.32	0.260	0.240	not significant	not significant	0.91	close	75% overlap
fluorene filt inf	8	0.78	3.49	1.68	1.41	0.96	0.57						0.48		
fluorene filt efl	8	0.35	11.67	3.30	2.13	3.72	1.13	0.59	0.019	0.015	1.932	-93.2	0.54	close	75% overlap
fluorene part inf	5	0.76	3.91	1.99	1.56	1.29	0.65						0.87		
fluorene part efl	5	0.05	2.18	0.97	0.61	0.90	0.93	0.86	0.016	0.008	0.507	49.3	0.46	close	75% overlap
phenanthrene filt inf	8	0.15	13.48	6.10	6.66	4.87	0.80						0.052		
phenanthrene filt efl	8	0.05	45.70	11.28	7.47	15.08	1.34	0.55	0.025	0.022	1.764	-76.4	0.33	yes	overlap
phenanthrene part inf	6	0.10	27.51	10.86	6.16	10.83	1.00						0.096		
phenanthrene part efl	6	0.05	9.29	3.32	1.74	4.04	1.22	0.86	0.005	0.003	0.313	68.7	0.028	yes	50% overlap
2-methylphenanthrene filt inf	8	0.37	3.56	1.43	1.31	0.99	0.69						0.88		
2-methylphenanthrene filt efl	8	0.31	6.22	2.15	1.90	1.78	0.83	0.53	0.030	0.025	1.650	-65	0.79	yes	mostly overlap
2-methylphenanthrene part inf	7	0.24	5.86	2.62	2.75	2.05	0.78						0.39		
2-methylphenanthrene part efl	7	0.05	2.08	0.95	0.81	0.77	0.81	0.86	0.002	0.001	0.343	65.7	0.24	yes	50% overlap
2-methylanthracene filt inf	8	0.03	4.97	0.68	0.07	1.74	2.55						<0.005		
2-methylanthracene filt efl	8	0.03	2.84	0.43	0.06	0.98	2.29	1.00	<0.001	<0.001	0.572	42.8	0.06	yes	overlap
2-methylanthracene part inf	7	0.04	3.80	0.75	0.21	1.36	1.82						0.69		
2-methylanthracene part efl	7	0.03	1.65	0.31	0.08	0.59	1.90	0.98	<0.001	<0.001	0.427	57.3	0.19	yes	mostly overlap
benz(a)anthracene filt inf	8	0.02	0.59	0.17	0.10	0.19	1.14						0.83		
benz(a)anthracene filt efl	8	0.03	0.35	0.14	0.12	0.10	0.68	0.86	0.001	0.000	0.626	37.4	0.68	yes	overlap
benz(a)anthracene part inf	7	0.31	9.62	2.45	0.97	3.32	1.36						0.56		
benz(a)anthracene part efl	7	0.01	2.03	0.88	1.03	0.68	0.77	0.38	0.140	0.130	not significant	not significant	0.013	close	75% overlap
fluoranthene filt inf	8	0.19	4.09	2.21	2.30	1.22	0.55						0.026		
fluoranthene filt efl	8	0.56	11.93	3.04	1.86	3.72	1.22	0.51	0.036	0.061	1.320	-32	0.55	yes	overlap
fluoranthene part inf	7	1.65	52.29	14.18	8.11	17.64	1.24						0.96		
fluoranthene part efl	7	0.05	11.33	5.02	4.20	4.14	0.82	0.21	0.260	0.250	not significant	not significant	0.038	close	25% overlap

pyrene filt inf	8	0.54	4.63	1.55	1.11	1.34	0.86						0.59		
pyrene filt efl	8	0.72	12.17	3.67	2.65	3.64	0.99	0.39	0.078	0.072	1.570	-57	0.82	yes	50% overlap
pyrene part inf	7	0.90	50.49	13.33	4.48	17.83	1.34						0.93		
pyrene part efl	7	0.32	13.84	5.17	5.11	4.50	0.87	0.84	0.002	0.001	0.287	71.3	0.096	yes	50% overlap
chrysene filt inf	8	0.21	1.75	0.60	0.38	0.53	0.88						0.077		
chrysene filt efl	8	0.11	0.82	0.42	0.35	0.27	0.63	0.73	0.005	0.003	0.542	45.8	0.58	yes	25% overlap
chrysene part inf	7	2.05	47.36	10.74	4.39	16.40	1.53						0.12		
chrysene part efl	7	0.07	5.20	2.49	3.00	1.95	0.78	0.15	0.340	0.350	not significant	not significant	0.032	close	75% overlap
benzo(b)fluoranthene filt inf	8	0.05	1.77	0.34	0.10	0.59	1.75						0.087		
benzo(b)fluoranthene filt efl	8	0.01	0.57	0.21	0.09	0.22	1.02	0.62	0.016	0.012	0.361	63.9	0.42	yes	mostly overlap
benzo(b)fluoranthene part inf	7	1.38	19.96	4.89	1.79	6.81	1.39						0.033		
benzo(b)fluoranthene part efl	7	0.05	2.95	1.61	1.84	1.16	0.72	0.32	0.150	0.140	not significant	not significant	0.01	close	75% overlap
Total PAH filt inf	8	9.29	77.32	33.16	28.88	20.69	0.62						0.7		
Total PAH filt efl	8	10.91	219.90	56.82	37.86	68.18	1.20	0.44	0.057	0.052	1.474	-47.4	0.54	close	75% overlap
Total PAH part inf	7	12.75	314.70	92.76	51.97	103.32	1.11						0.93		
Total PAH part efl	7	3.80	65.27	33.07	31.37	17.92	0.54	0.76	0.007	0.004	0.243	75.7	<0.005	yes	50% overlap

Media Filters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Naphthalene filt inf			
Naphthalene filt efl	1.0	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Naphthalene part inf			
Naphthalene part efl	0.1	use slope terms	marginal y = 0.25x (75% reduction)
acenaphthene filt inf			
acenaphthene filt efl	0.8	no significant difference based on the number of sample pairs (y = x)	y = 2.89x (189% increase)
acenaphthene part inf			
acenaphthene part efl	0.4	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
fluorene filt inf			
fluorene filt efl	0.56	no significant difference based on the number of sample pairs (y = x)	y = 1.93x (93% increase)
fluorene part inf			
fluorene part efl	0.21	no significant difference based on the number of sample pairs (y = x)	y = 0.51x (49% reduction)
phenanthrene filt inf			
phenanthrene filt efl	0.88	no significant difference based on the number of sample pairs (y = x)	y = 1.8x (76% increase)
phenanthrene part inf			
phenanthrene part efl	0.13	no significant difference based on the number of sample pairs (y = x)	y = 0.31x (69% reduction)
2-methylphenanthrene filt inf			
2-methylphenanthrene filt efl	0.27	no significant difference based on the number of sample pairs (y = x)	y = 1.7x (65% increase)
2-methylphenanthrene part inf			
2-methylphenanthrene part efl	0.097	marginal, use slope terms	y = 0.34x (66% increase)
2-methylanthracene filt inf			
2-methylanthracene filt efl	0.96	no significant difference based on the number of sample pairs (y = x)	y = 0.57x (43% reduction)
2-methylanthracene part inf			
2-methylanthracene part efl	0.44	no significant difference based on the number of sample pairs (y = x)	y = 0.43x (57% reduction)
benz(a)anthracene filt inf			
benz(a)anthracene filt efl	0.64	no significant difference based on the number of sample pairs (y = x)	y = 0.63x (37% reduction)
benz(a)anthracene part inf			
benz(a)anthracene part efl	0.61	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
fluoranthene filt inf			
fluoranthene filt efl	0.88	no significant difference based on the number of sample pairs (y = x)	y = 1.32x (32% increase)
fluoranthene part inf			
fluoranthene part efl	0.25	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
pyrene filt inf			
pyrene filt efl	0.1	marginal, use slope terms	marginal y = 1.57x (57% increase)
pyrene part inf			
pyrene part efl	0.61	no significant difference based on the number of sample pairs (y = x)	y = 0.29x (71% reduction)
chrysene filt inf			
chrysene filt efl	0.56	no significant difference based on the number of sample pairs (y = x)	y = 0.54x (46% reduction)

chrysene part inf			
chrysene part efl	0.097	marginal, y = 2.5 (COV = 0.78)	overall regression and slope terms are not significant
benzo(b)fluoranthene filt inf			
benzo(b)fluoranthene filt efl	0.71	no significant difference based on the number of sample pairs (y = x)	y = 0.36x (64% reduction)
benzo(b)fluoranthene part inf			
benzo(b)fluoranthene part efl	0.61	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
Total PAH filt inf			
Total PAH filt efl	0.43	no significant difference based on the number of sample pairs (y = x)	marginal y = 1.47x (47% increase)
Total PAH part inf			
Total PAH part efl	0.2	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

	Summary Statistics							Regression Statistics					log-normal probability plot		
Biofilters	count	min	max	average	median	stdev	COV	R^2	Sign. F	slope P	slope value	Percent reduction (based on slope term)	Anderson-Darling P value	similar distributions? (parallel prob. distributions)	visual overlap of 95% confidence intervals
Naphthalene filt inf	5	2.2	8.3	4.8	5.0	2.5	0.5						0.51		
Naphthalene filt efl	5	1.3	3.0	2.1	2.1	0.8	0.4	0.61	0.086	0.065	0.335	66.50	0.56	yes	50% overlap
Naphthalene part inf	5	0.6	14.4	3.9	1.8	5.9	1.5						0.19		
Naphthalene part efl	5	0.3	2.4	1.3	1.4	1.0	0.7	0.04	0.700	0.695	not significant	not significant	0.19	yes	mostly overlap
acenaphthene filt inf	3	0.1	0.2	0.1	0.1	0.1	0.4						0.06		
acenaphthene filt efl	3	0.1	0.2	0.1	0.1	0.1	0.4	0.69	0.279	0.167	not significant	not significant	0.06	yes	overlap
acenaphthene part inf	1			0.1									0.58		
acenaphthene part efl	1			0.1									0.61	close	75% overlap
fluorene filt inf	5	1.1	6.8	3.9	3.5	2.2	0.6						0.8		
fluorene filt efl	5	1.5	3.6	2.4	2.3	0.8	0.3	0.85	0.017	0.008	0.529	47.1	0.42	yes	50% overlap
fluorene part inf	5	0.7	5.9	2.4	1.5	2.1	0.9						n/a		
fluorene part efl	5	0.3	2.5	1.4	1.3	1.0	0.7	0.54	0.290	0.270	not significant	not significant	n/a		
phenanthrene filt inf	5	4.4	35.7	18.1	12.8	12.9	0.7						0.72		
phenanthrene filt efl	5	8.0	17.6	11.4	10.6	3.9	0.3	0.84	0.019	0.010	0.511	48.94	0.55	close	mostly overlap
phenanthrene part inf	5	4.7	197.4	66.1	46.7	79.4	1.2						0.31		
phenanthrene part efl	5	2.8	12.4	7.0	6.5	4.2	0.6	0.17	0.430	0.410	not significant	not significant	0.42	close	25% overlap
2-methylphenanthrene filt inf	5	0.5	6.3	3.6	3.8	2.7	0.8						0.26		
2-methylphenanthrene filt efl	5	1.0	4.1	2.3	2.0	1.4	0.6	0.97	0.001	0.000	0.594	40.6	0.61	yes	overlap
2-methylphenanthrene part inf	5	0.6	29.9	11.0	8.4	12.1	1.1						0.38		
2-methylphenanthrene part efl	5	0.5	2.4	1.5	1.4	0.9	0.6	0.21	0.384	0.367	not significant	not significant	0.5	close	50% overlap
2-methylanthracene filt inf	5	0.1	0.2	0.1	0.1	0.0	0.4						<0.005		
2-methylanthracene filt efl	5	0.1	0.1	0.1	0.1	0.0	0.2	0.89	0.018	0.005	0.688	31.25	<0.005	yes	50% overlap
2-methylanthracene part inf	3	0.8	2.0	1.4	1.5	0.6	0.4						0.45		
2-methylanthracene part efl	3	0.1	0.1	0.1	0.1	0.0	0.3	0.70	0.270	0.160	not significant	not significant	0.06	yes	huge separation
benz(a)anthracene filt inf	5	0.1	0.7	0.3	0.2	0.3	0.9						0.94		
benz(a)anthracene filt efl	5	0.1	0.2	0.1	0.2	0.1	0.6	0.78	0.034	0.021	0.391	60.9	0.02	yes	overlap
benz(a)anthracene part inf	5	0.7	37.7	13.8	9.2	15.5	1.1						0.51		

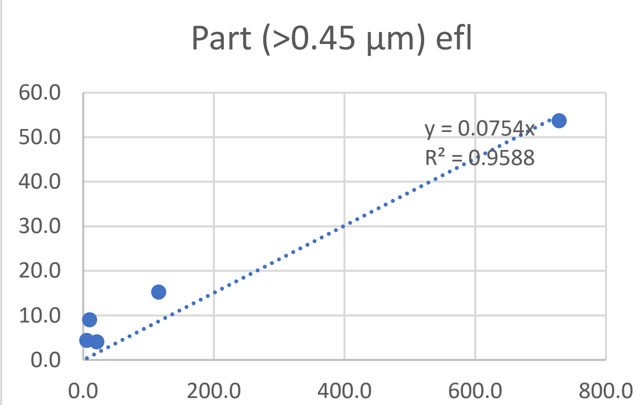
benz(a)anthracene part efl	5	0.7	2.3	1.5	1.4	0.7	0.4	0.31	0.280	0.250	not significant	not significant	0.85	close	50% overlap
fluoranthene filt inf	5	1.5	9.4	5.6	6.6	3.4	0.6						0.3		
fluoranthene filt efl	5	2.0	3.5	2.6	2.3	0.7	0.3	0.79	0.031	0.019	0.367	63.3	0.35	close	50% overlap
fluoranthene part inf	5	4.4	345.8	118.8	95.4	138.5	1.2						0.52		
fluoranthene part efl	5	4.0	11.8	6.8	6.0	3.0	0.4	0.45	0.170	0.150	not significant	not significant	0.6	close	25% overlap
pyrene filt inf	5	1.0	75.7	16.7	1.9	33.0	2.0						0.039		
pyrene filt efl	5	1.4	2.7	1.9	1.8	0.5	0.3	0.26	0.310	0.290	not significant	not significant	0.86	no	mostly overlap
pyrene part inf	5	7.3	297.9	84.2	51.1	121.3	1.4						0.54		
pyrene part efl	5	4.1	9.2	6.6	5.7	2.1	0.3	0.18	0.420	0.410	not significant	not significant	0.51	no	25% overlap
chrysene filt inf	5	0.8	2.7	1.3	1.1	0.8	0.6						0.039		
chrysene filt efl	5	0.5	0.8	0.6	0.6	0.1	0.2	0.90	0.009	0.004	0.384	61.6	0.26	close	mostly separate
chrysene part inf	5	6.2	152.9	56.0	35.9	61.1	1.1						0.58		
chrysene part efl	5	3.5	9.1	5.7	4.9	2.3	0.4	0.24	0.340	0.320	not significant	not significant	0.78	close	25% overlap
benzo(b)fluoranthene filt inf	5	0.1	0.8	0.4	0.3	0.3	0.7						0.76		
benzo(b)fluoranthene filt efl	5	0.1	0.3	0.2	0.1	0.1	0.5	0.91	0.009	0.004	0.374	62.6	0.24	yes	50% overlap
benzo(b)fluoranthene part inf	5	2.3	45.8	18.7	12.6	18.4	1.0						0.69		
benzo(b)fluoranthene part efl	5	1.5	4.6	2.7	2.7	1.3	0.5	0.27	0.310	0.290	not significant	not significant	0.51	close	25% overlap
Total PAH filt inf	4	17.7	94.4	59.3	62.6	39.8	0.7						0.26		
Total PAH filt efl	4	30.3	51.3	37.0	33.2	9.9	0.3	0.86	0.048	0.022	0.514	48.6	0.15	close	mostly overlap
Total PAH part inf	5	40.1	1398.0	518.6	349.8	566.8	1.1						0.53		
Total PAH part efl	5	27.8	80.1	53.1	48.8	20.3	0.4	0.30	0.290	0.260	not significant	not significant	0.85	close	25% overlap

Biofilters	Mann Whitney, a rank sum non-parametric paired test		
	P	Effluent concentration based on nonparametric pair test	Effluent concentration based on significant regression slopes
Naphthalene filt inf			
Naphthalene filt efl	0.10	no significant difference based on the number of sample pairs (y = x)	marginal y = 0.34x (67% reduction)
Naphthalene part inf			
Naphthalene part efl	0.68	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
acenaphthene filt inf			
acenaphthene filt efl	1	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
acenaphthene part inf			
acenaphthene part efl	0.3	n/a	n/a
fluorene filt inf			
fluorene filt efl	0.4	no significant difference based on the number of sample pairs (y = x)	y = 0.53x (47% reduction)
fluorene part inf			
fluorene part efl	n/a	n/a	overall regression and slope terms are not significant
phenanthrene filt inf			
phenanthrene filt efl	0.53	no significant difference based on the number of sample pairs (y = x)	y = 0.51x (49% reduction)
phenanthrene part inf			
phenanthrene part efl	0.21	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
2-methylphenanthrene filt inf			
2-methylphenanthrene filt efl	0.68	no significant difference based on the number of sample pairs (y = x)	y = 0.59x (41% reduction)
2-methylphenanthrene part inf			
2-methylphenanthrene part efl	0.3	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
2-methylanthracene filt inf			
2-methylanthracene filt efl	0.23	no significant difference based on the number of sample pairs (y = x)	y = 0.69x (31% reduction)
2-methylanthracene part inf			
2-methylanthracene part efl	0.08	marginal y = 0.1 (COV = 0.3)	overall regression and slope terms are not significant
benz(a)anthracene filt inf			
benz(a)anthracene filt efl	0.33	no significant difference based on the number of sample pairs (y = x)	y = 0.39x (61% reduction)
benz(a)anthracene part inf			
benz(a)anthracene part efl	0.4	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant
fluoranthene filt inf			
fluoranthene filt efl	0.3	no significant difference based on the number of sample pairs (y = x)	y = 0.37x (63% reduction)
fluoranthene part inf			
fluoranthene part efl	0.095	marginal y = 6.8 (COV = 0.4)	overall regression and slope terms are not significant
pyrene filt inf			
pyrene filt efl	0.53	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

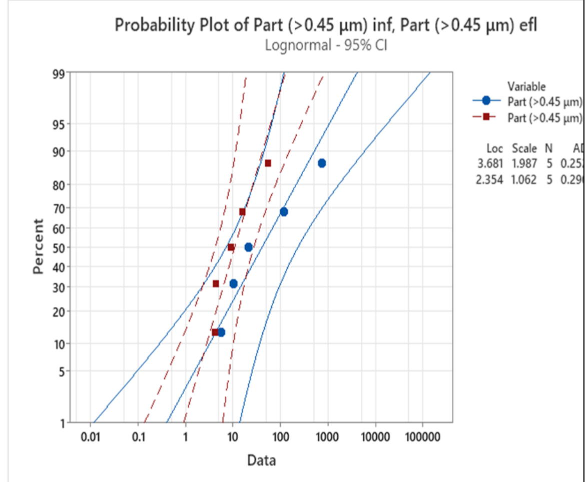
pyrene part inf			
pyrene part efl	0.037	y = 6.6 (COV = 0.3)	overall regression and slope terms are not significant
chrysene filt inf			
chrysene filt efl	0.012	use slope terms	y = 0.38x (62% reduction)
chrysene part inf			
chrysene part efl	0.06	marginal y = 5.7 (COV = 0.4)	overall regression and slope terms are not significant
benzo(b)fluoranthene filt inf			
benzo(b)fluoranthene filt efl	0.074	marginal, use slope term	y = 0.37x (63% reduction)
benzo(b)fluoranthene part inf			
benzo(b)fluoranthene part efl	0.095	marginal y = 2.7 (COV = 0.5)	overall regression and slope terms are not significant
Total PAH filt inf			
Total PAH filt efl	0.67	no significant difference based on the number of sample pairs (y = x)	y = 0.51x (49% reduction
Total PAH part inf			
Total PAH part efl	0.21	no significant difference based on the number of sample pairs (y = x)	overall regression and slope terms are not significant

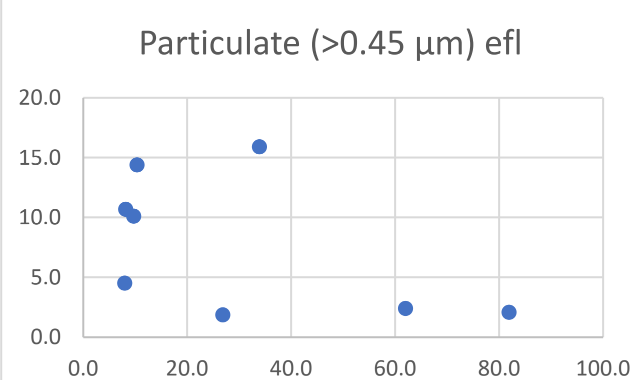
Appendix E: Particulates

Total Particulates (>0.45um)

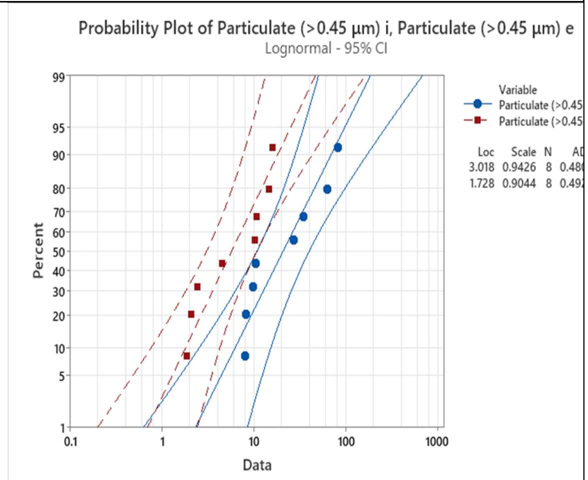


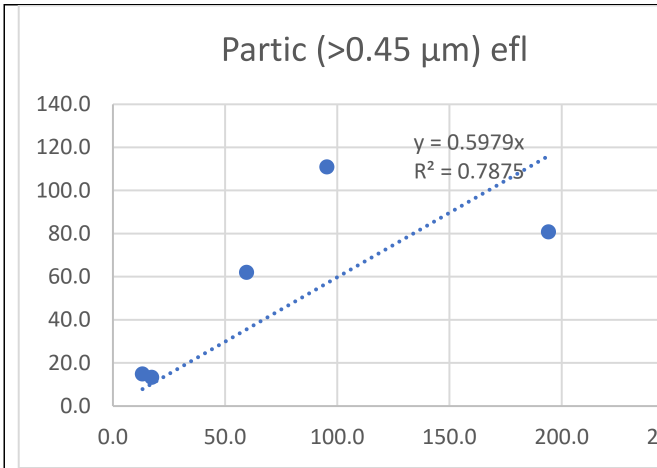
Sedimentation



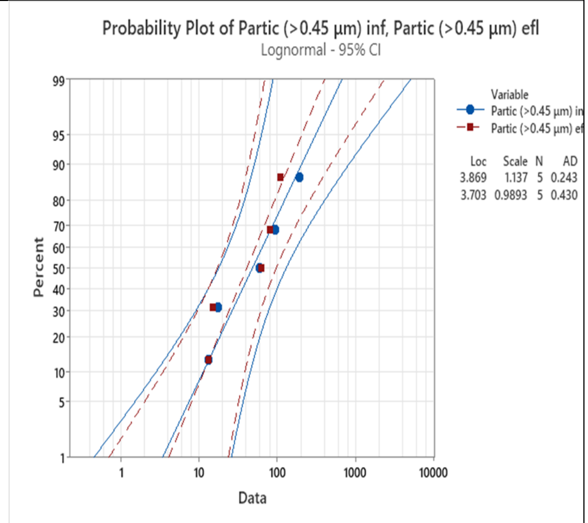


Media Filters

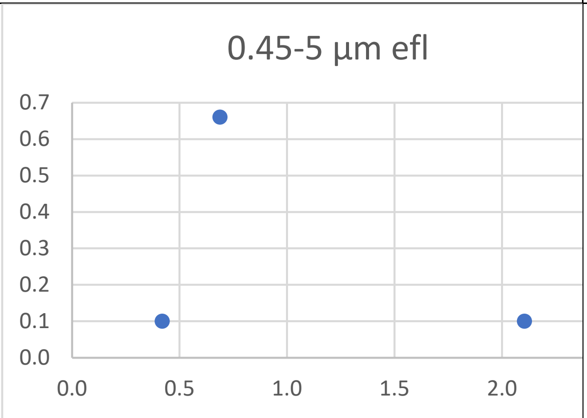
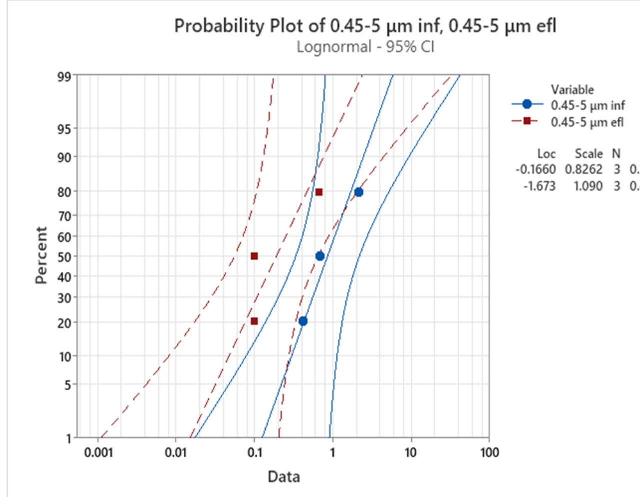
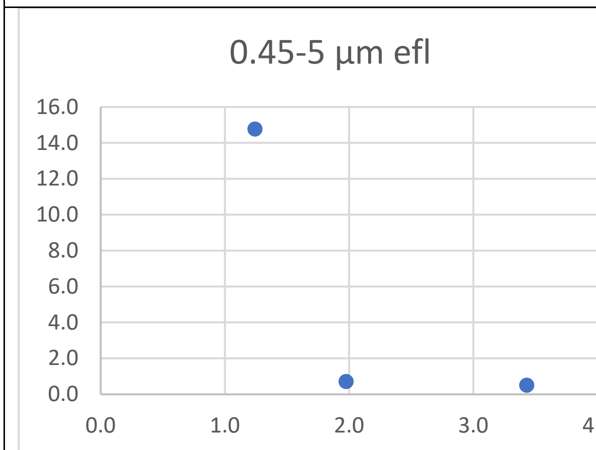
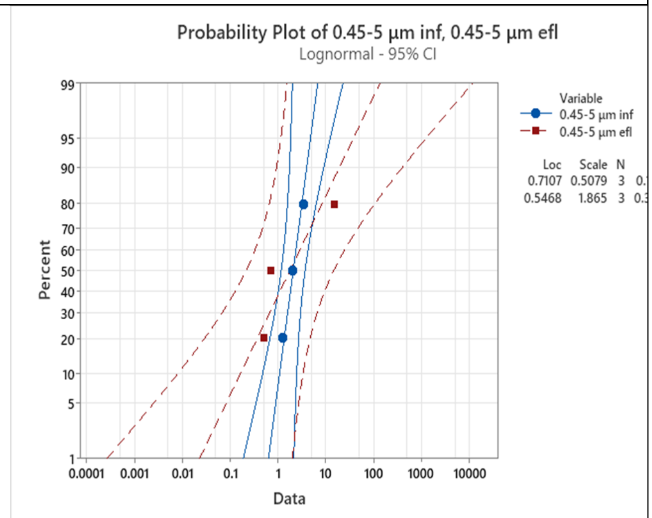




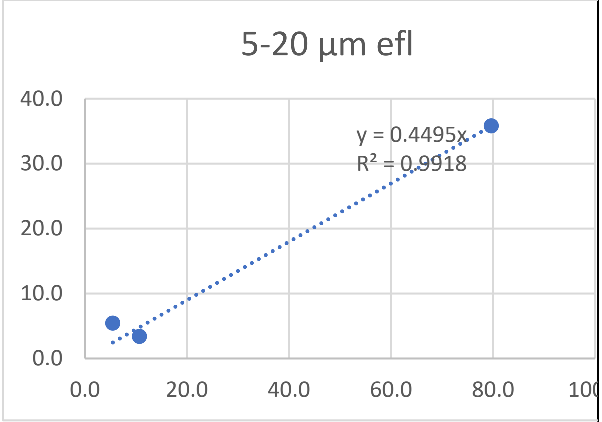
Biofilters and bioswales



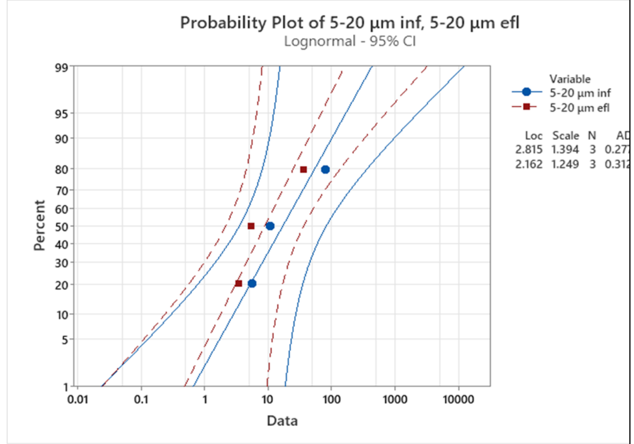
Particulates (0.45 – 5 um)

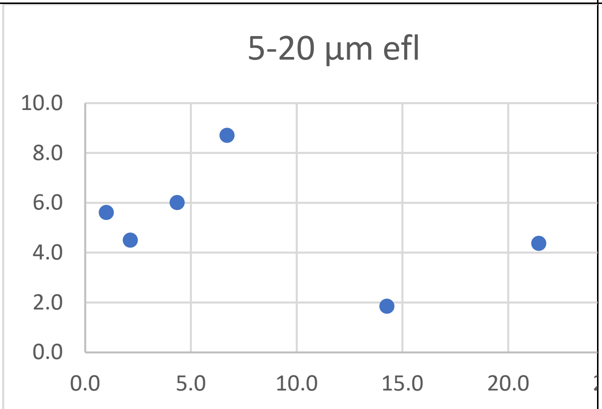
n/a Sedimentation	
 Media Filters	
 Biofilters and bioswales	

Particulates (5 – 20 um)

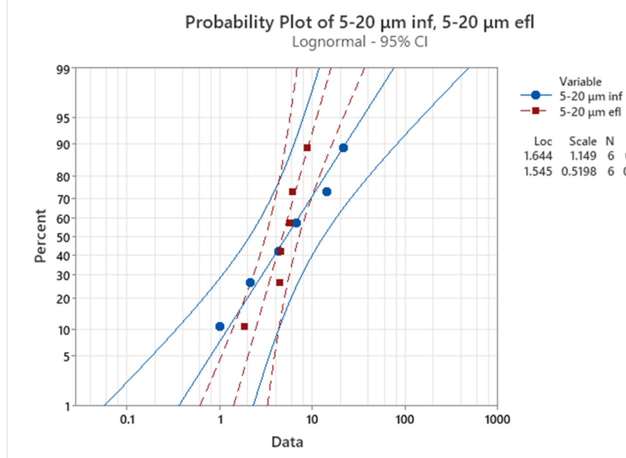


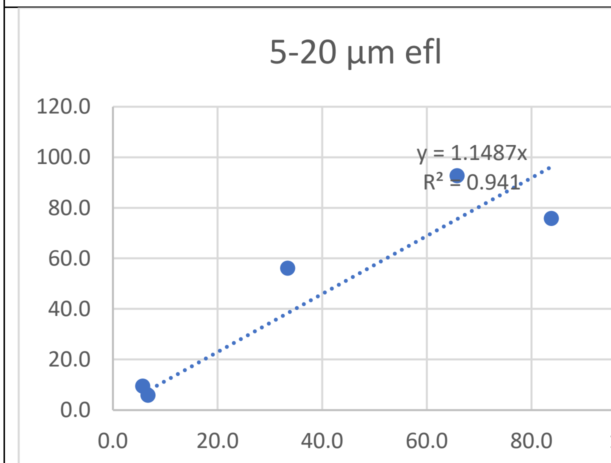
Sedimentation



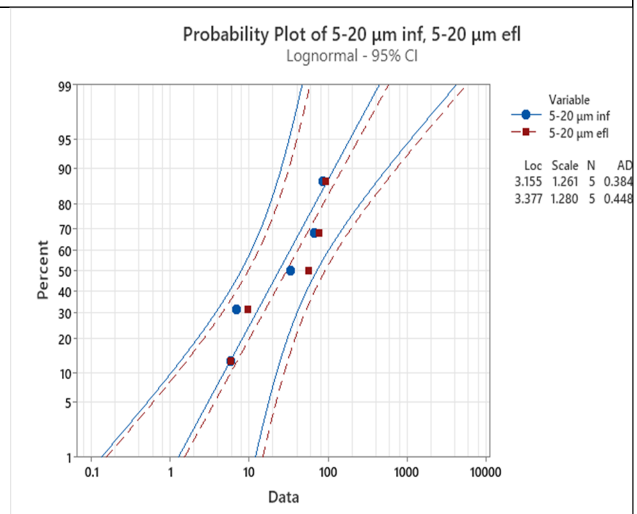


Media Filters

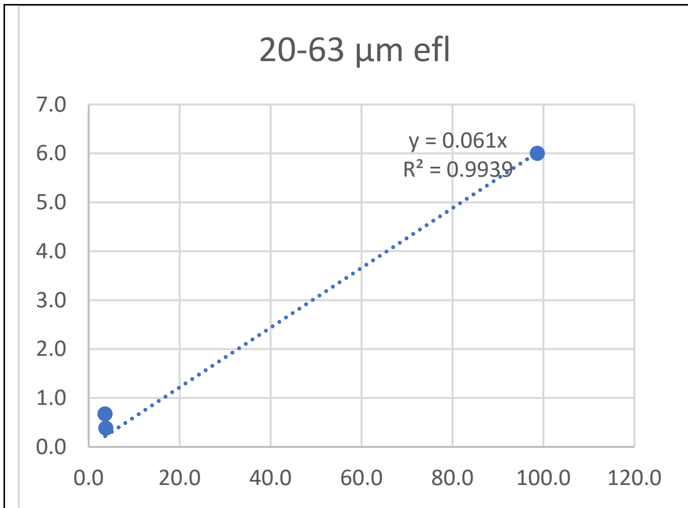




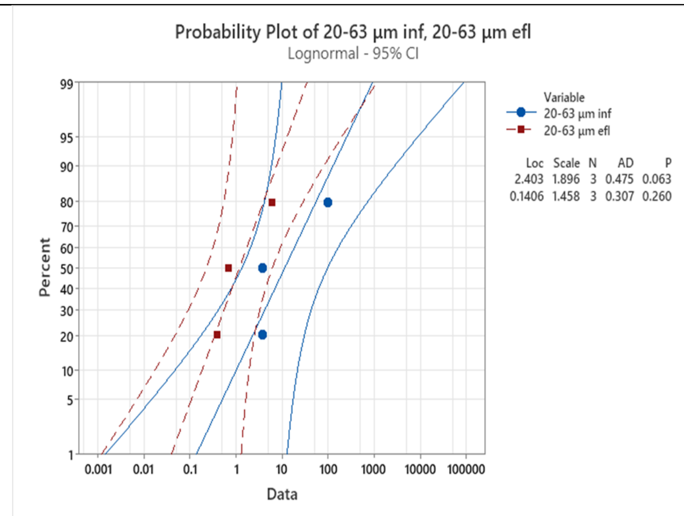
Biofilters and bioswales

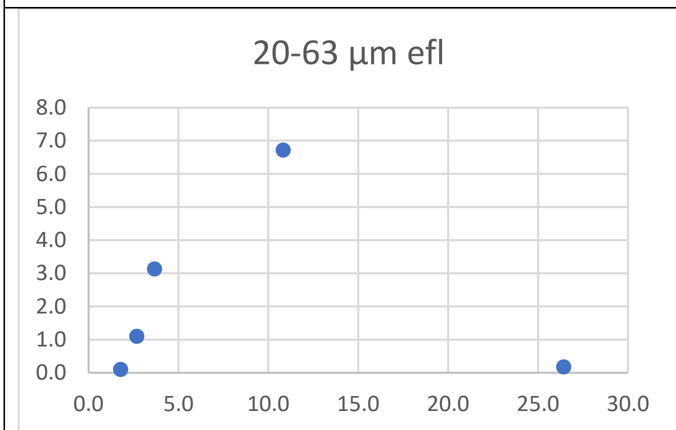


Particulates (20-63 um)

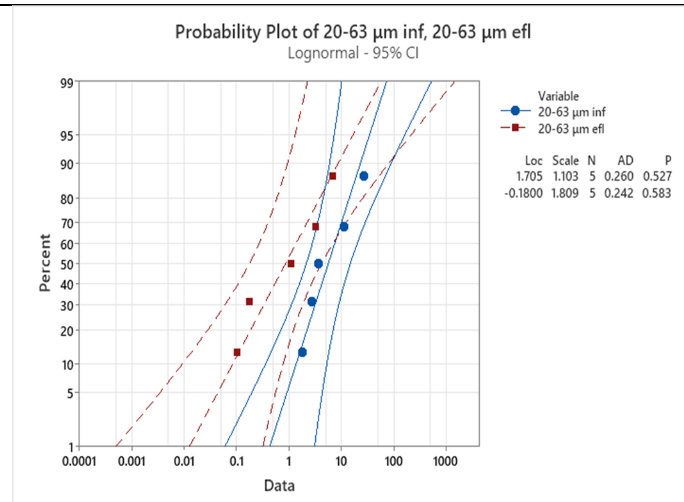


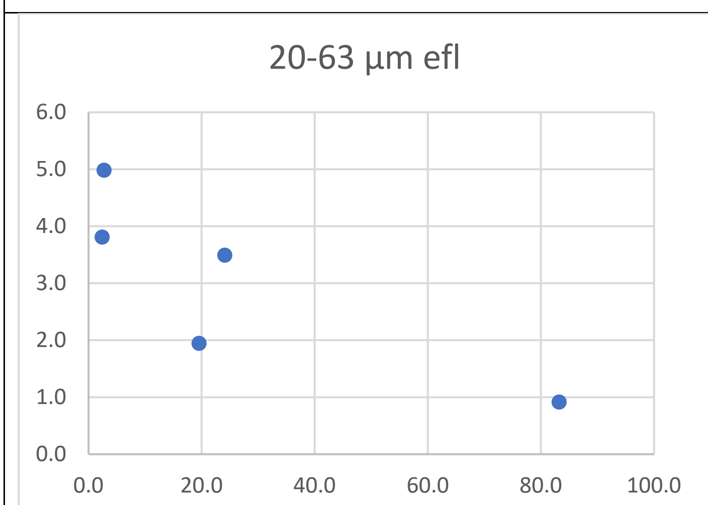
Sedimentation



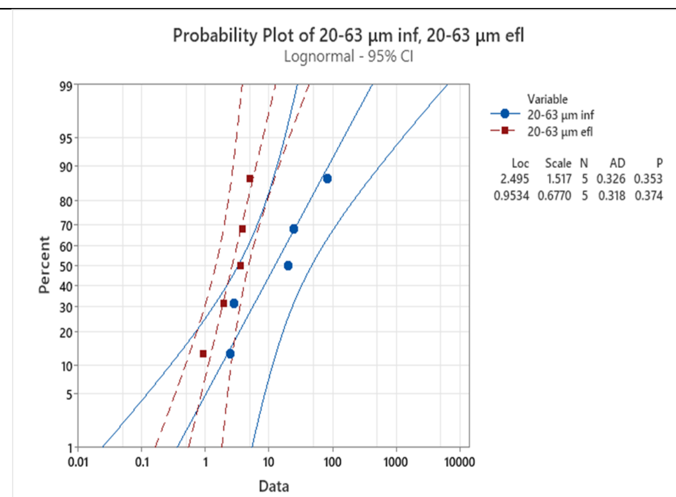


Media Filters

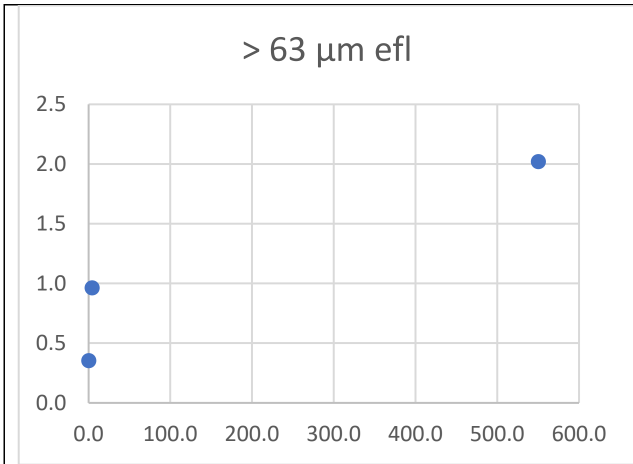




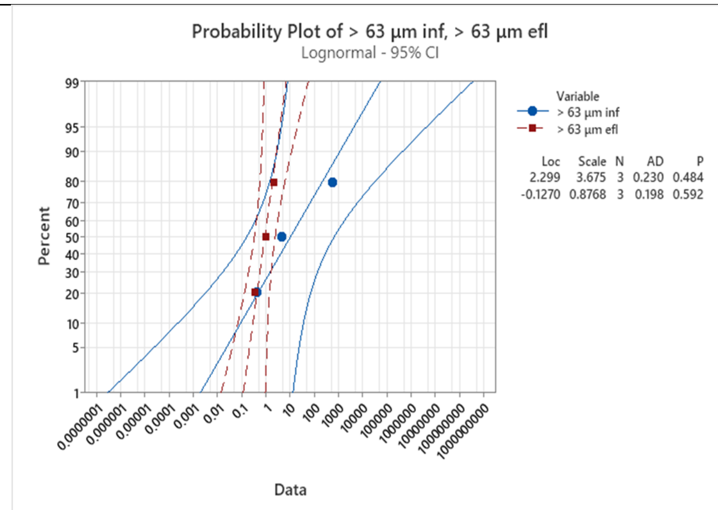
Biofilters and bioswales

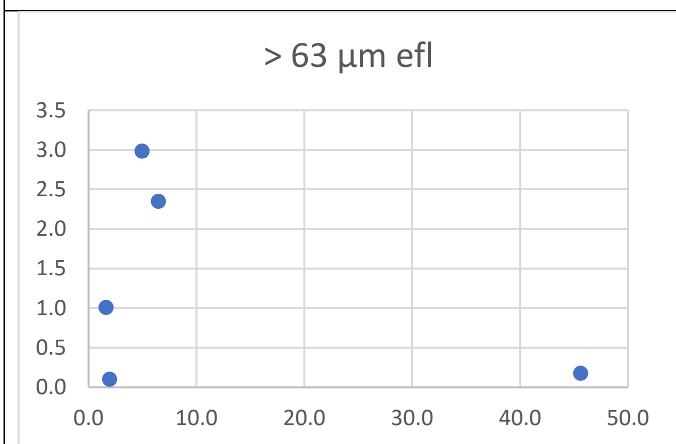


Particulates (>63 um)

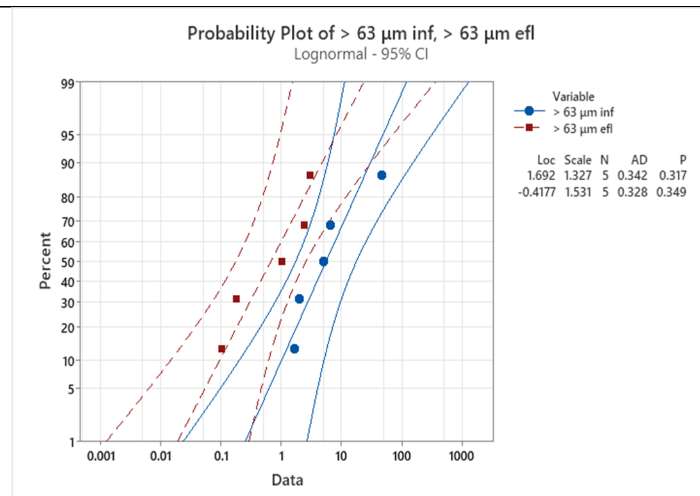


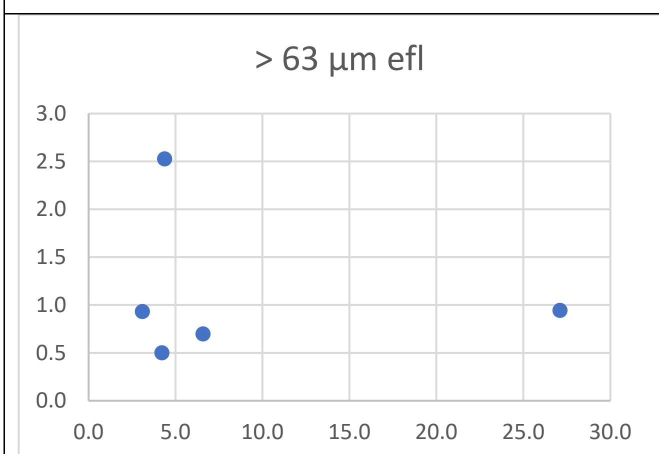
Sedimentation



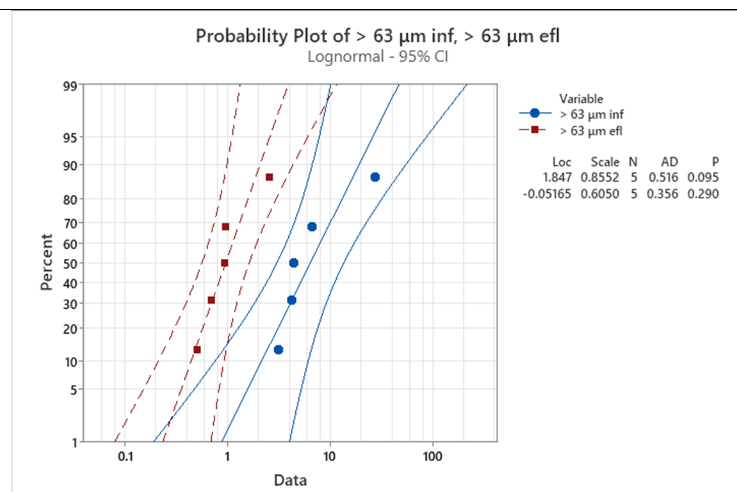


Media Filters

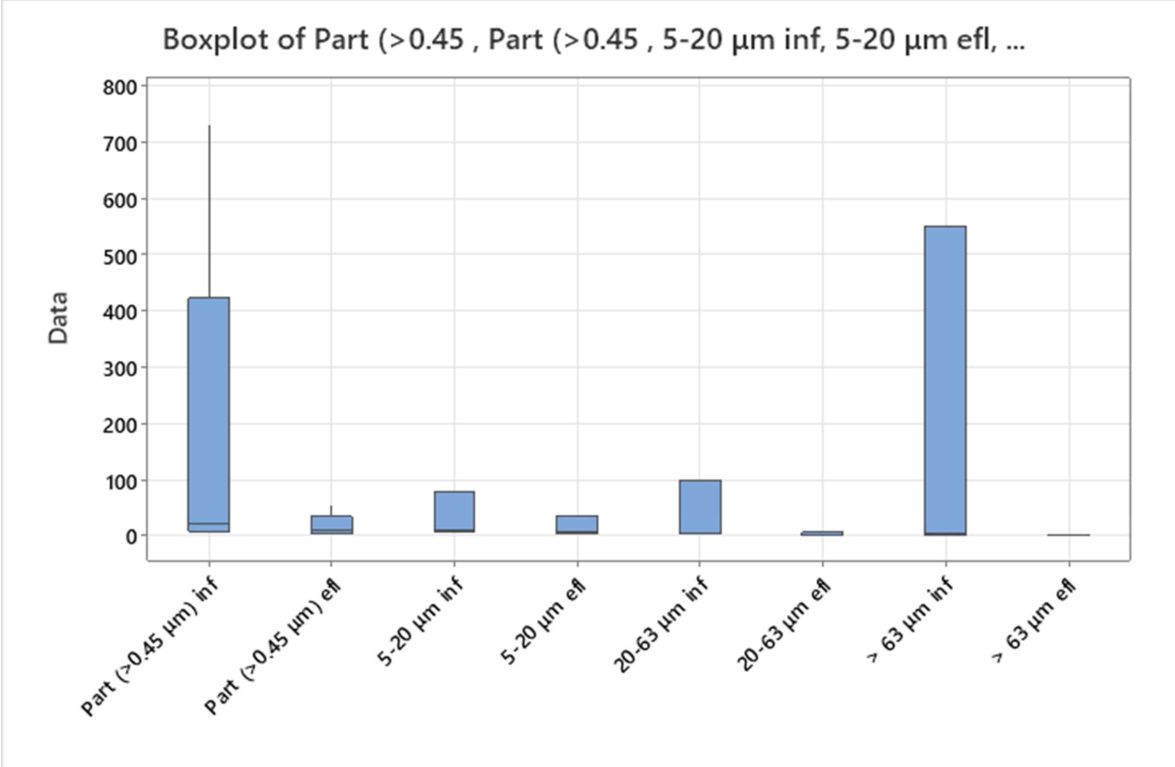




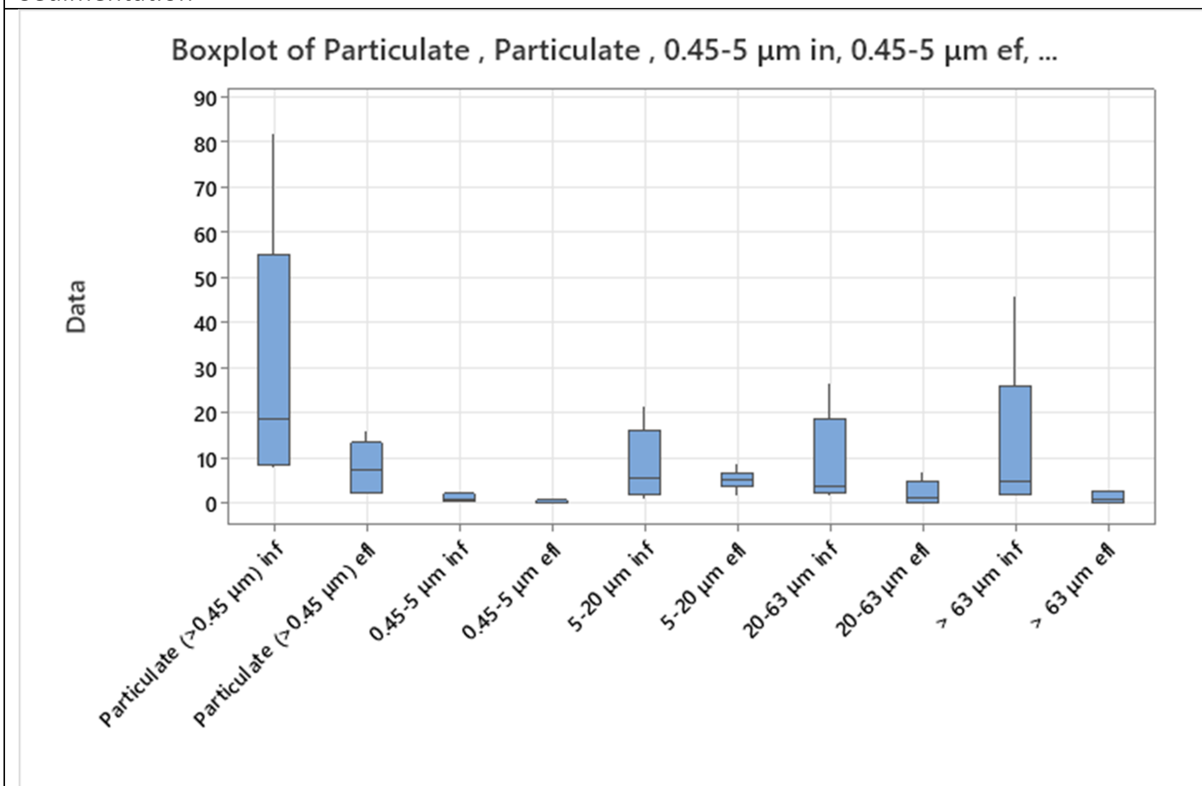
Biofilters and bioswales



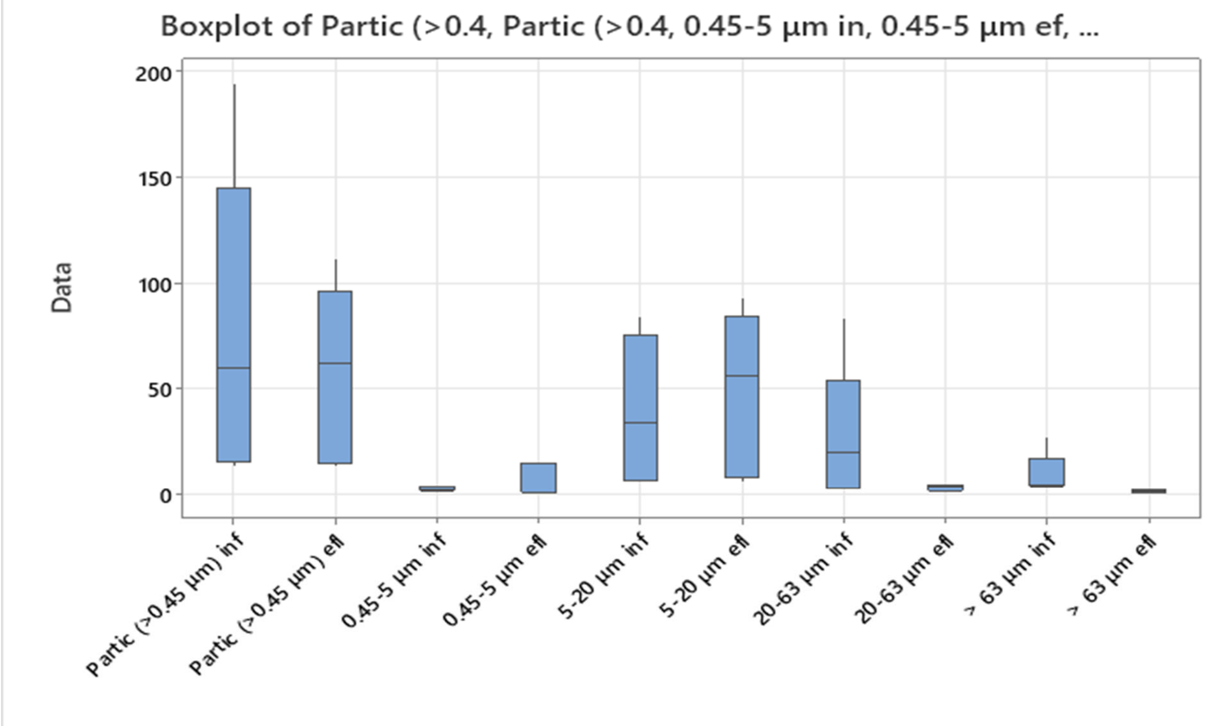
Particulates



Sedimentation



Media Filters

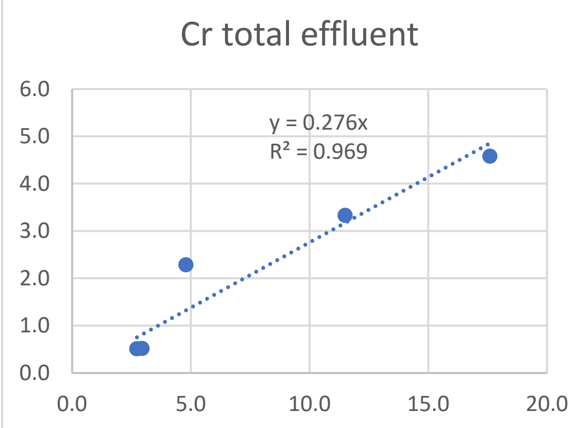


Biofilters and bioswales

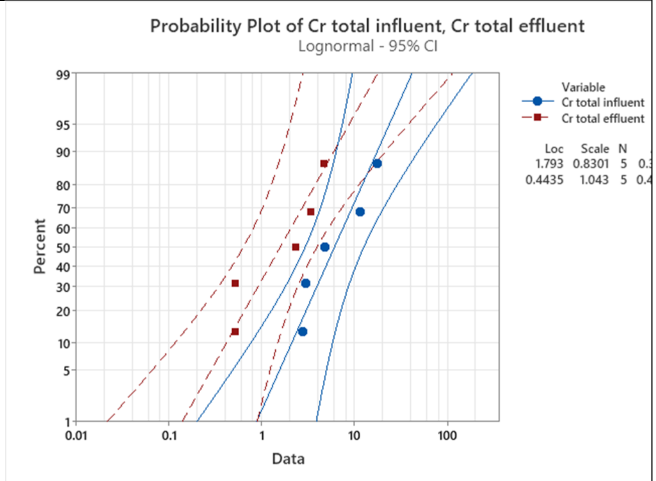
Appendix F: Heavy Metals

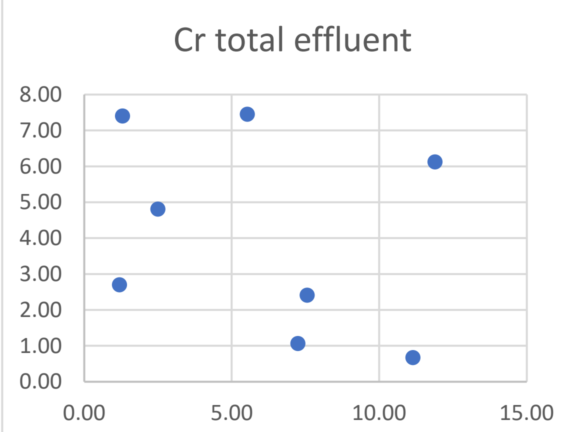
Chromium

Chromium, total

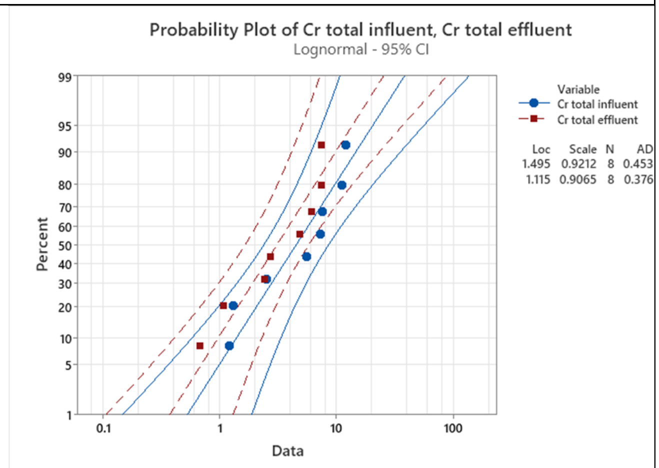


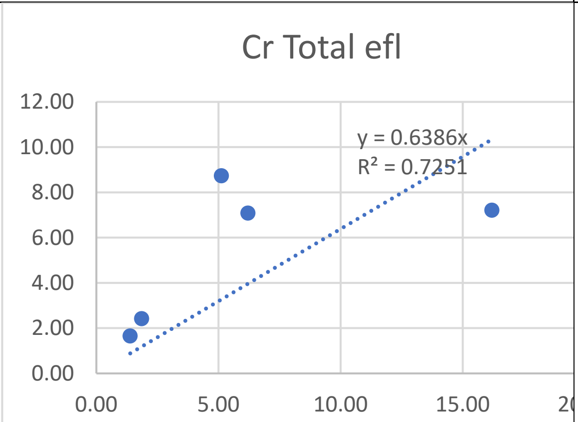
Sedimentation



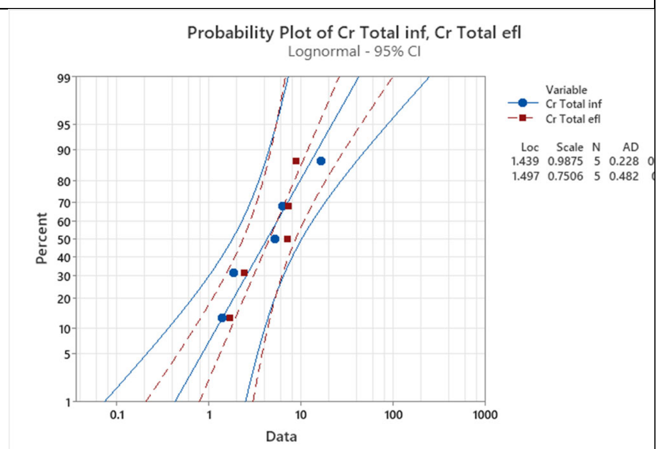


Media Filters

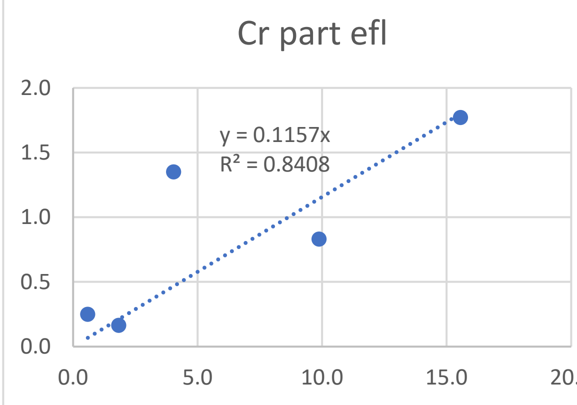




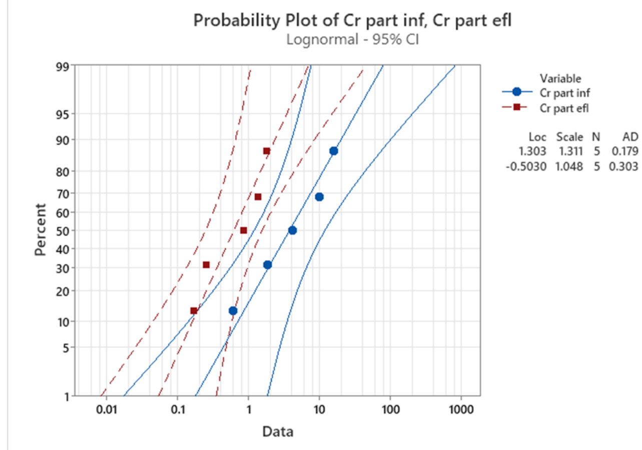
Biofilters and bioswales

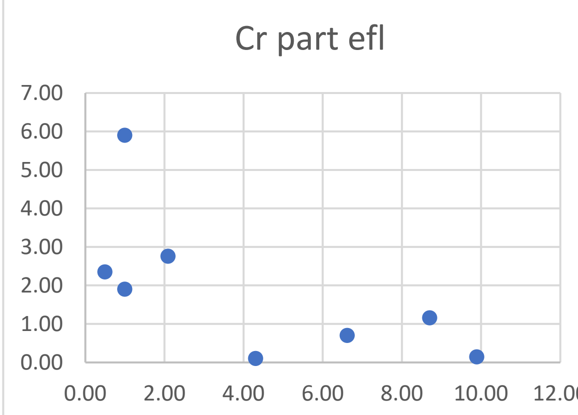


Chromium, particulate (>0.45 um)

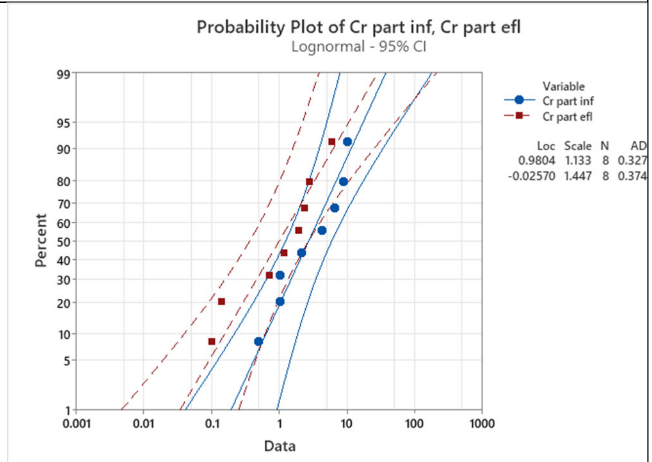


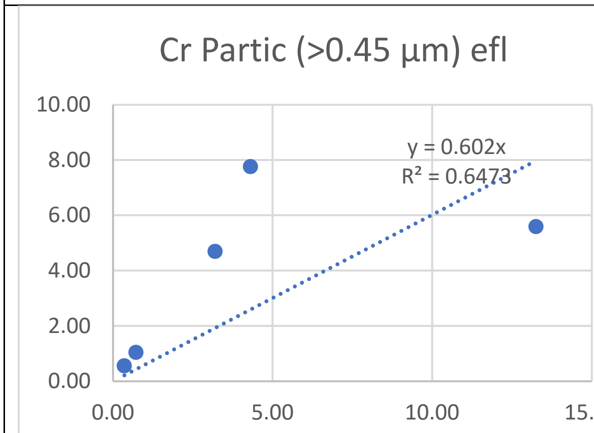
Sedimentation



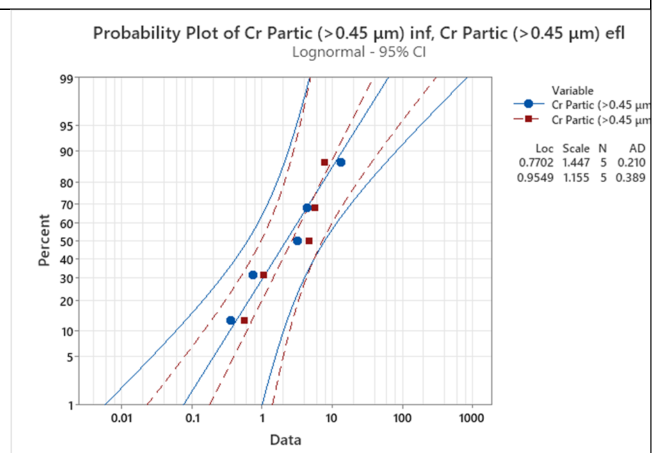


Media Filters

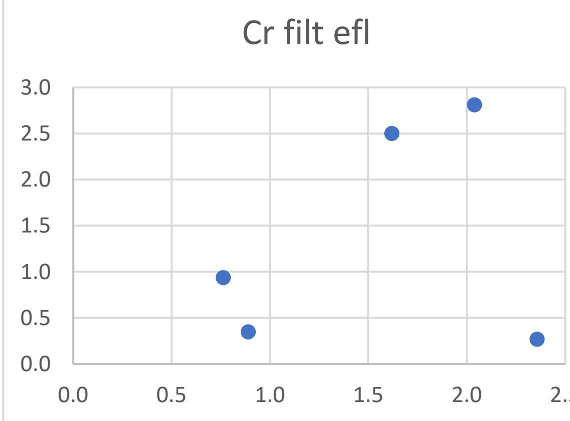




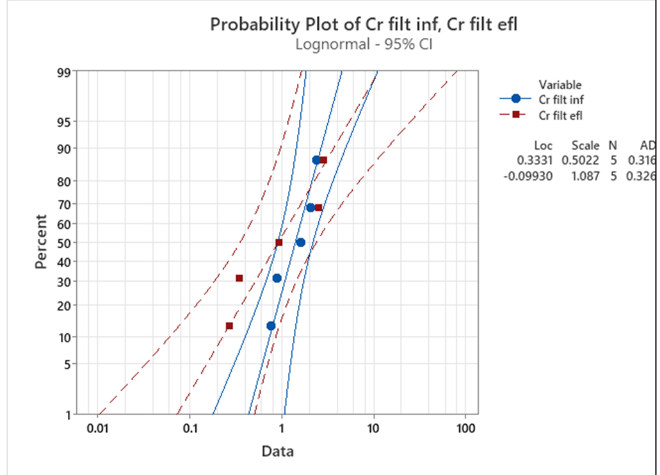
Biofilters and bioswales

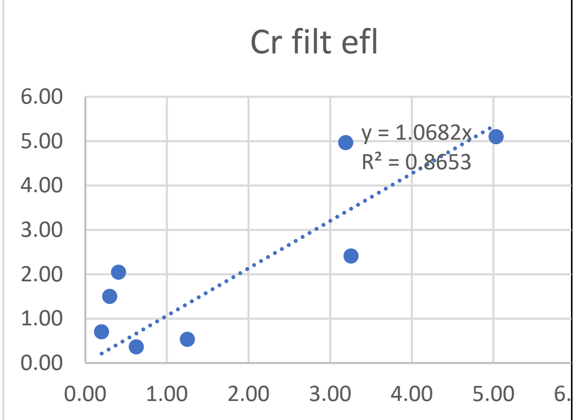


Chromium, filtered (<0.45 um)

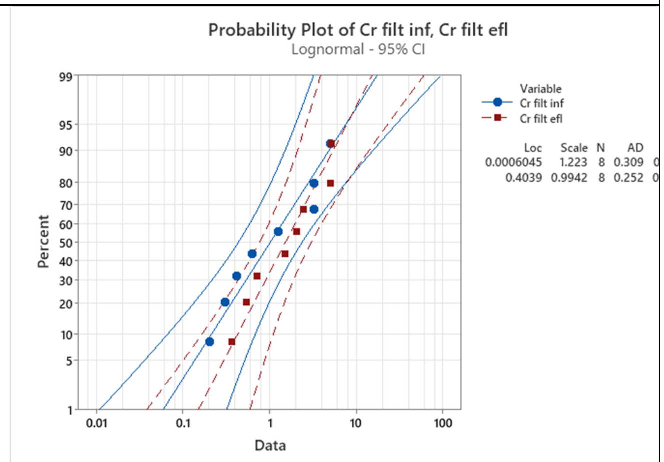


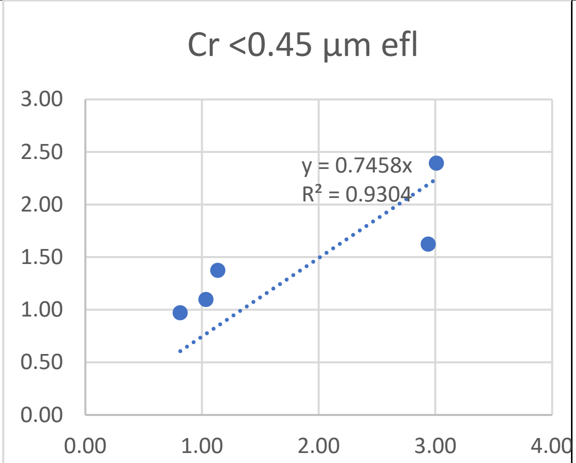
Sedimentation



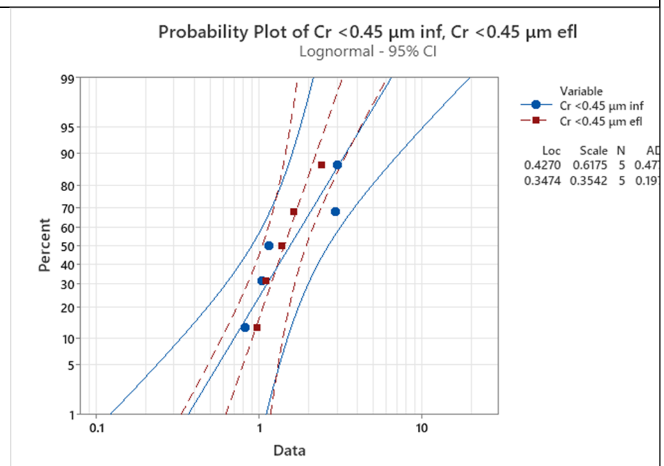


Media Filters

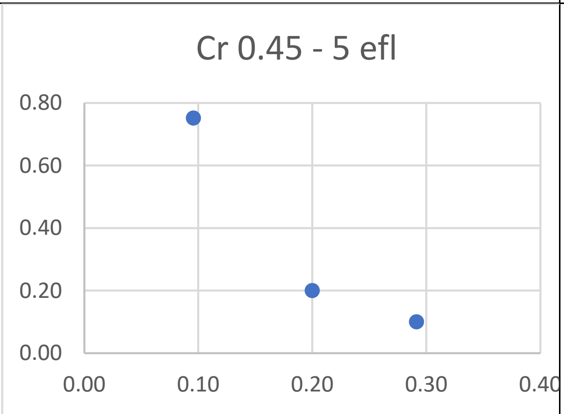
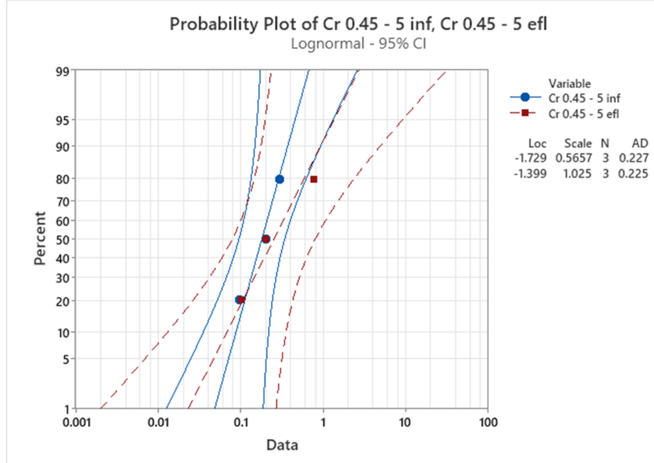




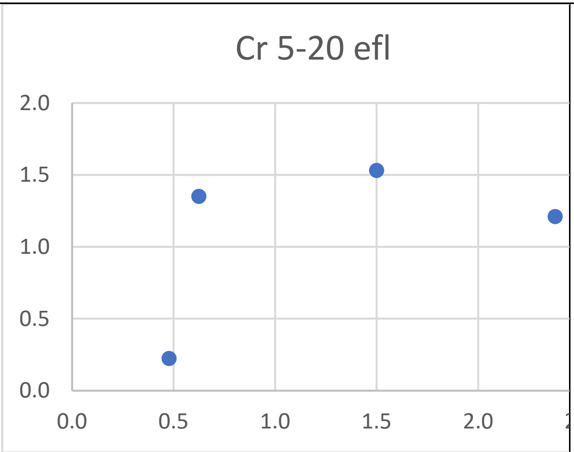
Biofilters and bioswales

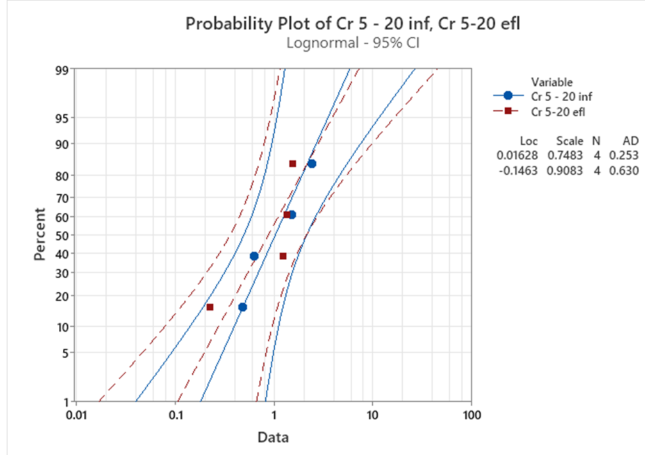


Chromium, 0.45 to 5 um

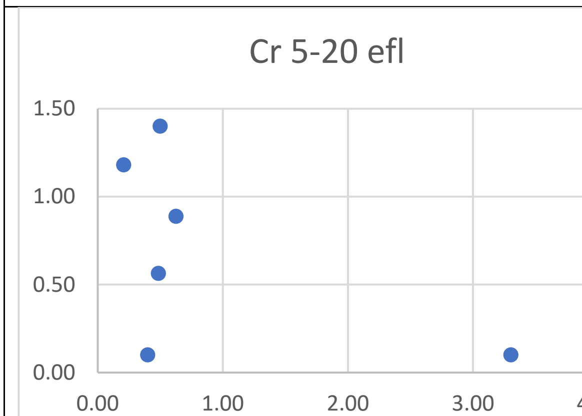
n/a Sedimentation	
 Media Filters	
n/a Biofilters and bioswales	

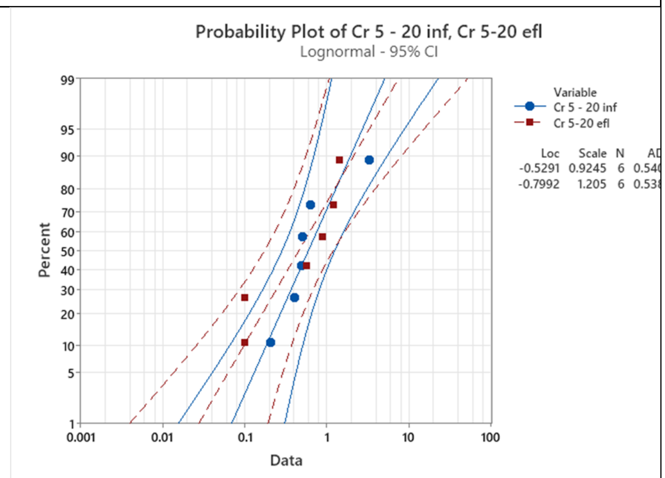
Chromium, 5 to 20 um



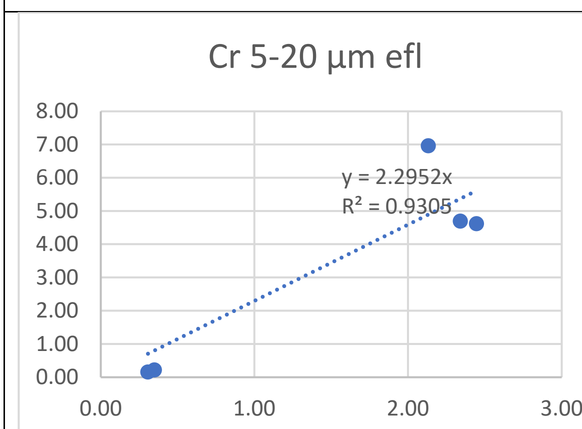


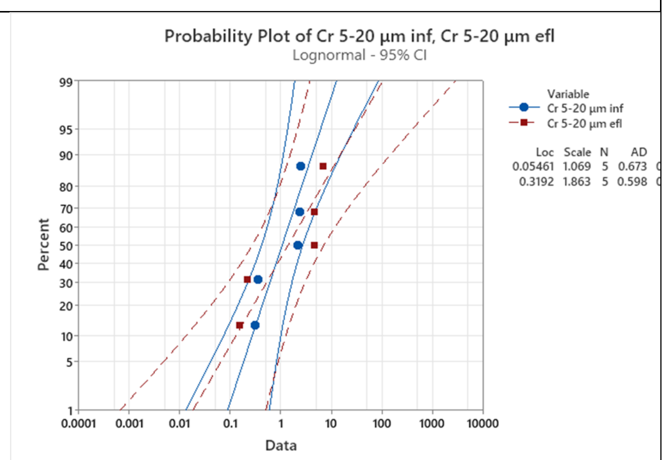
Sedimentation





Media Filters



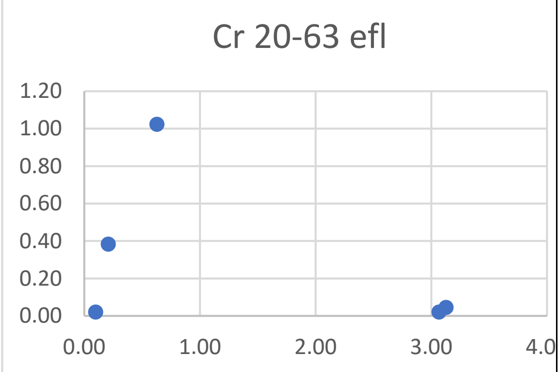


Biofilters and bioswales

Chromium, 20 to 63 um

n/a

Sedimentation



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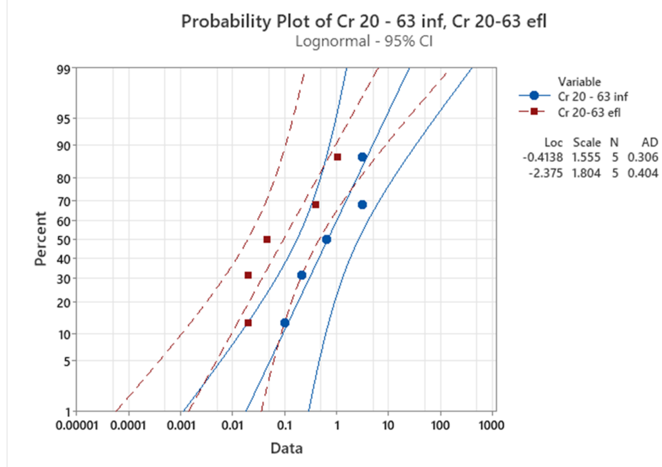
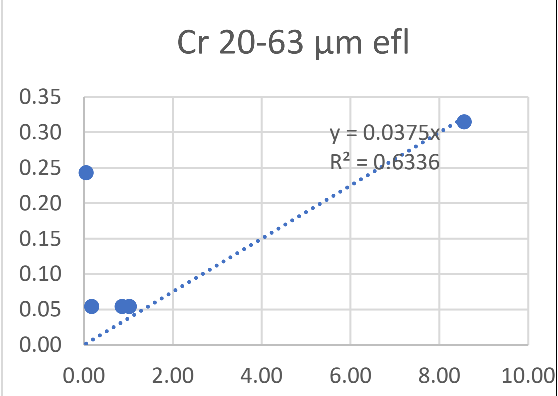
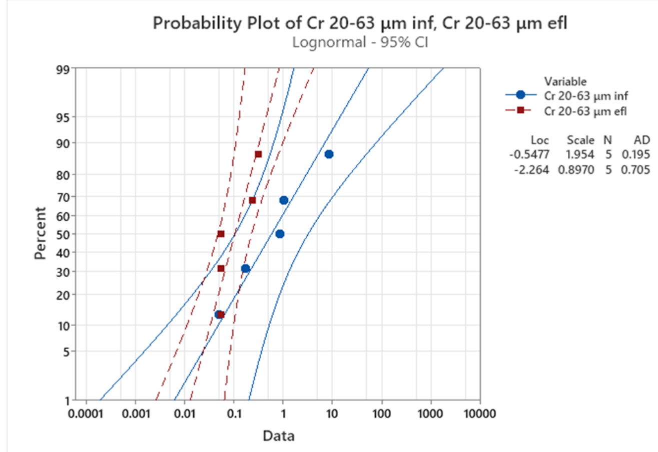


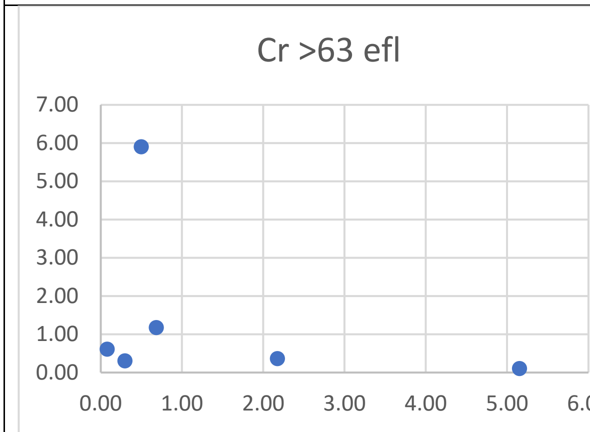


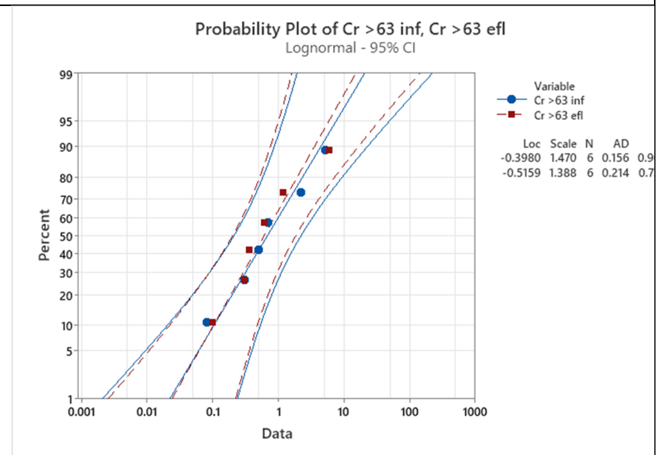
Biofilters and bioswales



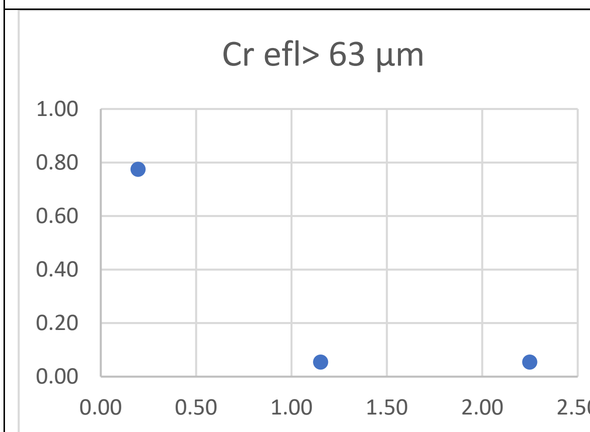
Chromium >63 um

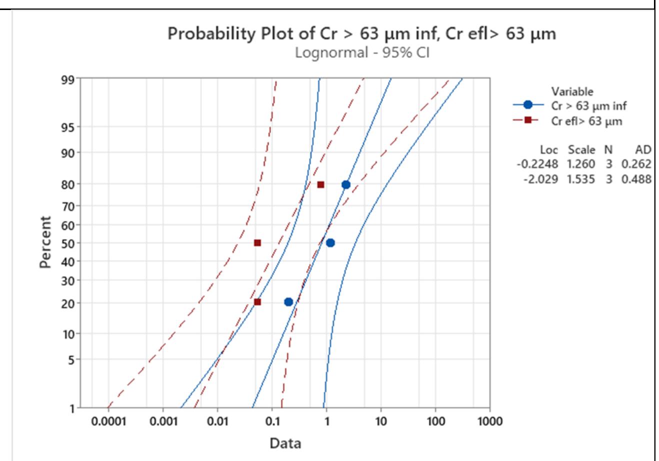
n/a
Sedimentation



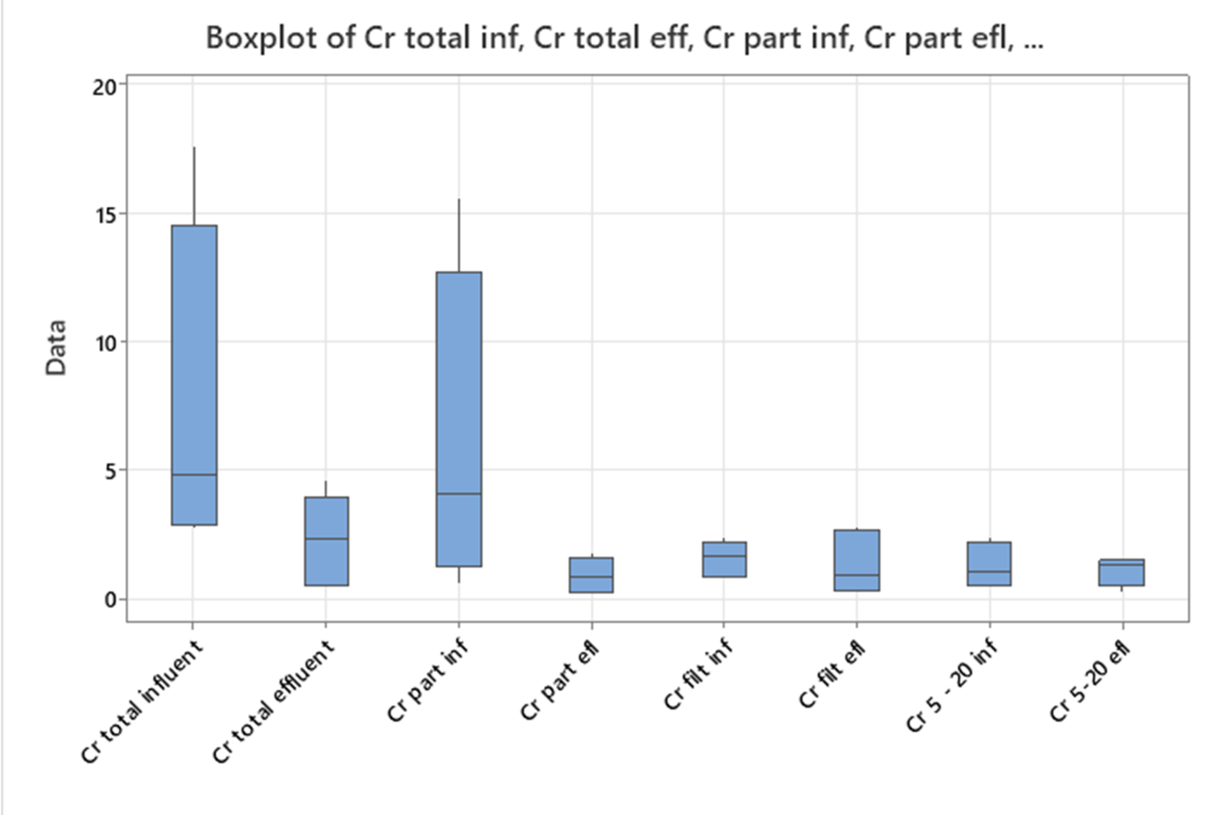


Media Filters

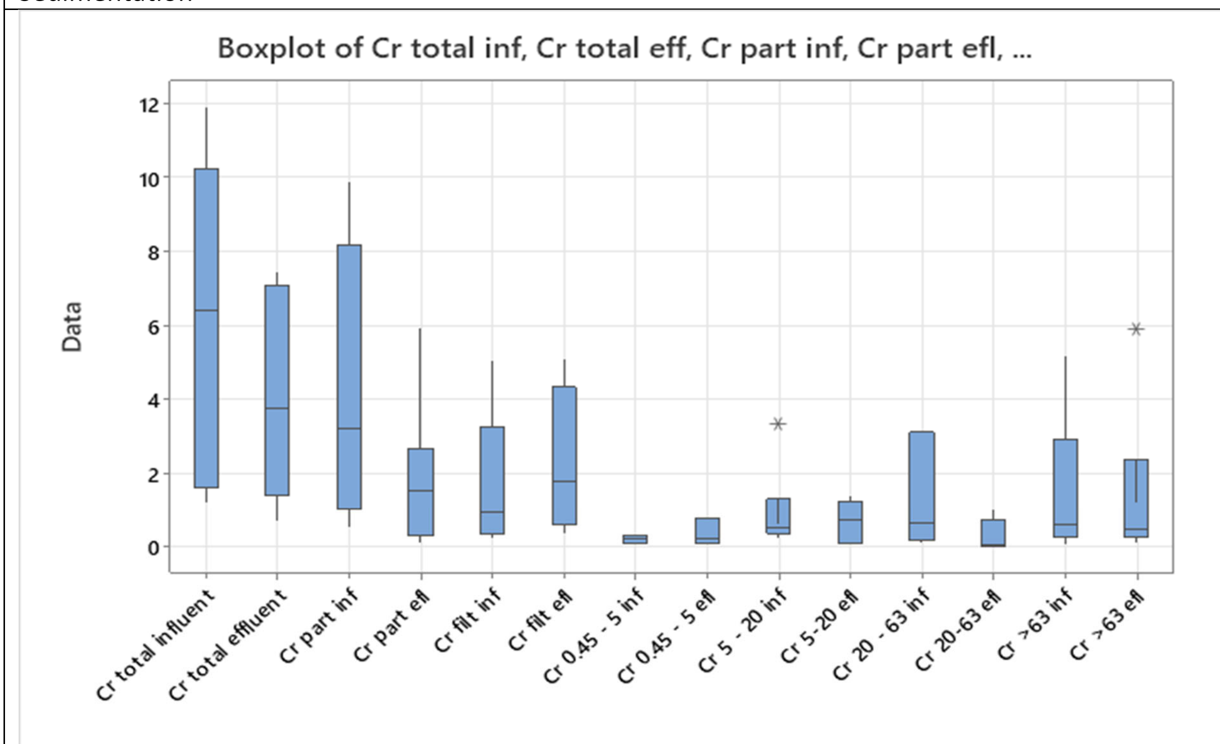




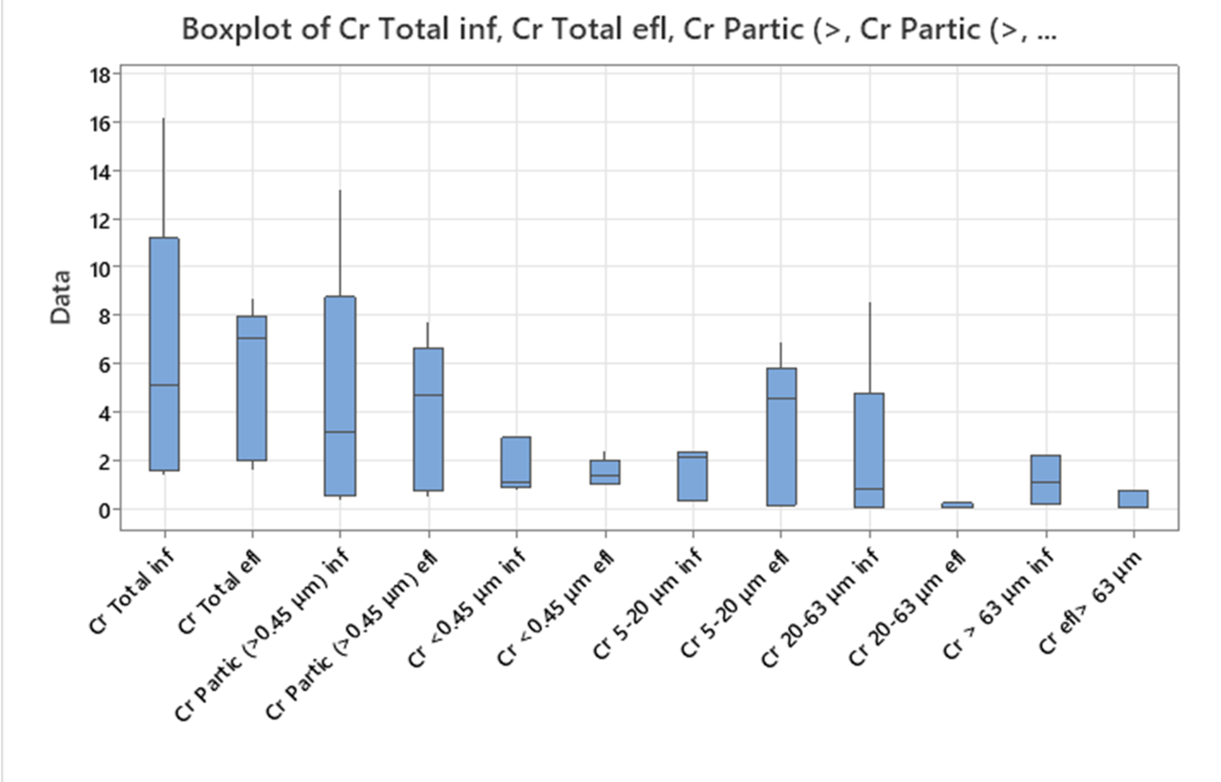
Biofilters and bioswales



Sedimentation



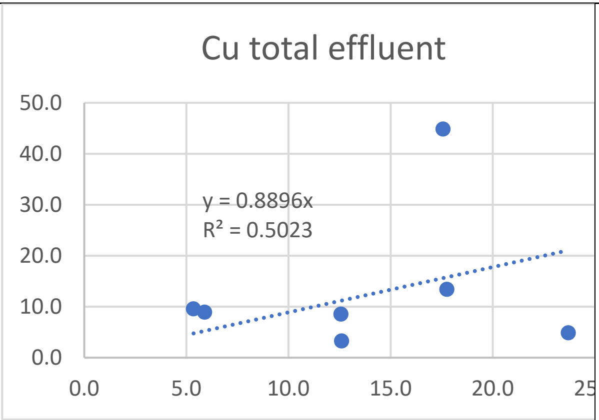
Media filters



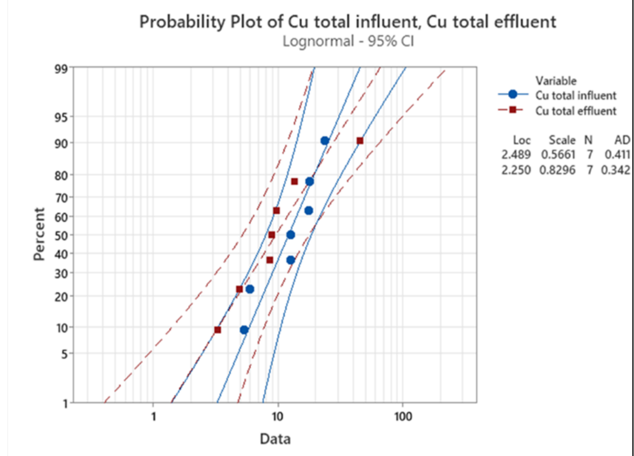
Biofilters and bioswales

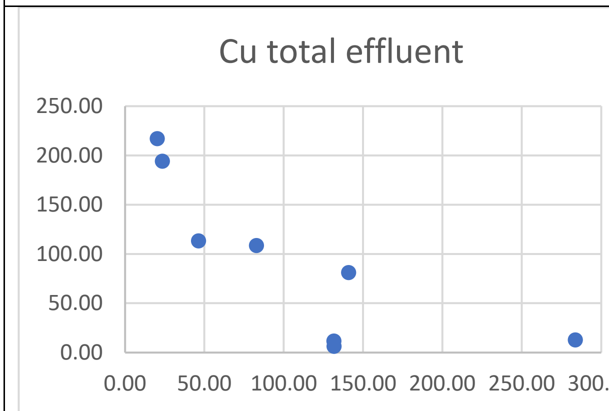
Copper

Copper, Total

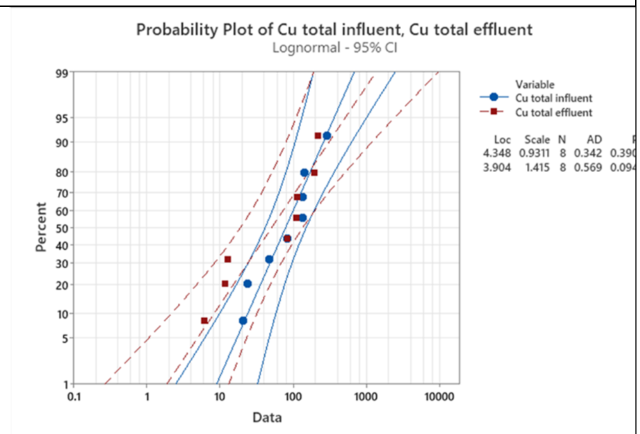


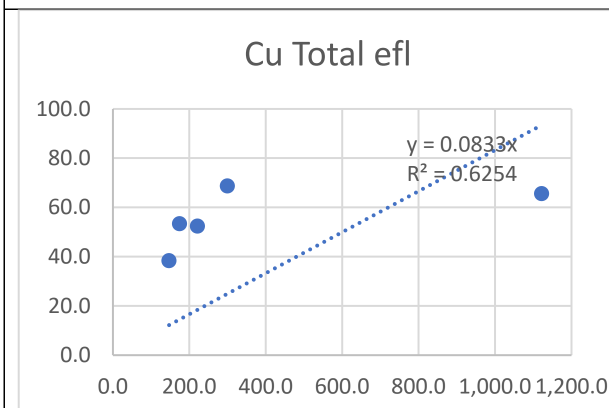
Sedimentation



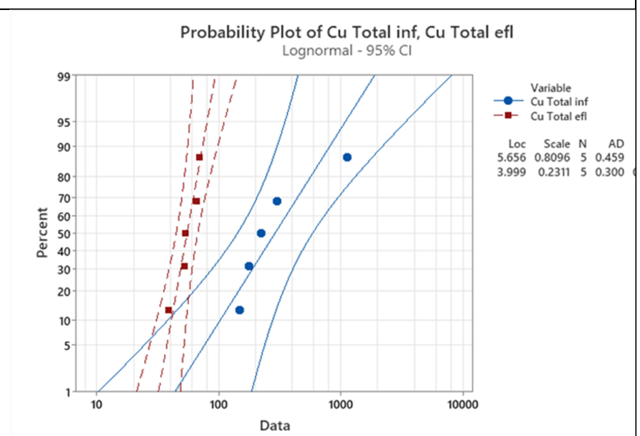


Media Filters

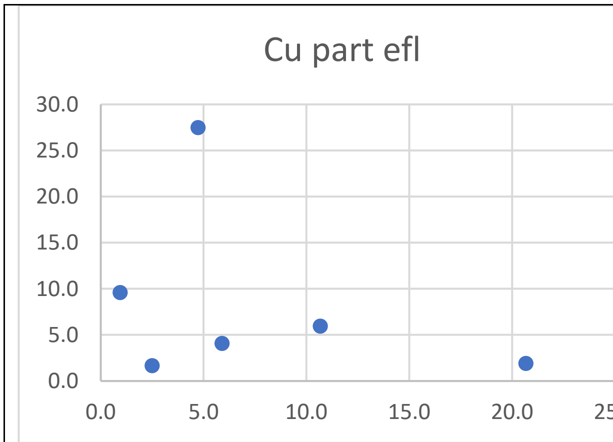




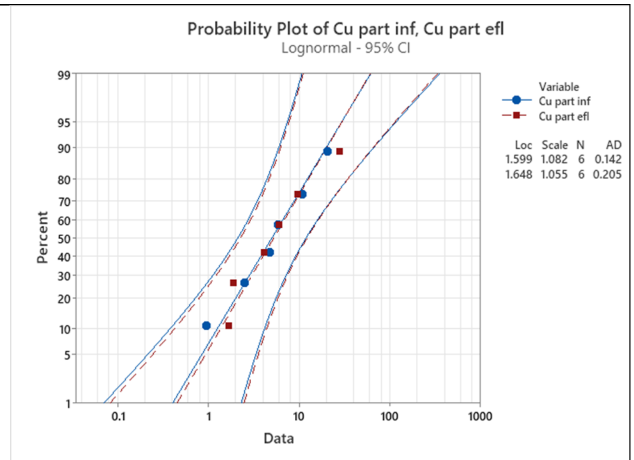
Biofilters and bioswales

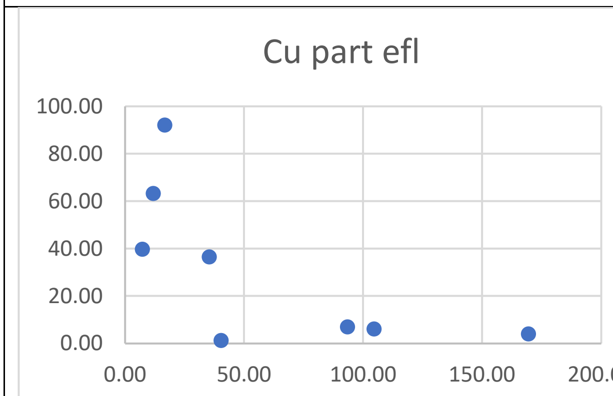


Copper, Particulate (>0.45 µm)

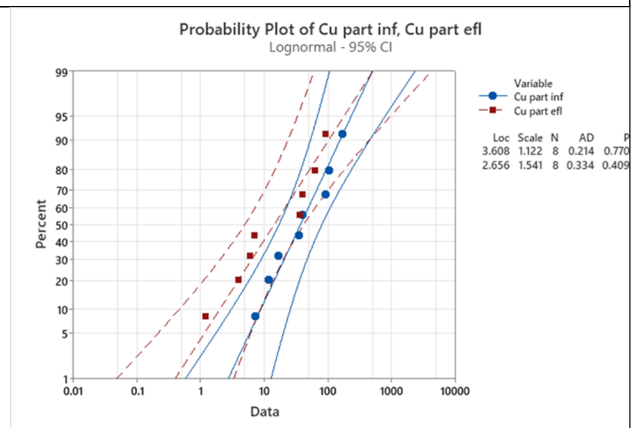


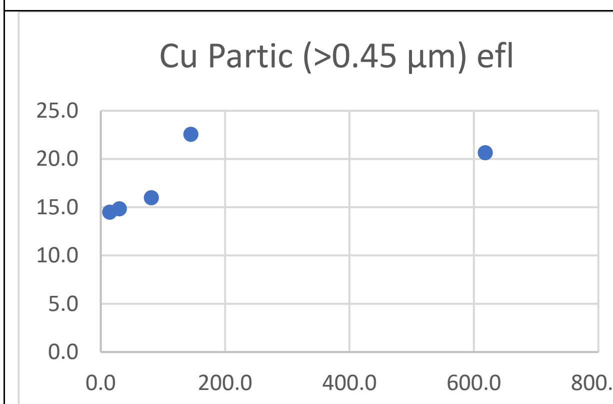
Sedimentation



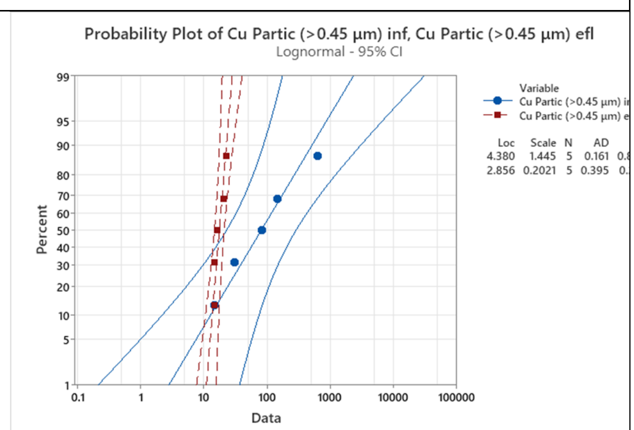


Media Filters

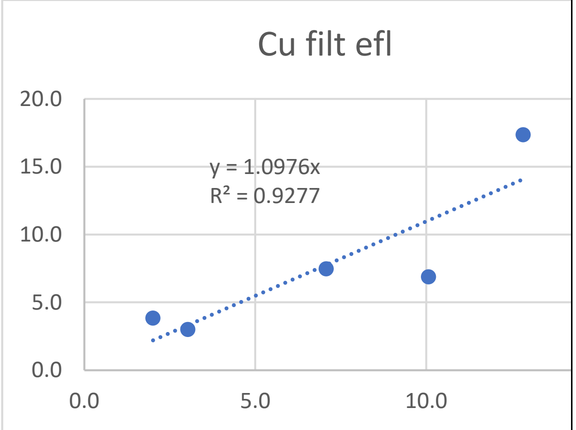




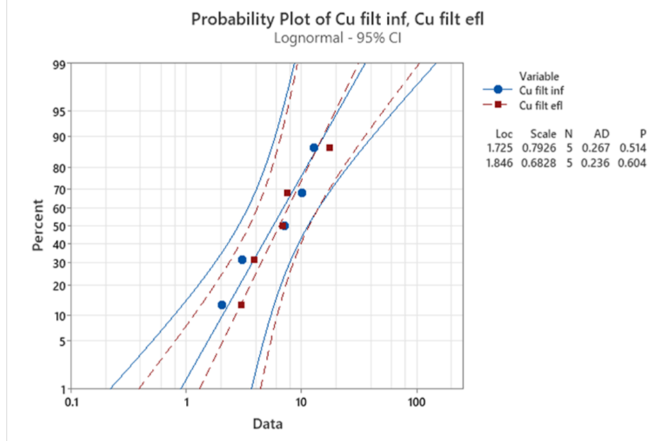
Biofilters and bioswales

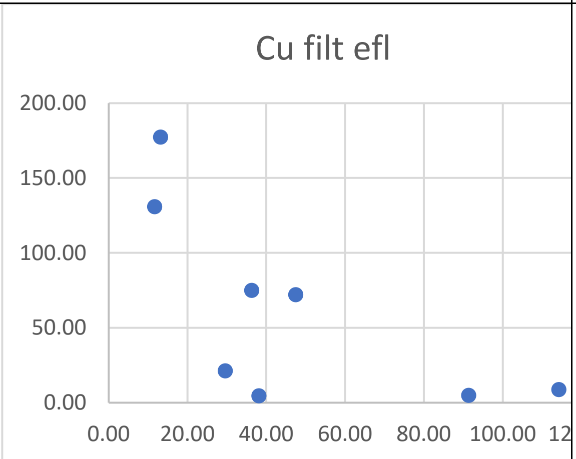


Copper, Filtered (<0.45 µm)

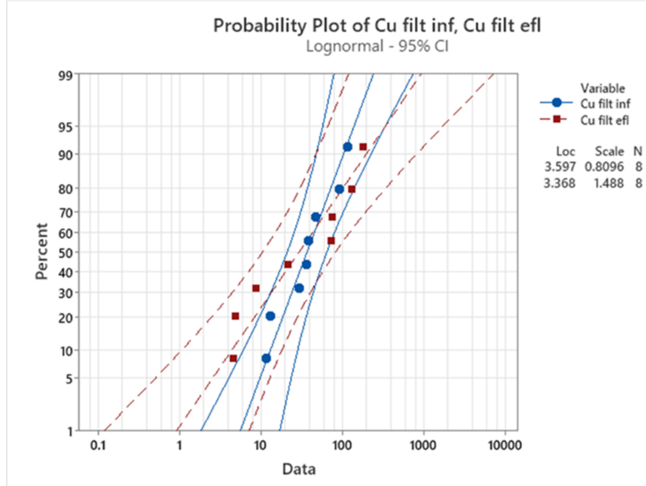


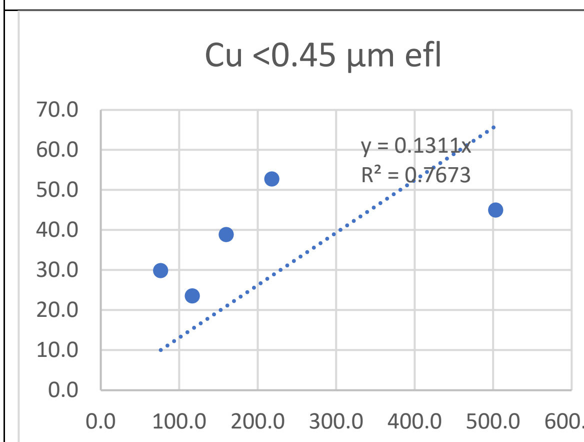
Sedimentation



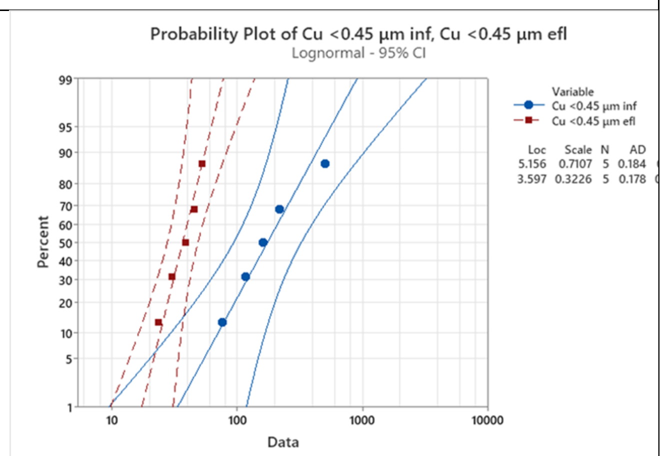


Media Filters



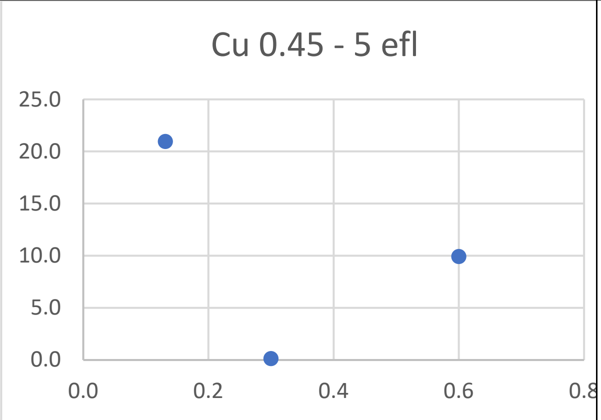


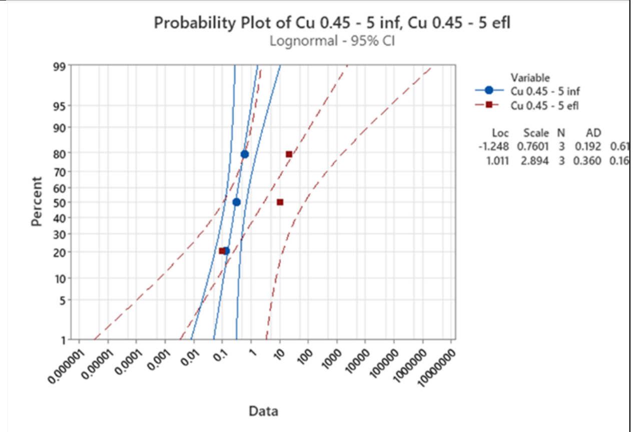
Biofilters and bioswales



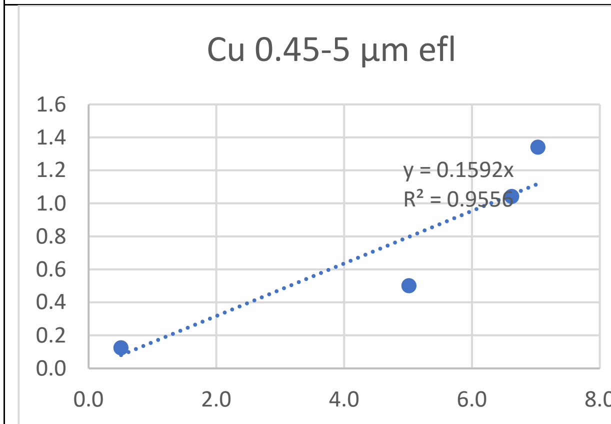
Copper, 0.45 to 5 µm

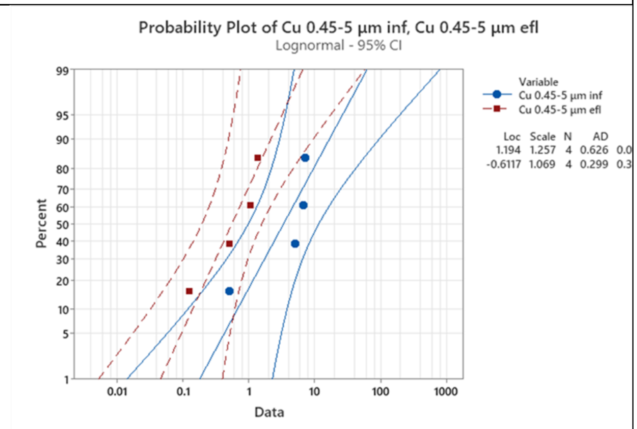
n/a
Sedimentation





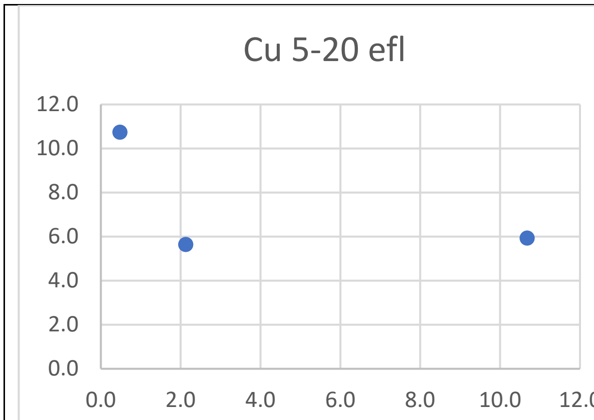
Media Filters

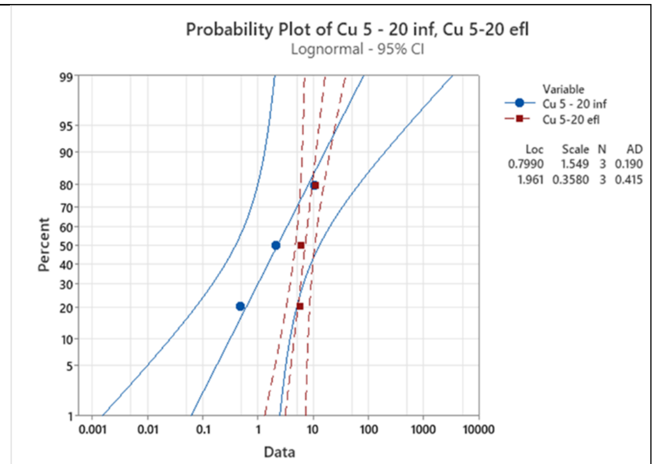




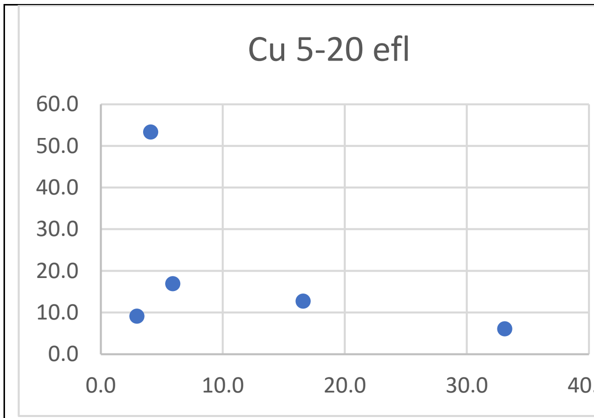
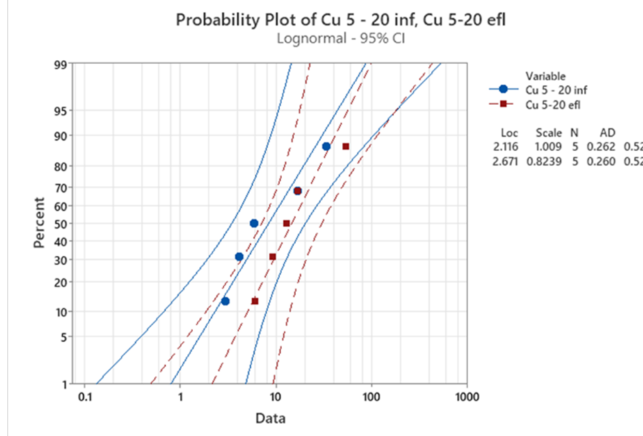
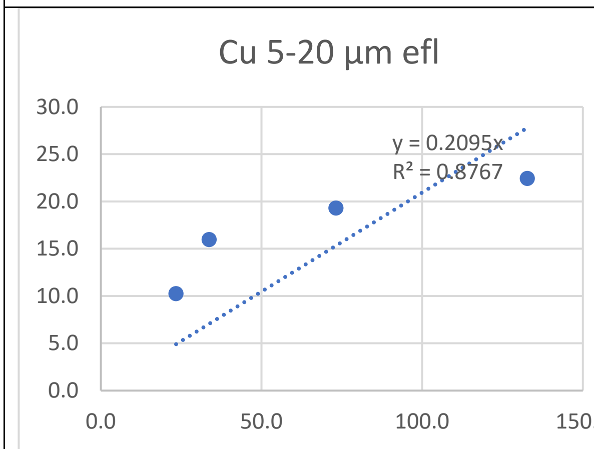
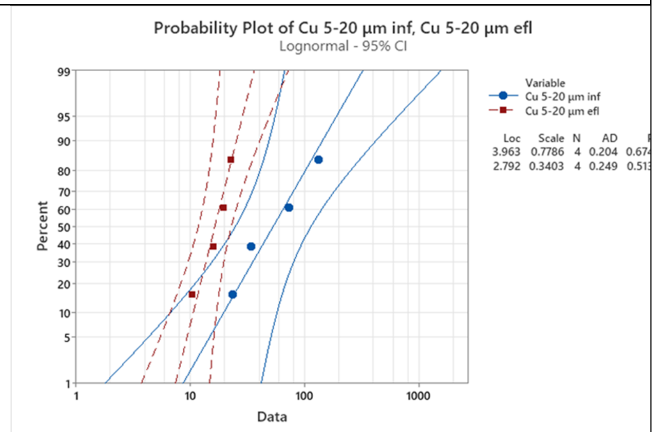
Biofilters and bioswales

Copper, 5 to 20 µm

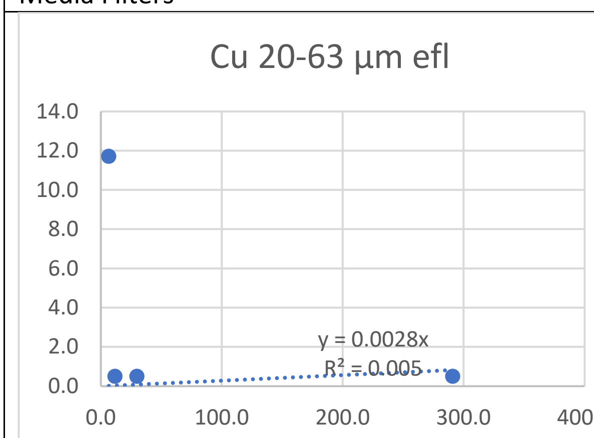
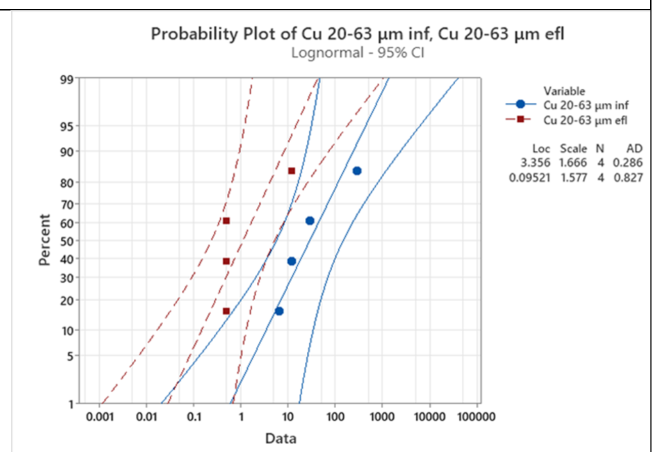




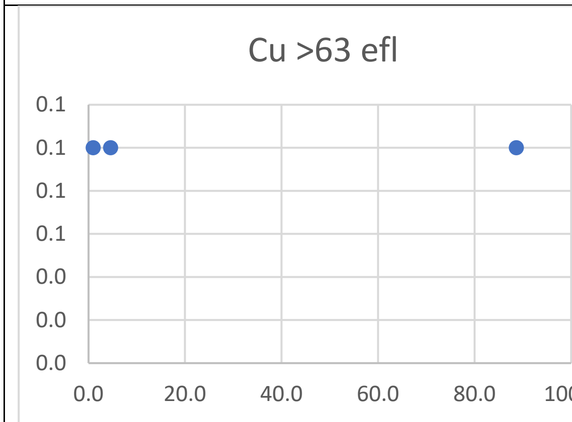
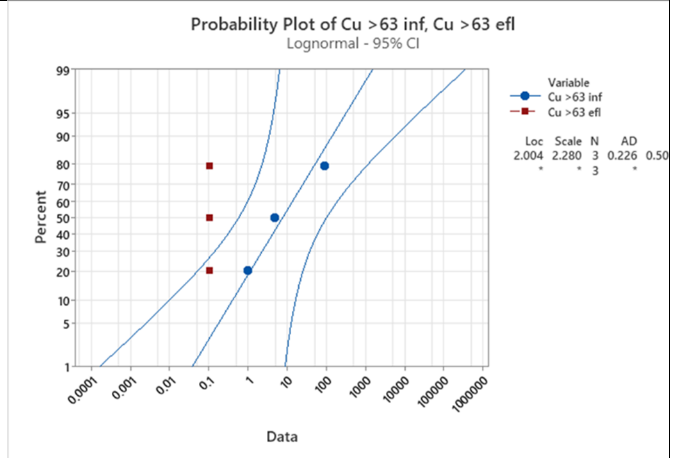
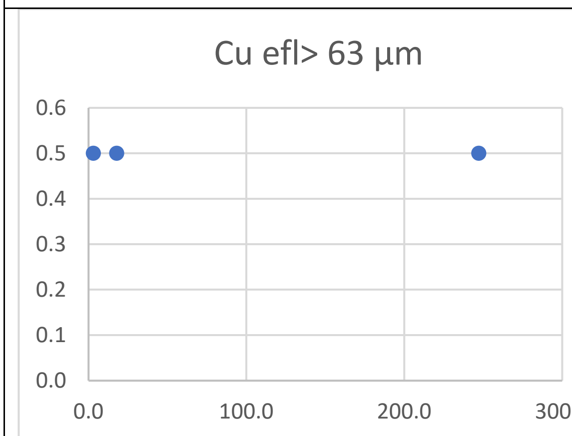
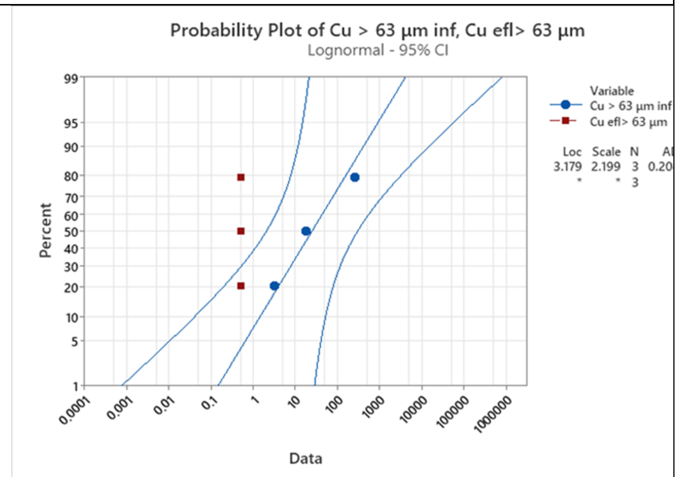
Sedimentation

 Media Filters	
 Biofilters and bioswales	

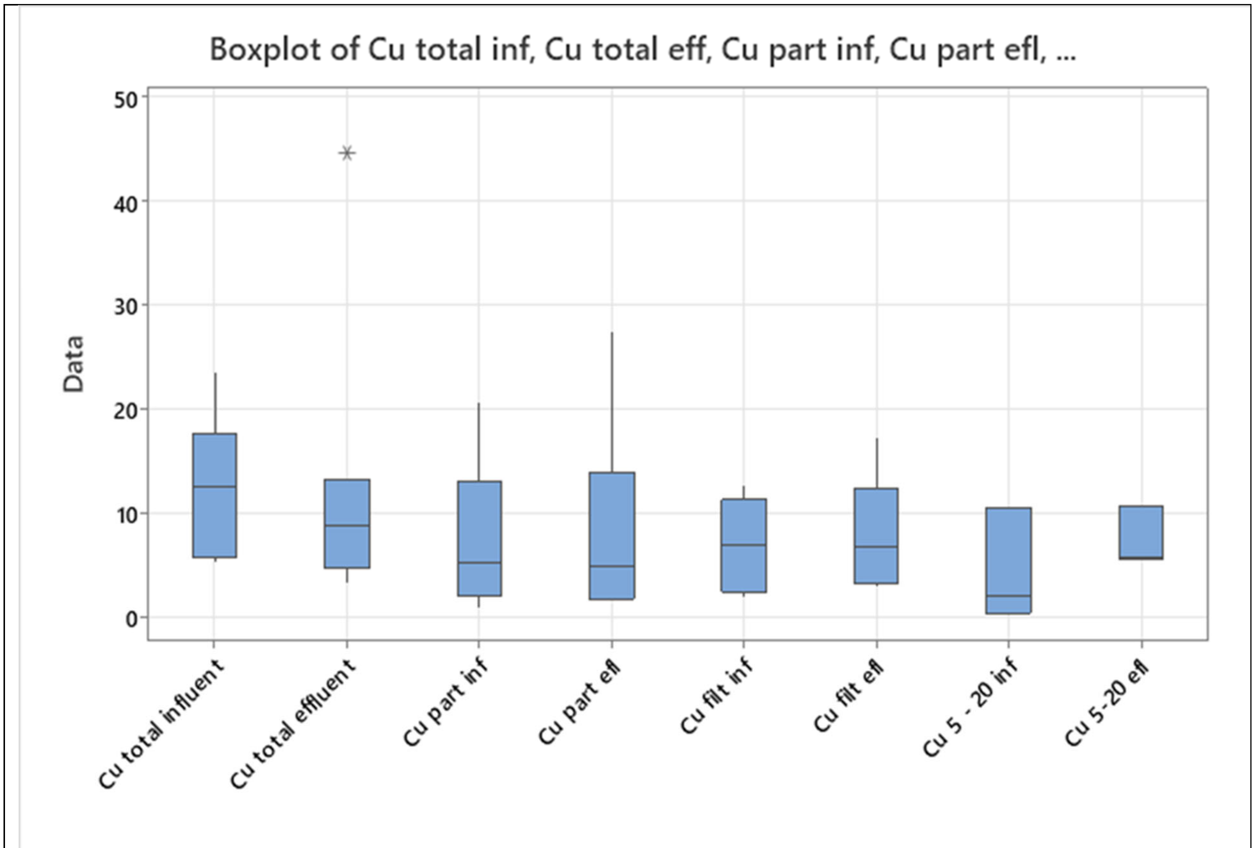
Copper, 20 to 63 µm

n/a Sedimentation	
n/a Media Filters	
 Biofilters and bioswales	

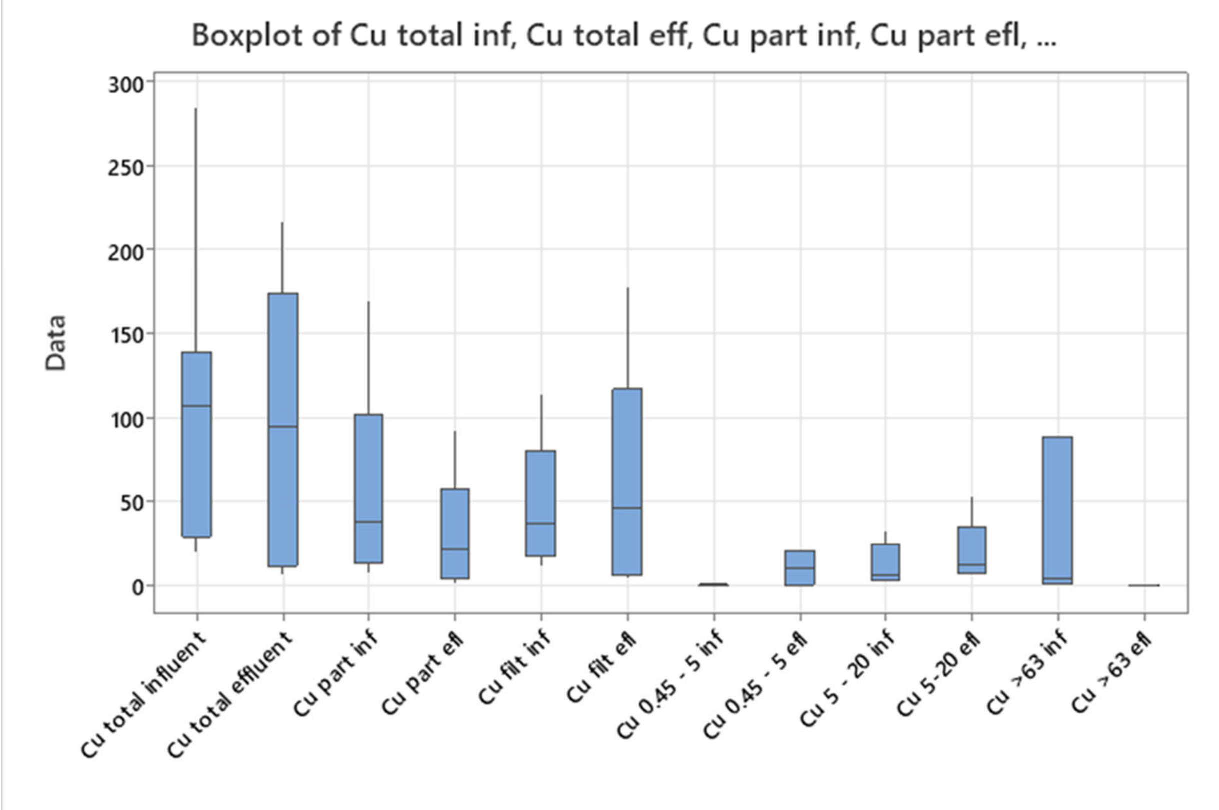
Copper, >63 µm

n/a Sedimentation	
 Media Filters	
 Biofilters and bioswales	

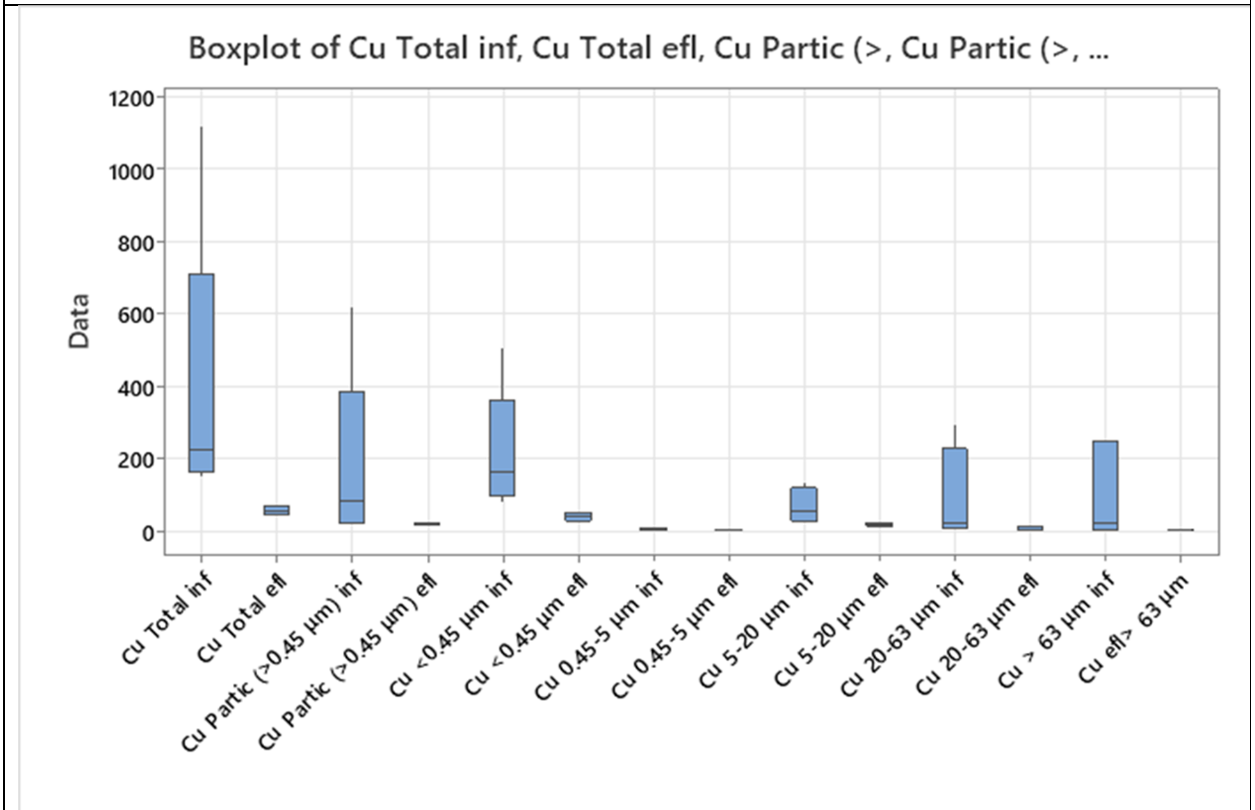
Copper box and whisker plots



Sedimentation



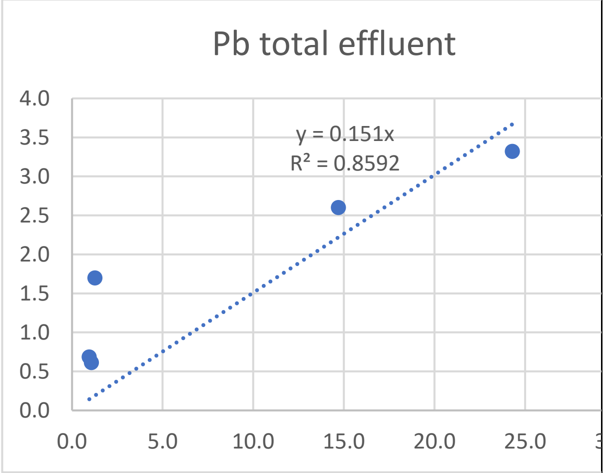
Media filters

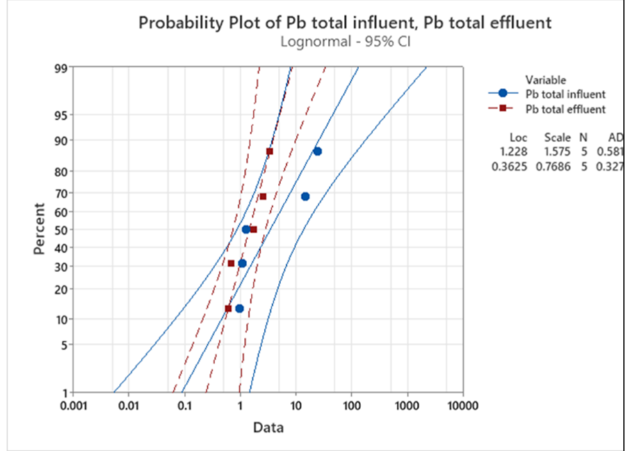


Biofilters and bioswales

Lead

Lead, Total





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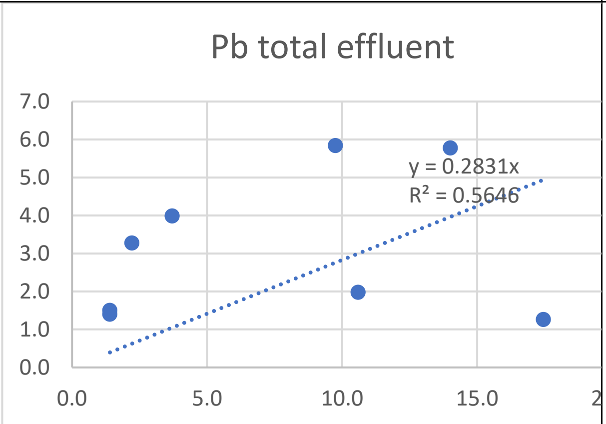

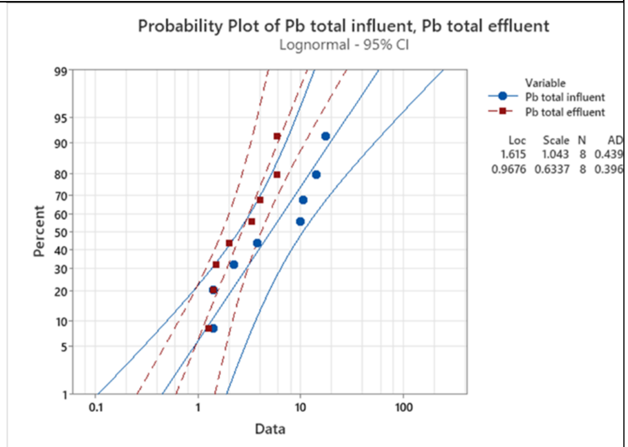

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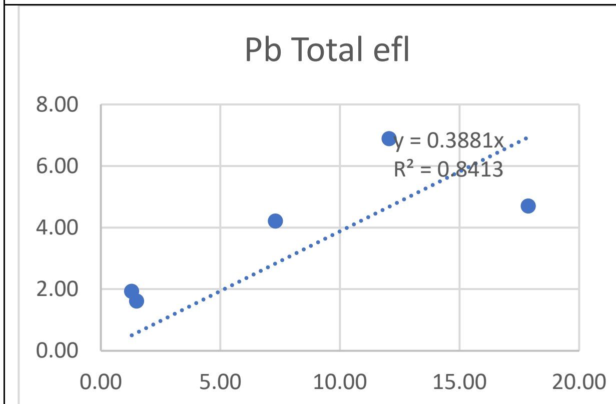
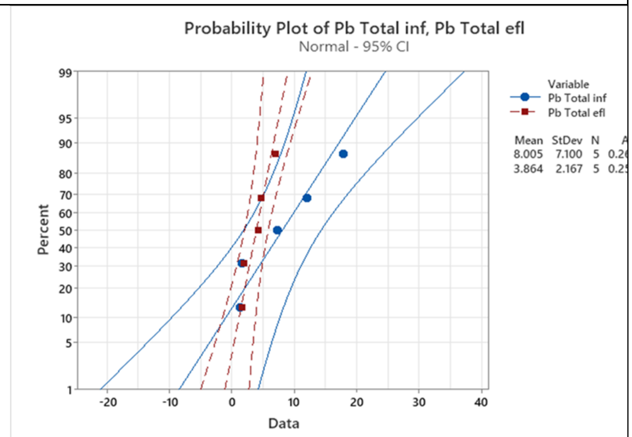
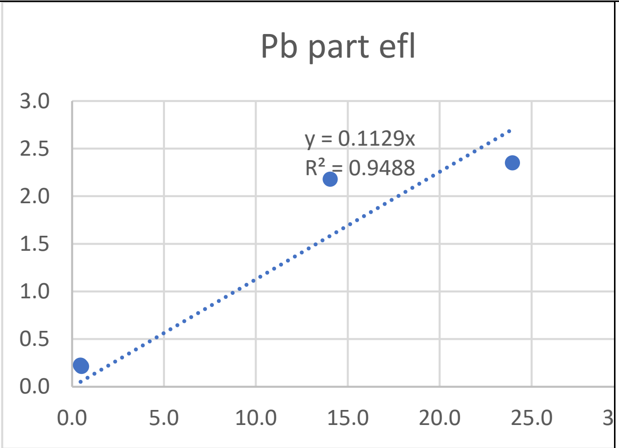
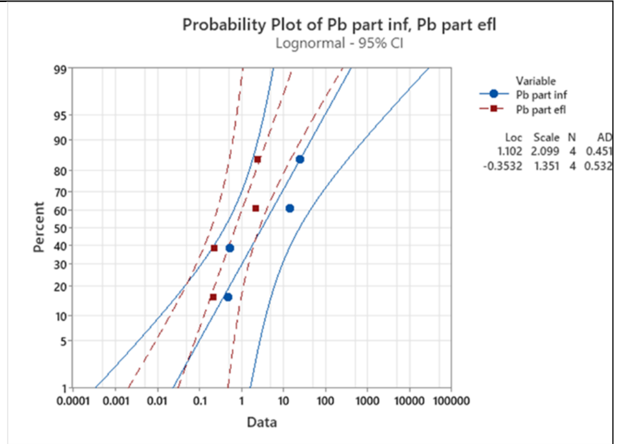




Biofilters and bioswales

Lead, Particulate (>0.45 µm)





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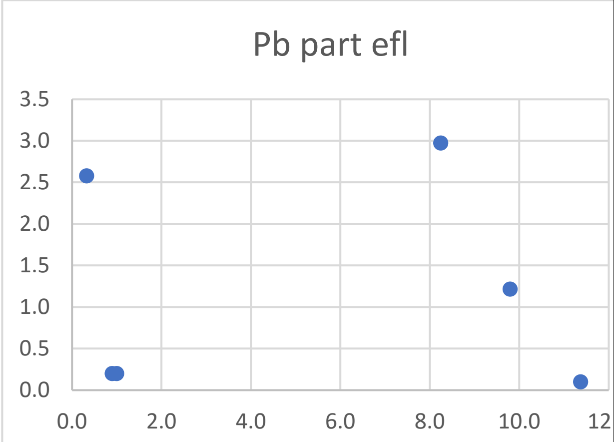

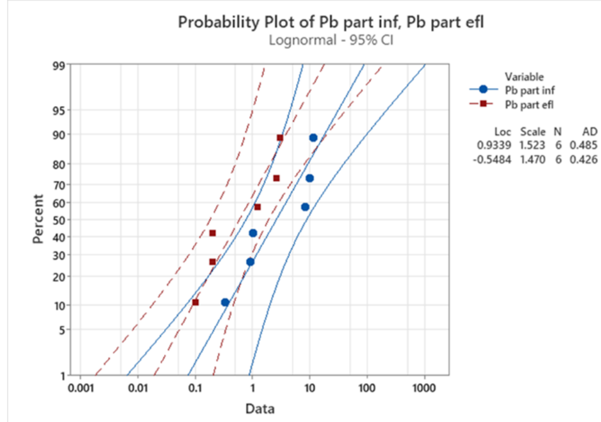

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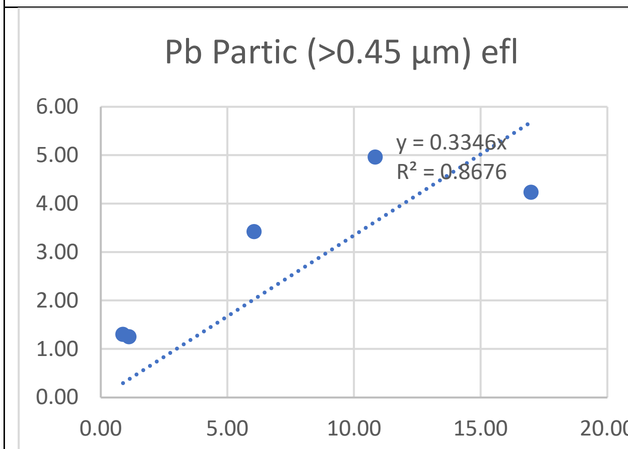
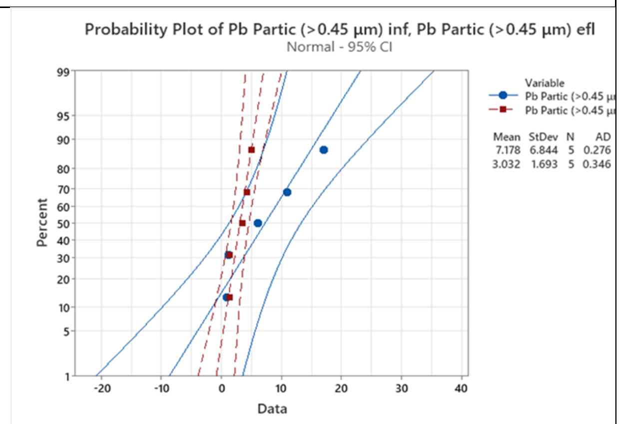
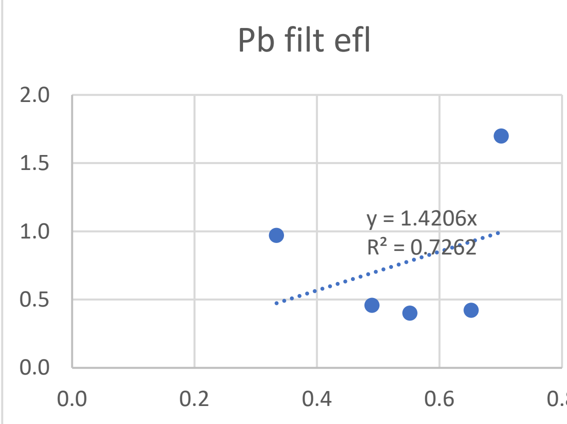
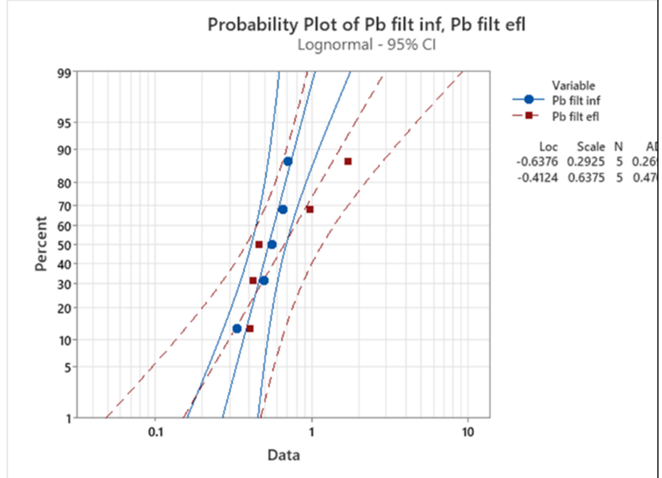




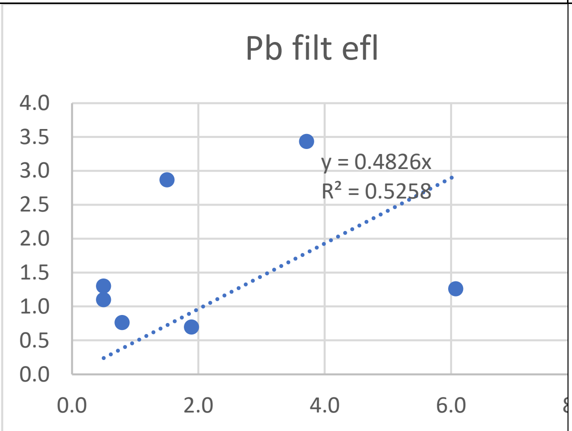
Biofilters and bioswales

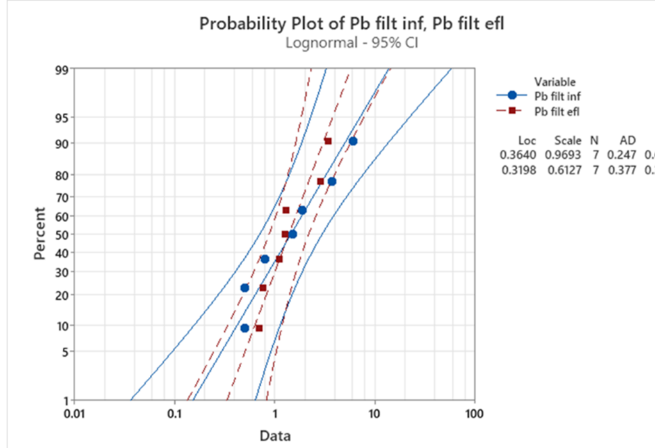
Lead, Filtered <0.45 µm)





Sedimentation





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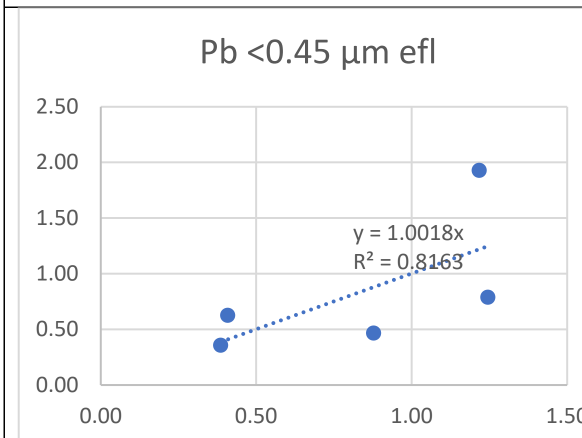

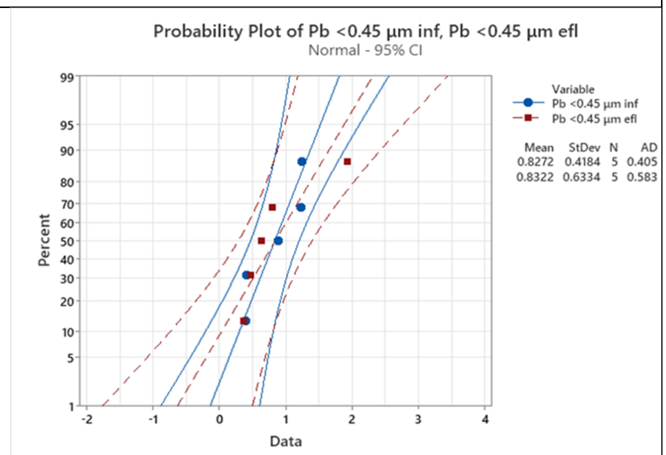

Biofilters and bioswales

Lead 0.45 to 5 µm

n/a Sedimentation	
n/a Media Filters	
n/a Biofilters and bioswales	

Lead 5 to 20 µm

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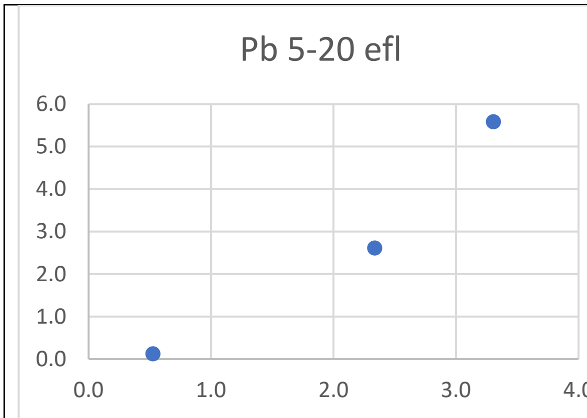
<td>

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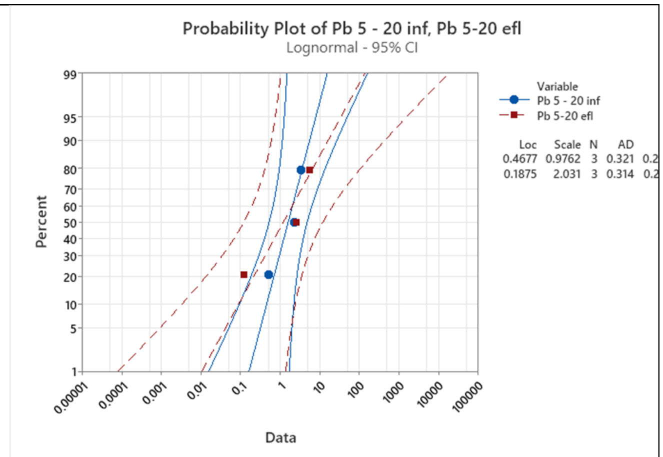
<td>
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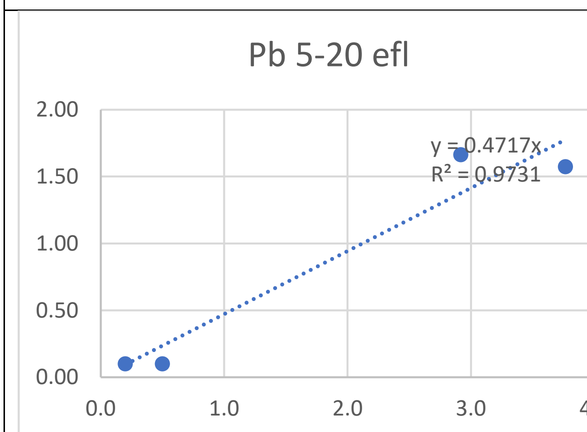
<td>

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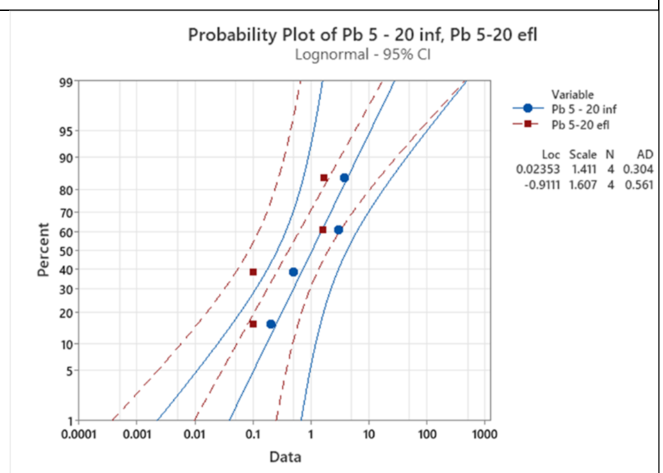
<td>
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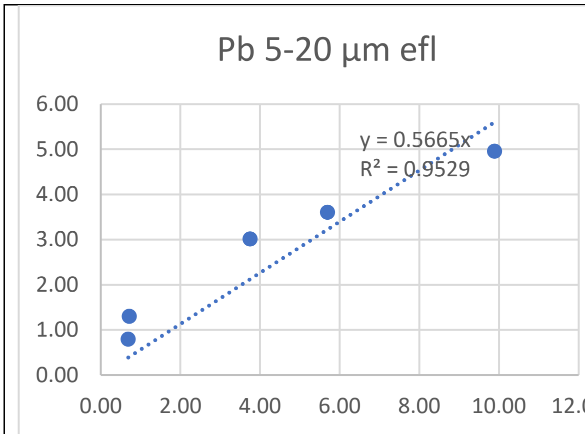
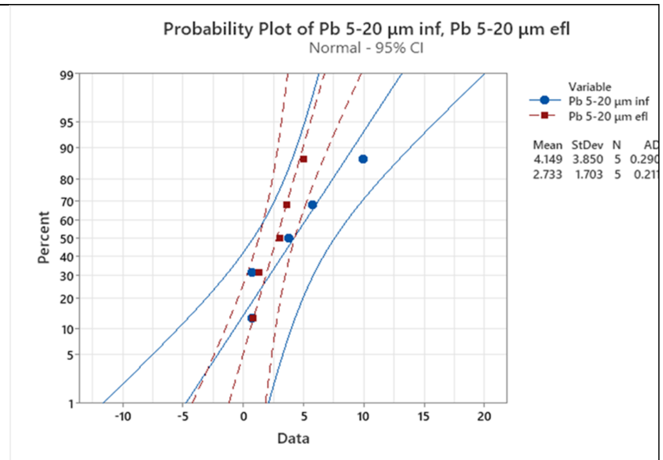
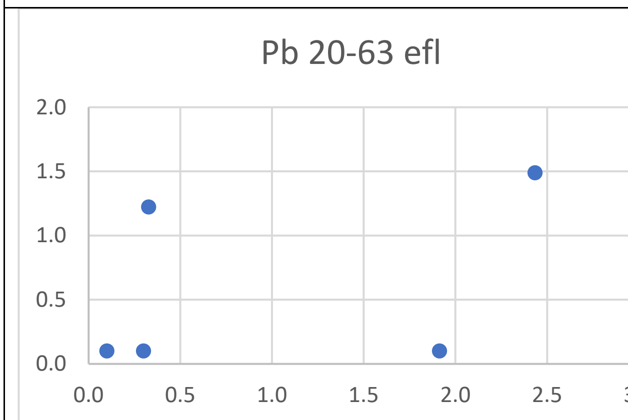


Biofilters and bioswales



Lead 20 to 63 µm

n/a
Sedimentation



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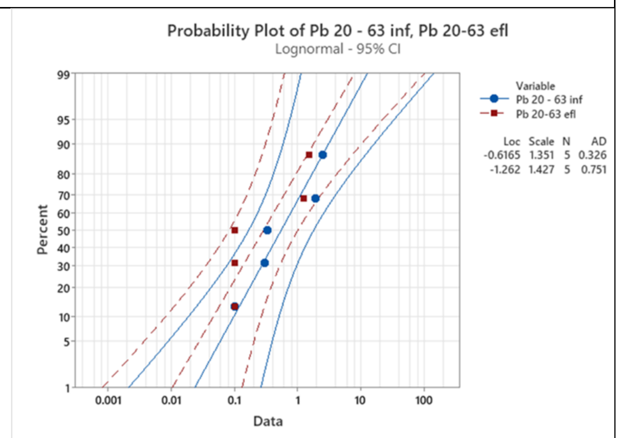

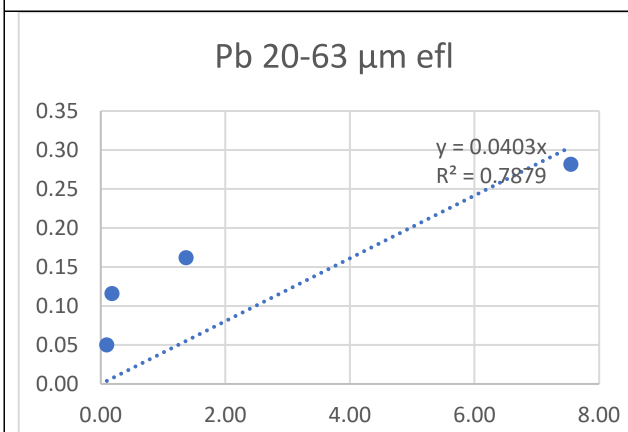

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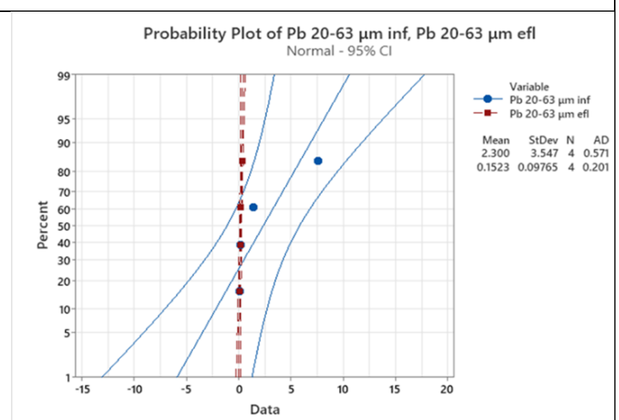
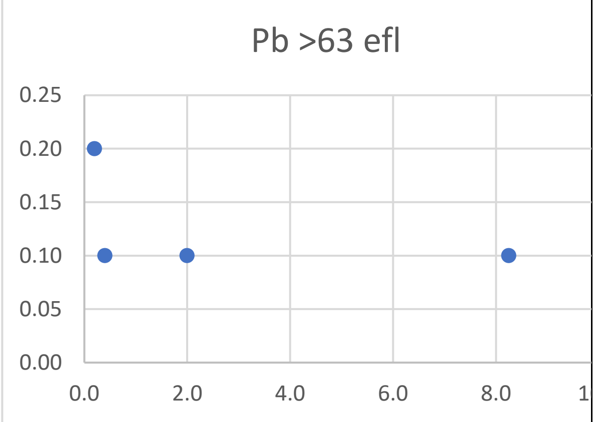
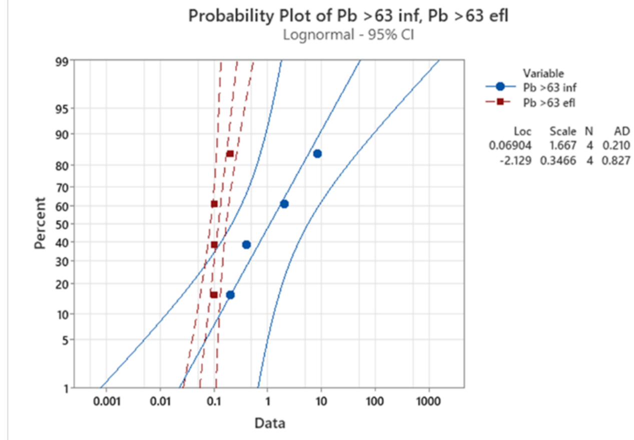


Lead >63 µm

n/a

Sedimentation





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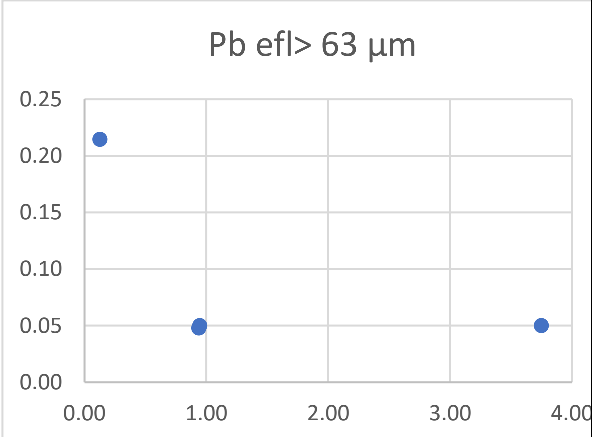
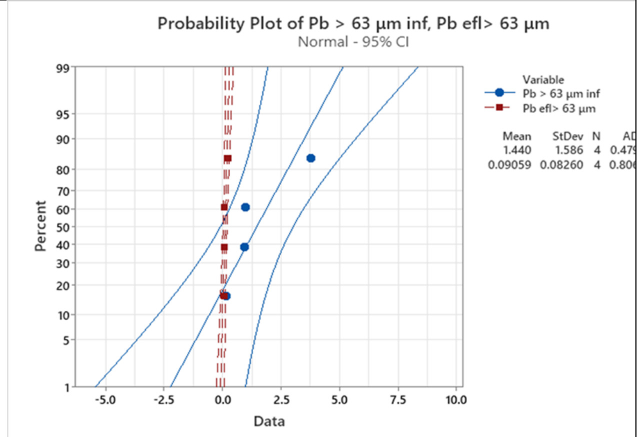
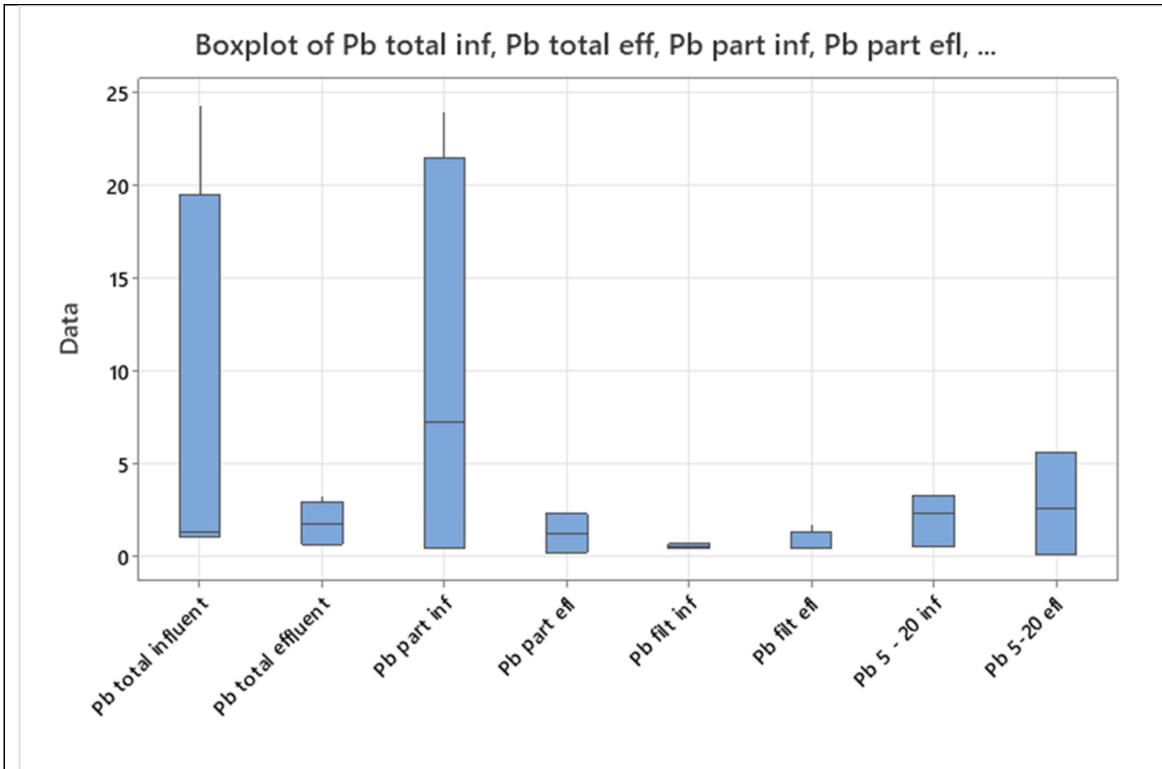




Biofilters and bioswales

Lead box and whisker plots



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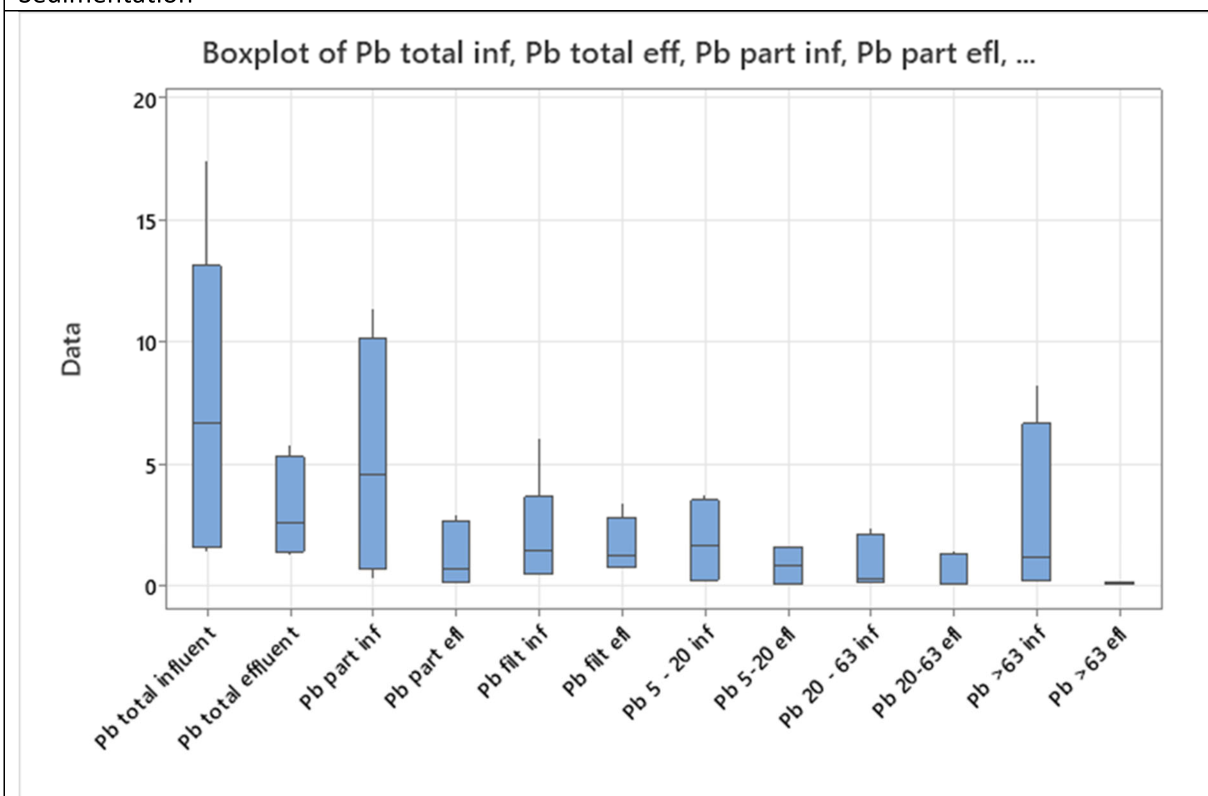

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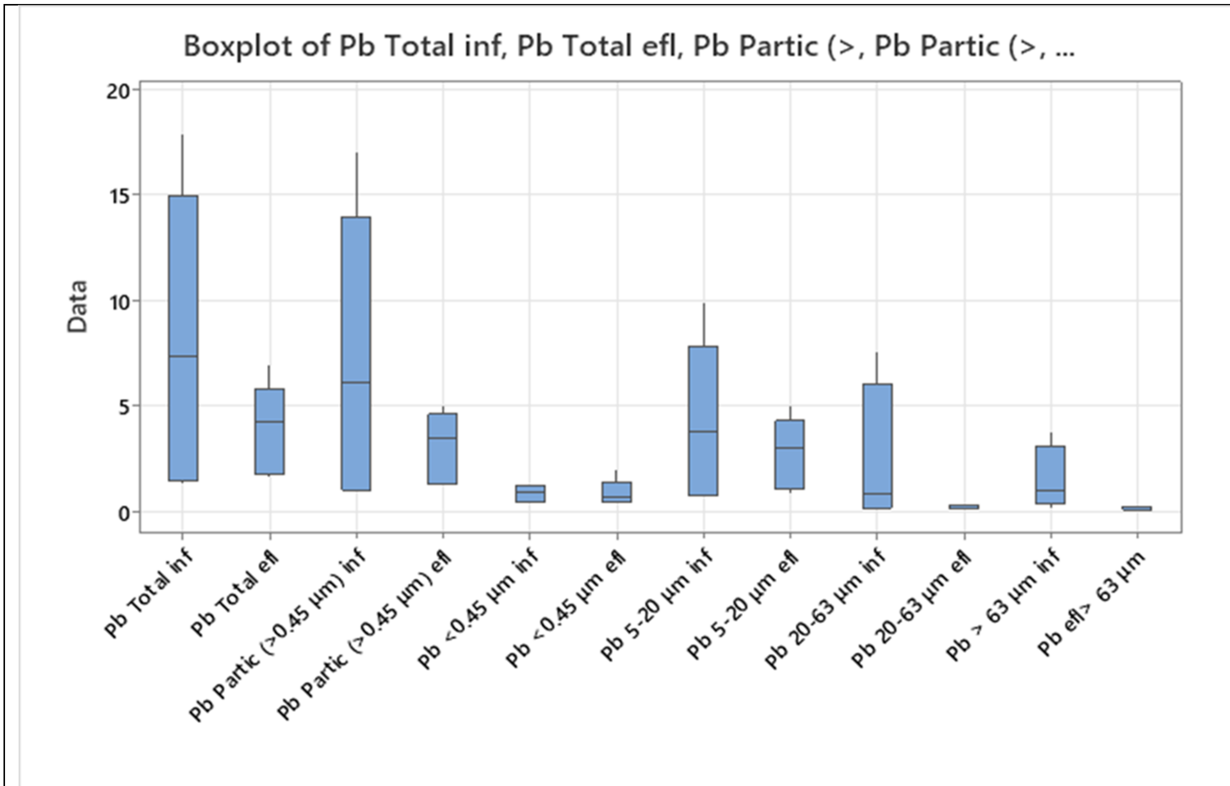
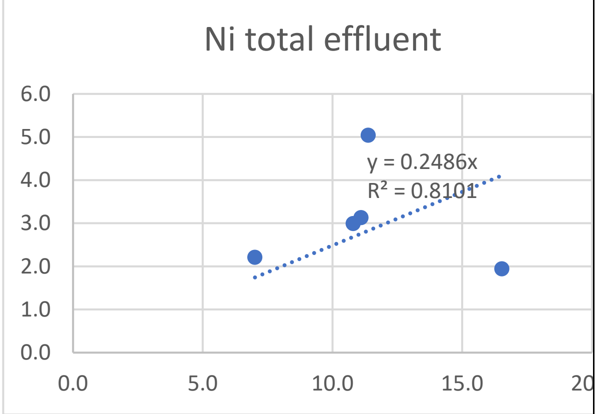


Biofilters and bioswales

Nickel

Nickel, Total



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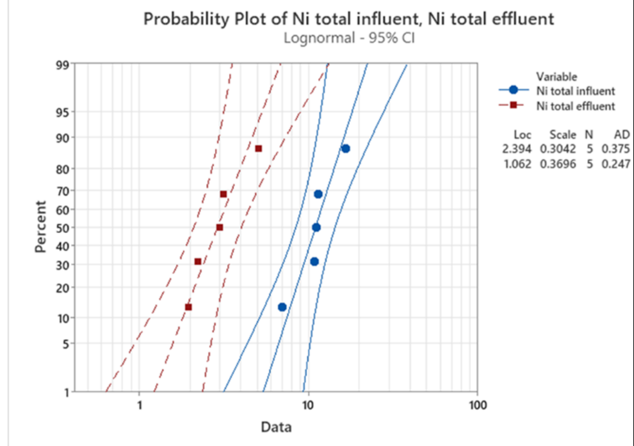

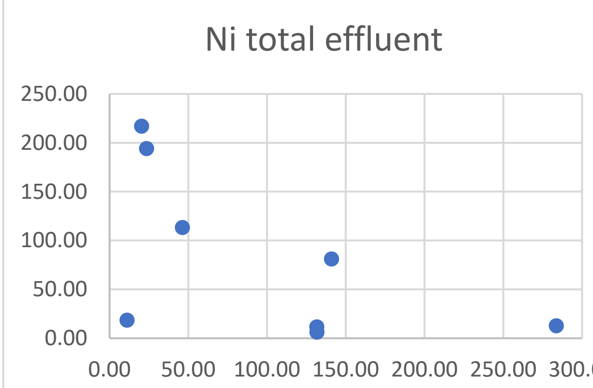

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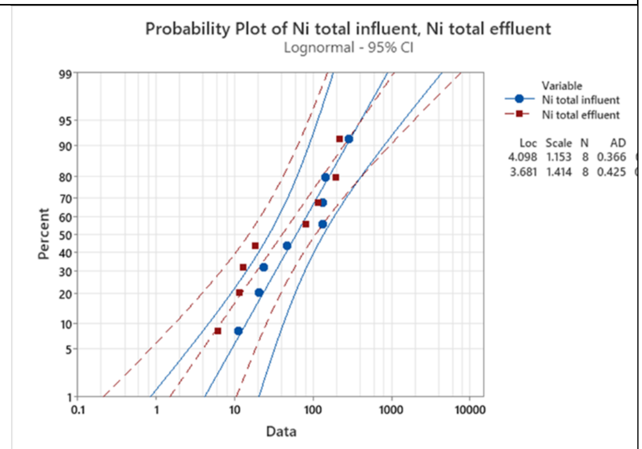
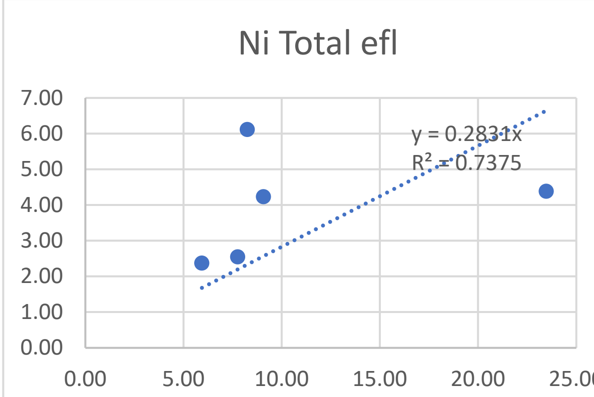
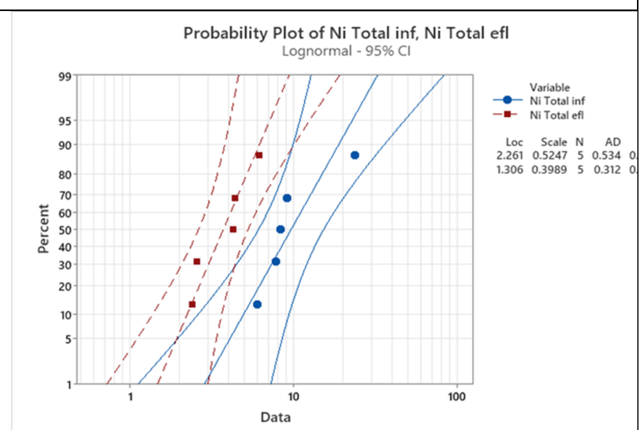
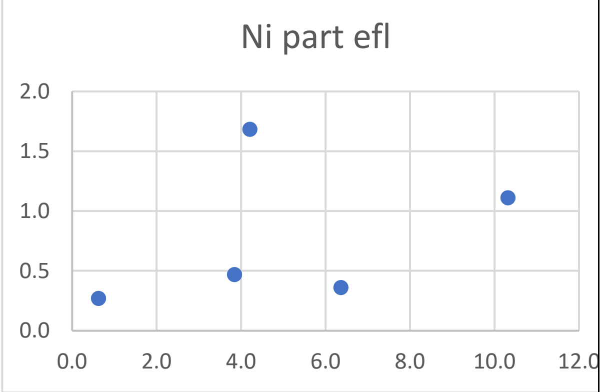


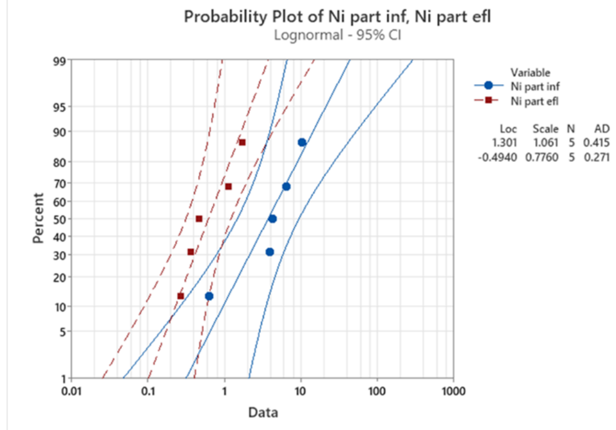


Biofilters and bioswales



Nickel, Particulate (>0.45 µm)





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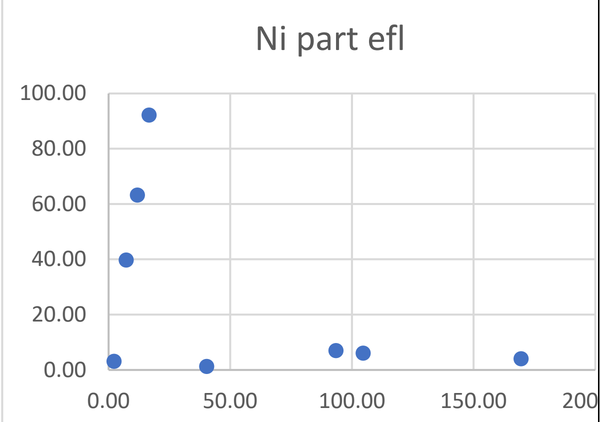

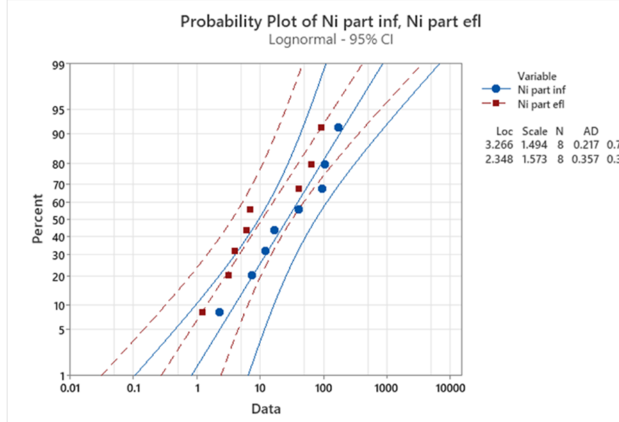

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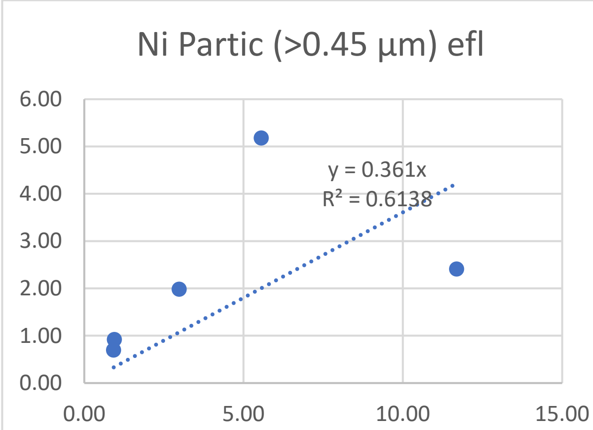
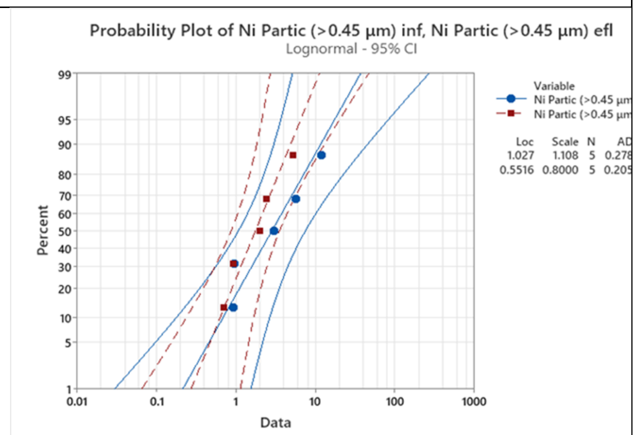
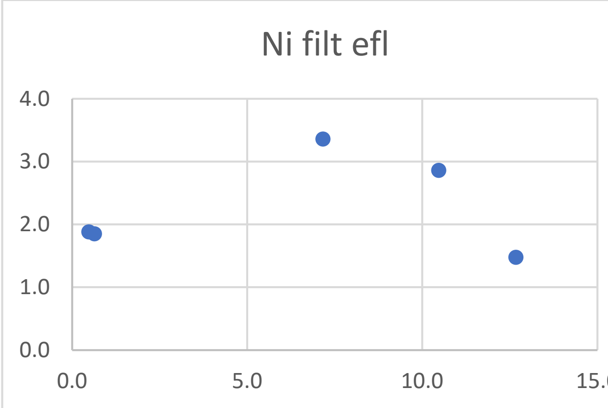
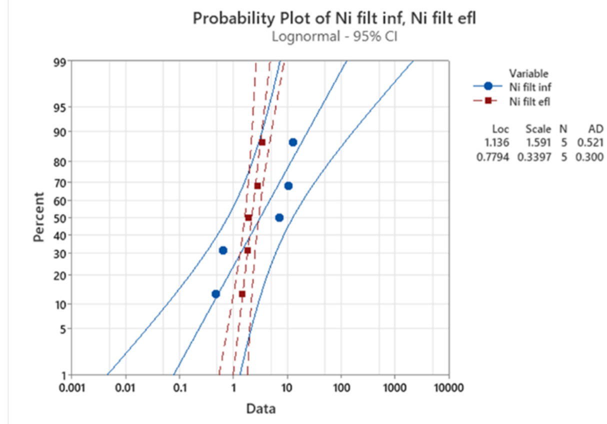




Biofilters and bioswales

Nickel, Filtered (<0.45 µm)





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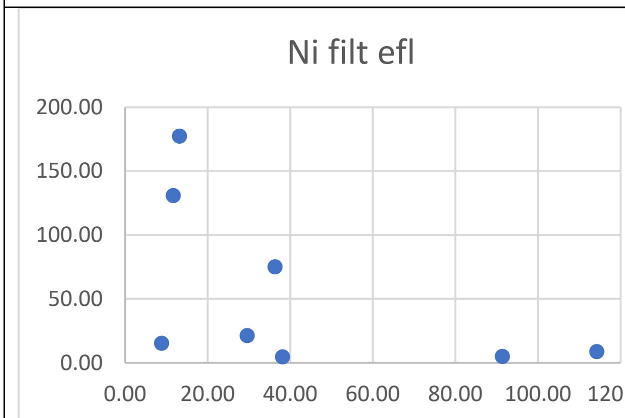

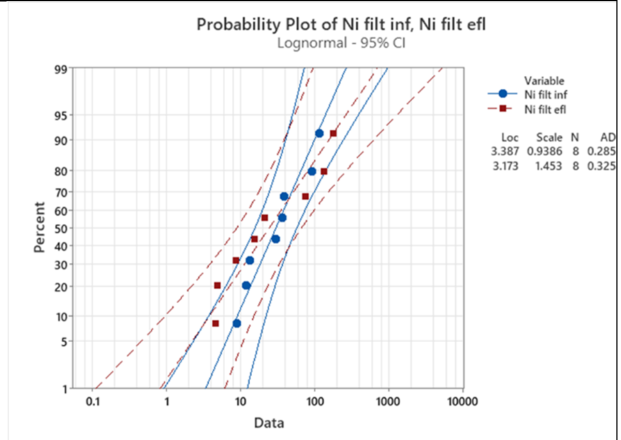

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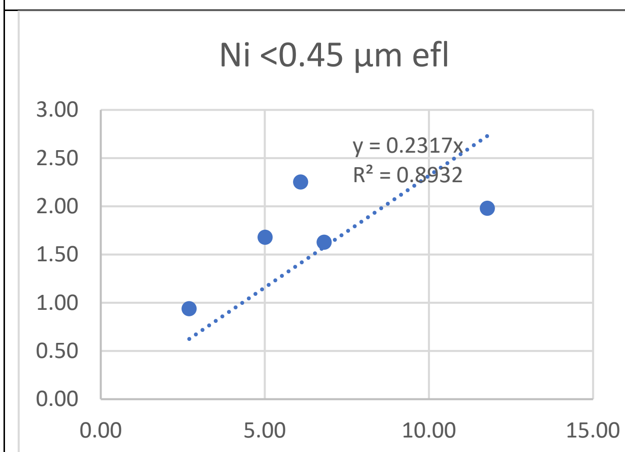
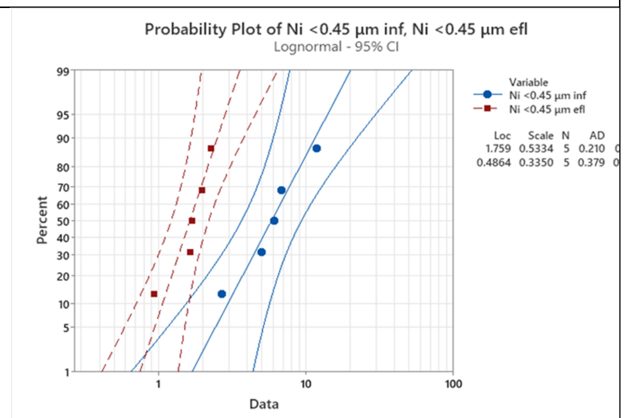
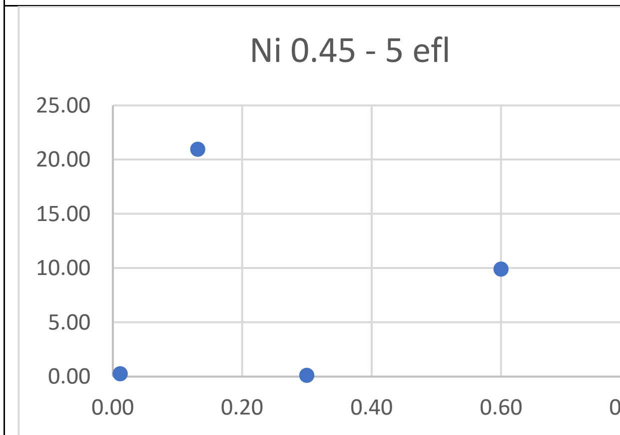
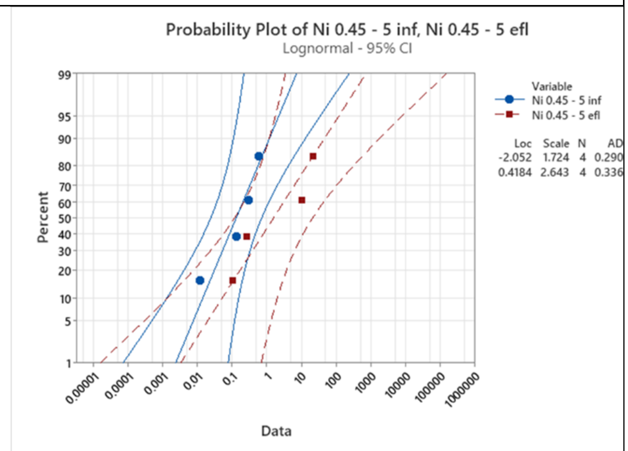
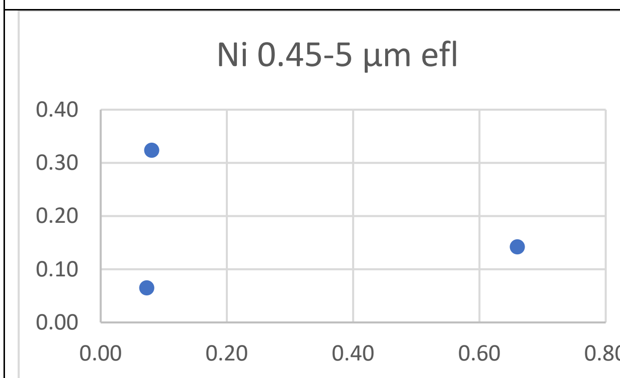
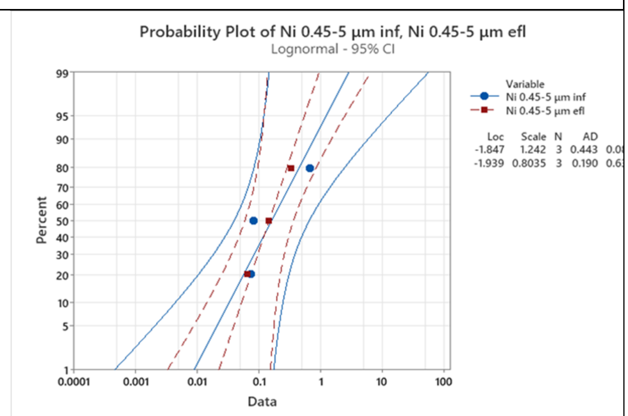


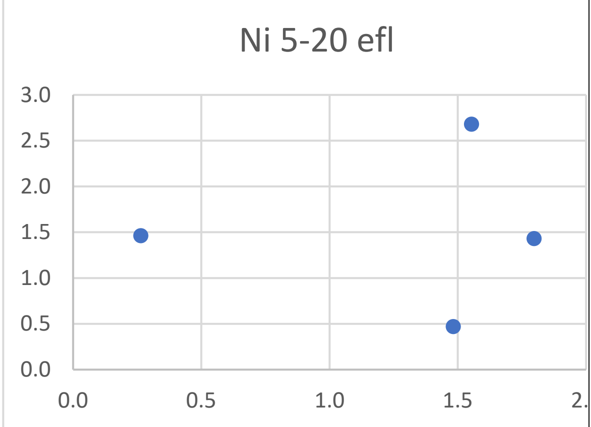


Biofilters and bioswales

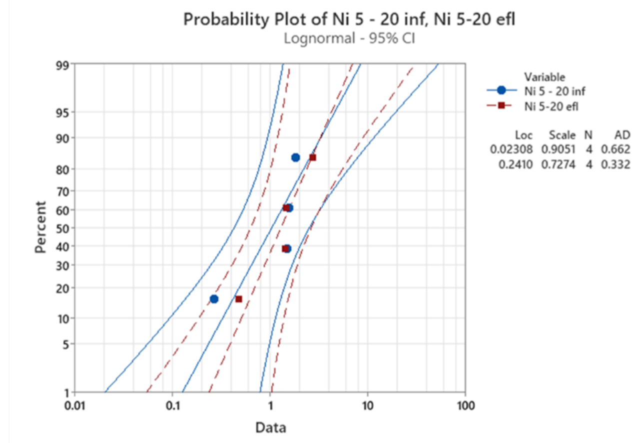
Nickel 0.45 to 5 µm

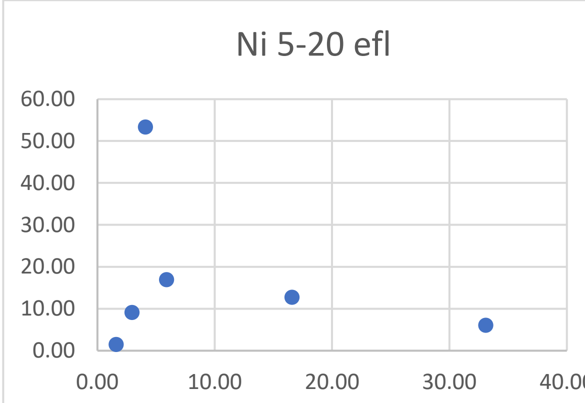
n/a Sedimentation	
 Media Filters	
 Biofilters and bioswales	

Nickel 5 to 20 µm

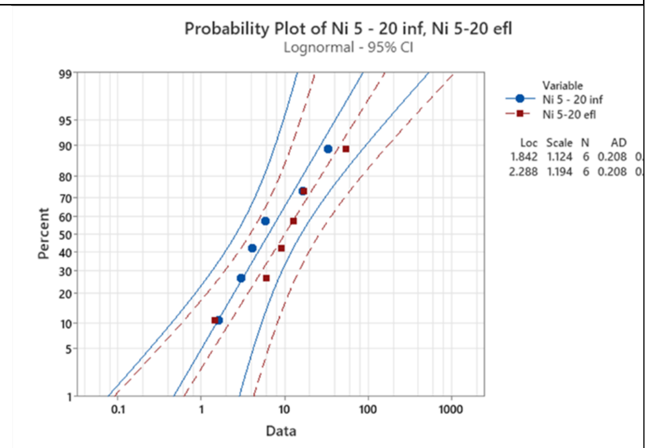


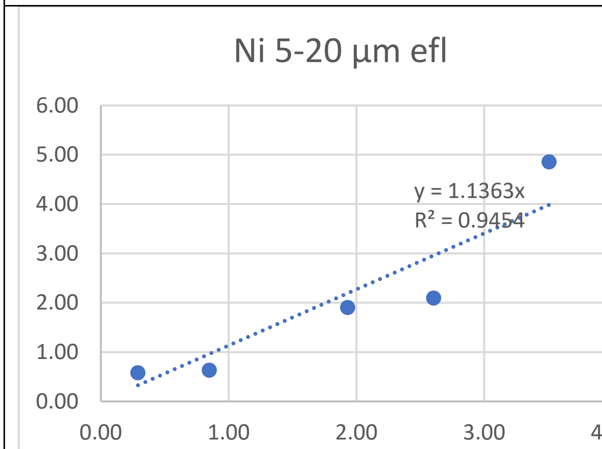
Sedimentation



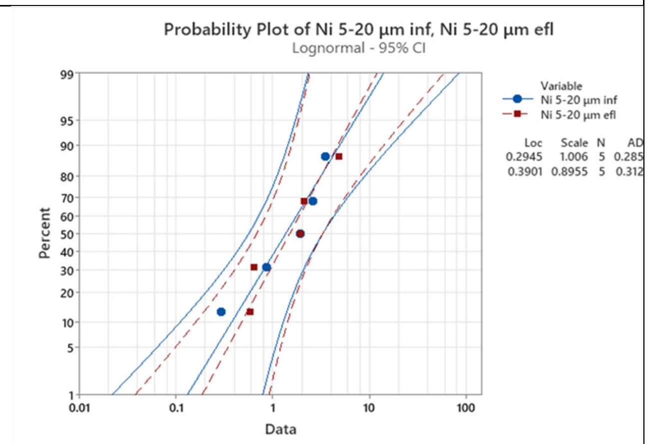


Media Filters



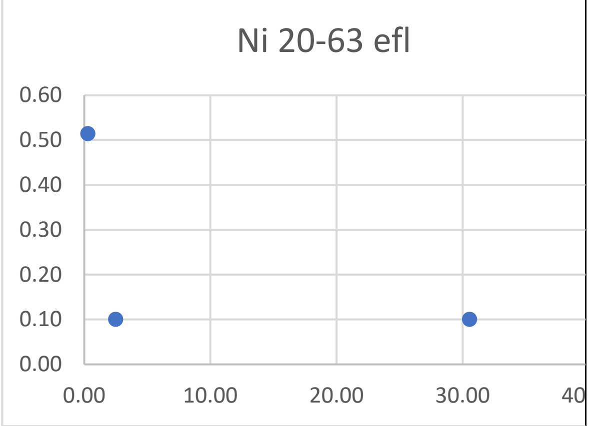


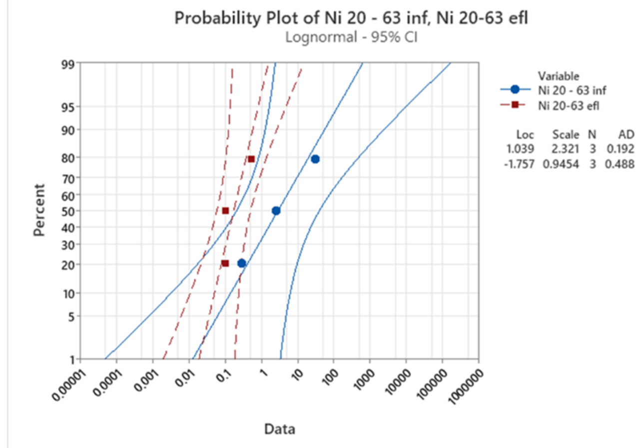
Biofilters and bioswales



Nickel 20 to 63 µm

n/a
Sedimentation





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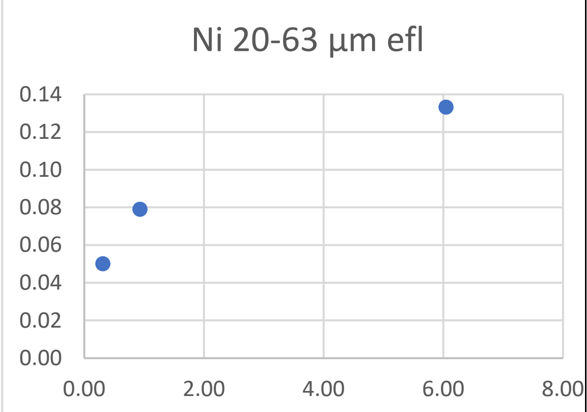
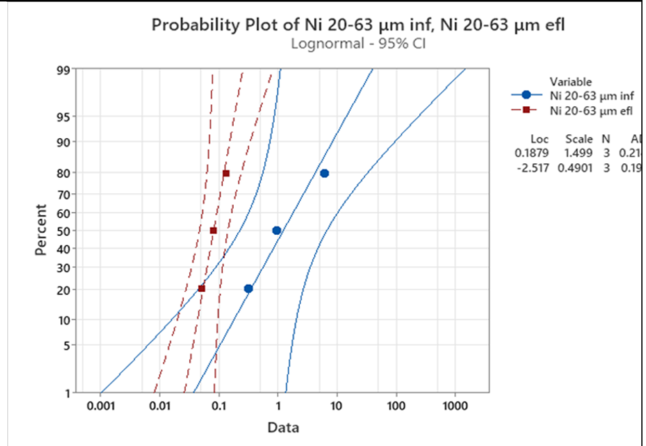
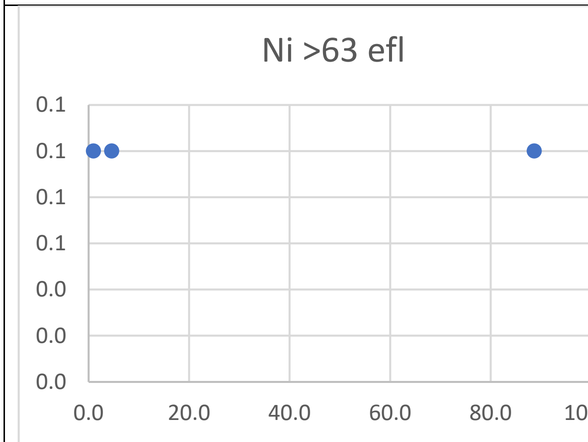




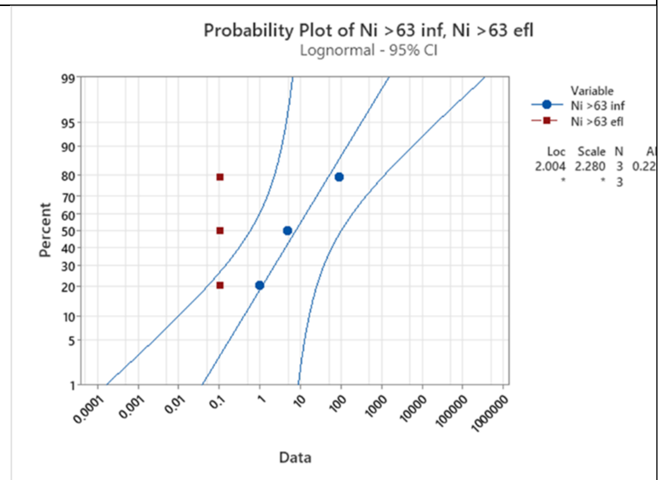
Biofilters and bioswales

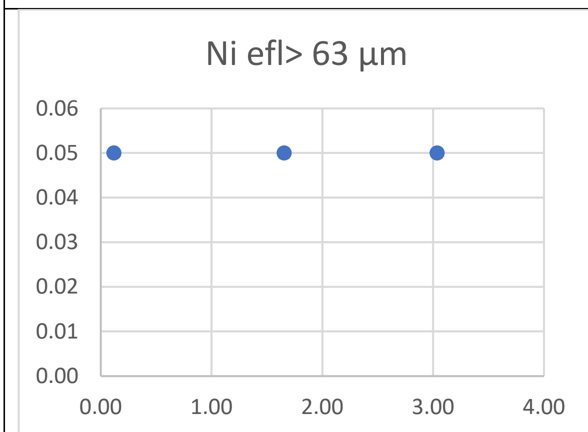
Nickel >63 µm

n/a
Sedimentation

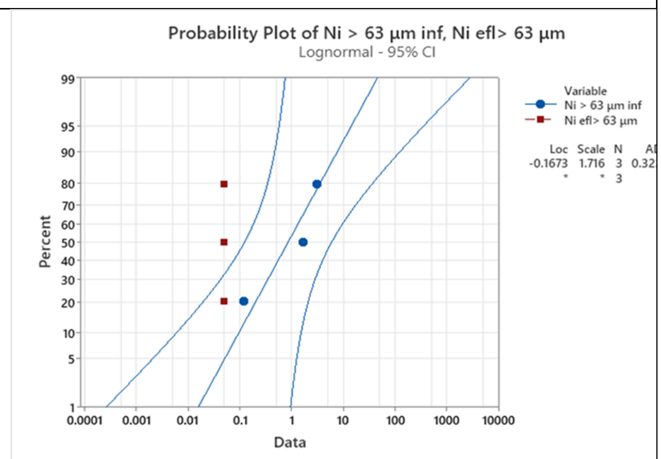


Media Filters

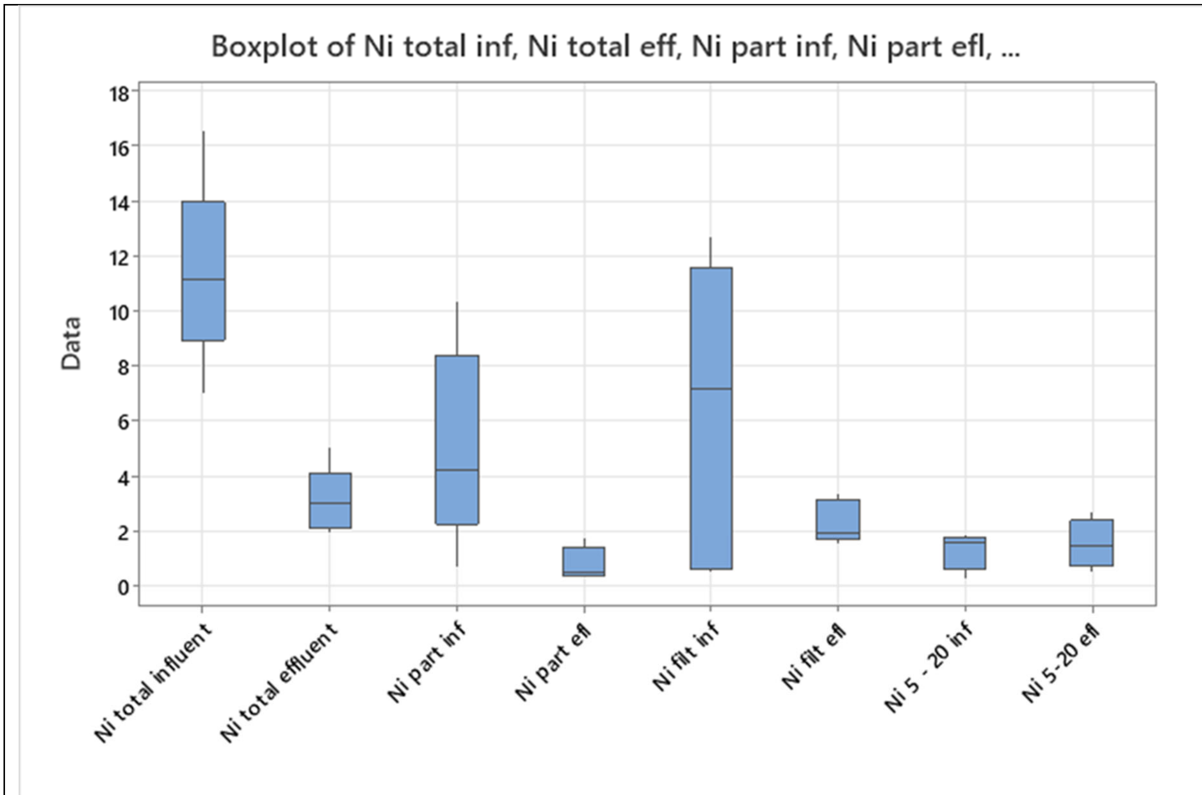




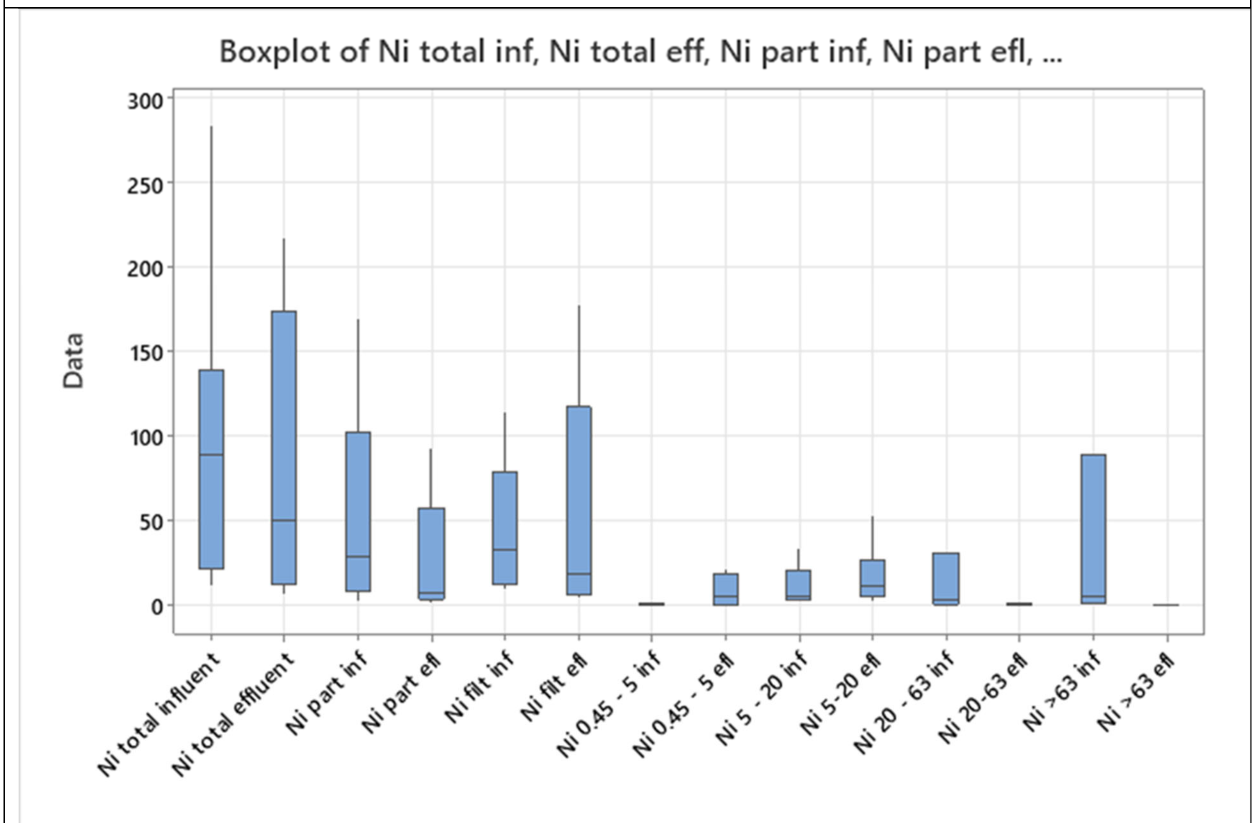
Biofilters and bioswales



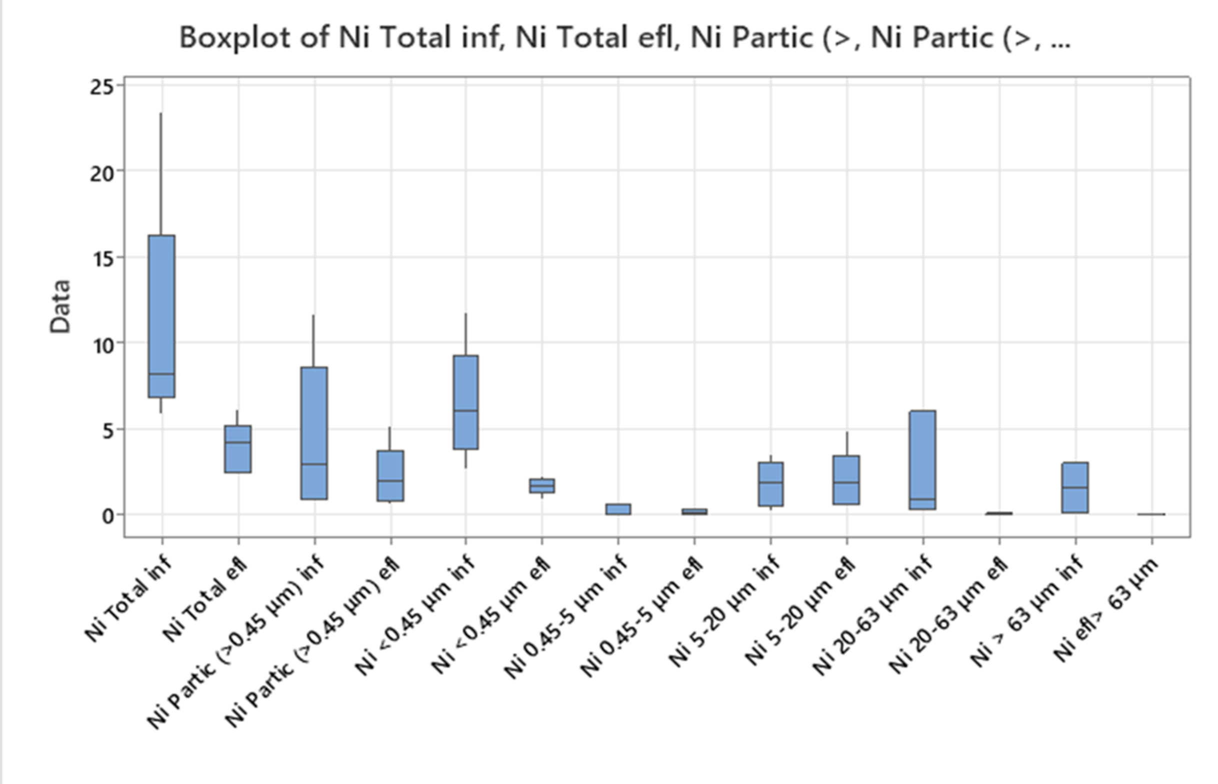
Nickel box and whisker plots



Sedimentation



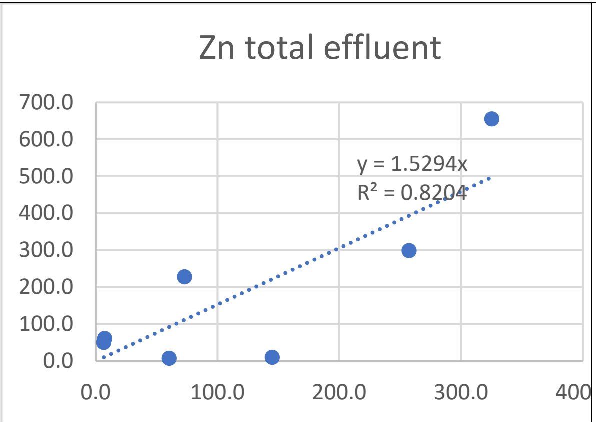
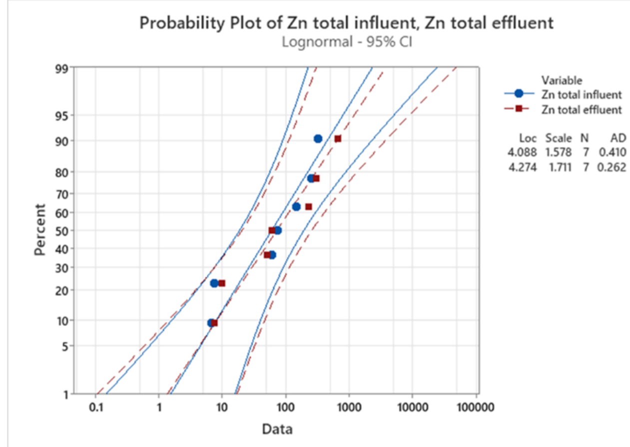
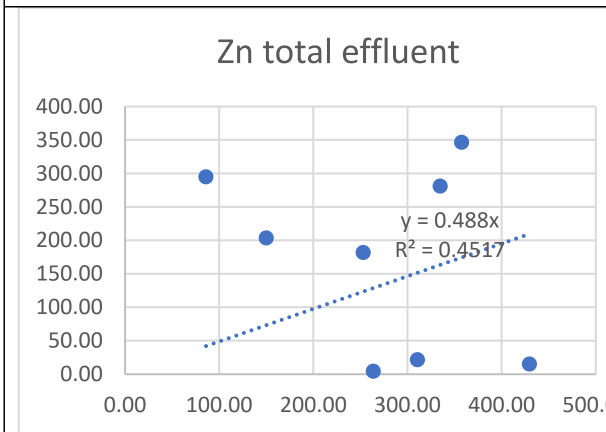
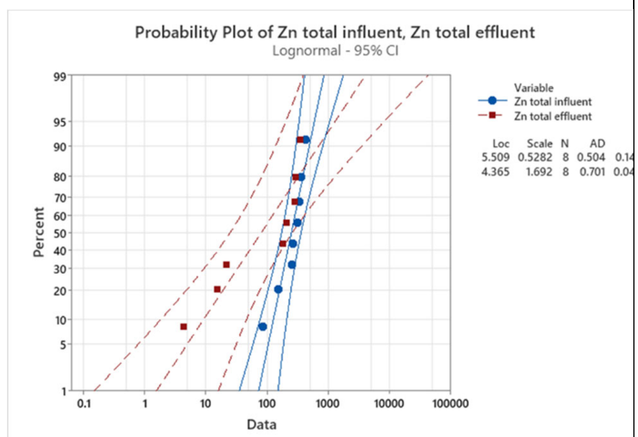
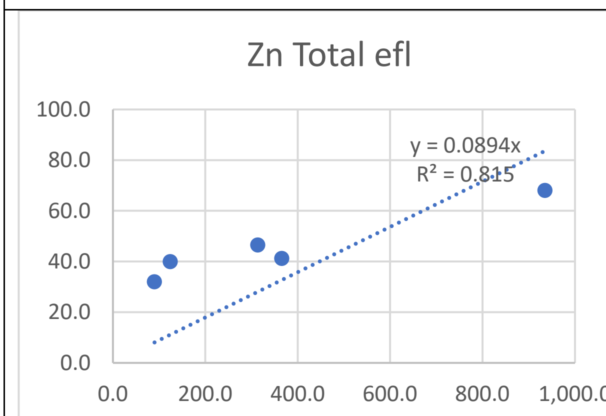
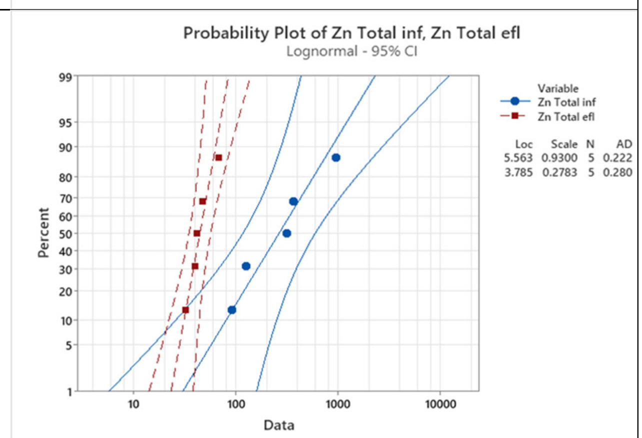
Media Filters



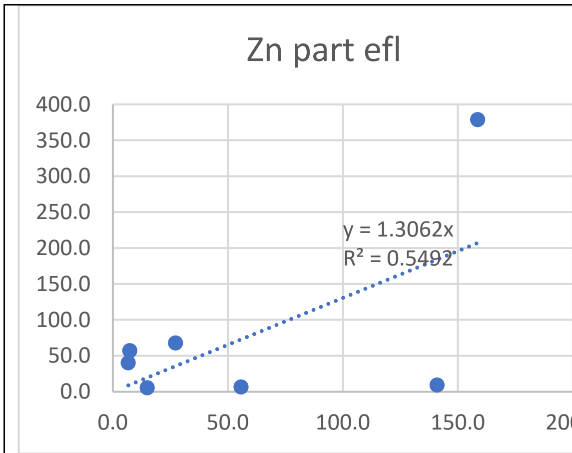
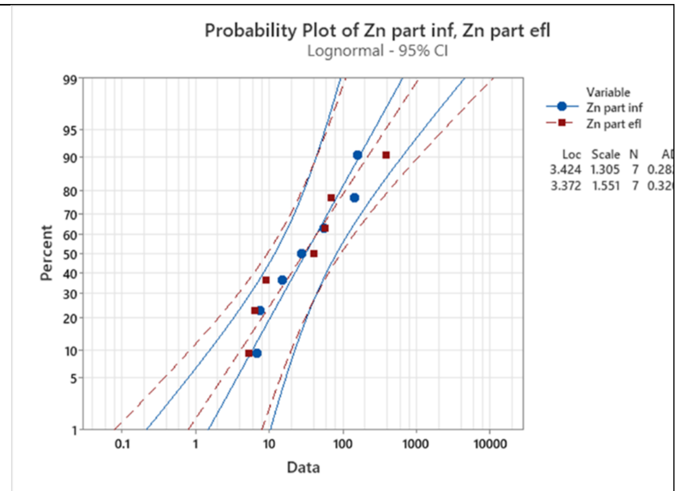
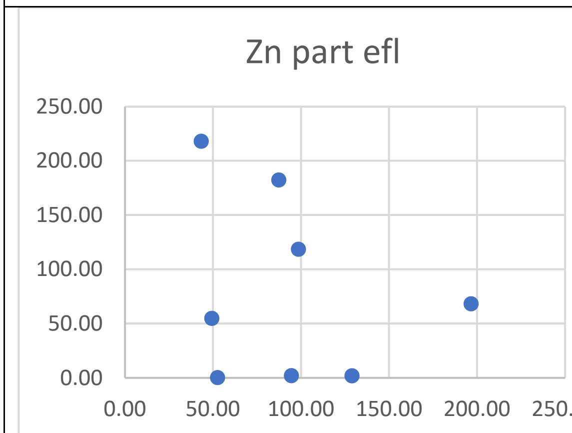
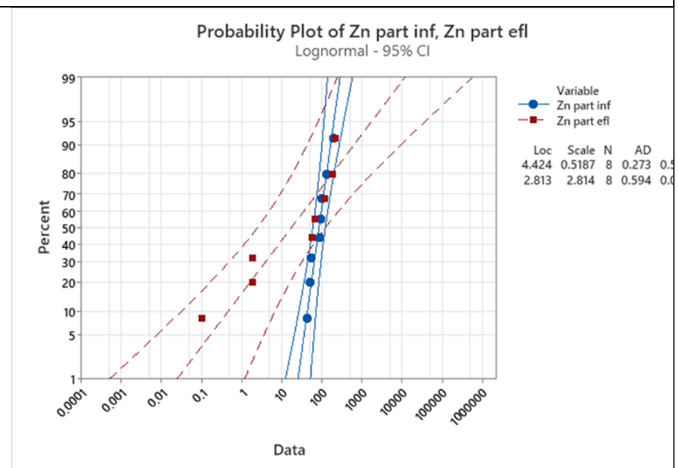
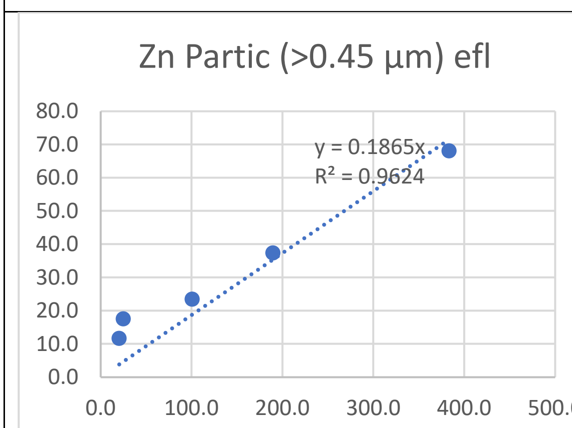
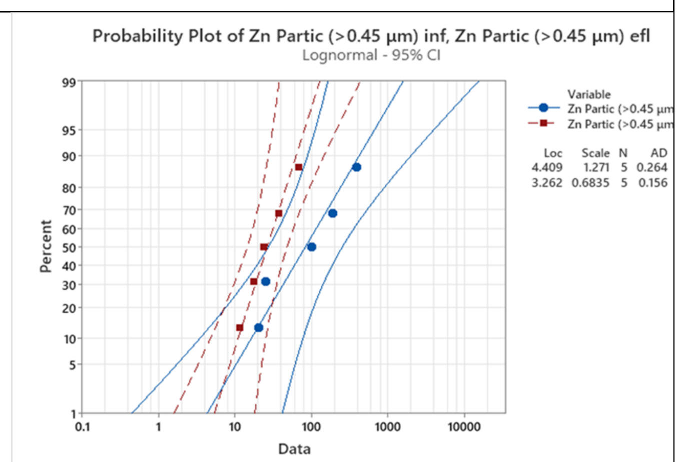
Biofilters and bioswales

Zinc

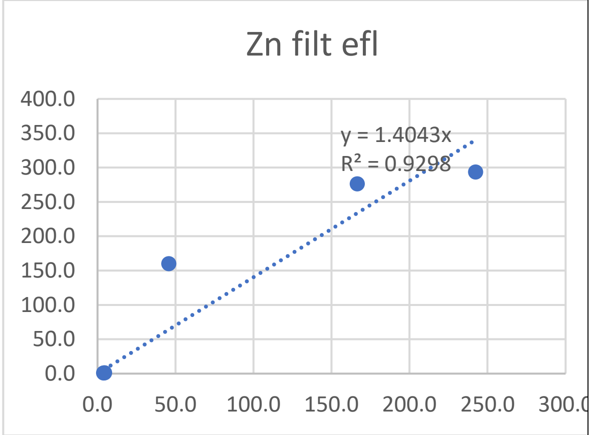
Zinc, Total

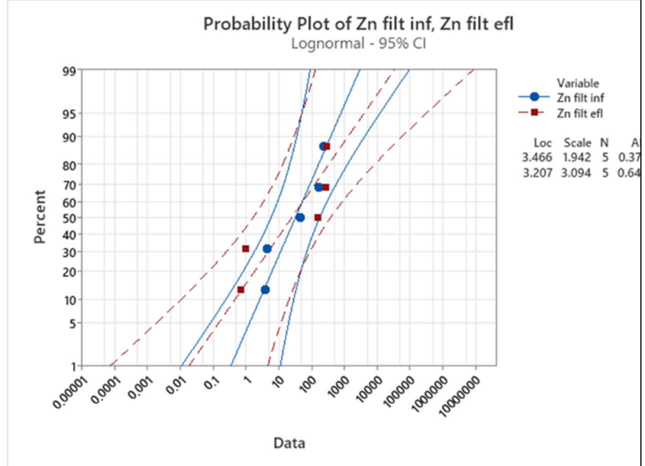
 Sedimentation	
 Media Filters	
 Biofilters and bioswales	

Zinc, Particulate (>0.45 µm)

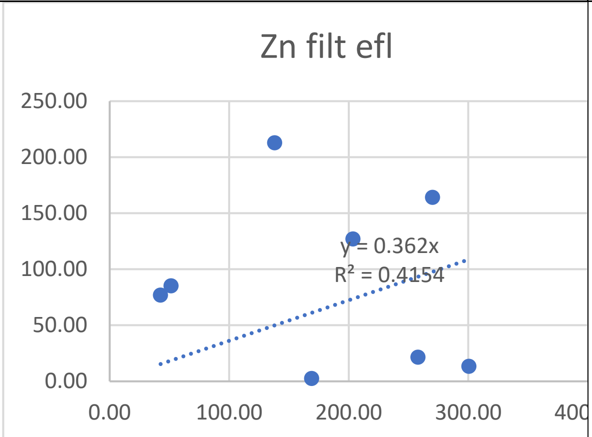
 Sedimentation	
 Media Filters	
 Biofilters and bioswales	

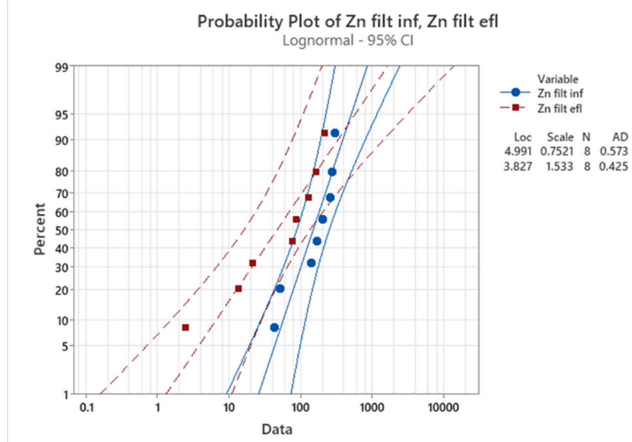
Zinc, Filtered (<0.45 µm)



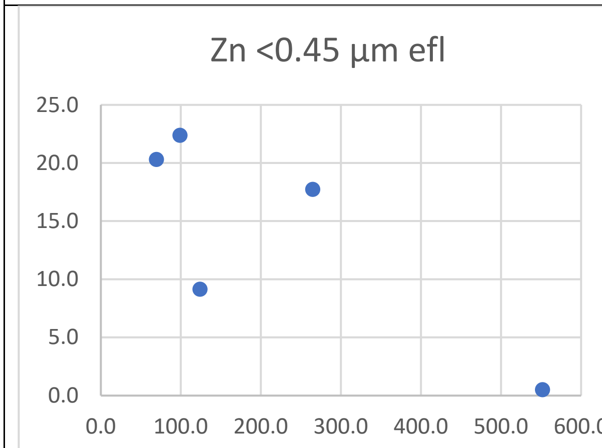


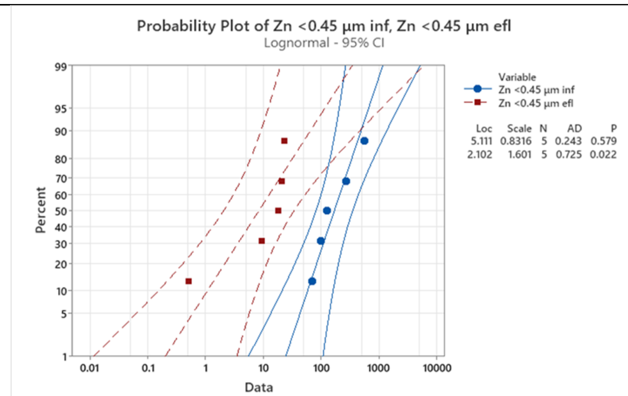
Sedimentation





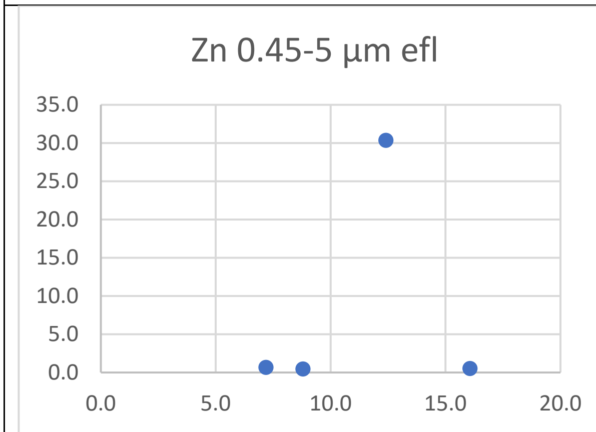
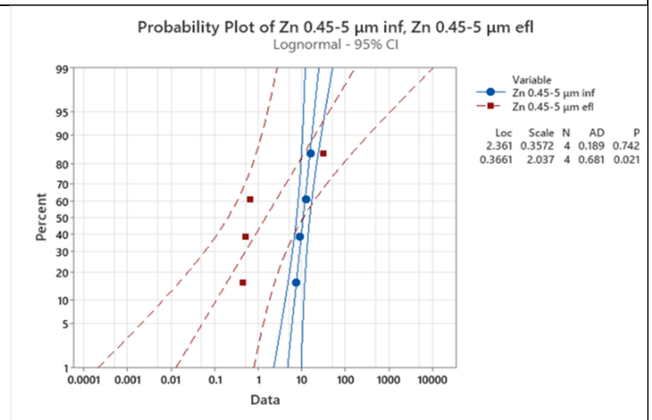
Media Filters



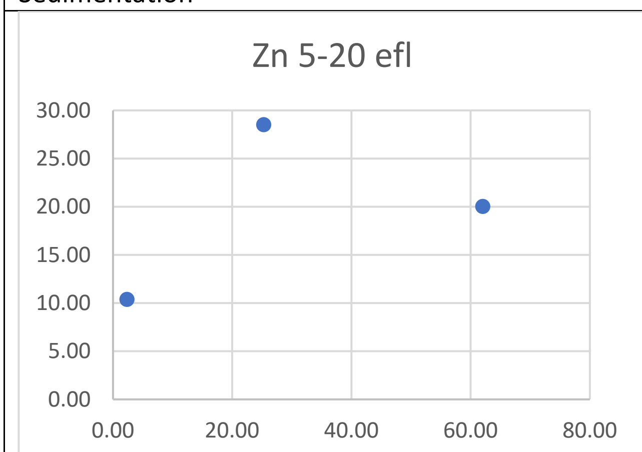
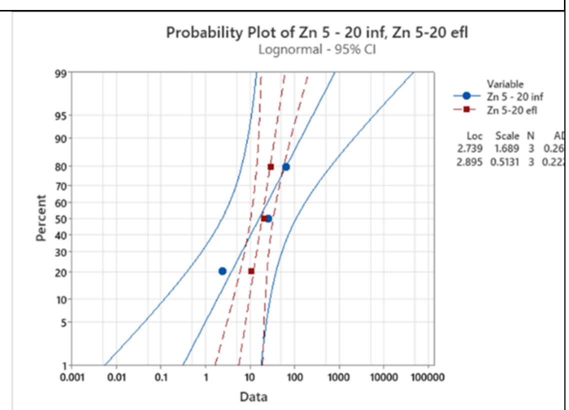


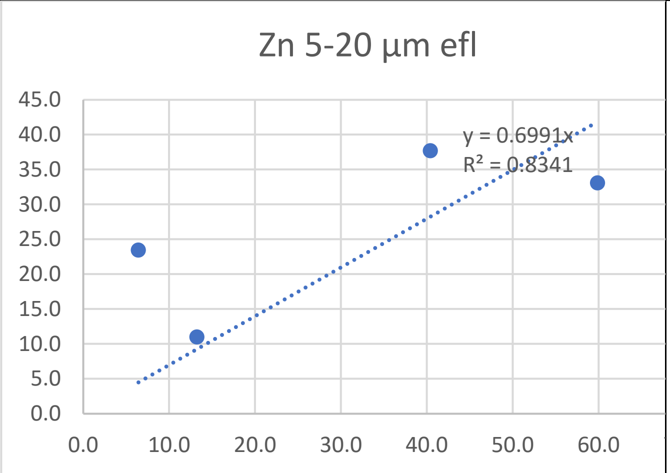
Biofilters and bioswales

Zinc 0.45 to 5 µm

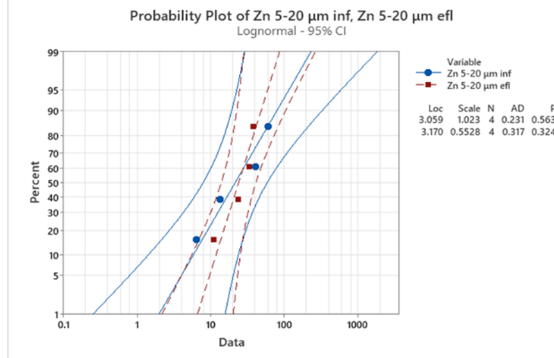
n/a Sedimentation	
n/a Media Filters	
 Biofilters and bioswales	

Zinc 5 to 20 µm

n/a Sedimentation	
 Media Filters	

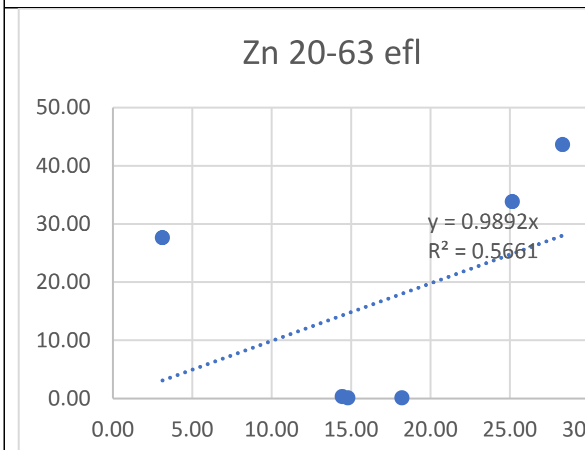


Biofilters and bioswales

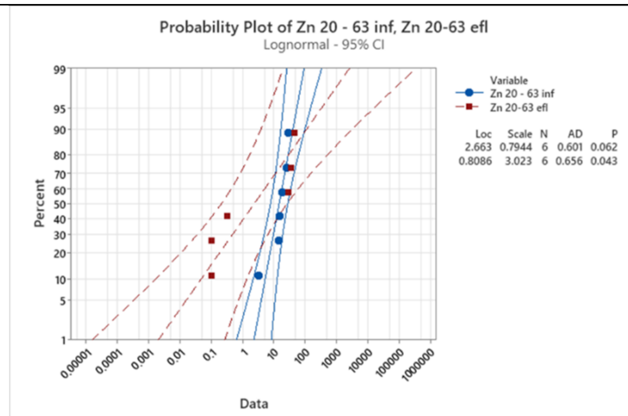


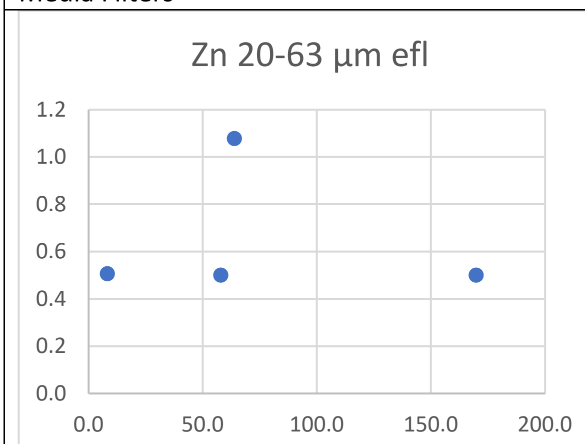
Zinc 20 to 63 µm

n/a
Sedimentation

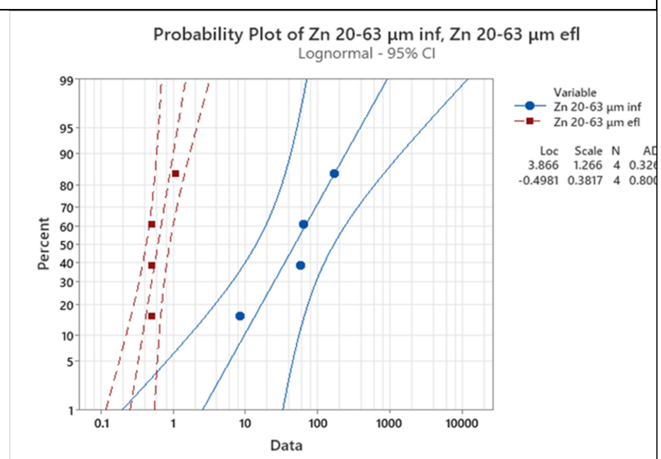


Media Filters

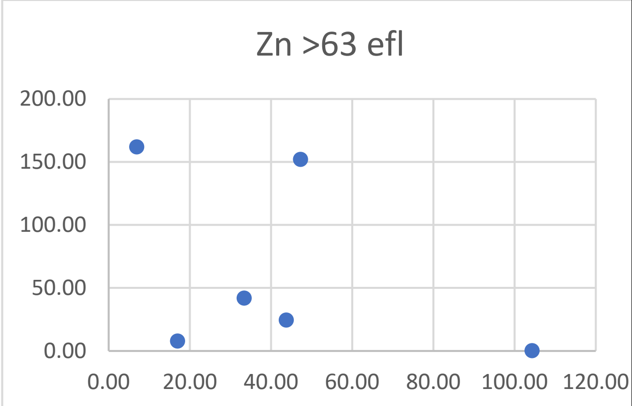
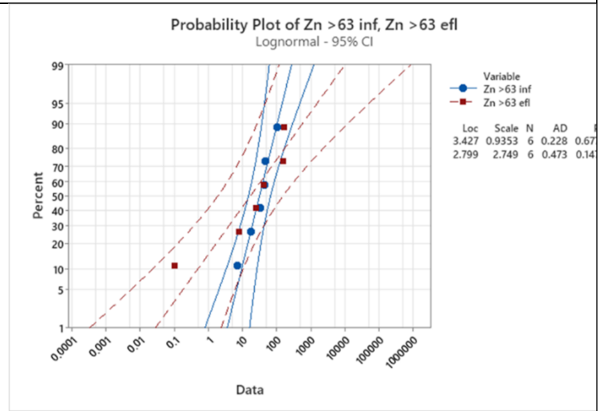
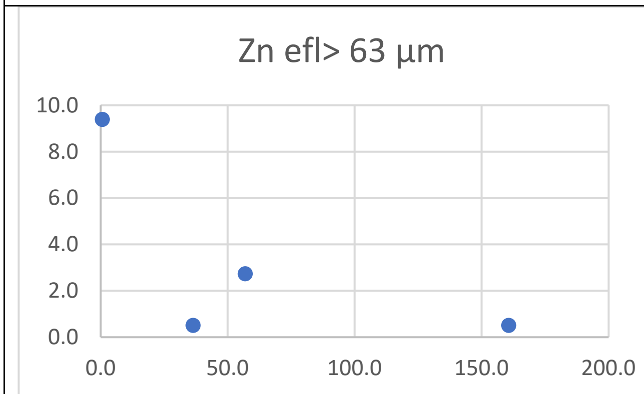
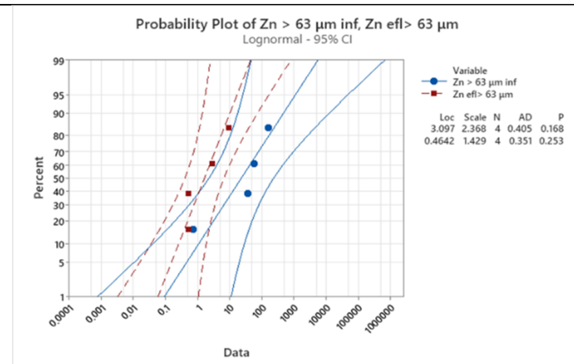




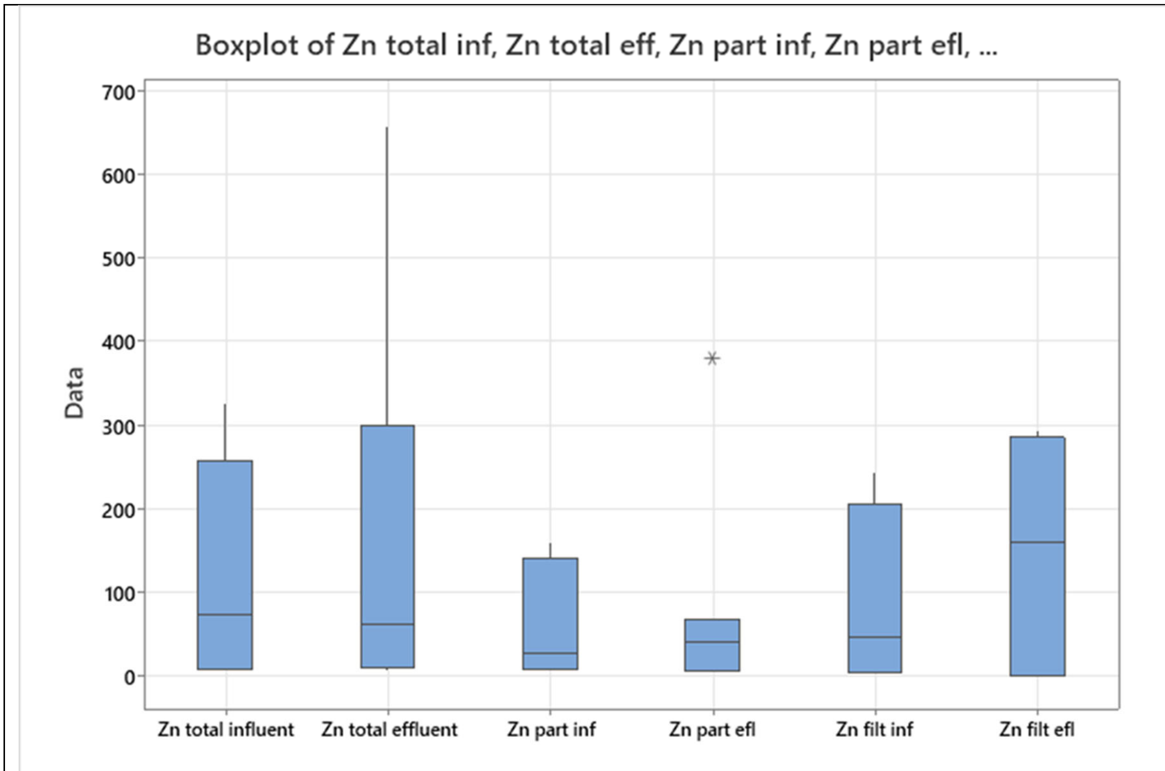
Biofilters and bioswales



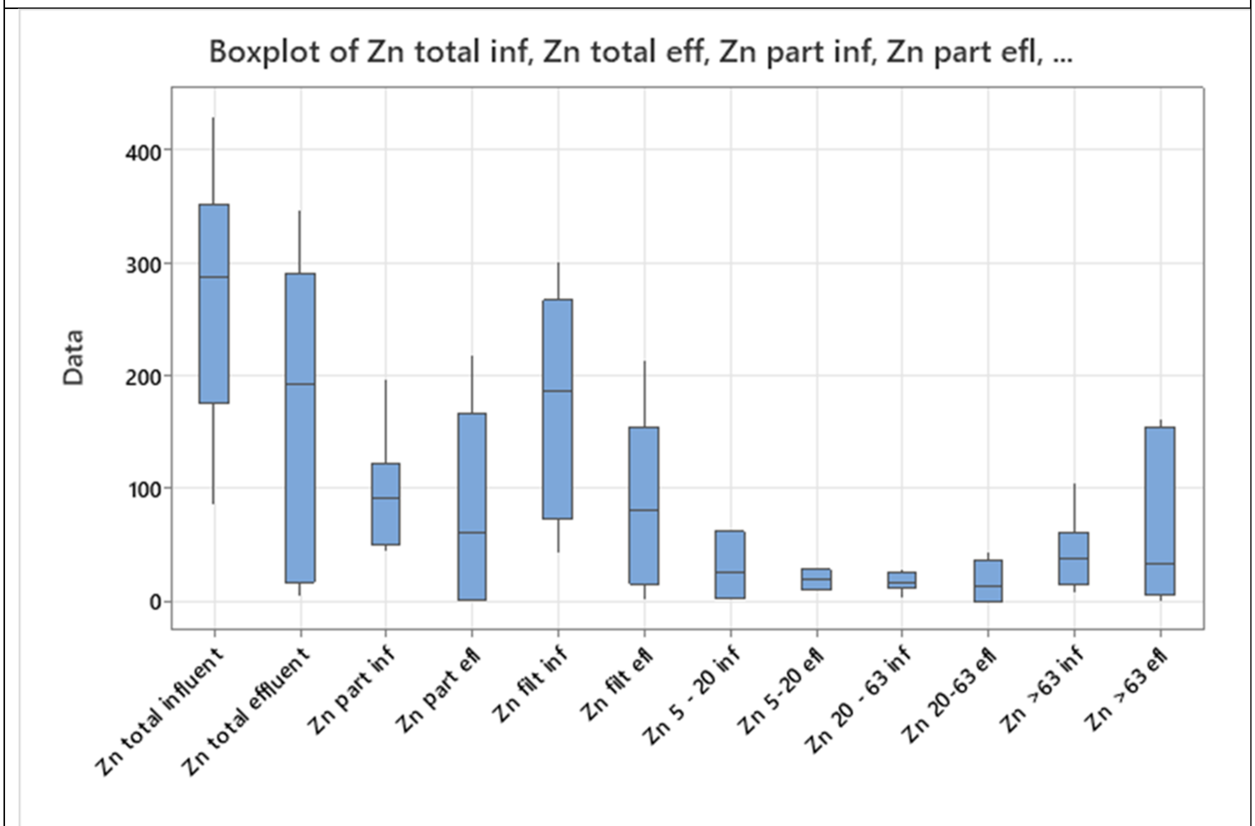
Zinc >63 µm

n/a Sedimentation	
 Media Filters	
 Biofilters and bioswales	

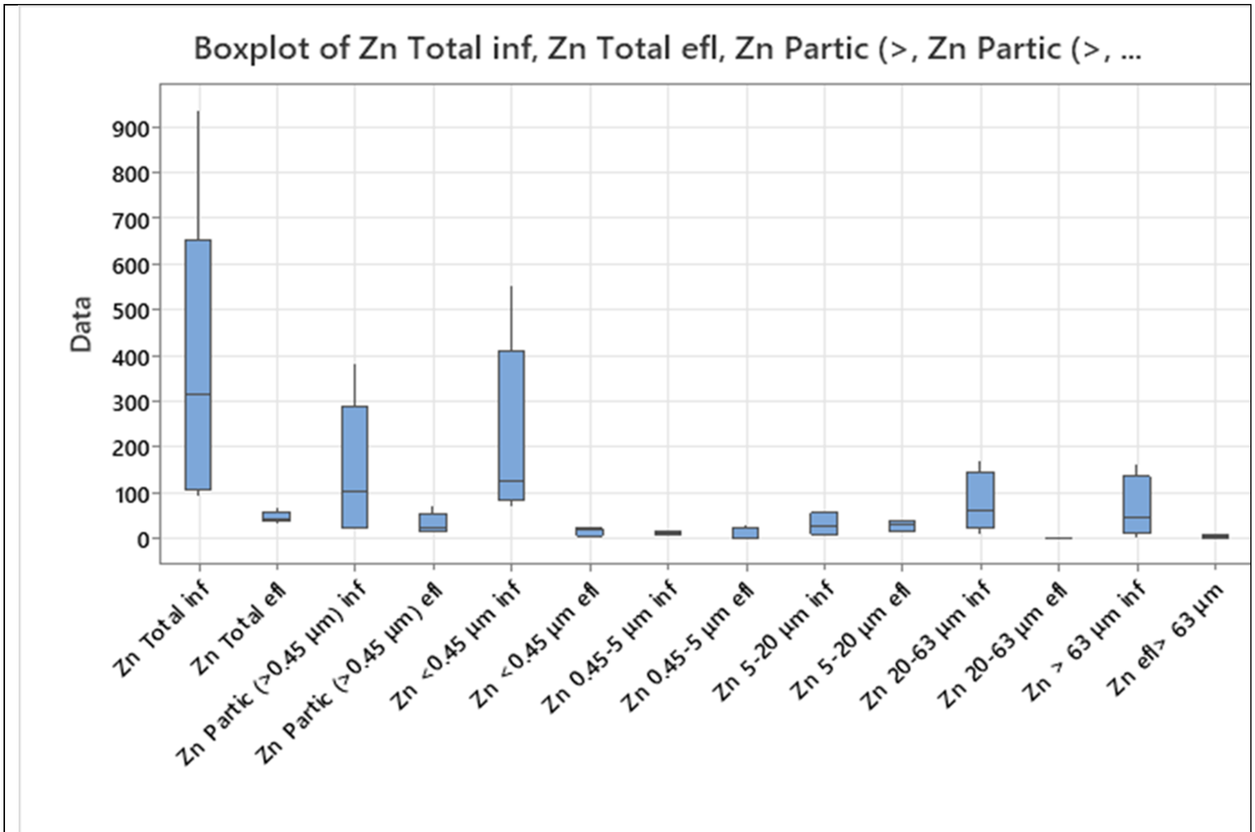
Zinc box and whisker plots



Sedimentation



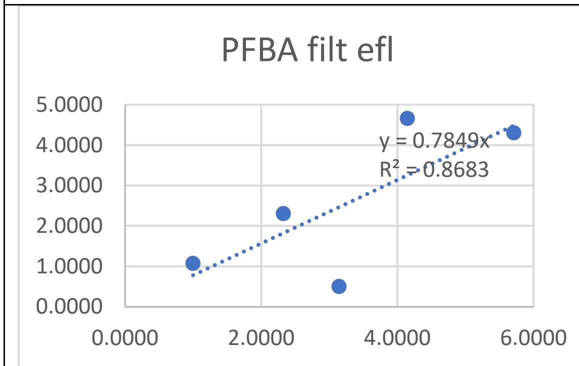
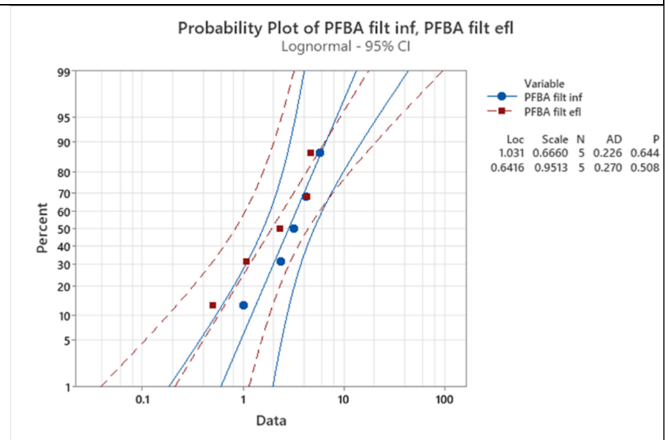
Media Filters



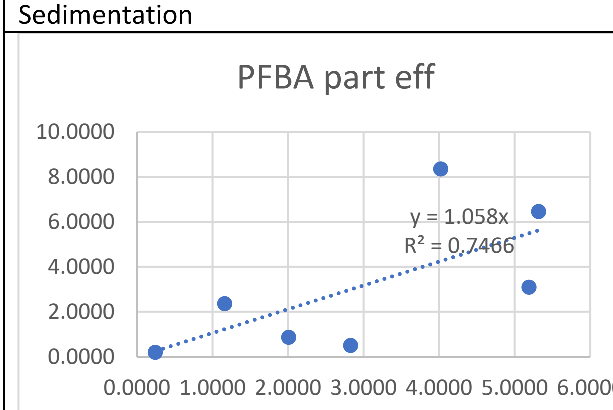
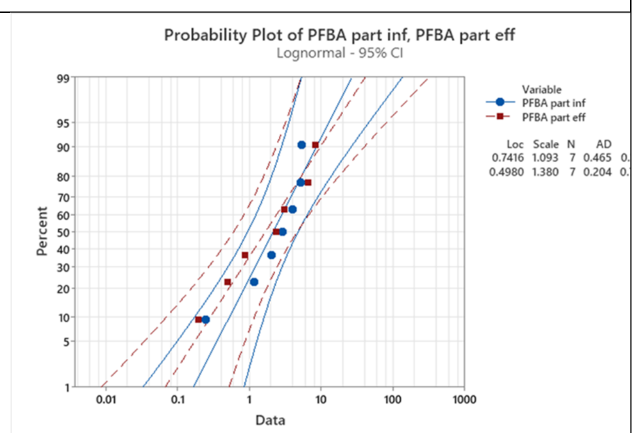
Biofilters and bioswales

Appendix G: PFAS Compounds

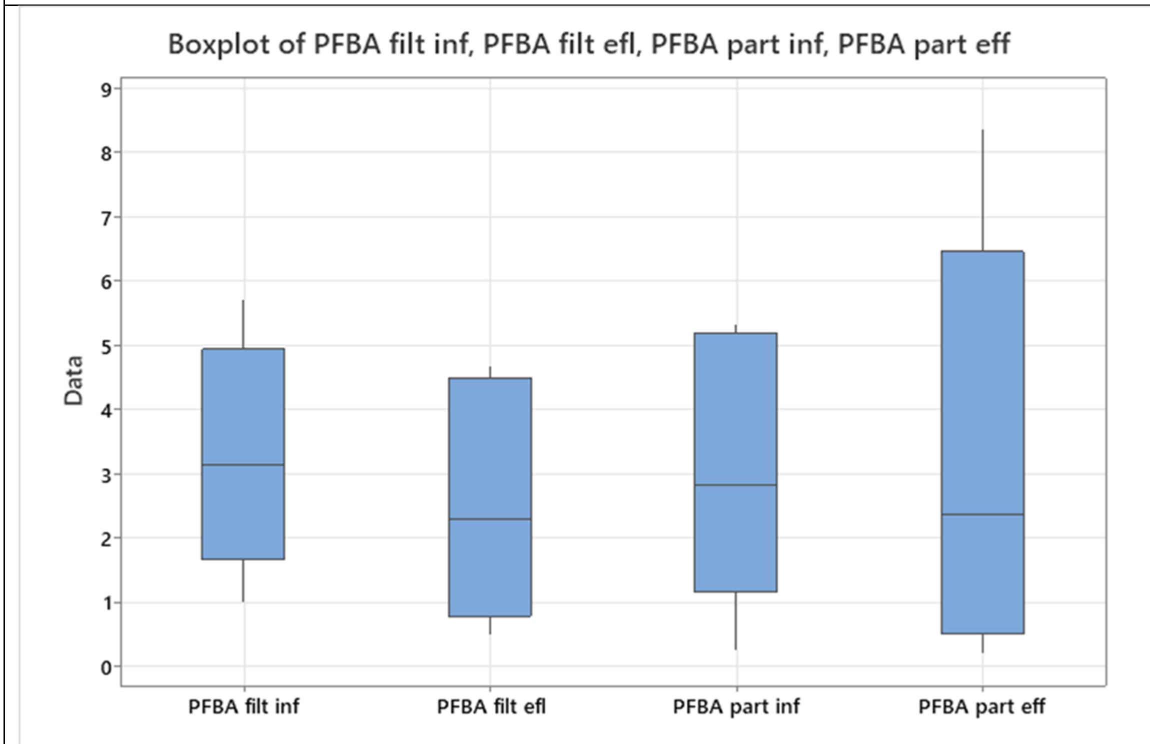
PFBA filtered (<0.45 µm)

n/a Sedimentation	
 Media Filters	
n/a Biofilters and bioswales	

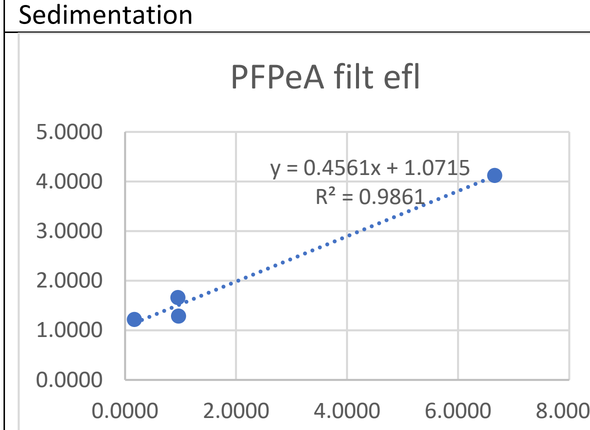
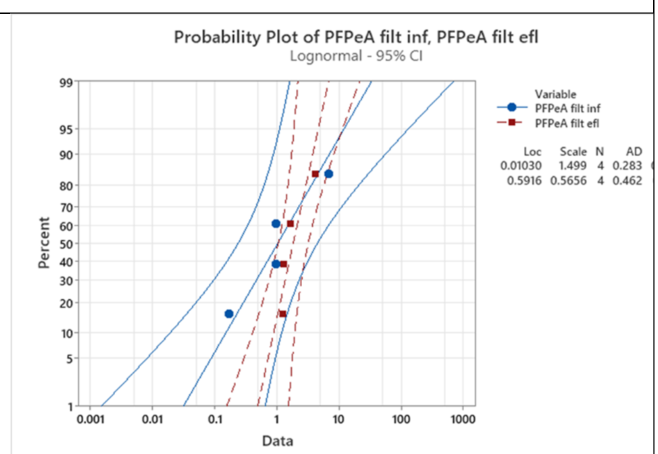
PFBA particulate (>0.45 µm)

n/a Sedimentation	
 Media Filters	
n/a Biofilters and bioswales	

PFBA box and whisker plots

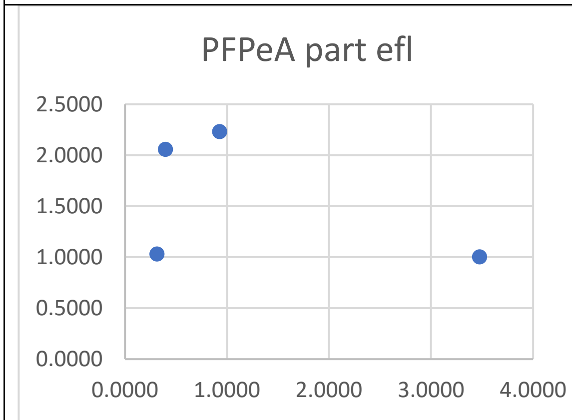
n/a Sedimentation
 Media Filters
n/a Biofilters and bioswales

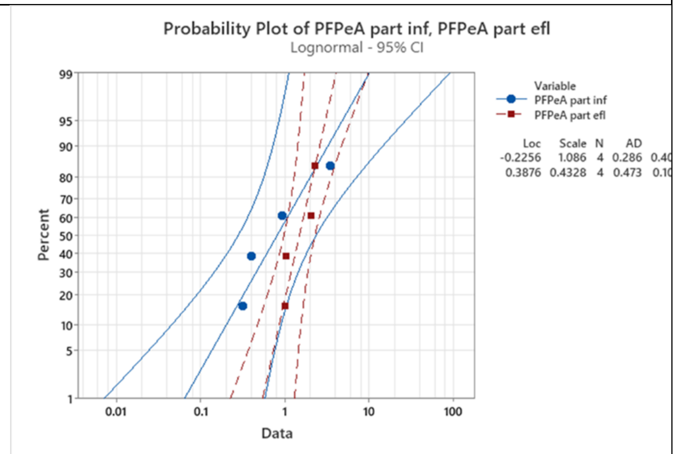
PFPeA filtered (<0.45 µm)

n/a Sedimentation	
 Media Filters	
n/a Biofilters and bioswales	

PFPeA particulate (>0.45 µm)

n/a
Sedimentation



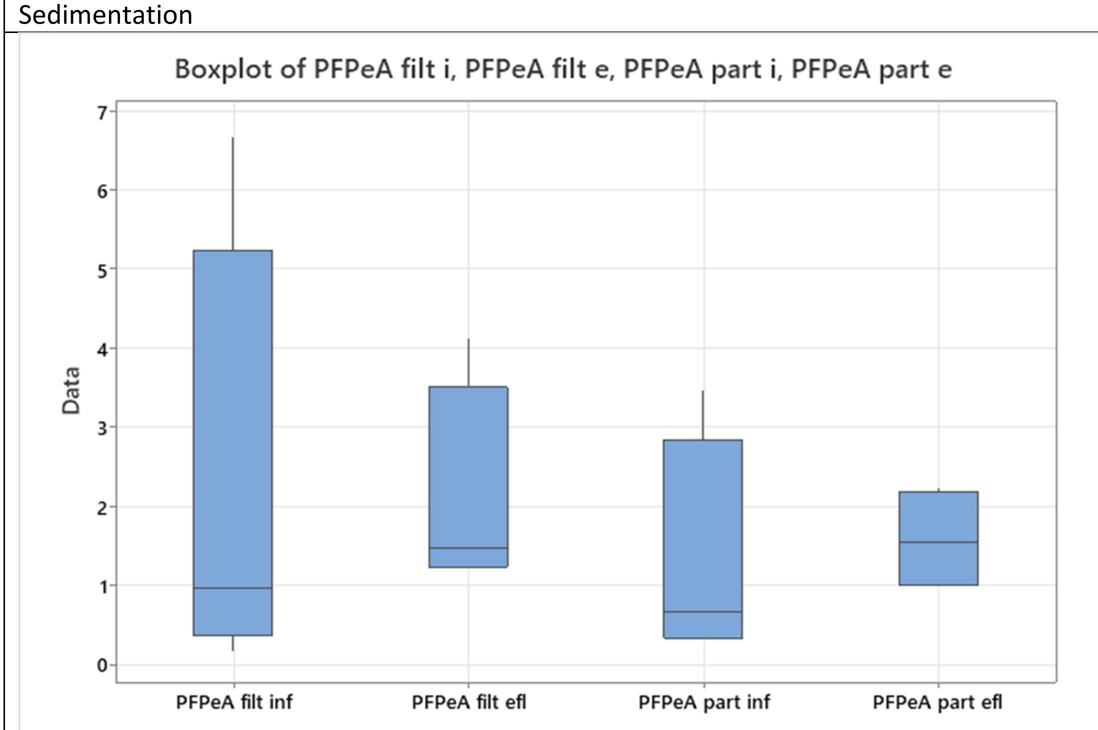


Media Filters

n/a
Biofilters and bioswales

PFPeA box and whisker plots

n/a
Sedimentation



Media Filters

n/a
Biofilters and bioswales

PFHxA filtered (<0.45 µm)

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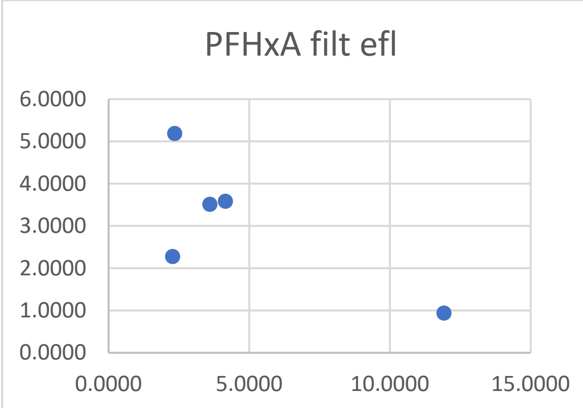
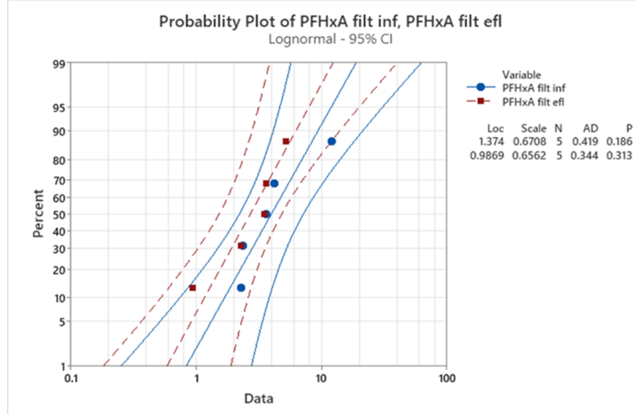
Sedimentation</td><td></td></tr>
<tr><td>

Media Filters</td><td>
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<tr><td>n/a
Biofilters and bioswales</td><td></td></tr>
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PFHxA particulate (>0.45 µm)

<table>
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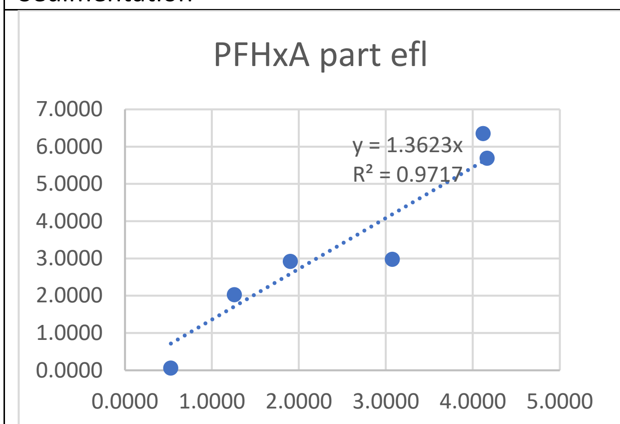
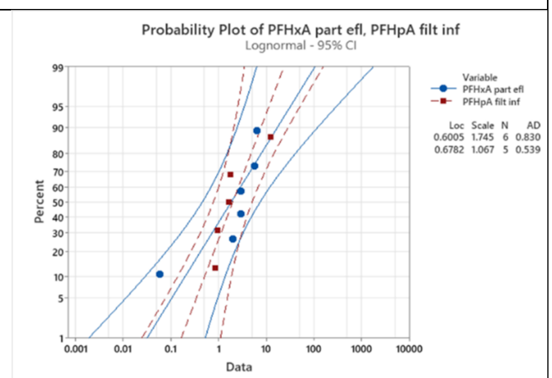
Sedimentation</td><td></td></tr>
<tr><td>

Media Filters</td><td>
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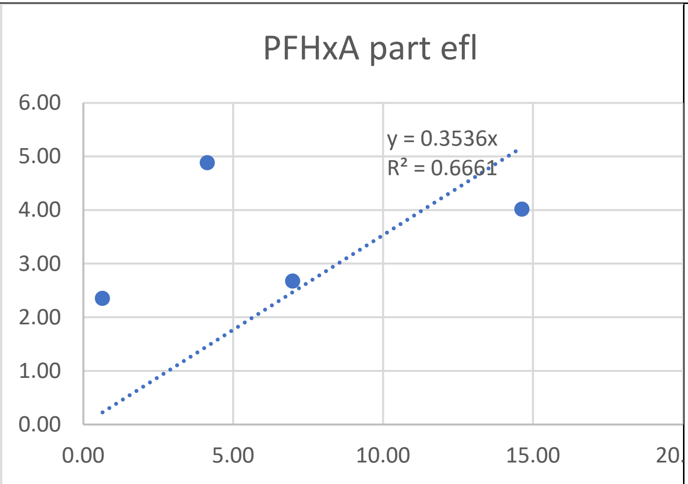
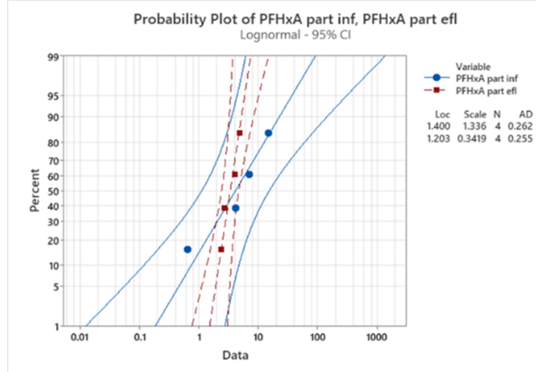


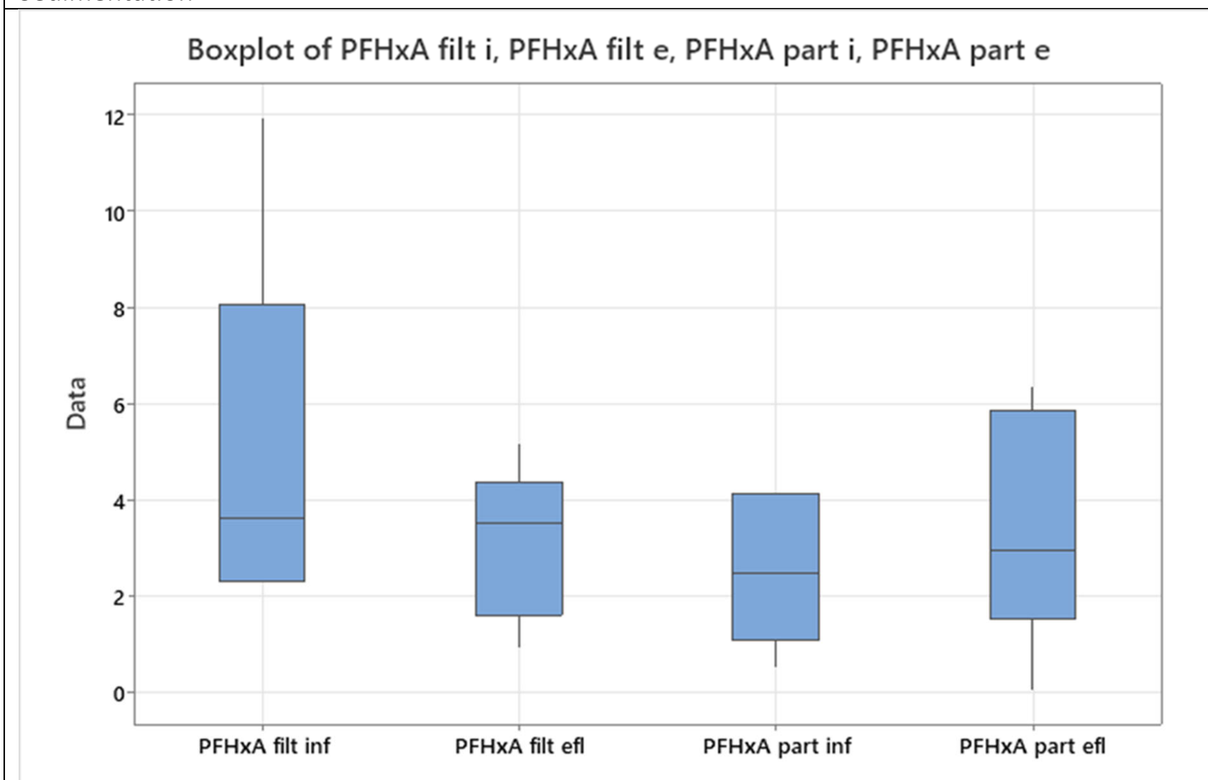


Biofilters and bioswales

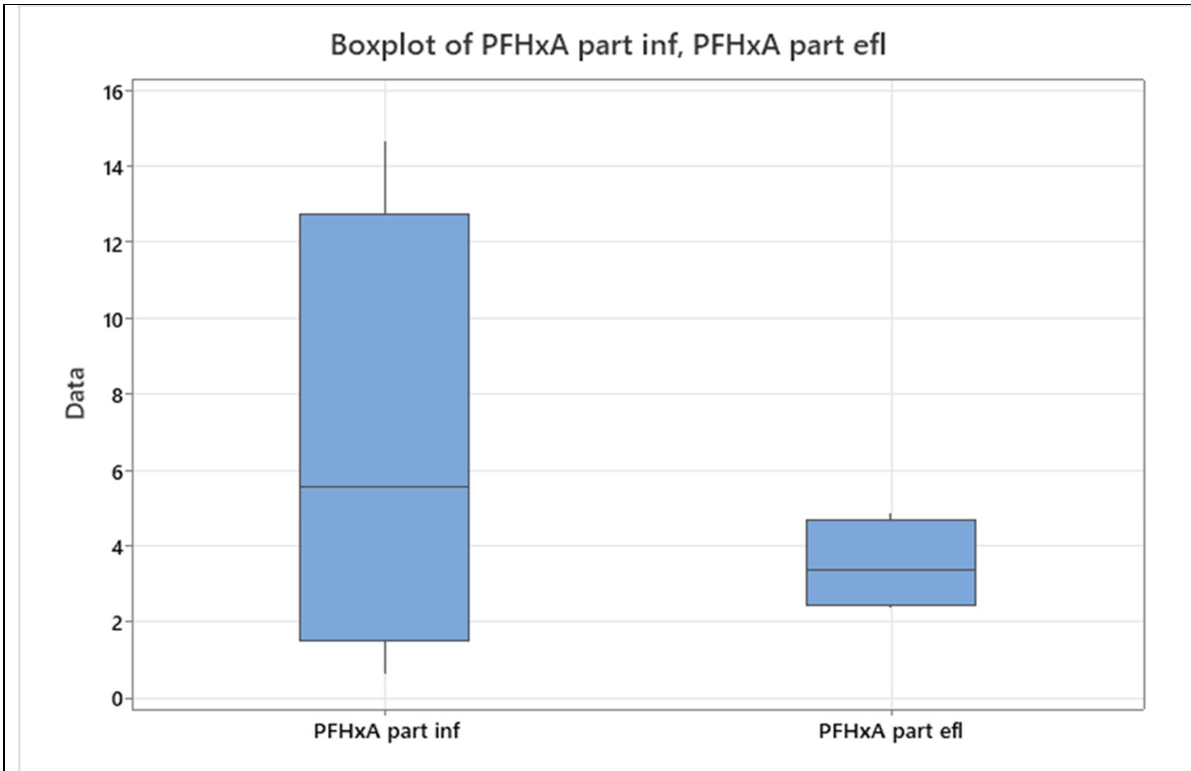
PFHxA box and whisker plots

n/a

Sedimentation



Media Filters

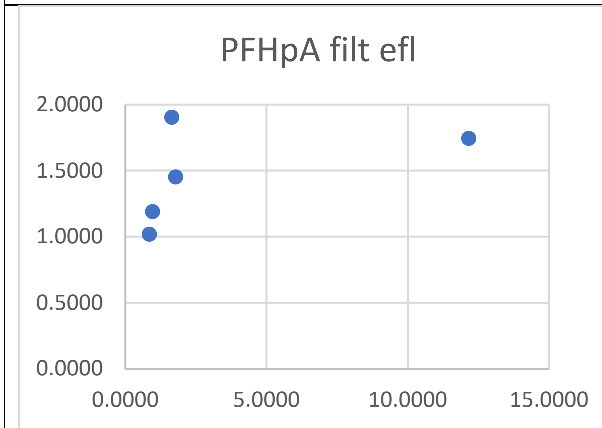


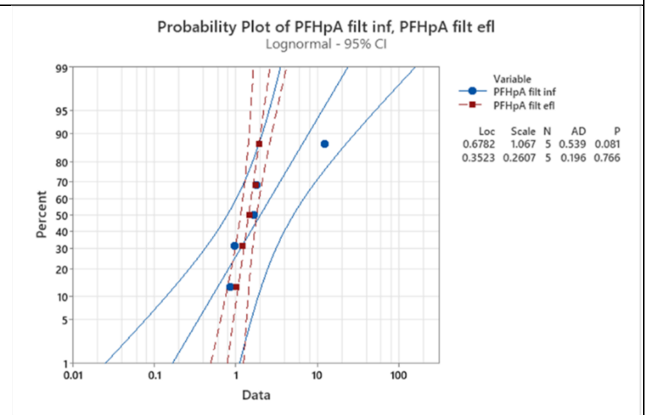
Biofilters and bioswales

PFHpA filtered (<0.45 µm)

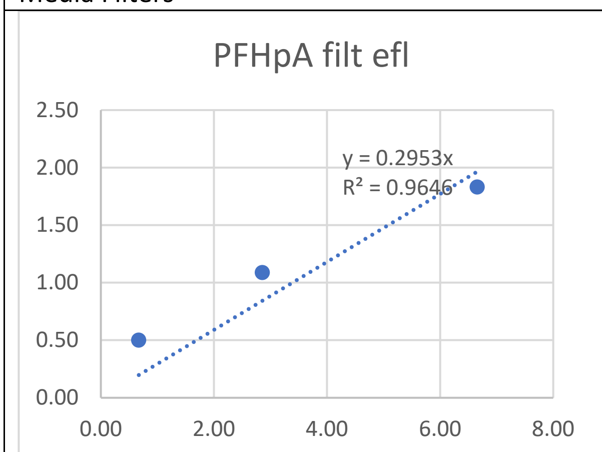
n/a

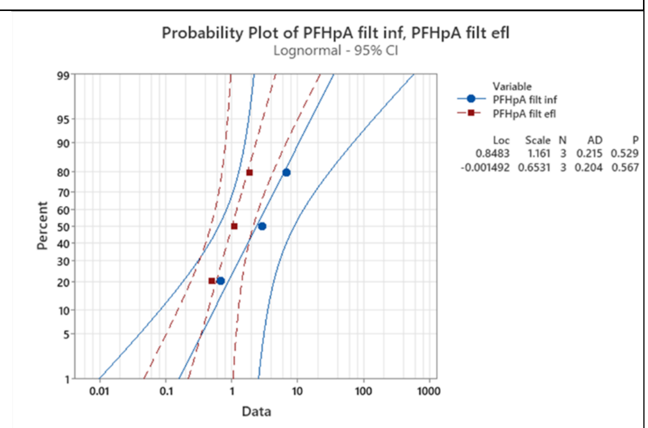
Sedimentation





Media Filters



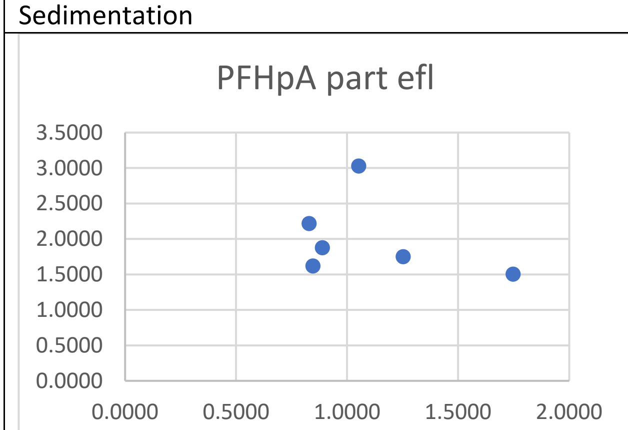


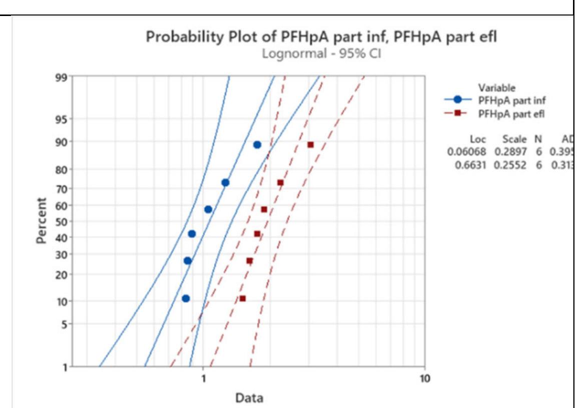
Biofilters and bioswales

PFHpA particulate (>0.45 µm)

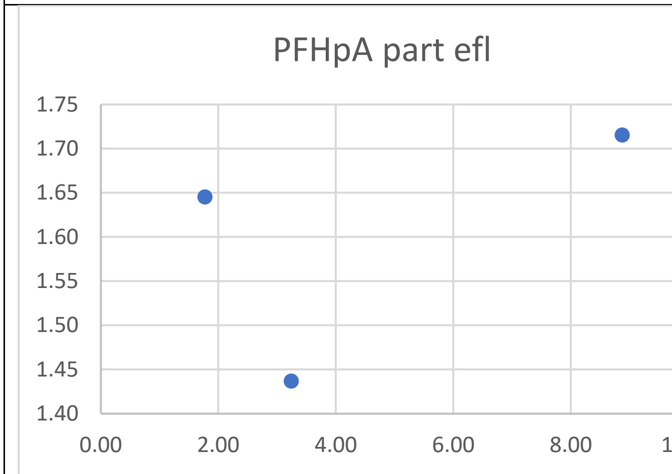
n/a

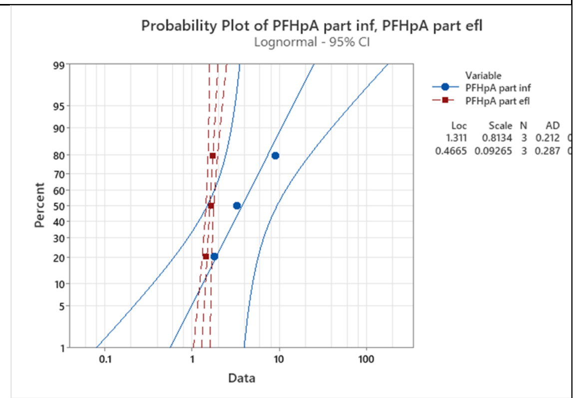
Sedimentation





Media Filters



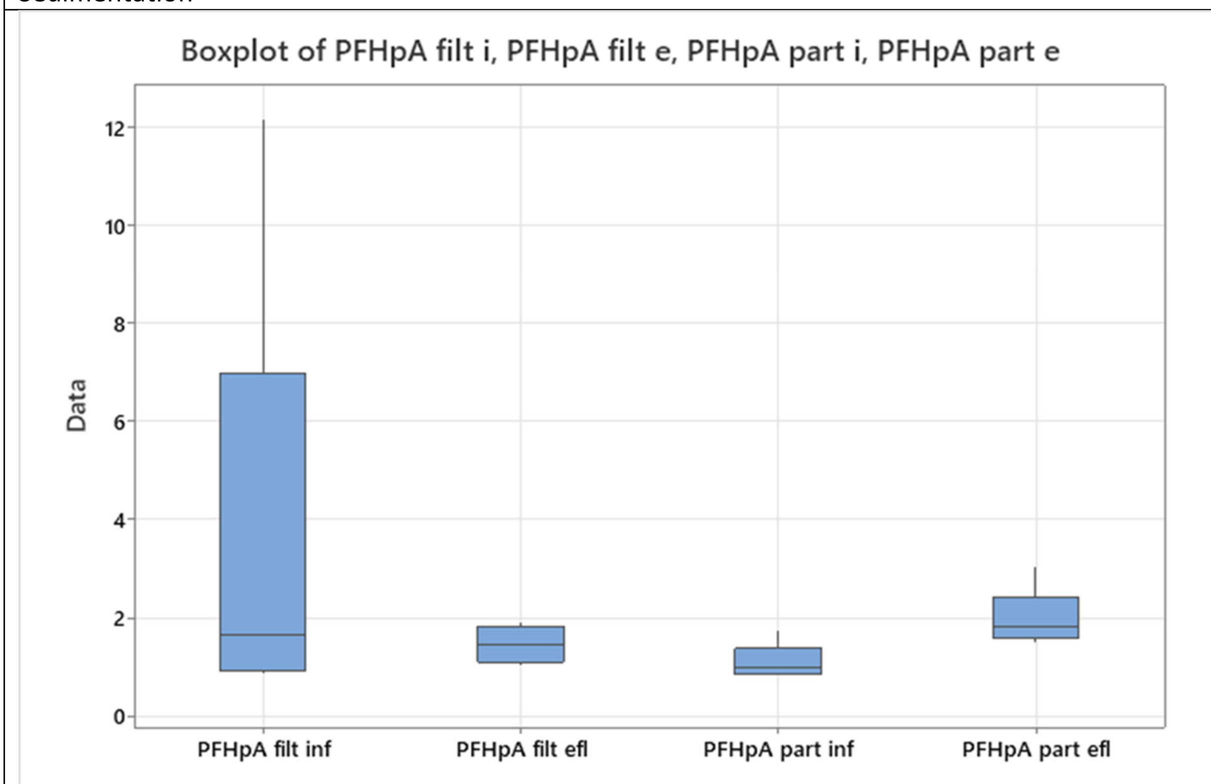


Biofilters and bioswales

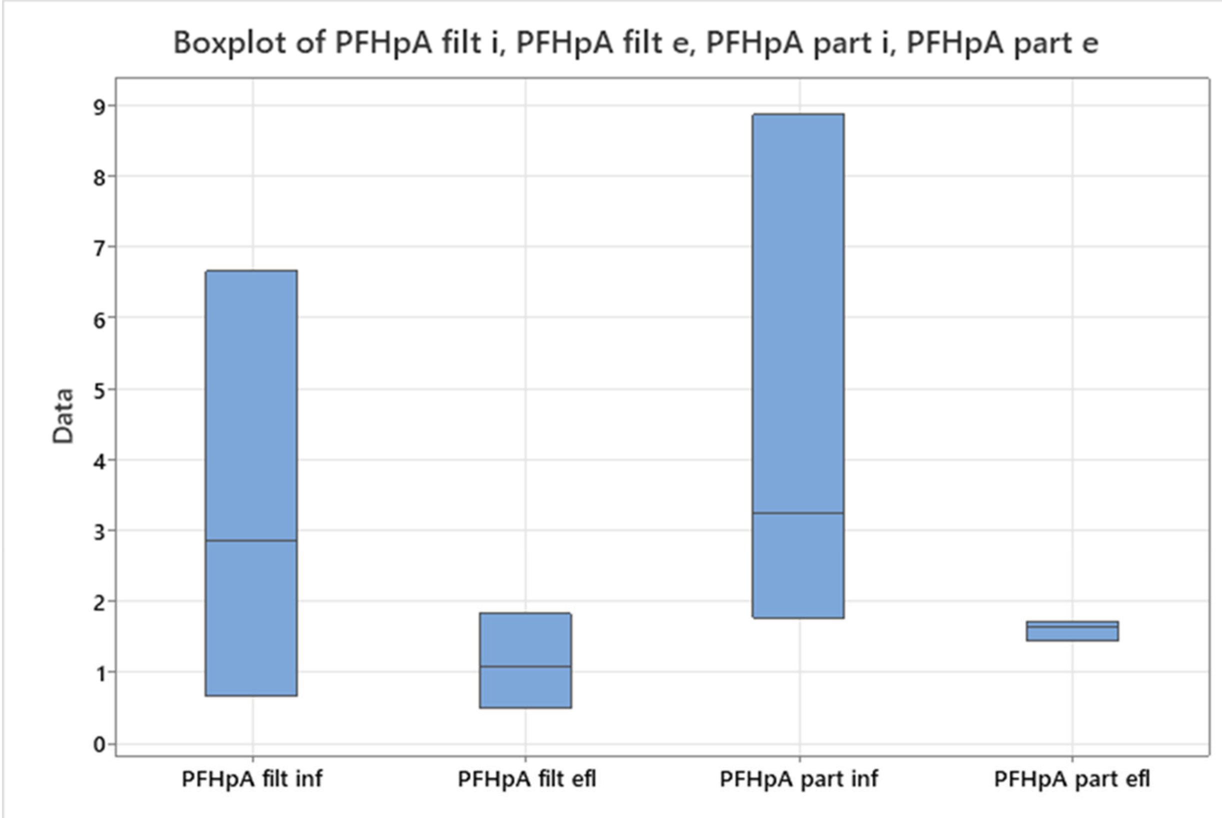
PFHpA box and whisker plots

n/a

Sedimentation



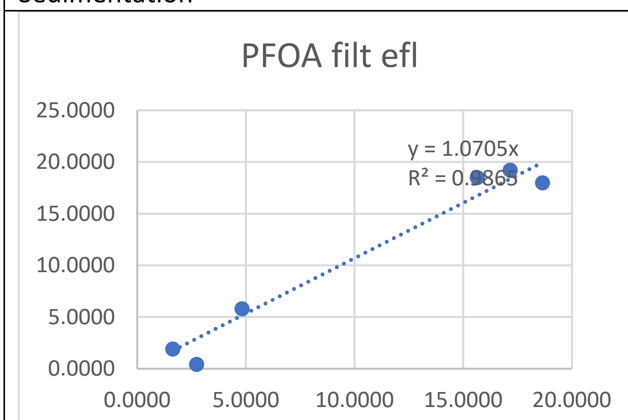
Media Filters

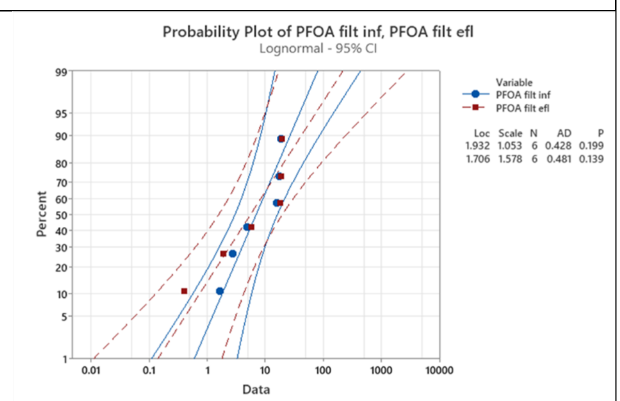


Biofilters and bioswales

PFOA filtered (<0.45 µm)

n/a
Sedimentation





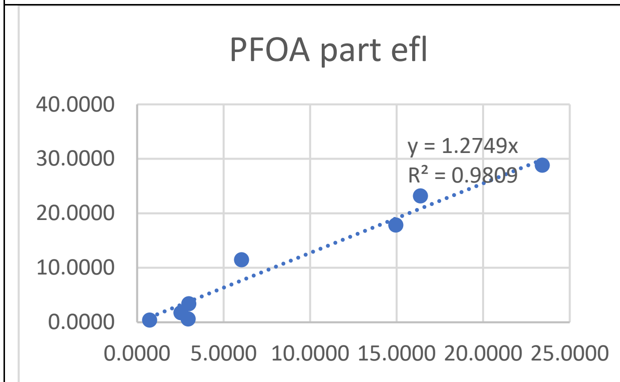
Media Filters

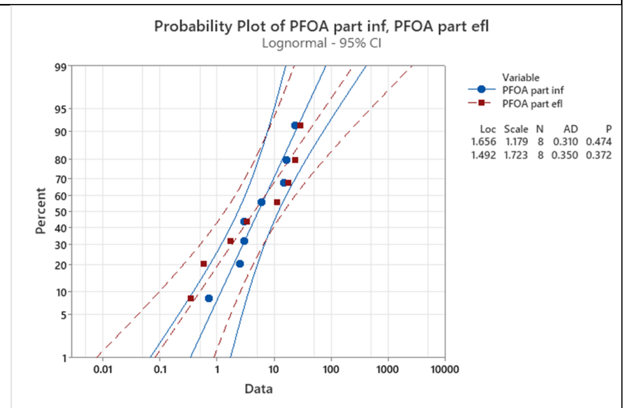
n/a
Biofilters and bioswales

PFOA particulate (>0.45 µm)

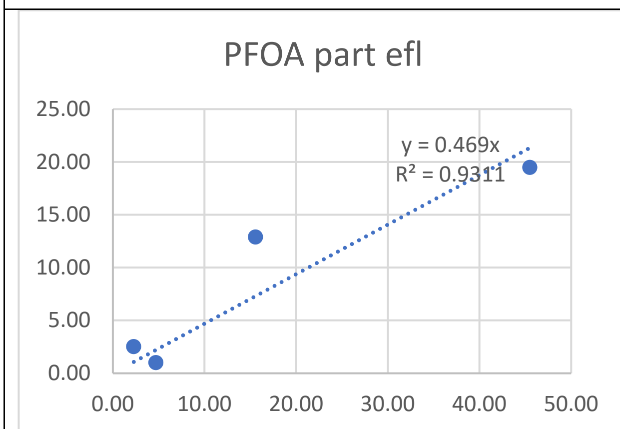
n/a

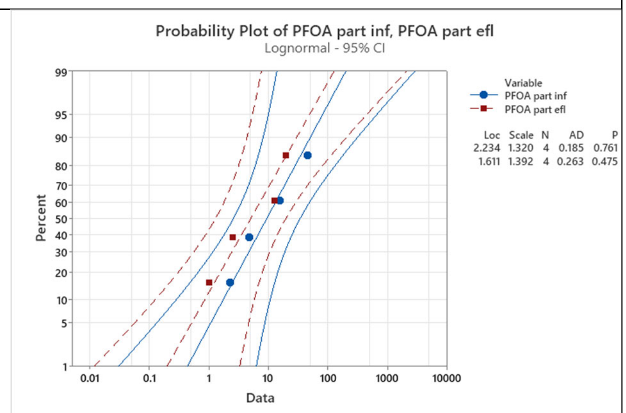
Sedimentation





Media Filters



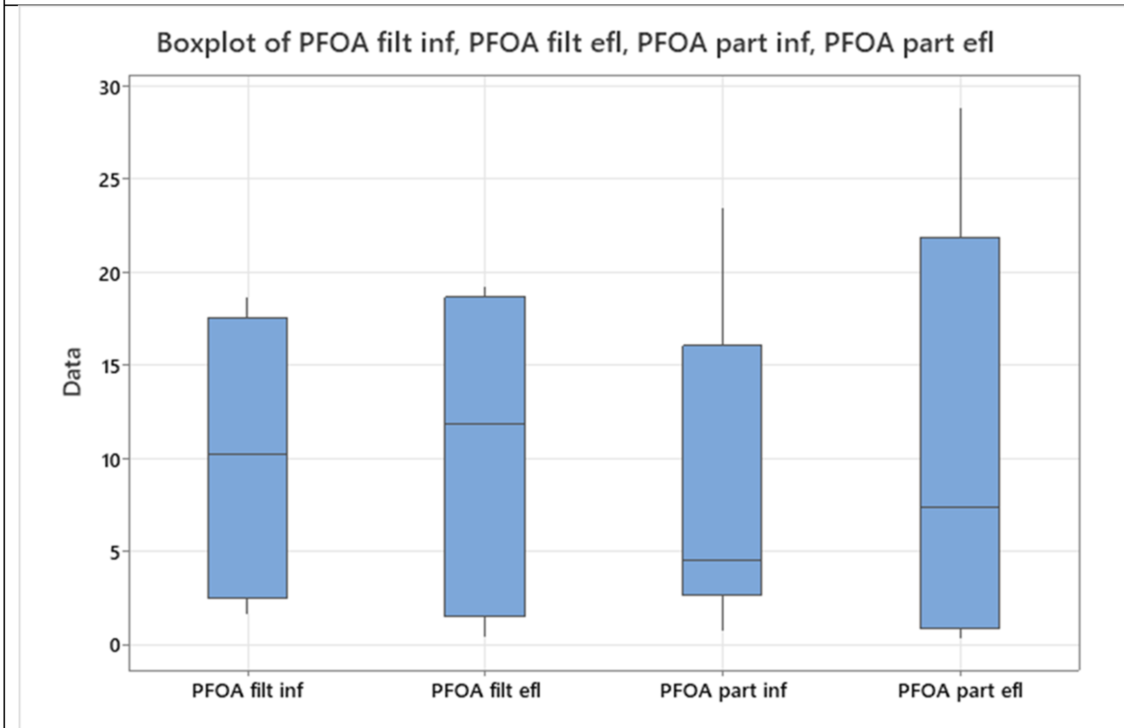


Biofilters and bioswales

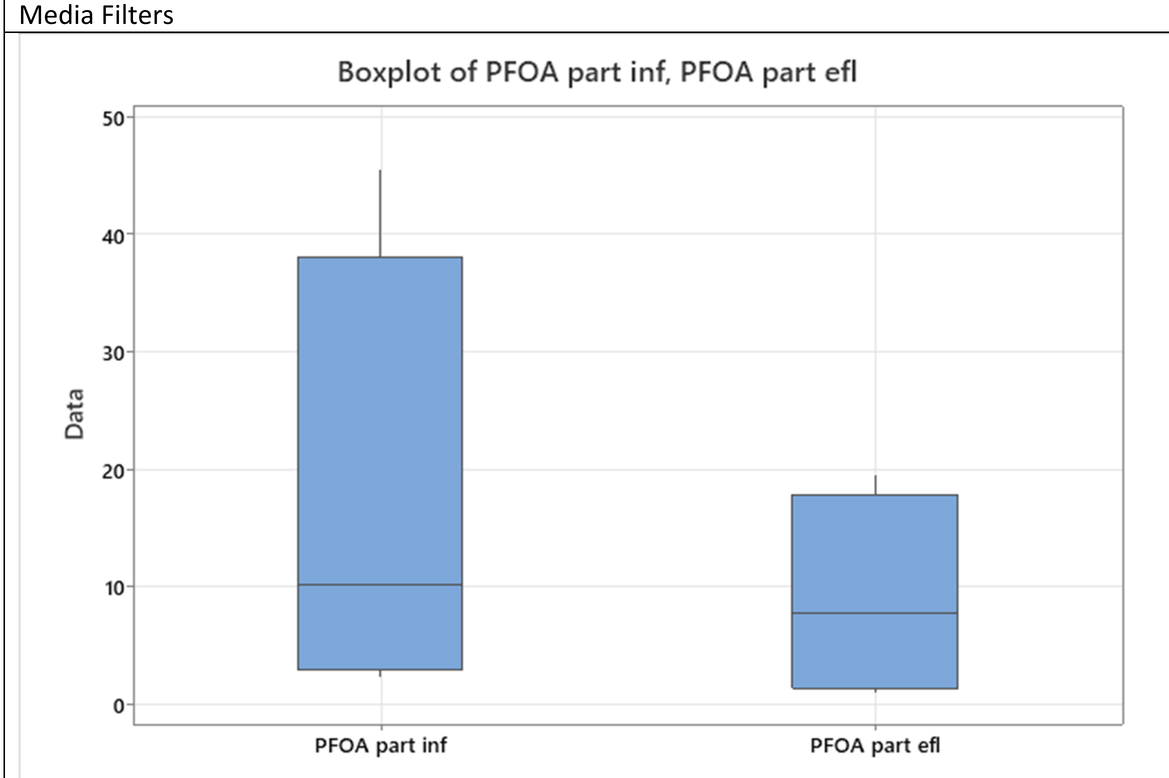
PFOA box and whisker plots

n/a

Sedimentation



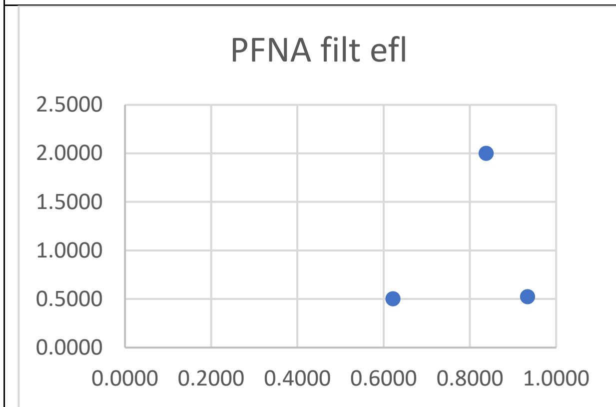
Media Filters

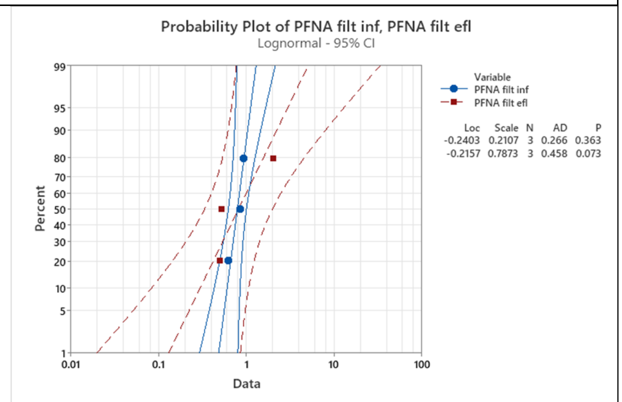


Biofilters and bioswales

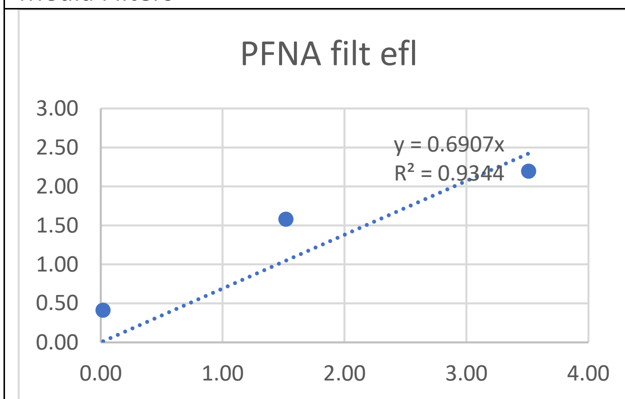
PFNA filtered (<0.45 µm)

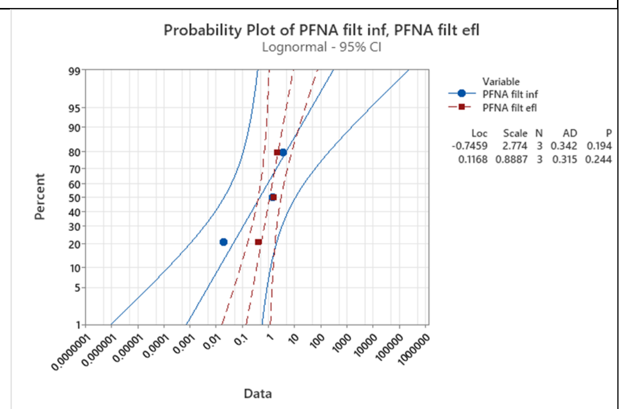
n/a
Sedimentation





Media Filters

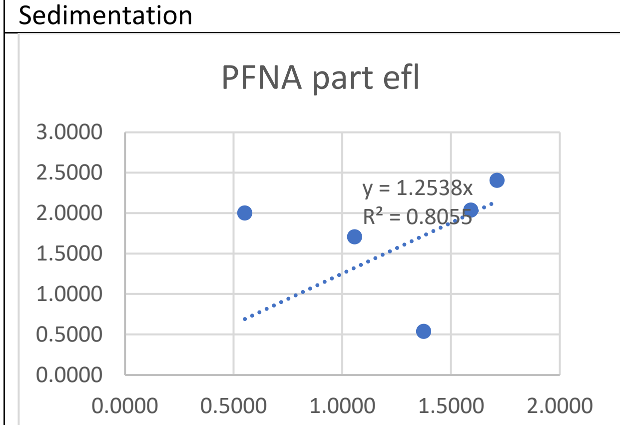


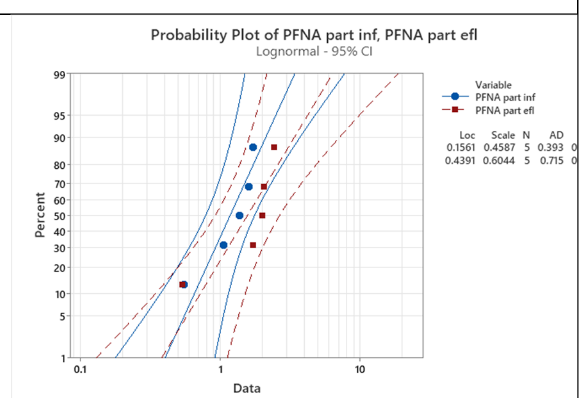


Biofilters and bioswales

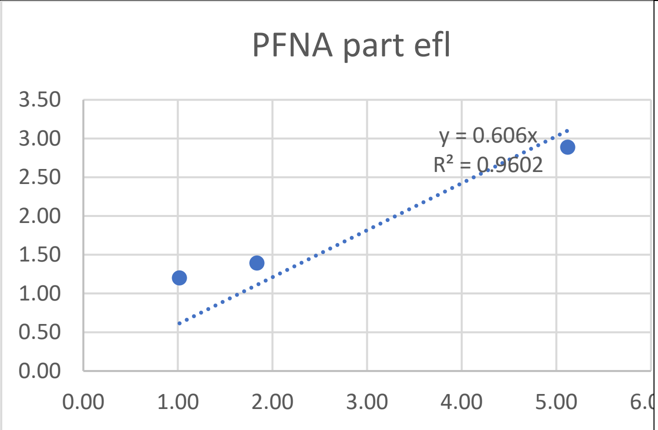
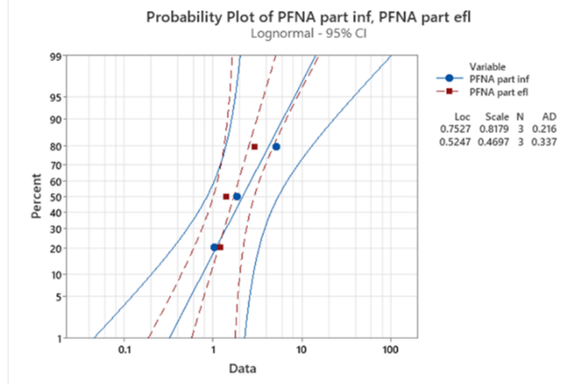
PFNA particulate (>0.45 µm)

n/a
Sedimentation

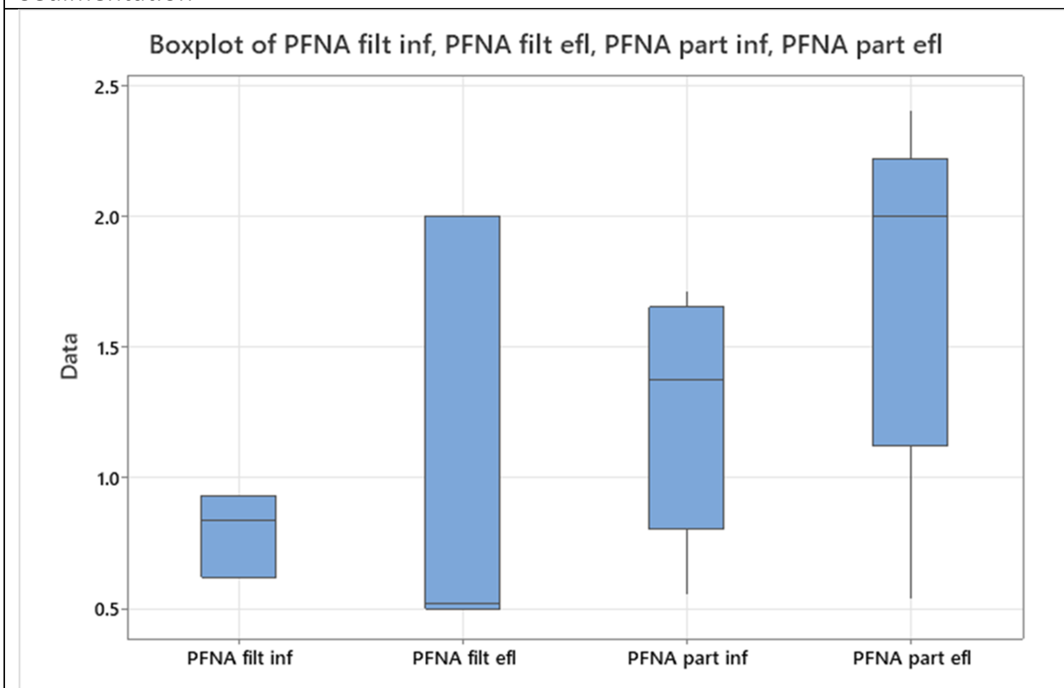


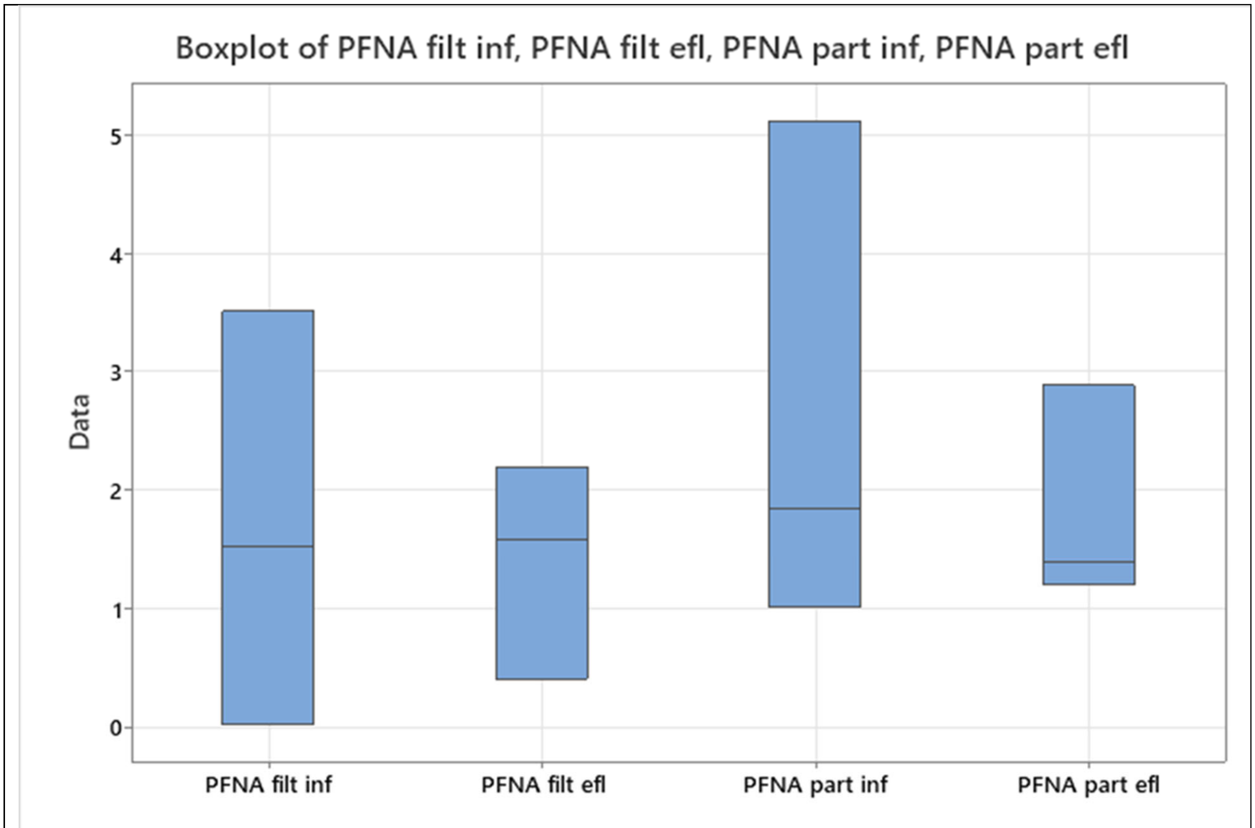


Media Filters

 Biofilters and bioswales	

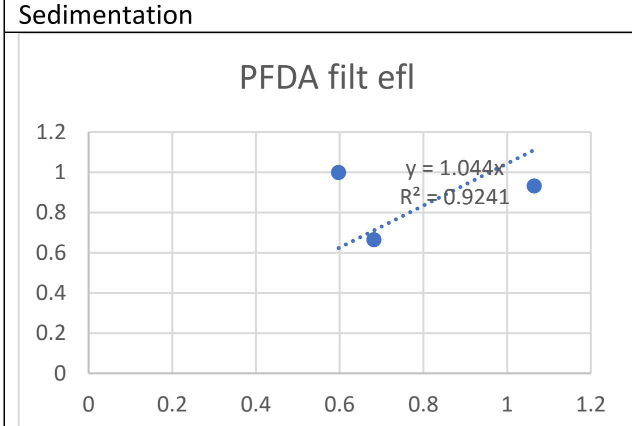
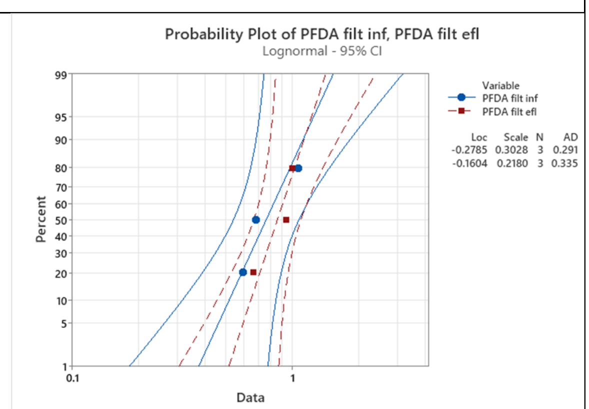
PFNA box and whisker plots

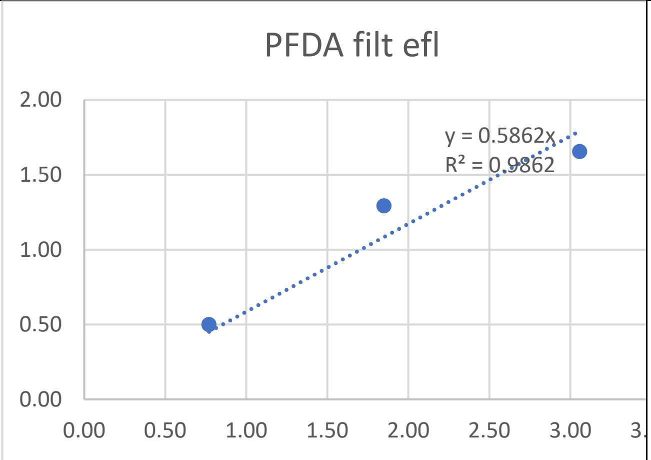
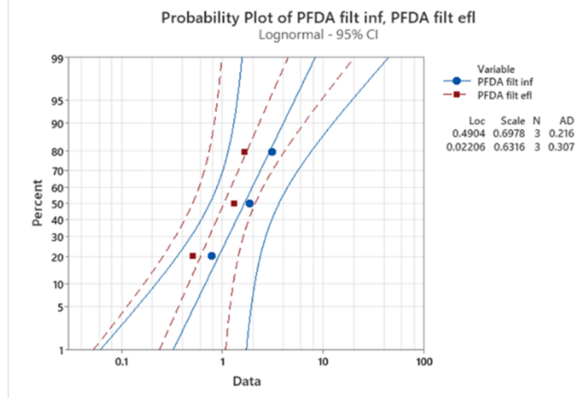
n/a Sedimentation
 Media Filters



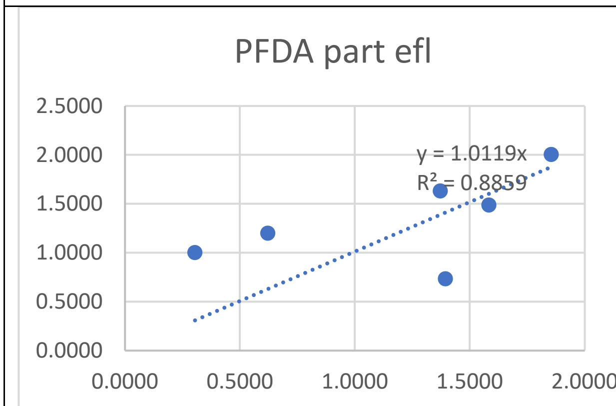
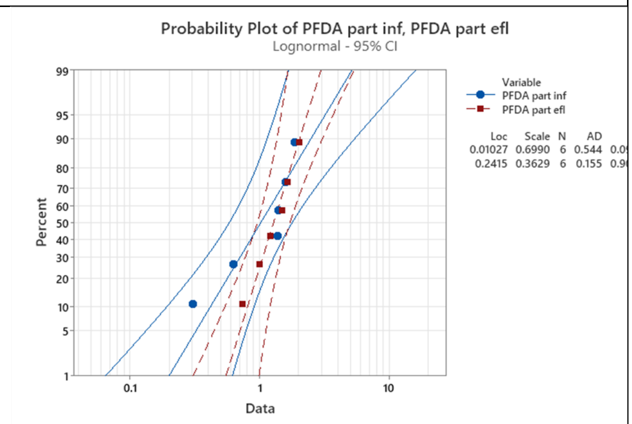
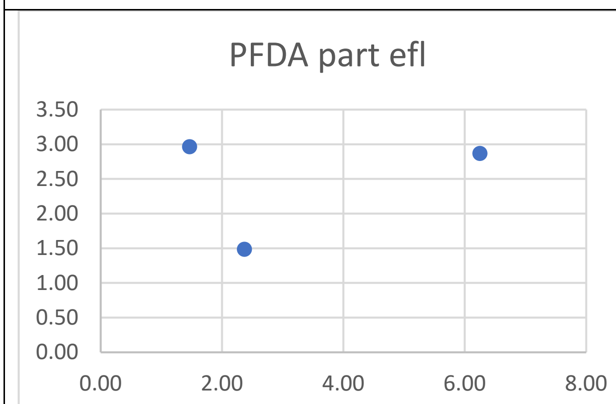
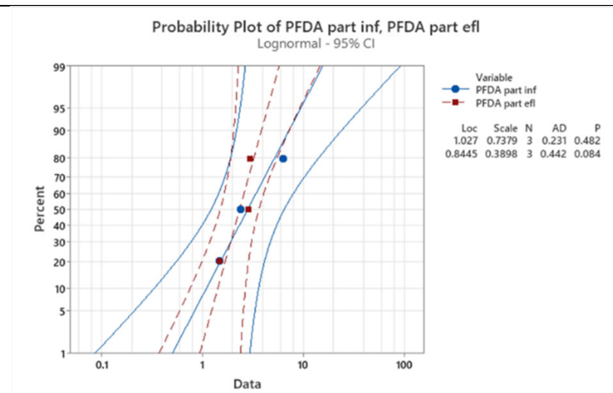
Biofilters and bioswales

PFDA filtered (<0.45 µm)

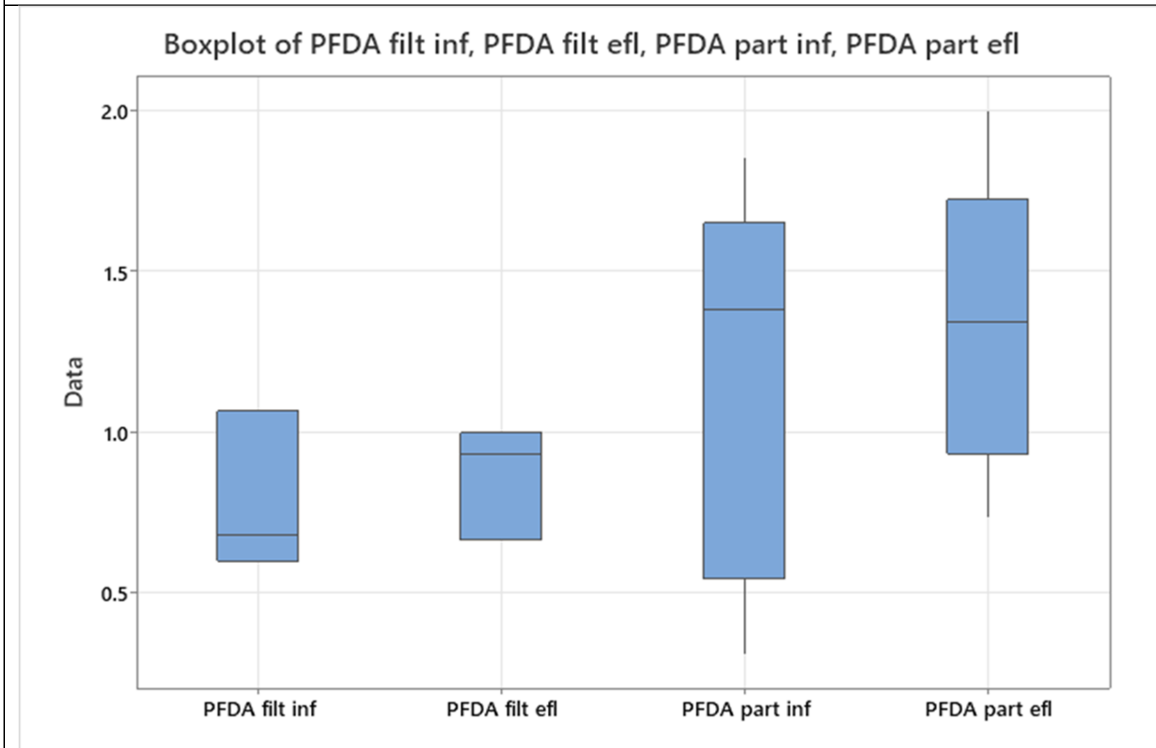
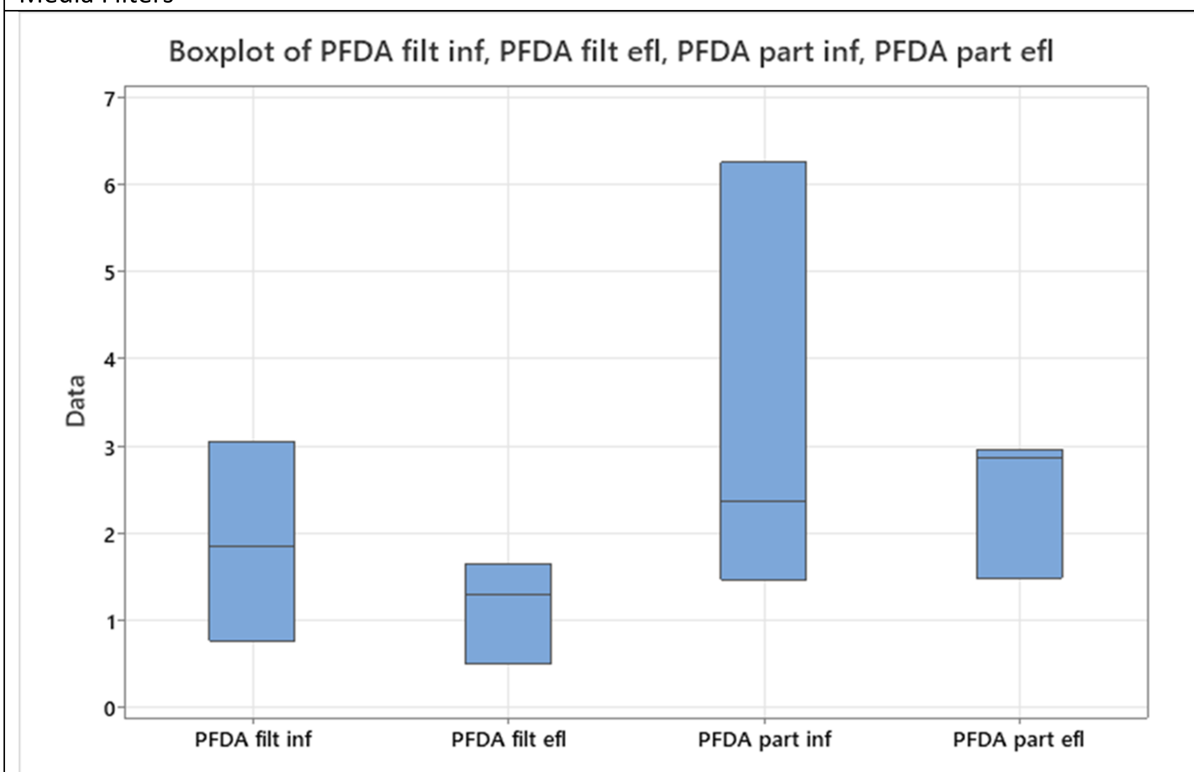
n/a Sedimentation	
 Media Filters	

 Biofilters and bioswales	

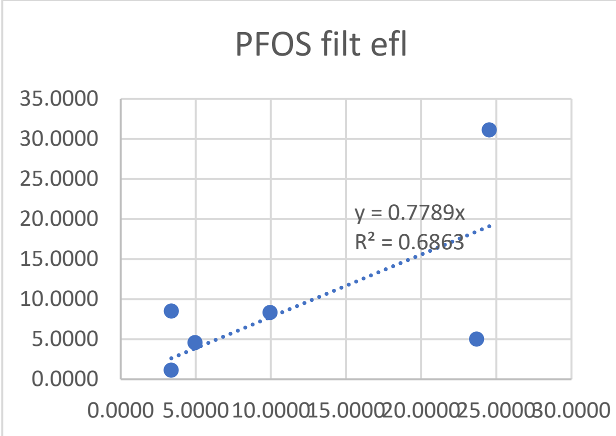
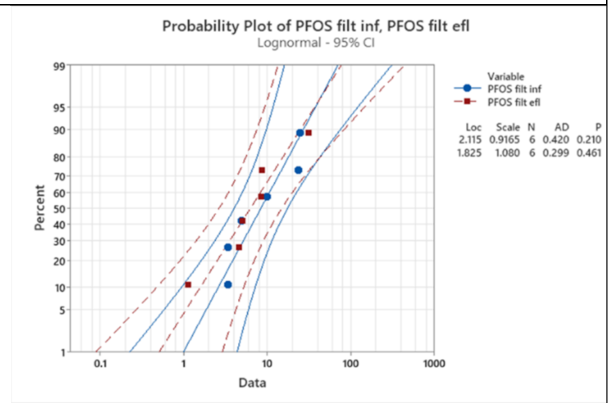
PFDA particulate (>0.45 µm)

n/a Sedimentation	
 Media Filters	
 Biofilters and bioswales	

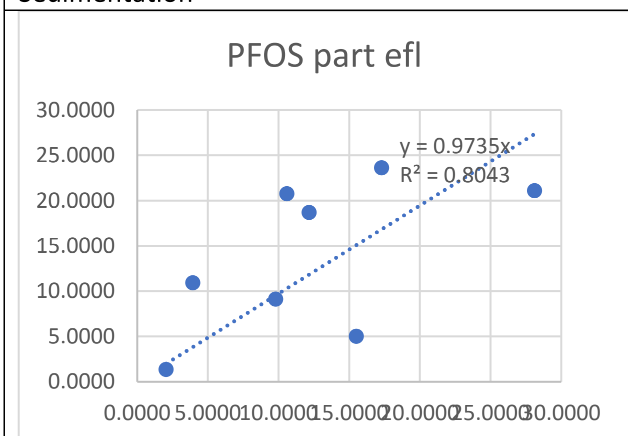
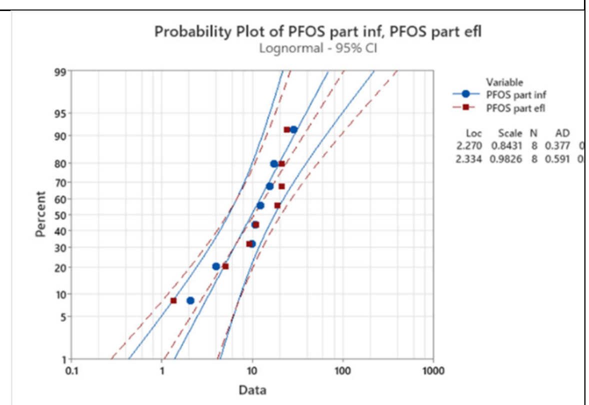
PFDA box and whisker plots

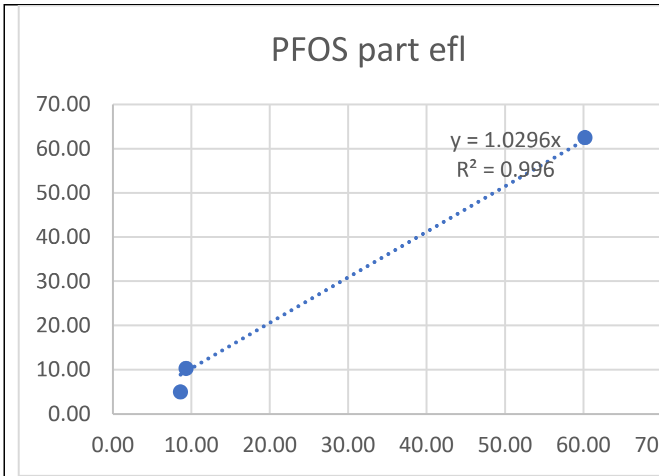
n/a Sedimentation
 Media Filters
 Biofilters and bioswales

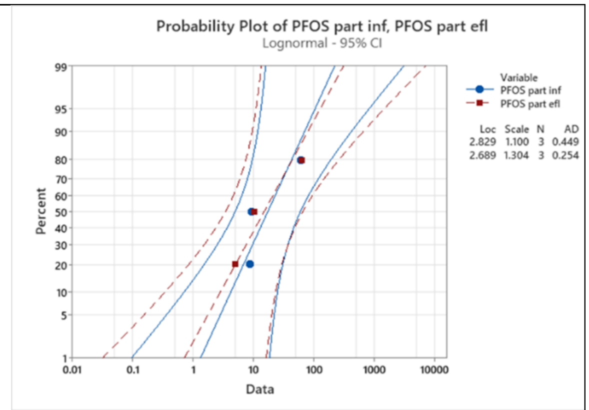
PFOS filtered (<0.45 µm)

n/a Sedimentation	
 Media Filters	
n/a Biofilters and bioswales	

PFOS particulate (>0.45 µm)

n/a Sedimentation	
 Media Filters	

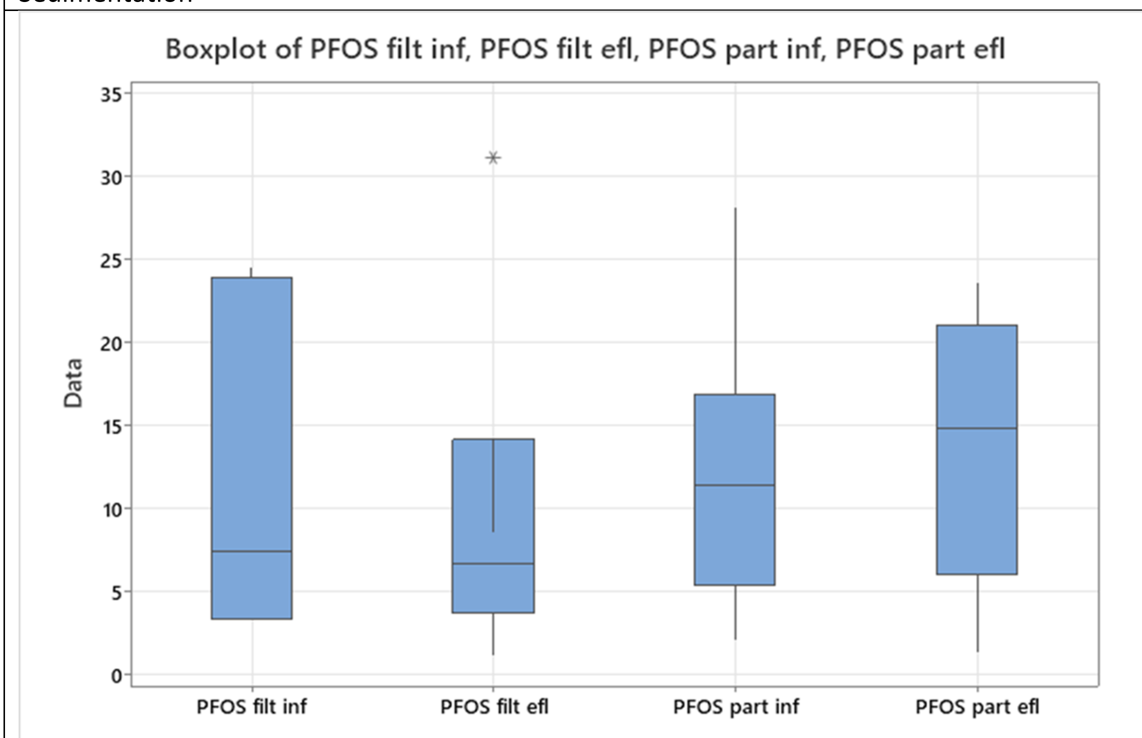




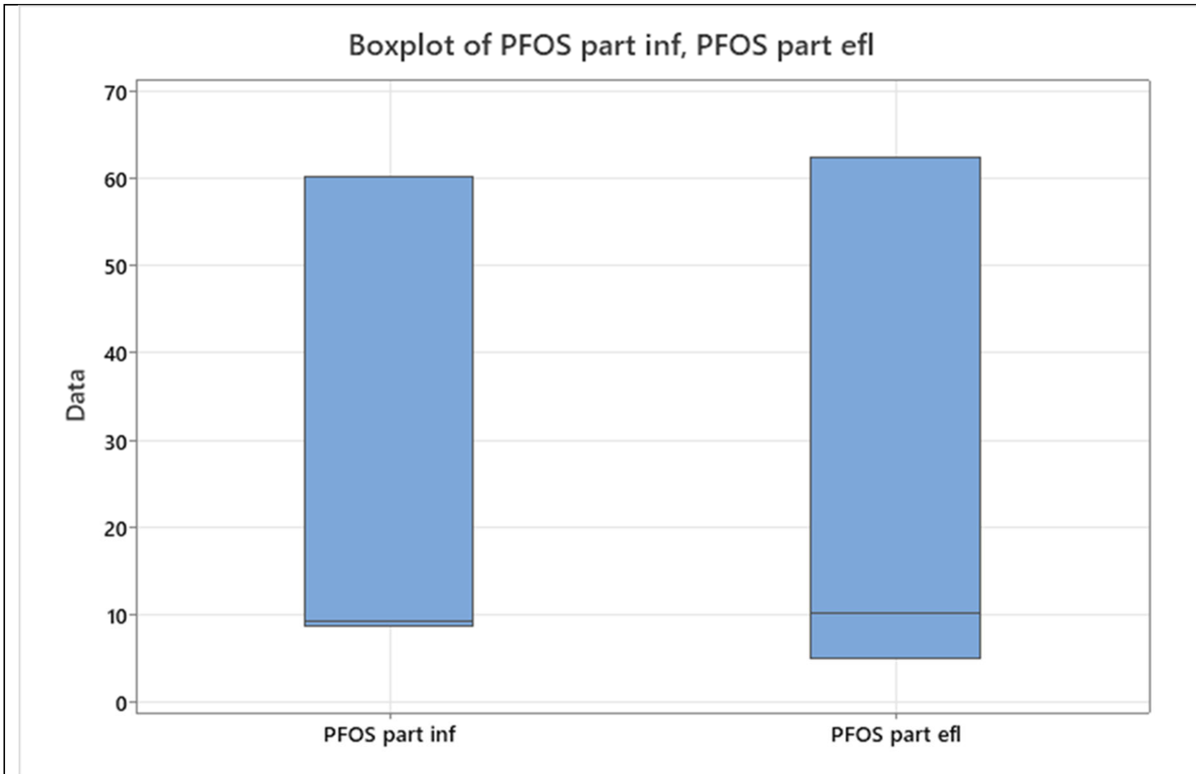
Biofilters and bioswales

PFOS box and whisker plots

n/a
Sedimentation

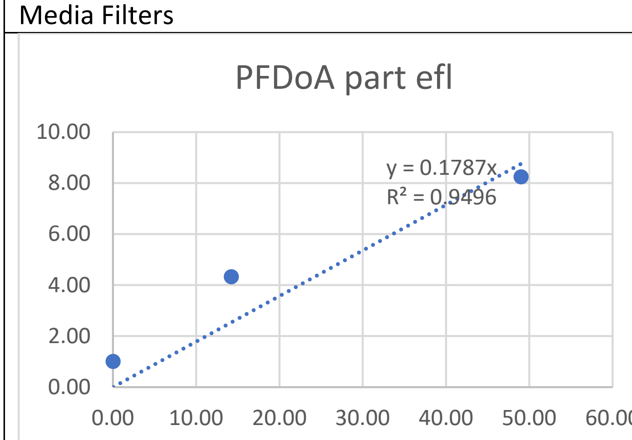
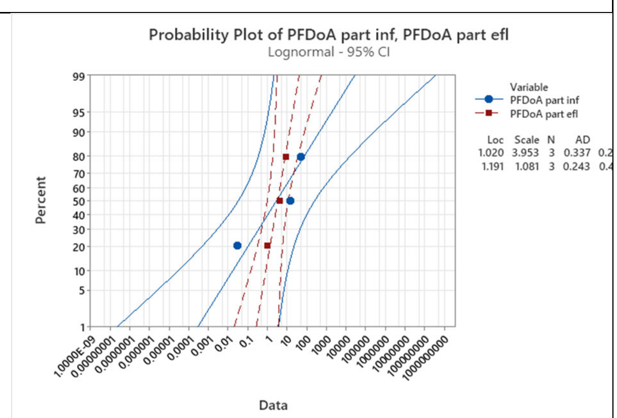


Media Filters

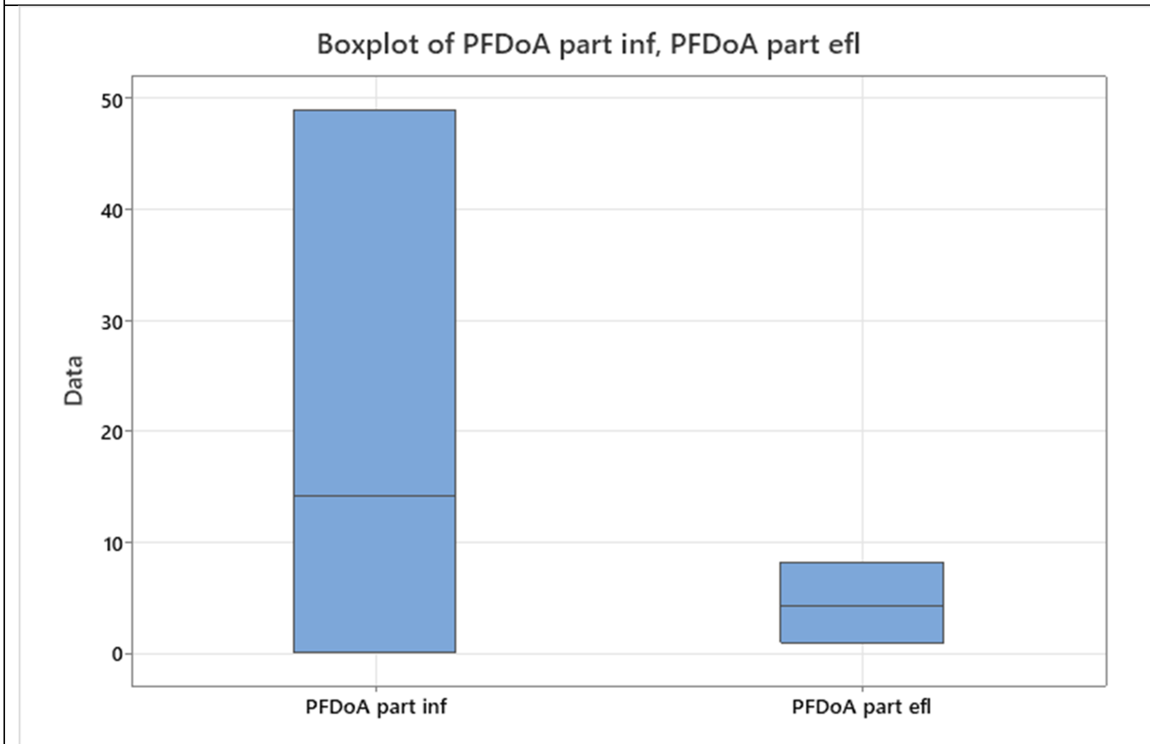


Biofilters and bioswales

PFDoA particulate (>0.45 µm)

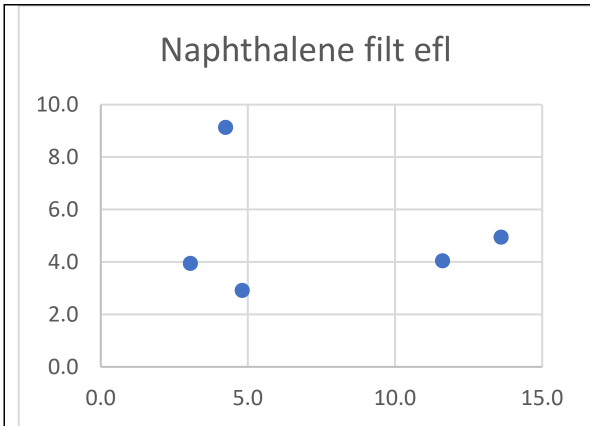
n/a Sedimentation	
n/a Media Filters	
 Biofilters and bioswales	

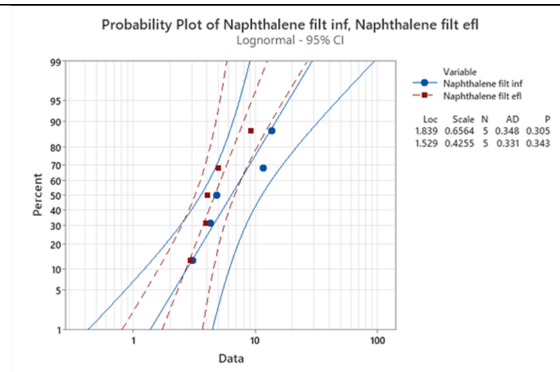
PFDoA box and whisker plots

n/a Sedimentation
n/a Media Filters
 Biofilters and bioswales

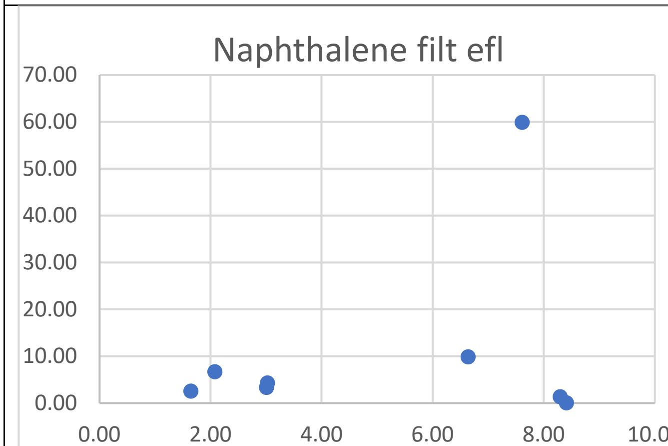
Appendix H: PAHs

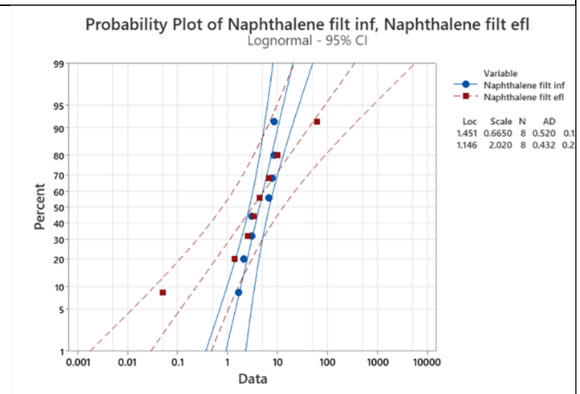
Naphthalene filtered (<0.45 µm)



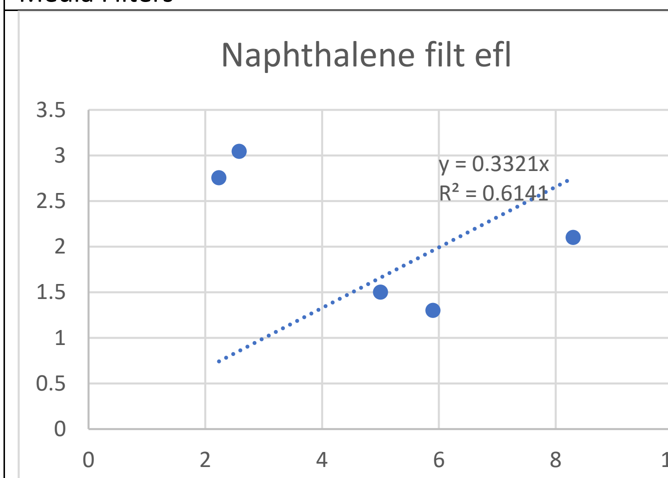


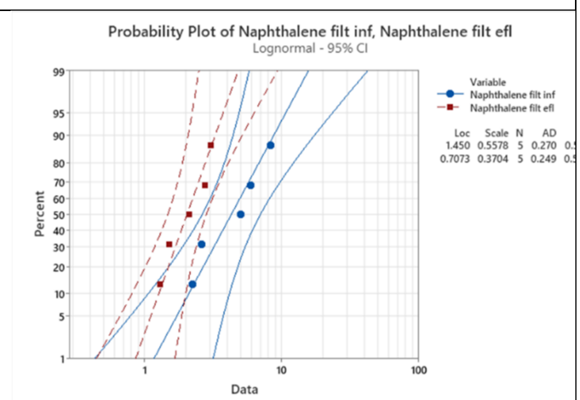
Sedimentation





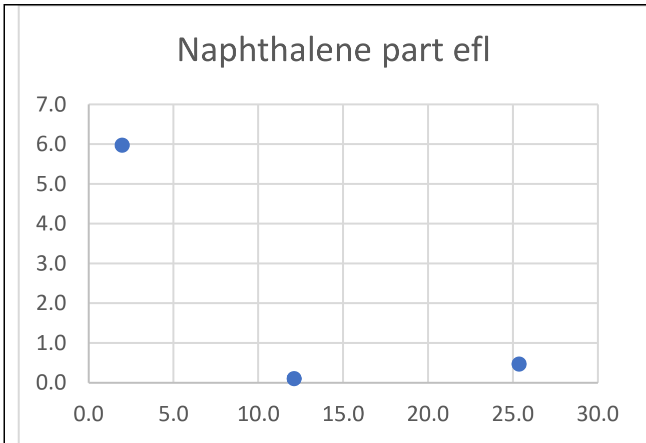
Media Filters



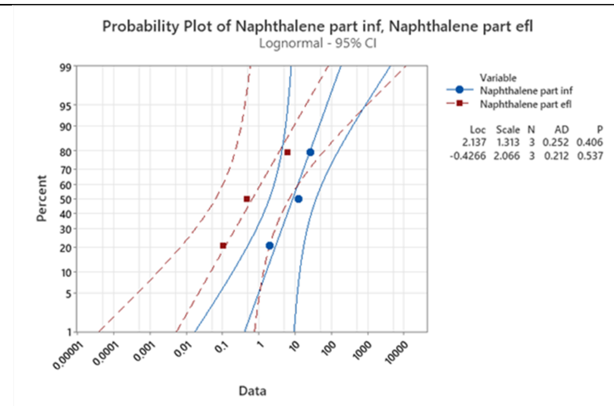


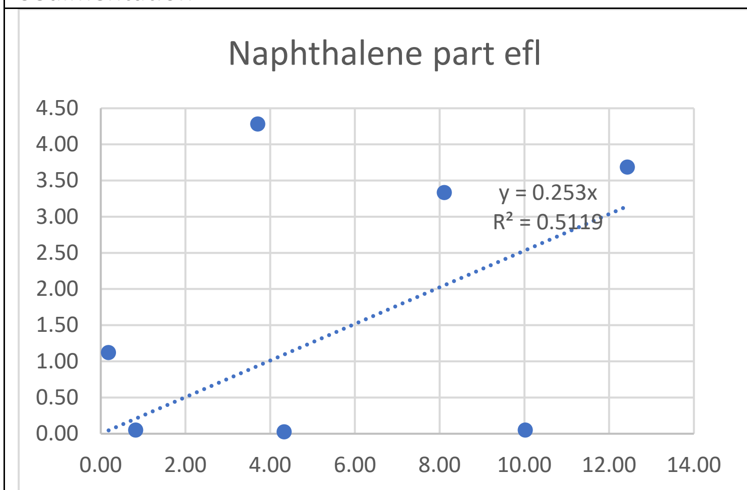
Biofilters and bioswales

Naphthalene particulates (>0.45 µm)

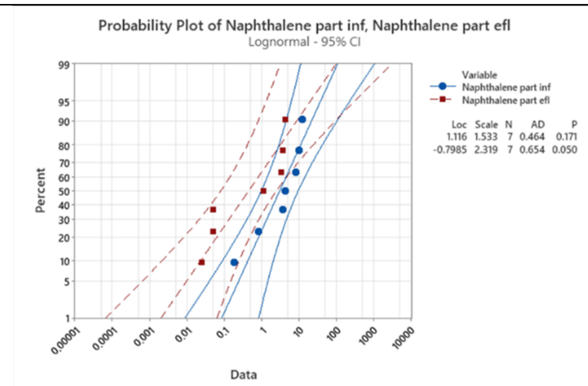


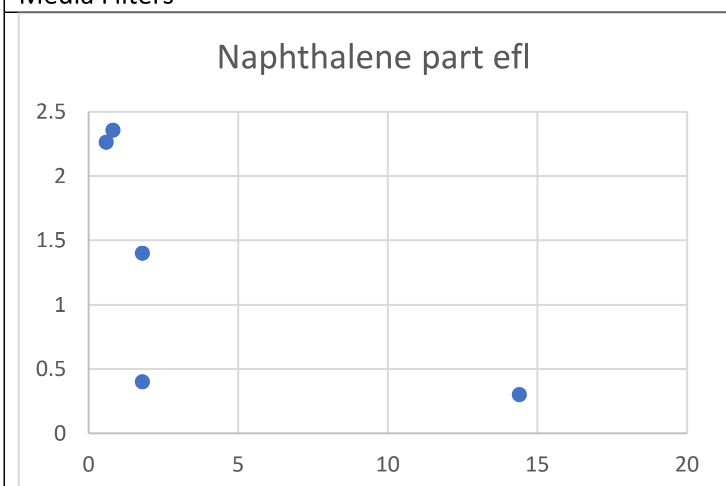
Sedimentation



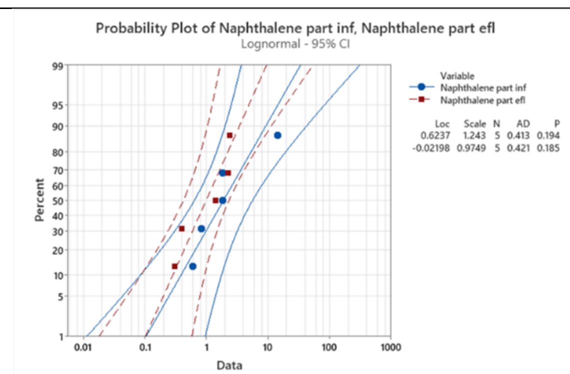


Media Filters

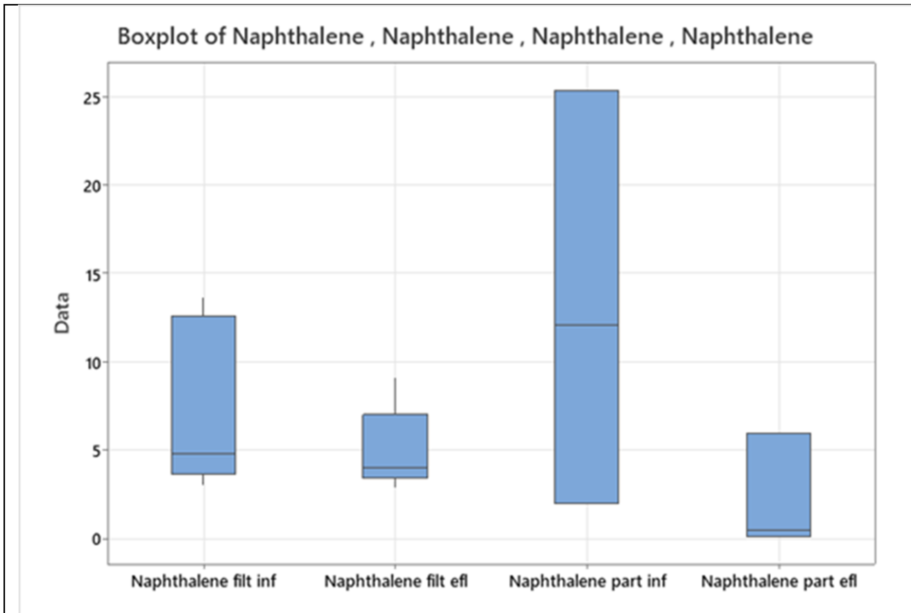




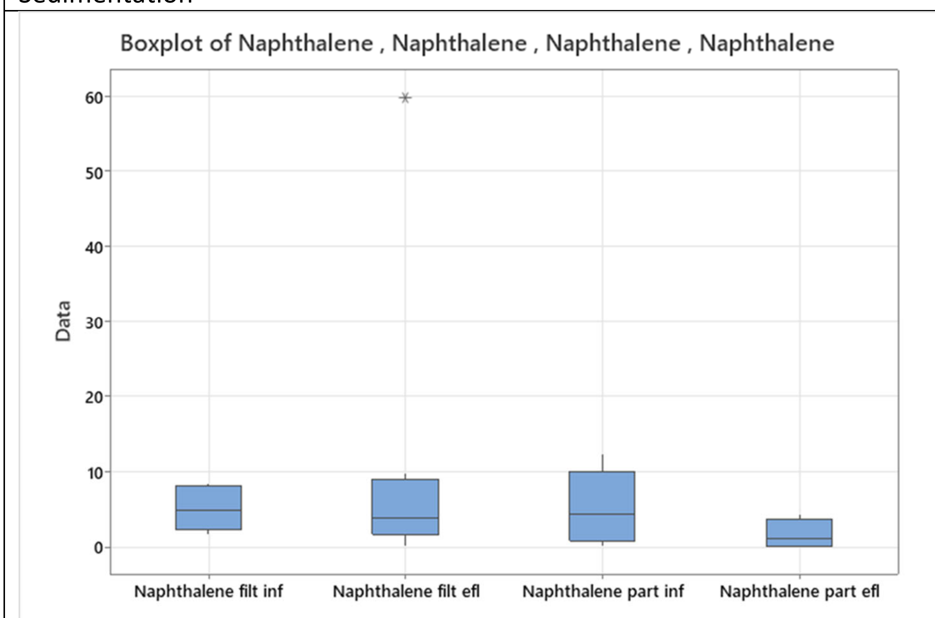
Biofilters and bioswales



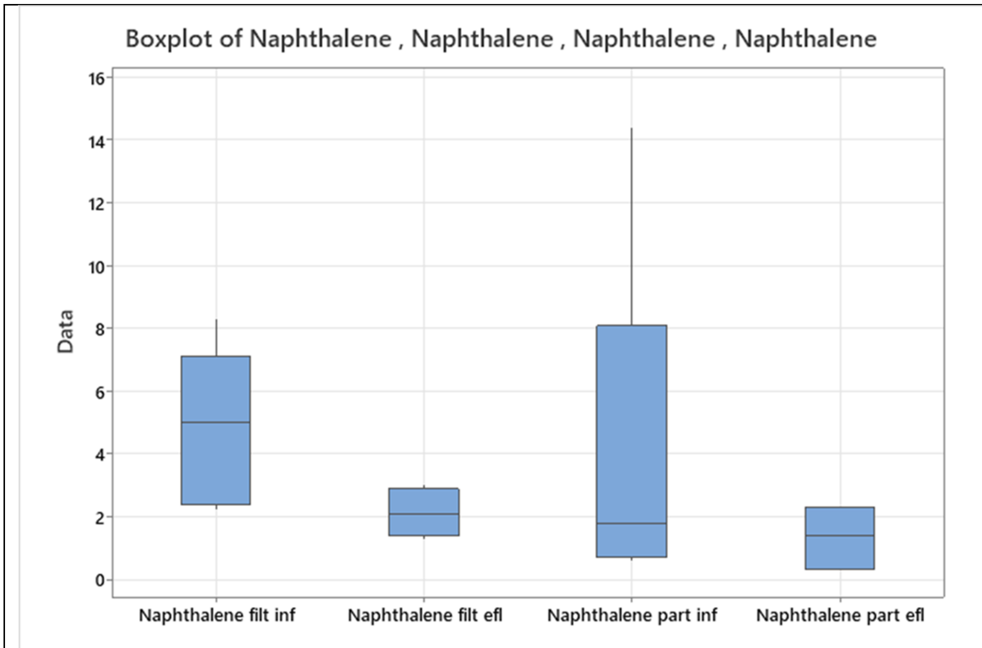
Naphthalene box and whisker plots



Sedimentation

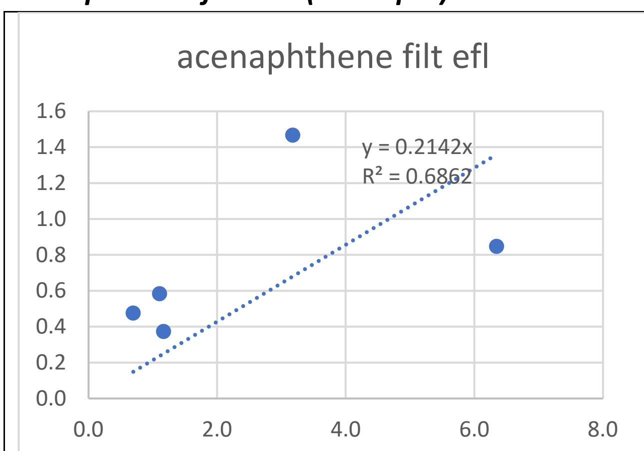


Media Filters

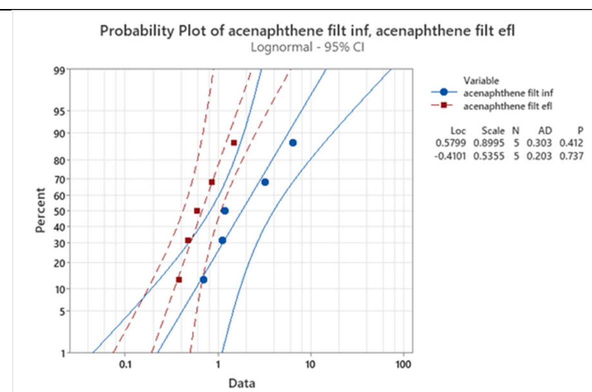


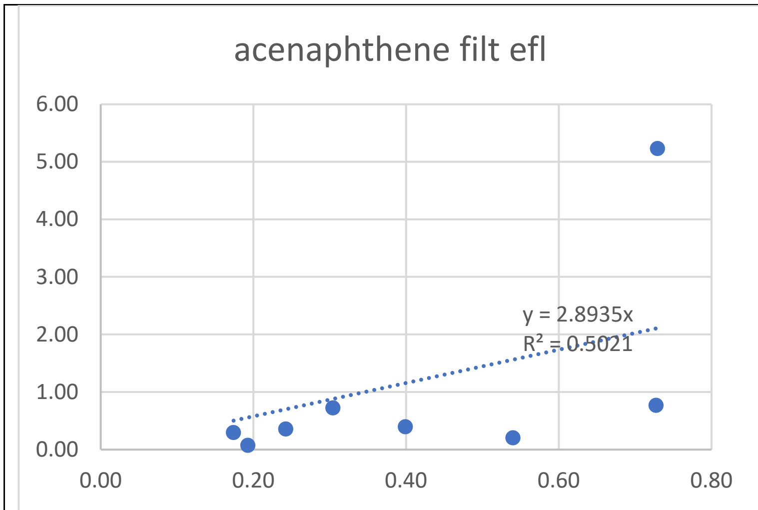
Biofilters and bioswales

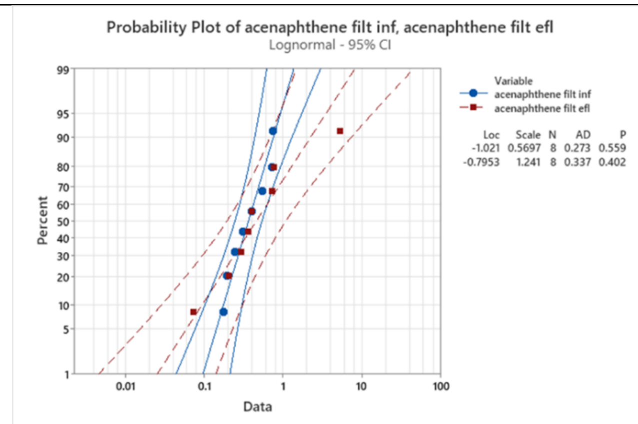
Acenaphthene filtered (<0.45 µm)



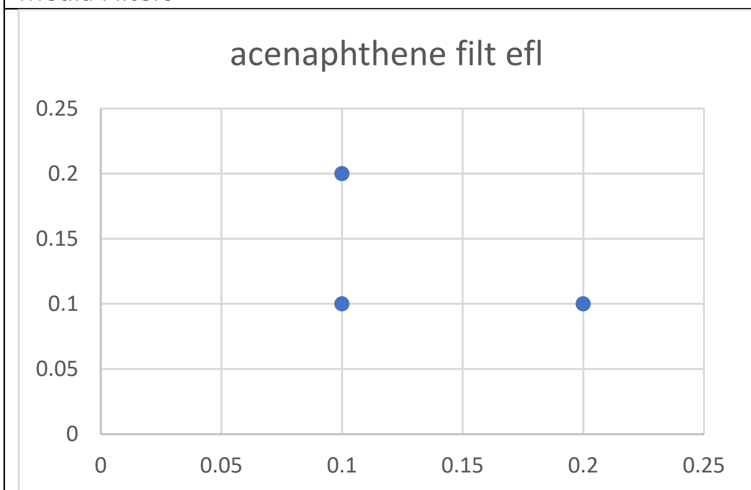
Sedimentation

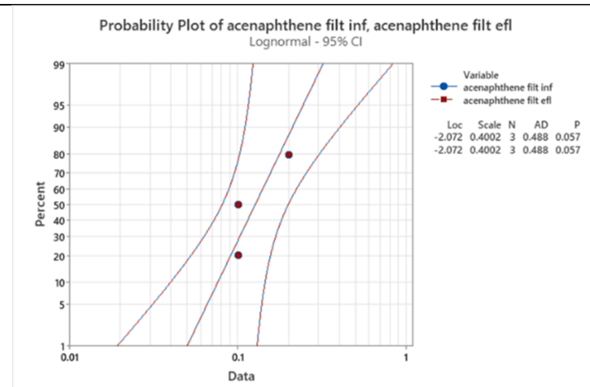






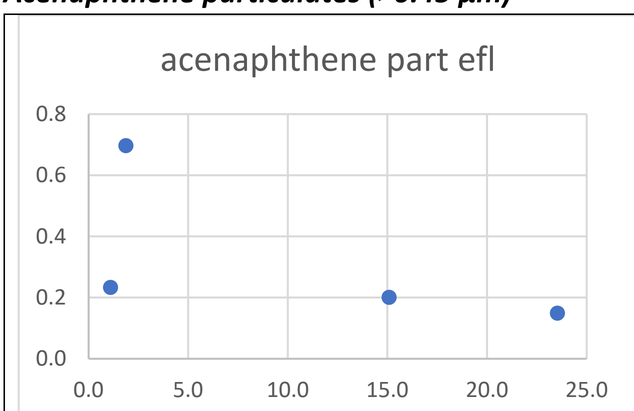
Media Filters

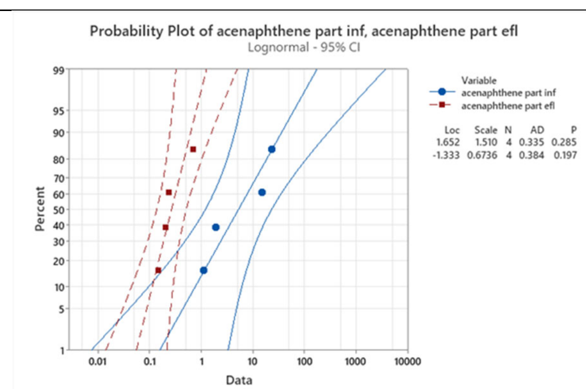




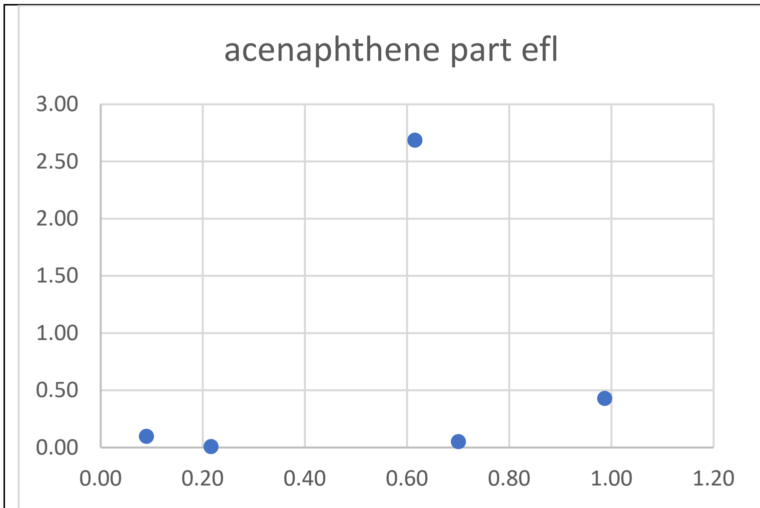
Biofilters and bioswales

Acenaphthene particulates (>0.45 µm)

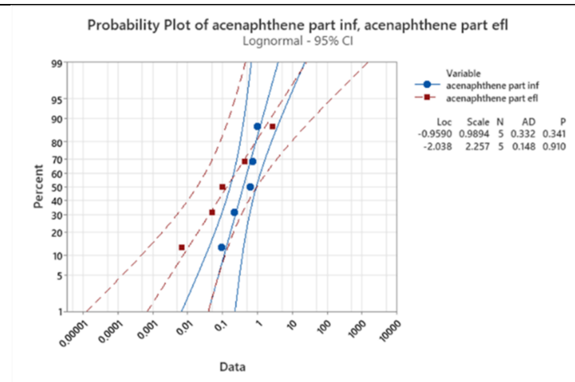




Sedimentation



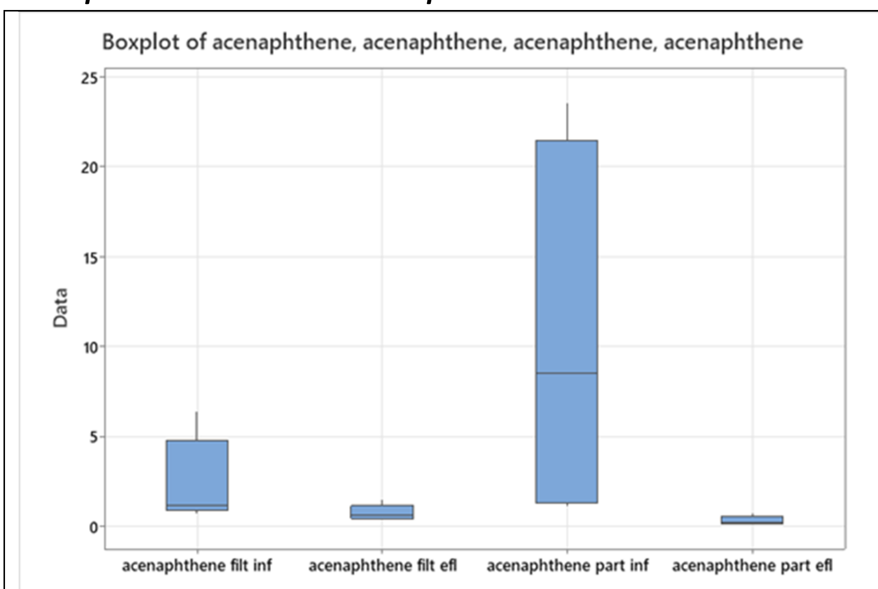
Media Filters



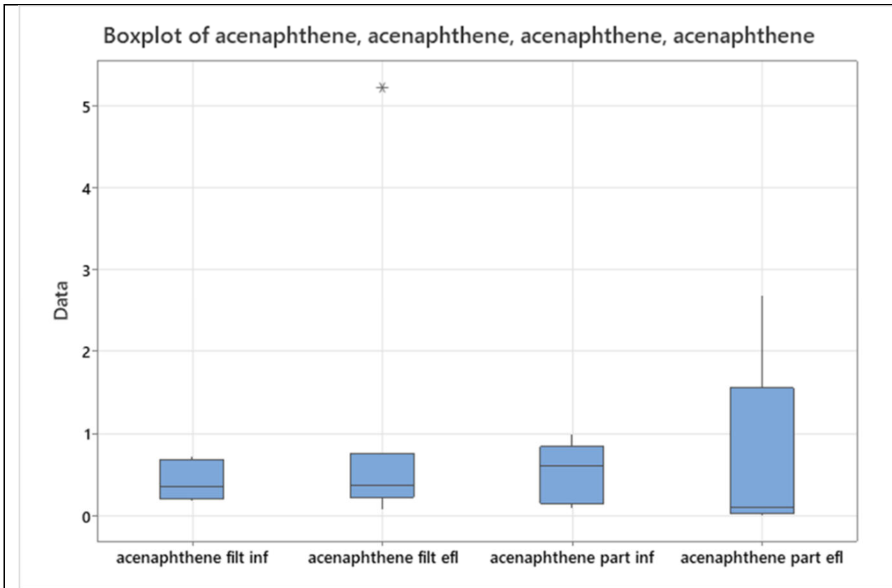
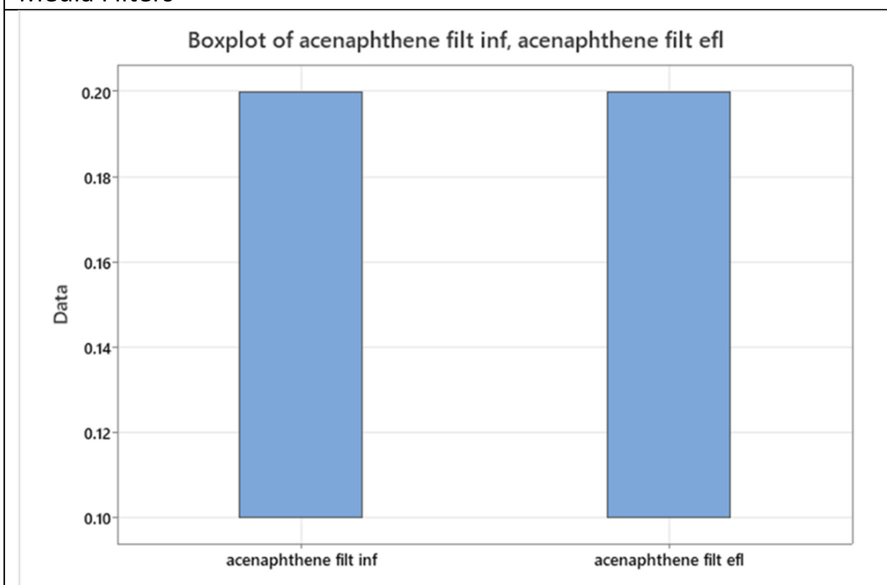
n/a

Biofilters and bioswales

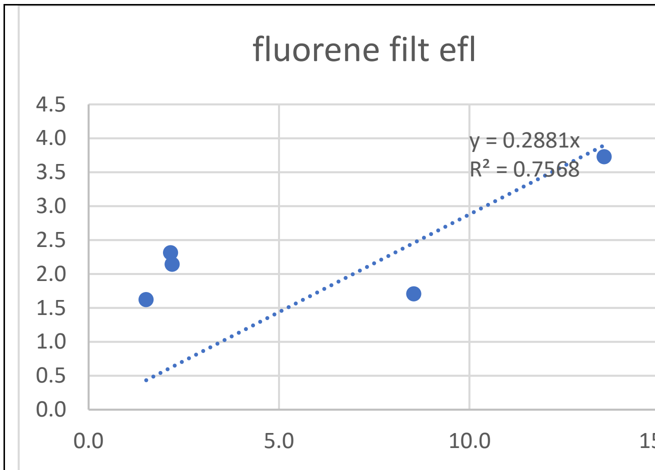
Acenaphthene box and whisker plots

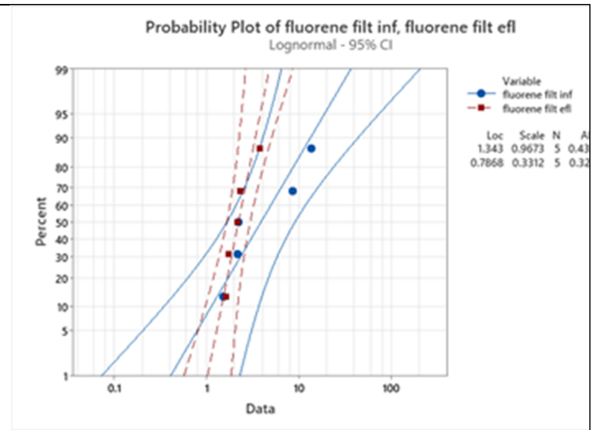


Sedimentation

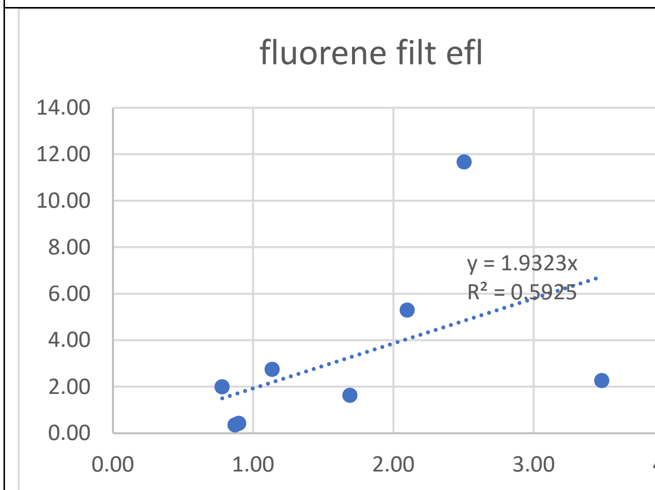
 Media Filters
 Biofilters and bioswales

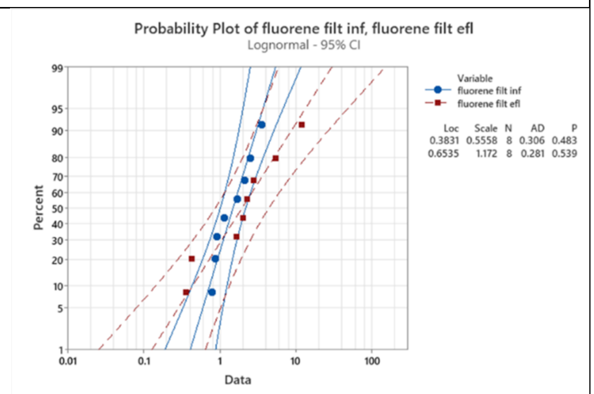
Fluorene filtered (<0.45 µm)



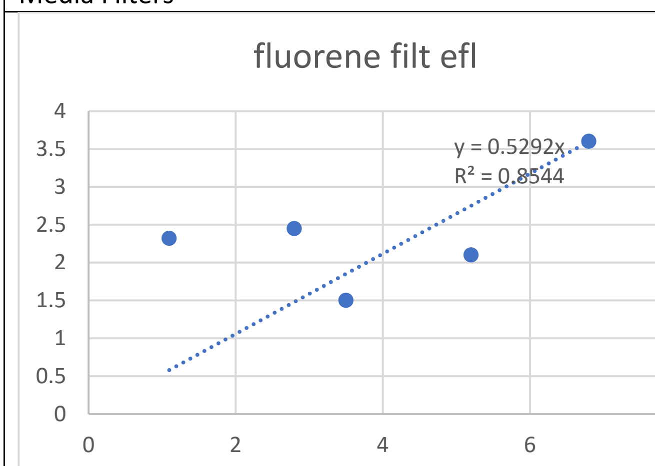


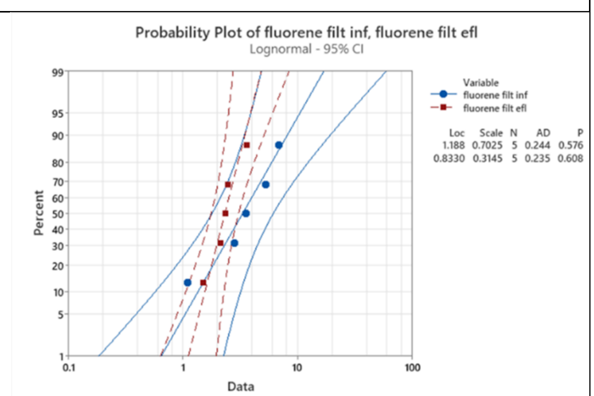
Sedimentation





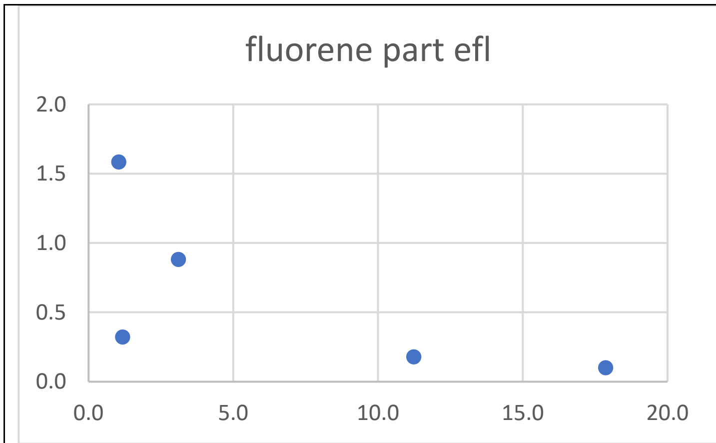
Media Filters



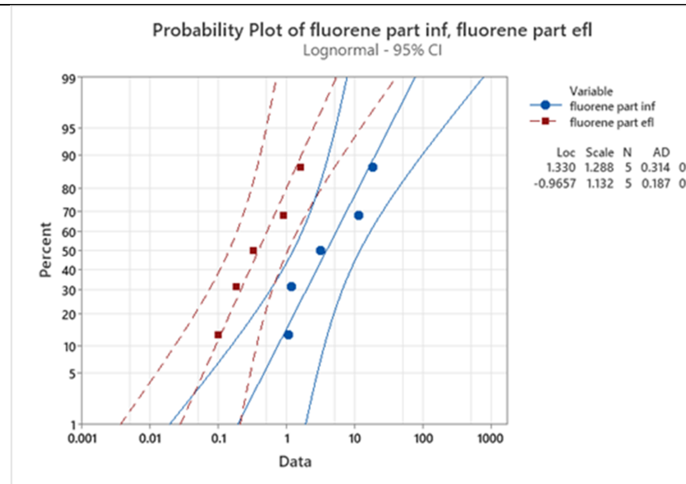


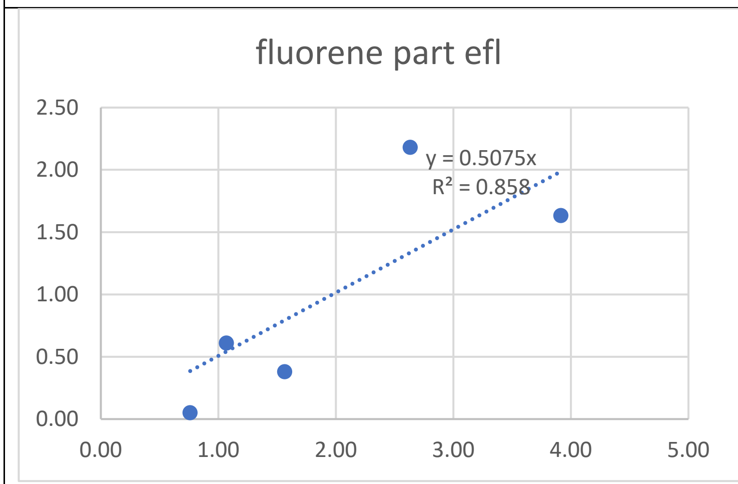
Biofilters and bioswales

__Fluorene particulates (>0.45 µm)__

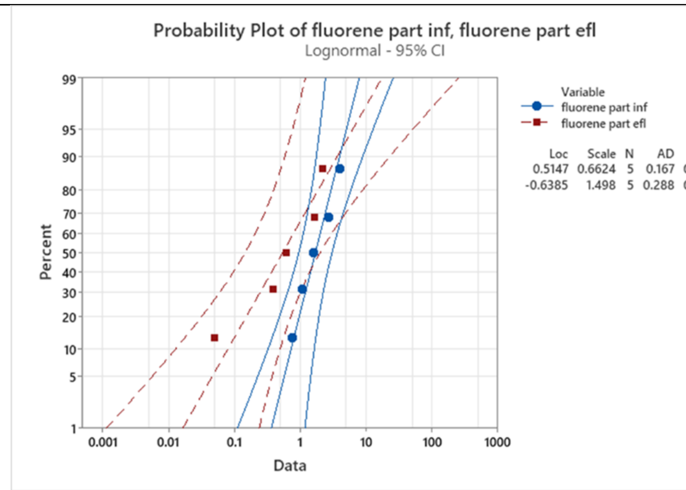


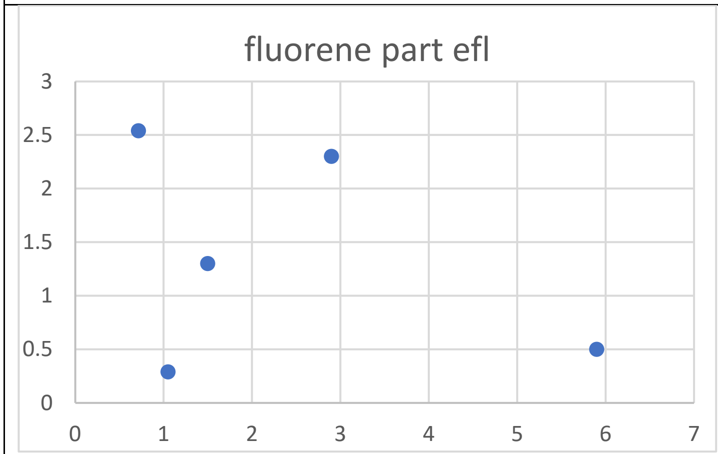
Sedimentation



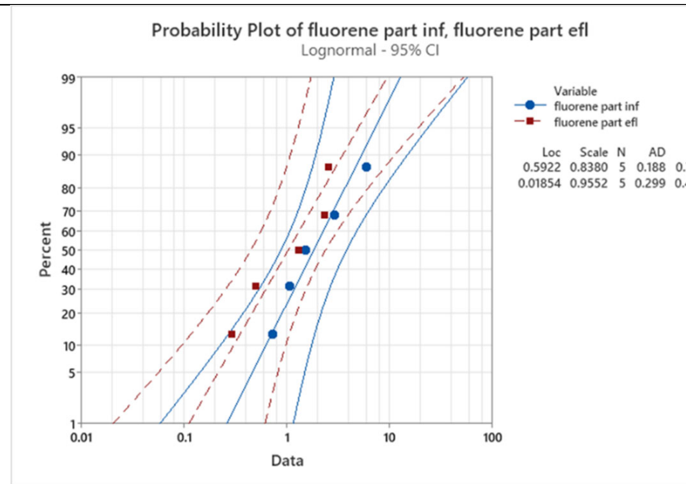


Media Filters

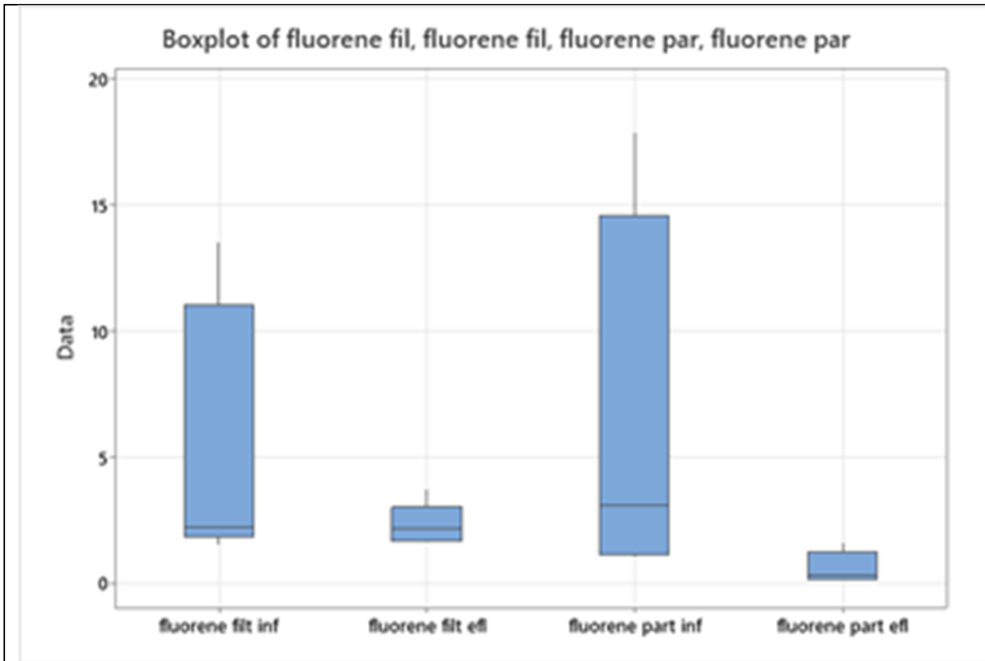




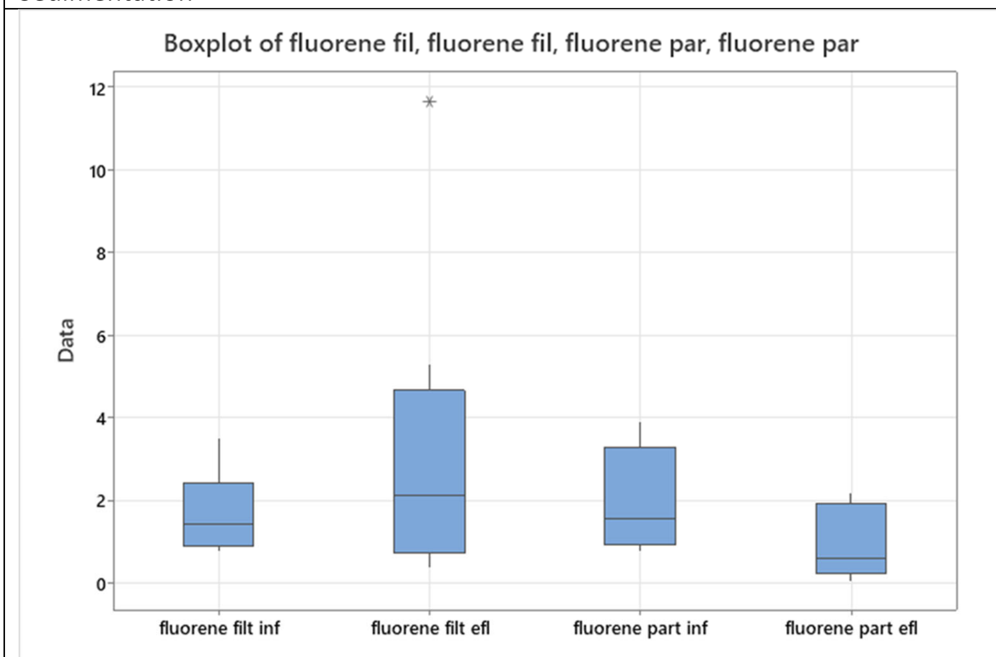
Biofilters and bioswales



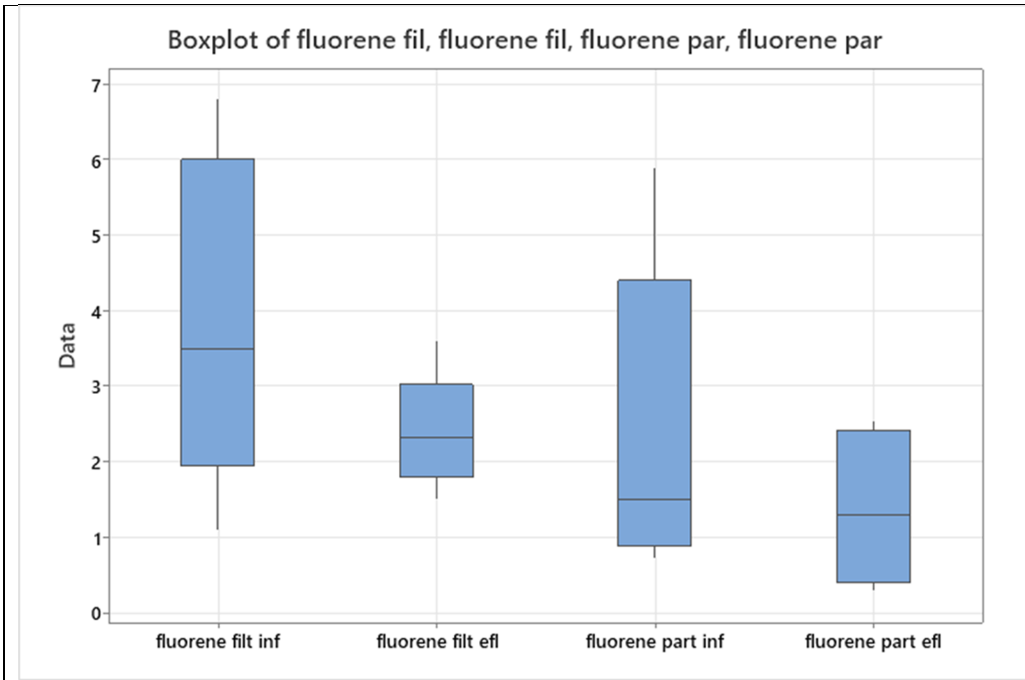
Fluorene box and whisker plots



Sedimentation

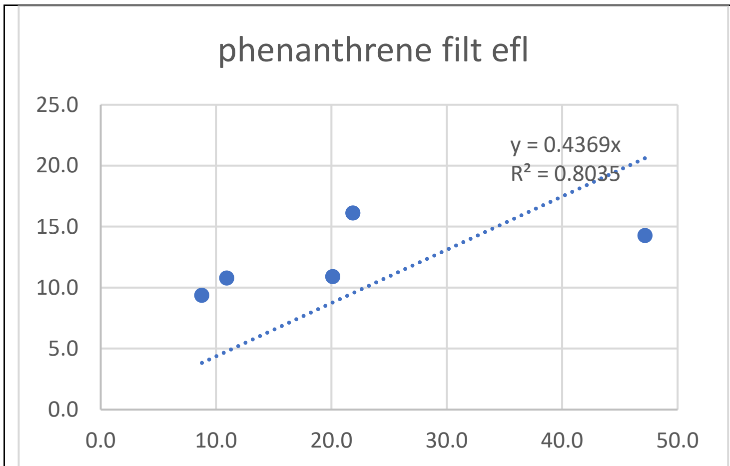


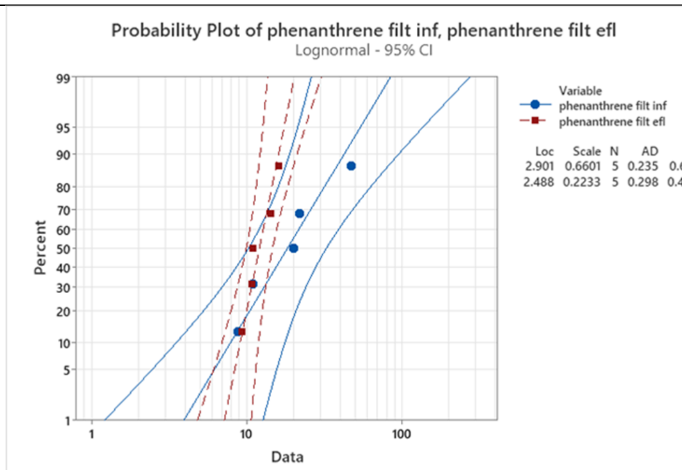
Media Filters



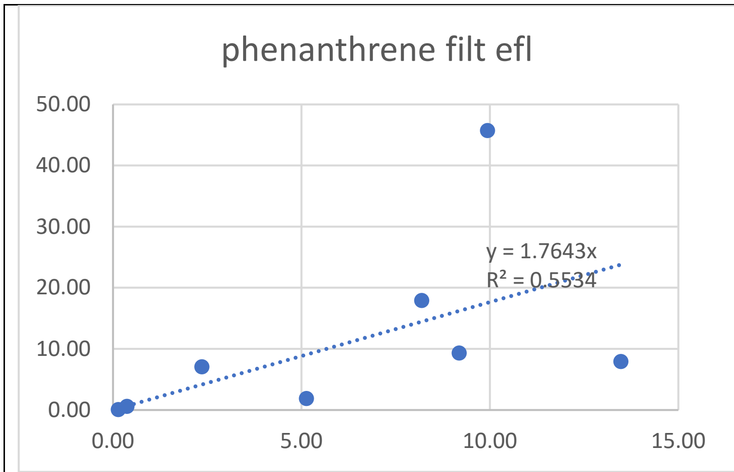
Biofilters and bioswales

Phenanthrene filtered (<0.45 µm)

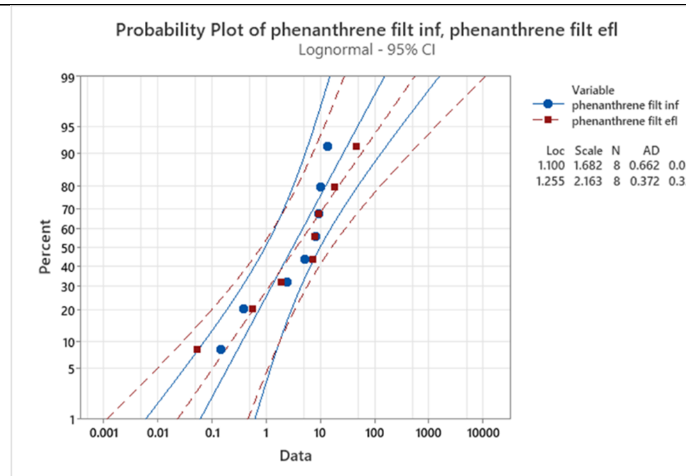


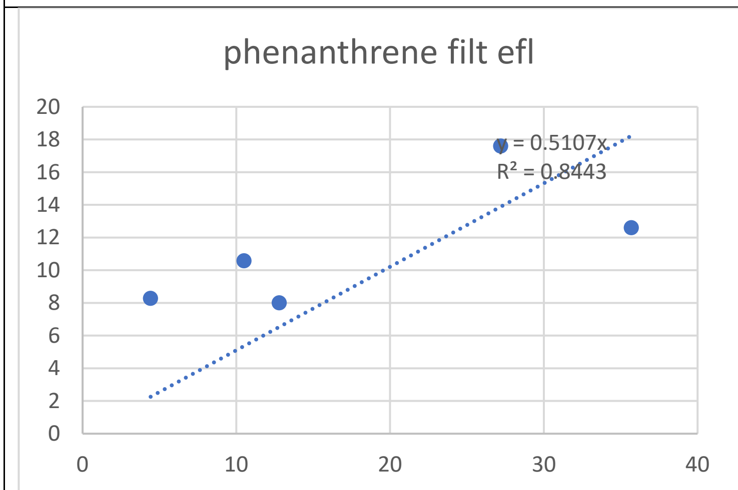


Sedimentation

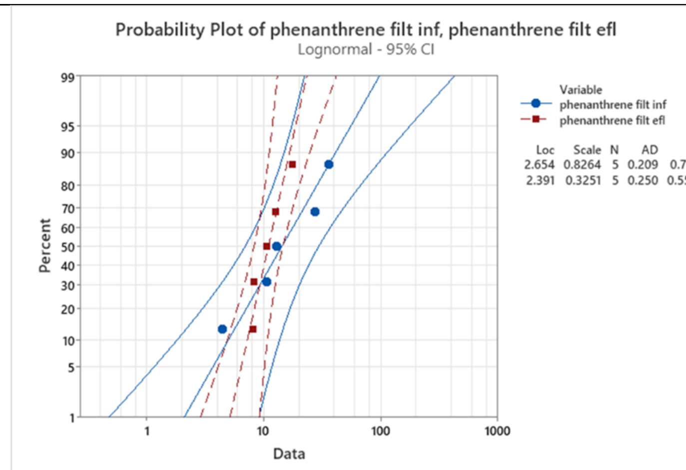


Media Filters

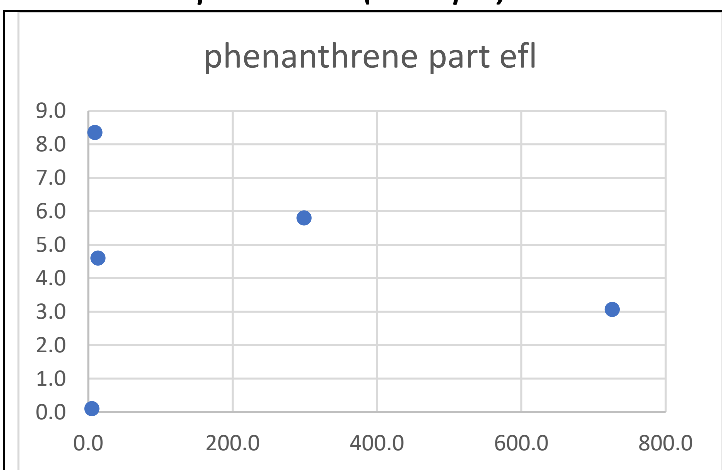




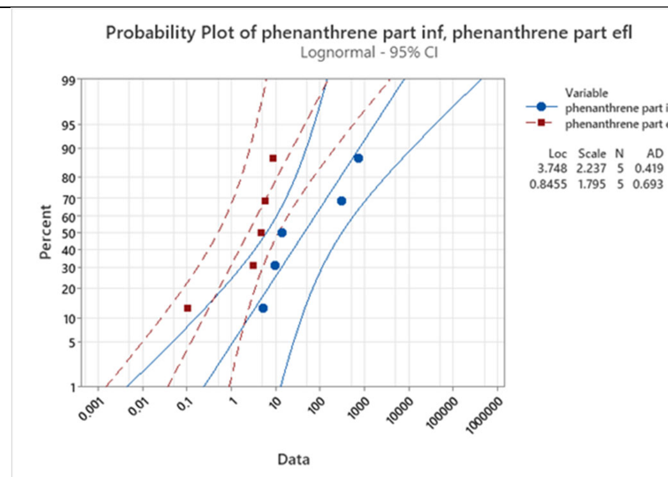
Biofilters and bioswales

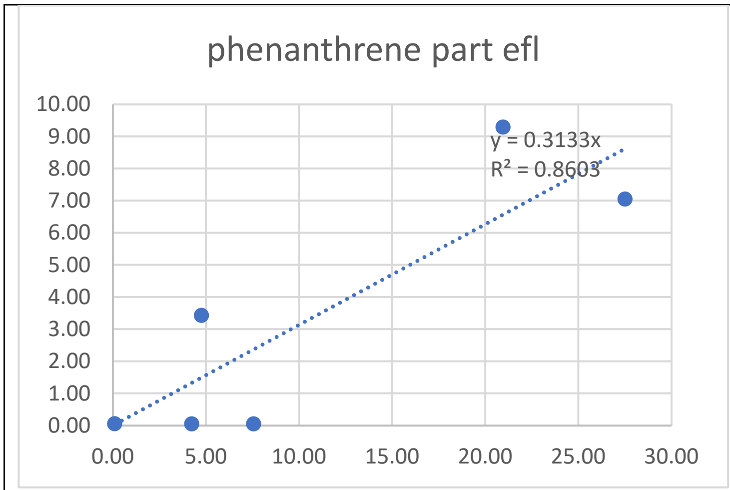


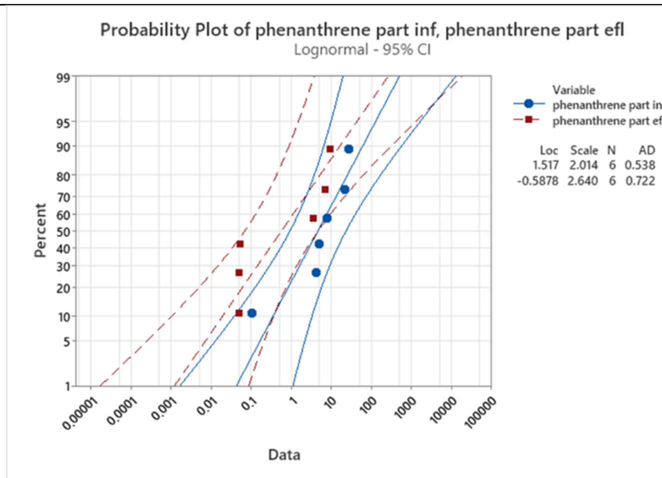
Phenanthrene particulates (>0.45 µm)



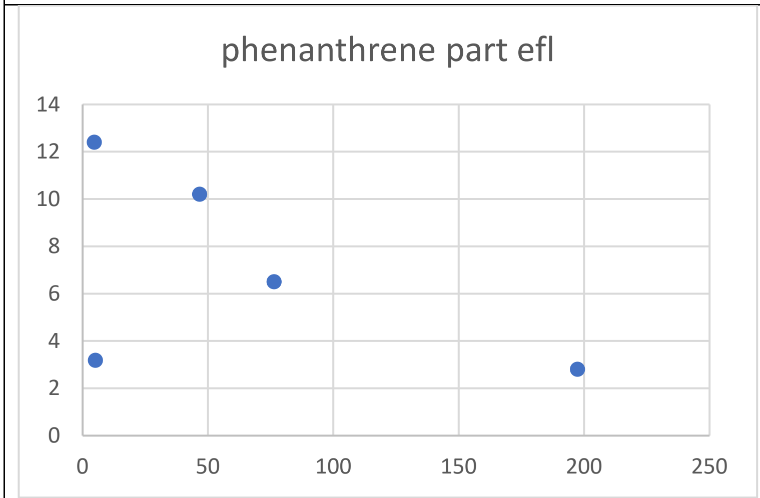
Sedimentation

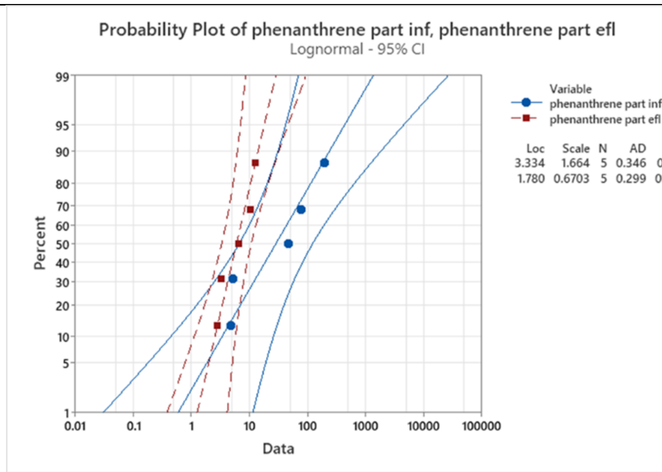






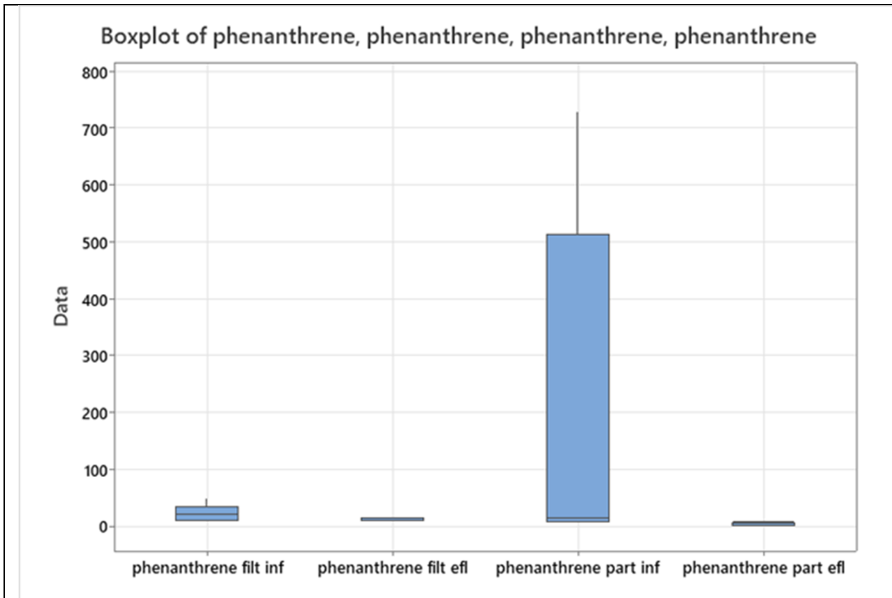
Media Filters



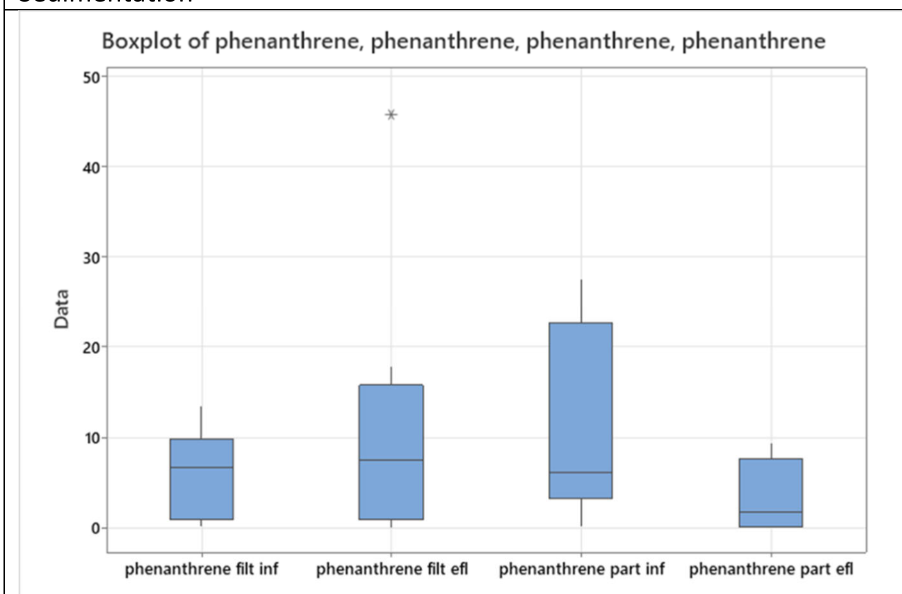


Biofilters and bioswales

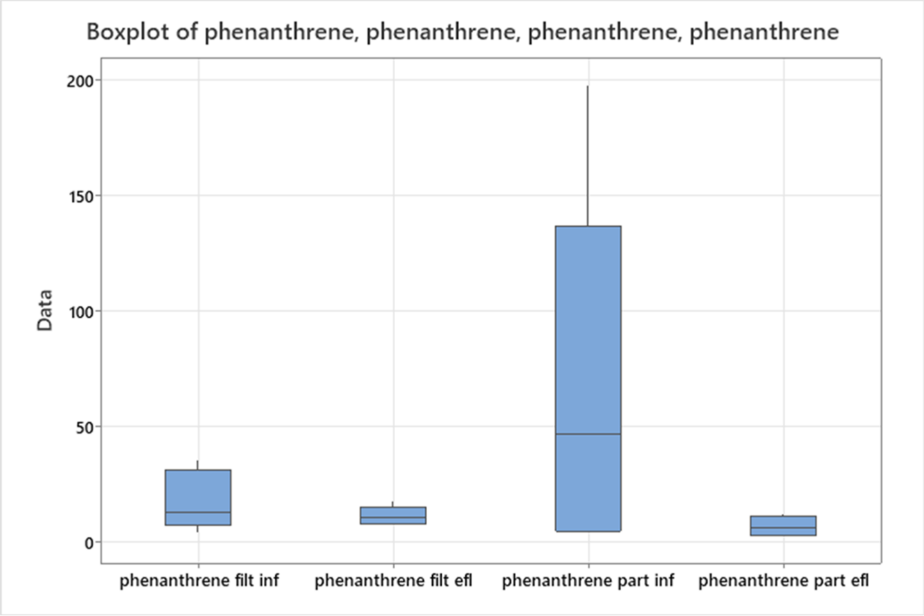
Phenanthrene box and whisker plots



Sedimentation

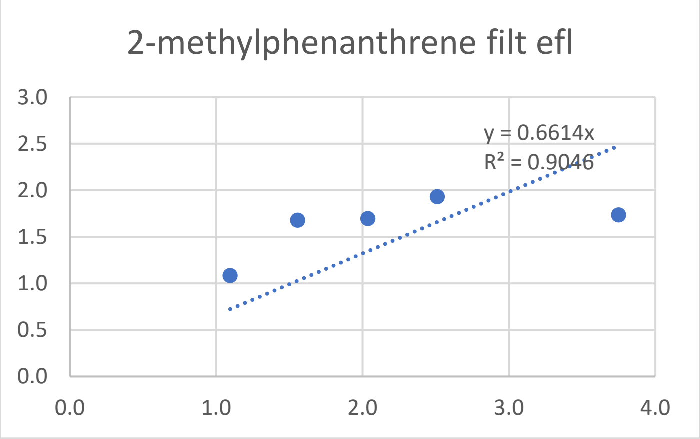


Media Filters

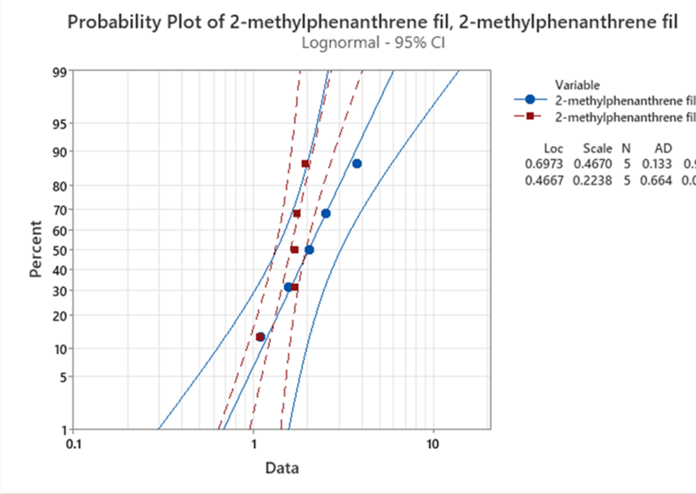


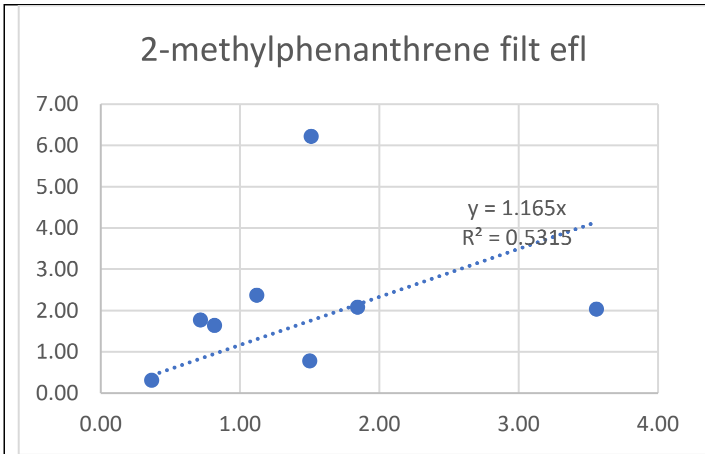
Biofilters and bioswales

2-methylphenanthrene filtered (<0.45 µm)

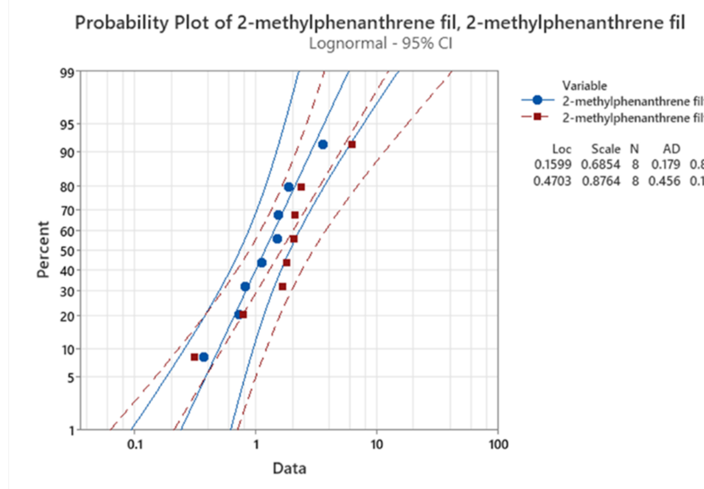


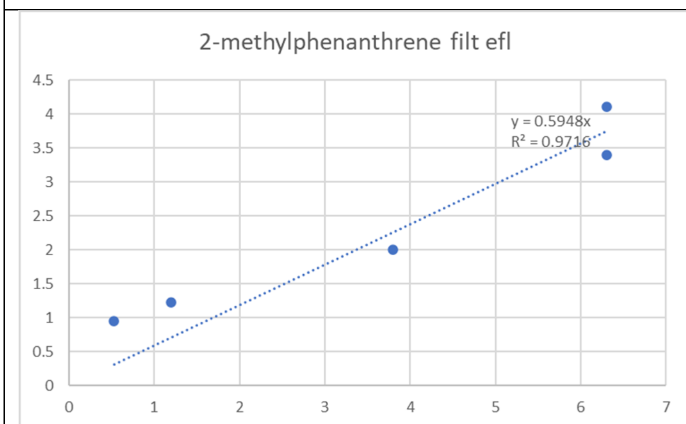
Sedimentation



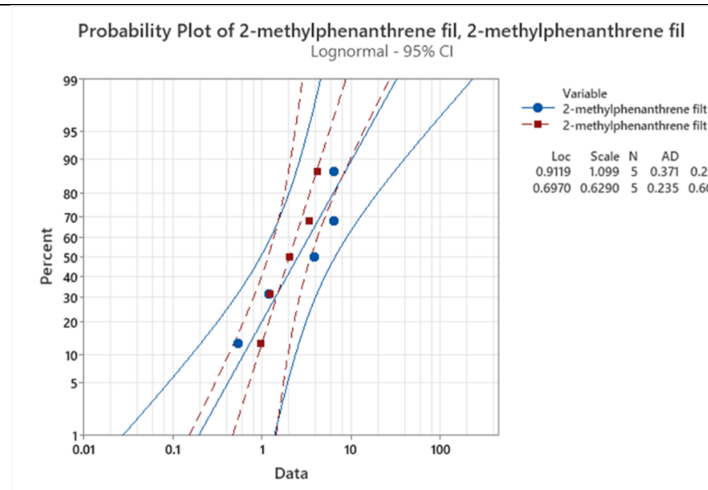


Media Filters

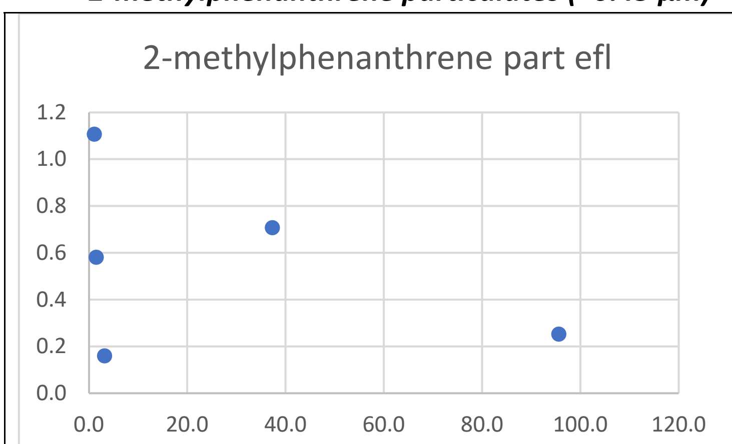




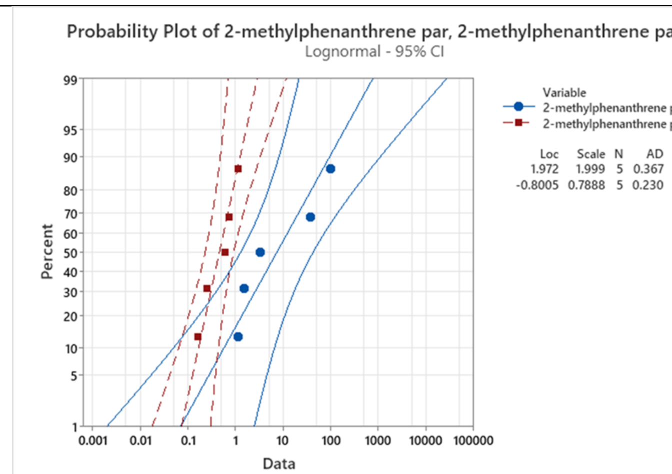
Biofilters and bioswales

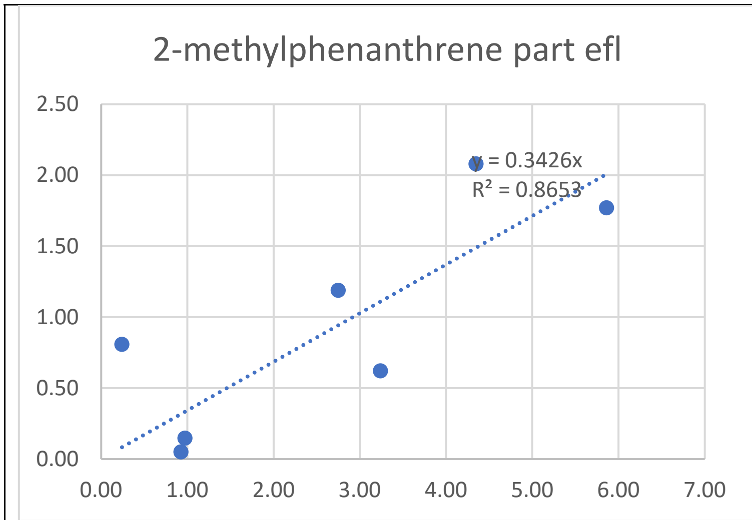


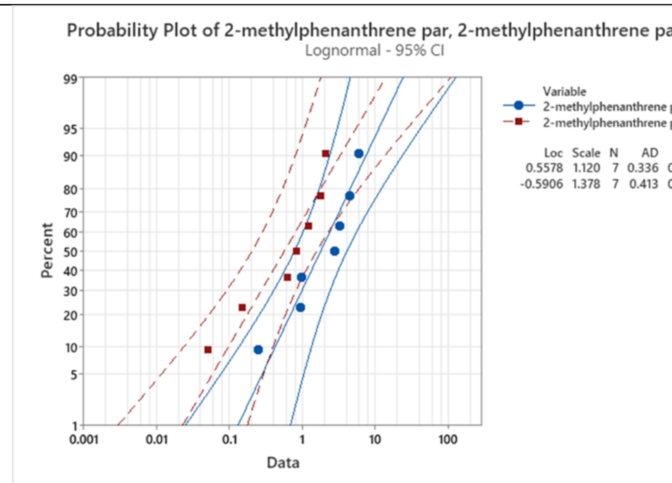
2-methylphenanthrene particulates (>0.45 µm)



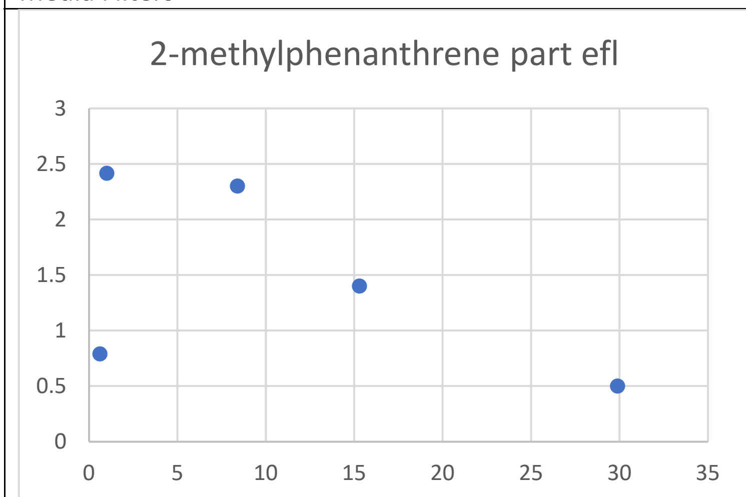
Sedimentation

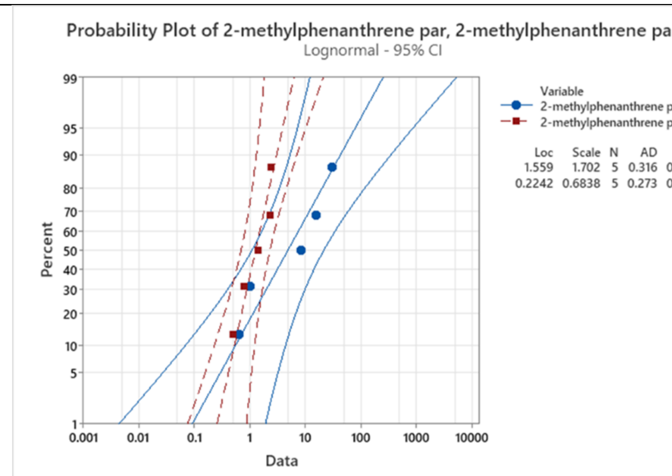






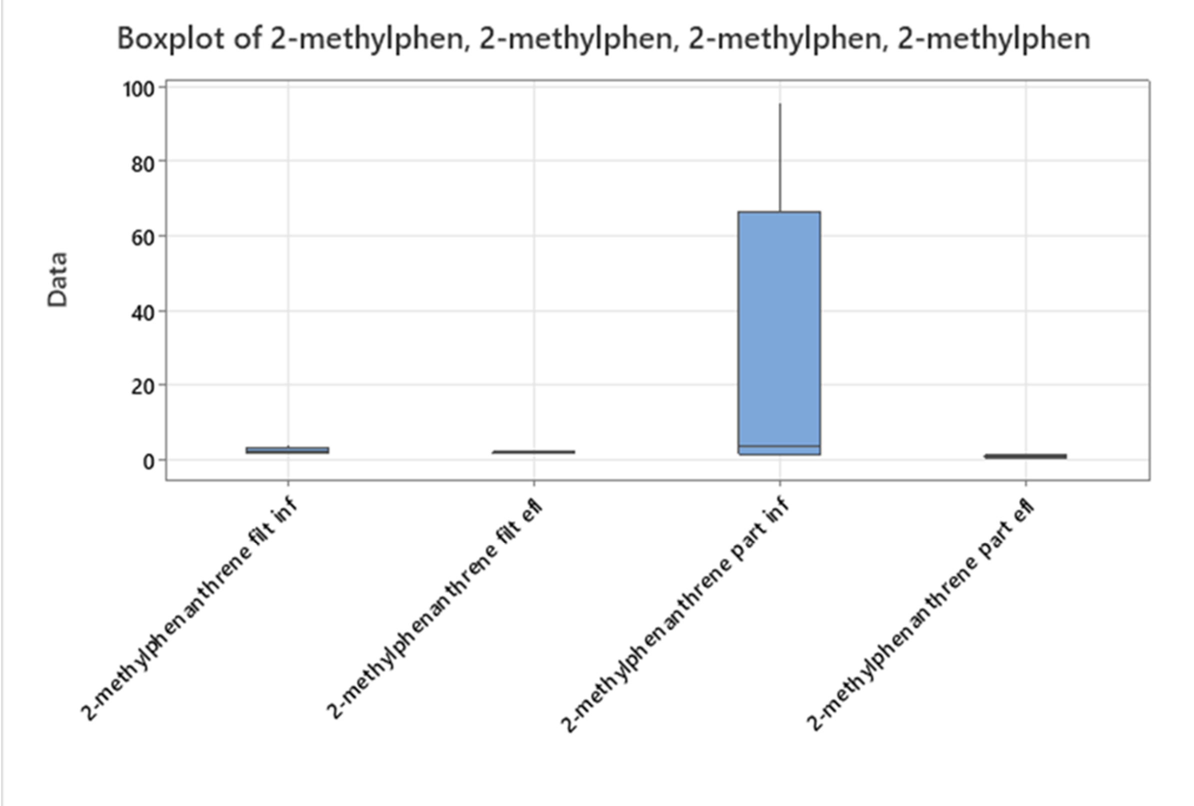
Media Filters



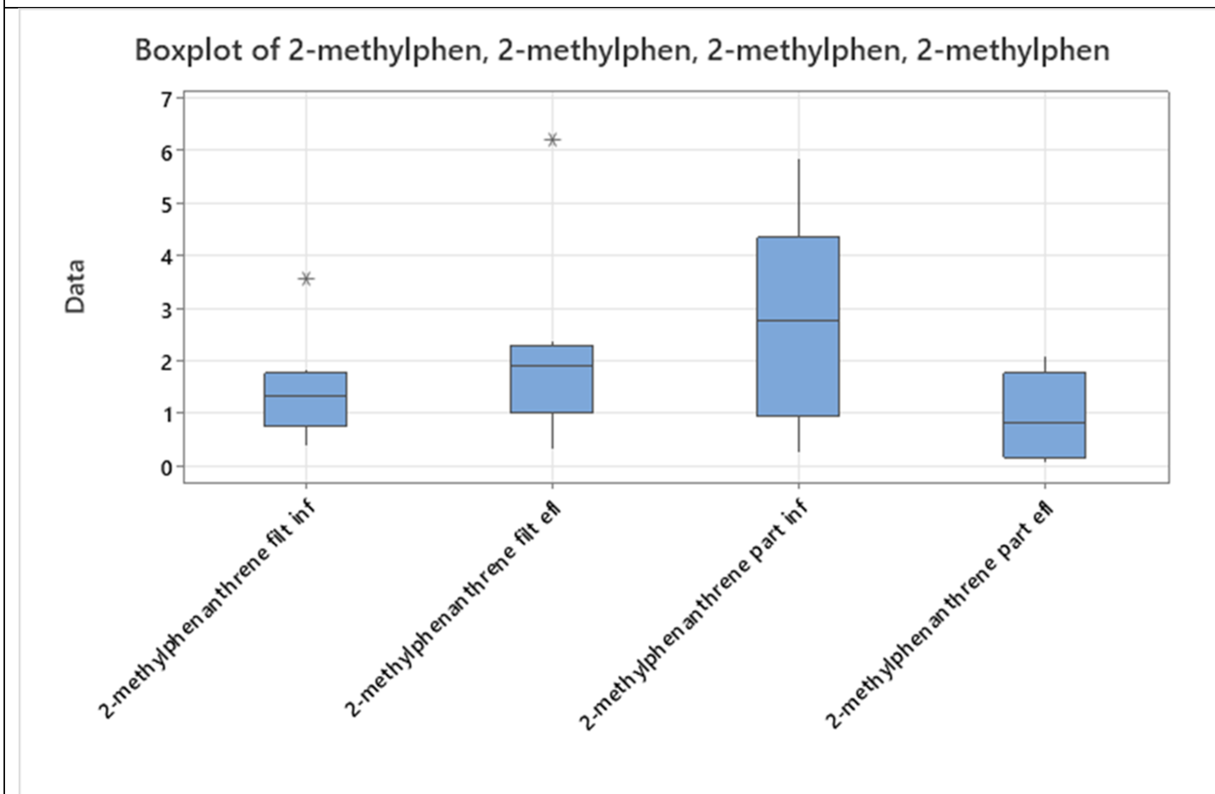


Biofilters and bioswales

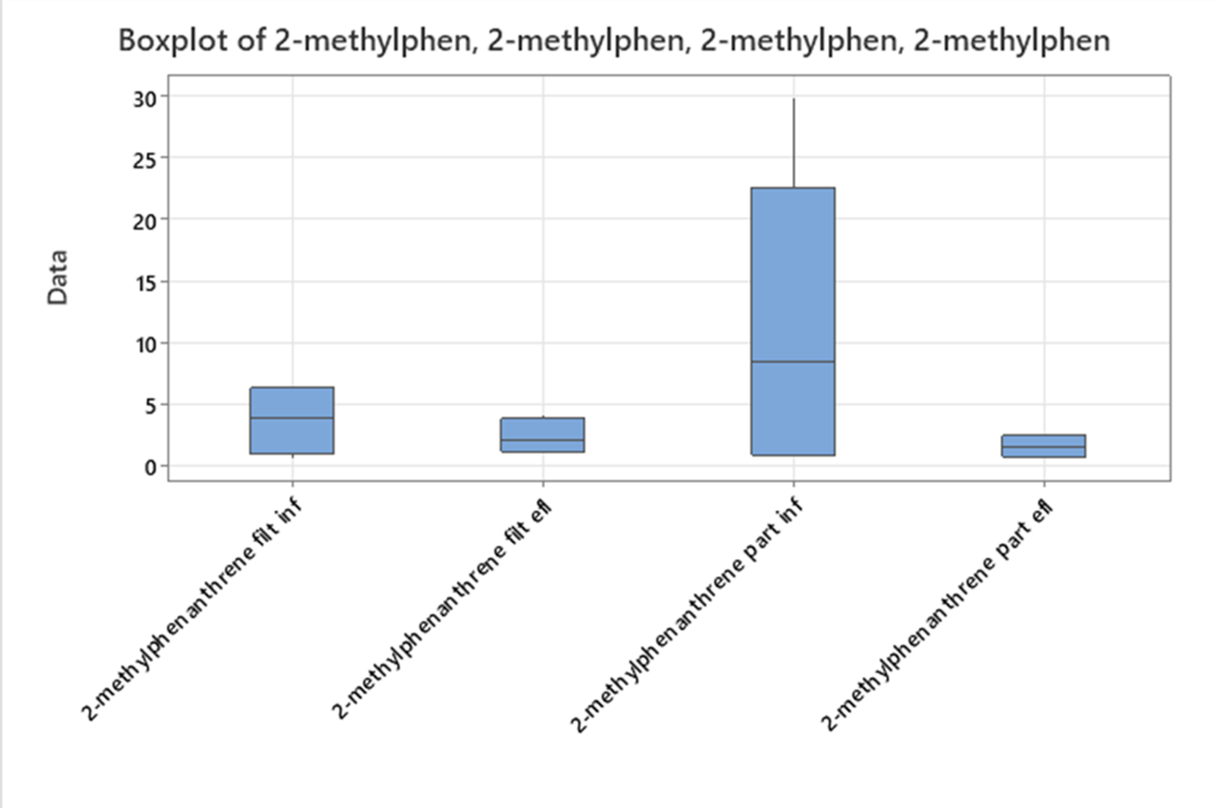
2-methylphenanthrene box and whisker plots



Sedimentation

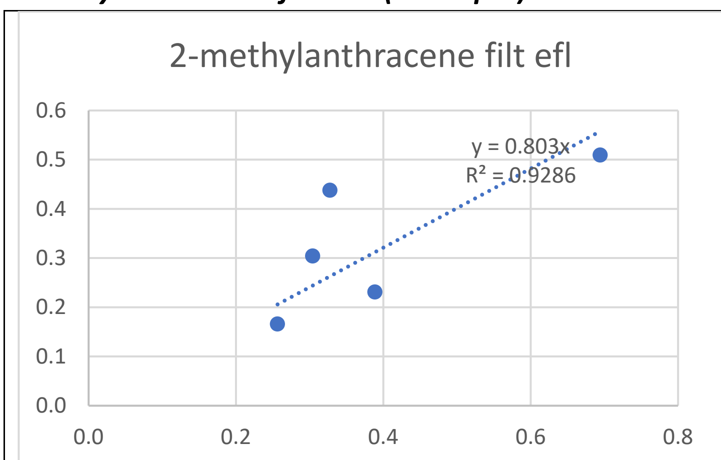


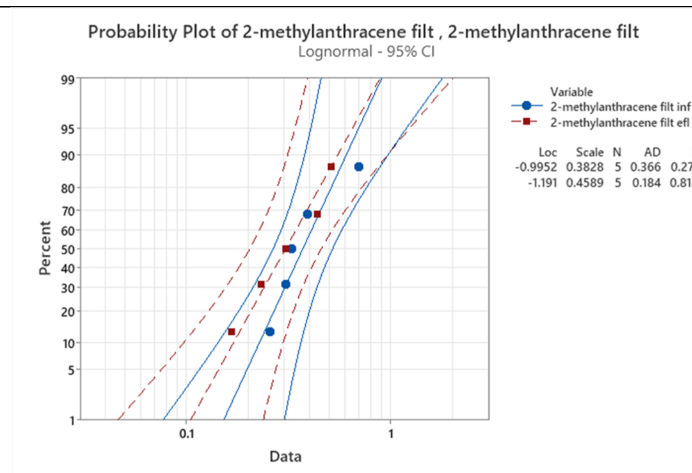
Media Filters



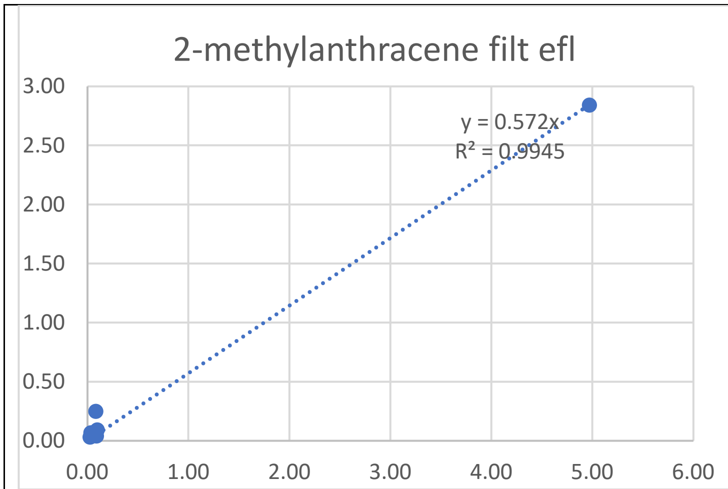
Biofilters and bioswales

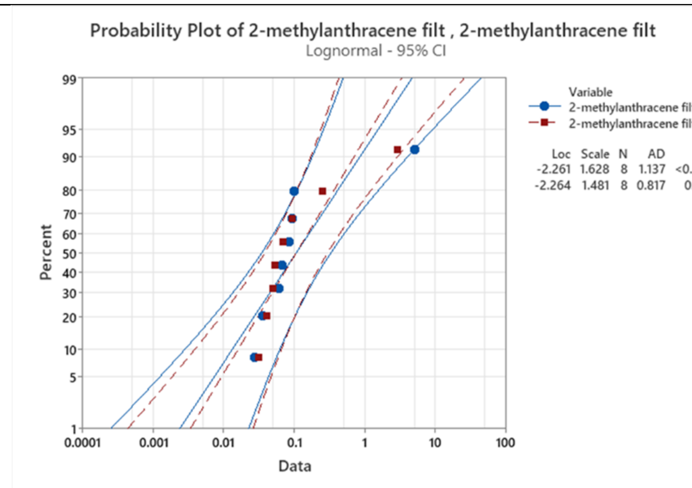
2-methylanthracene filtered (<0.45 µm)



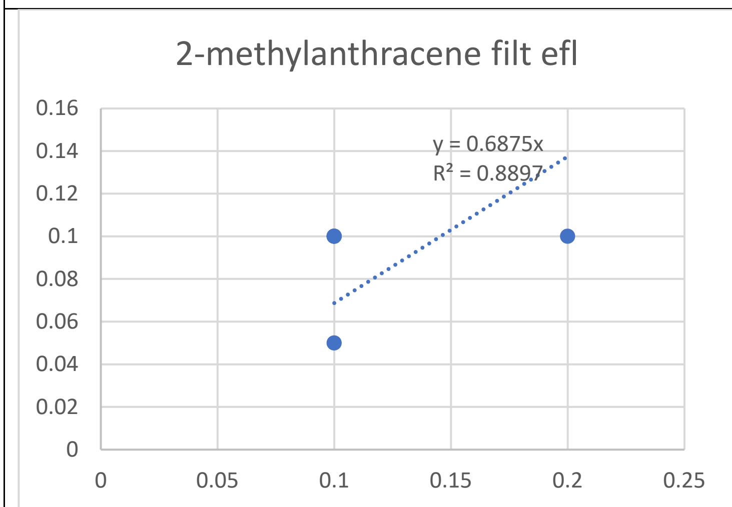


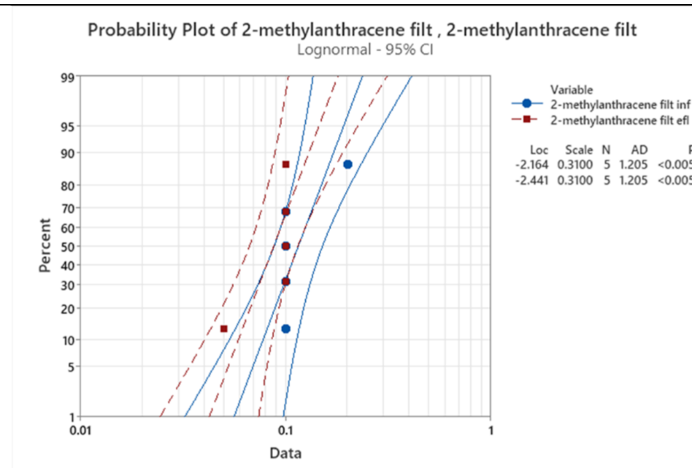
Sedimentation





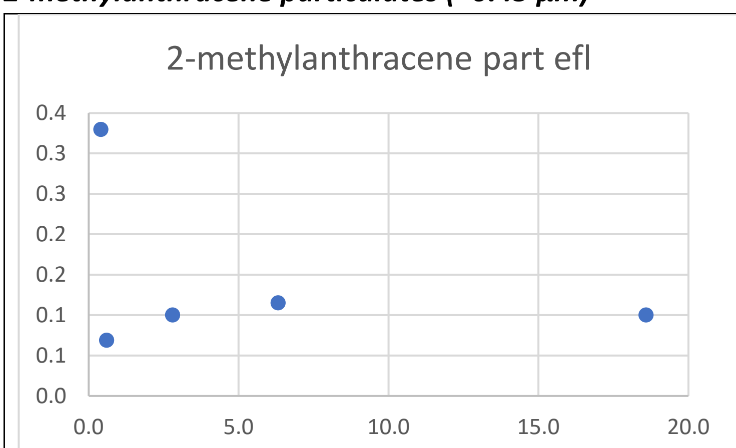
Media Filters



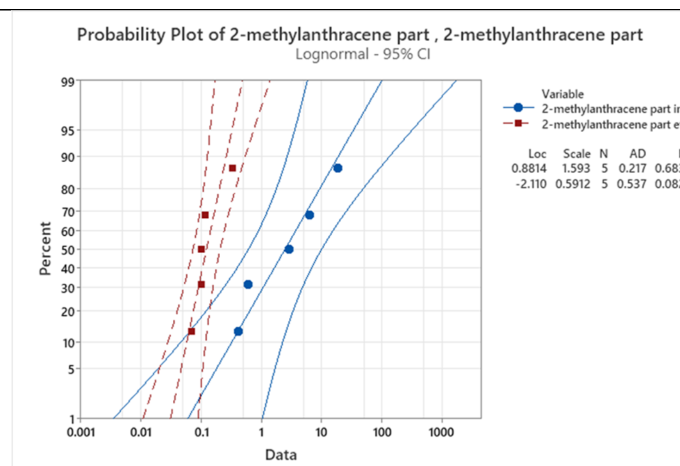


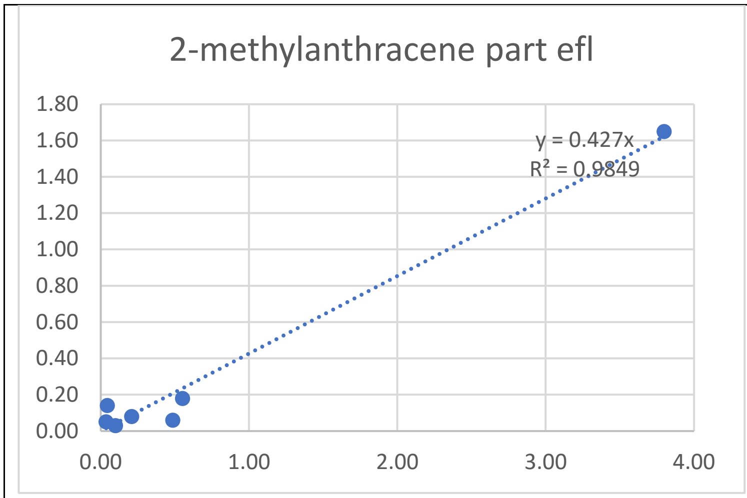
Biofilters and bioswales

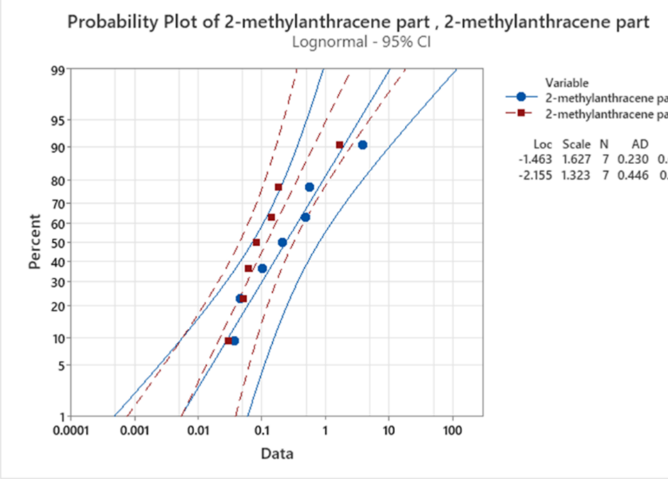
2-methylanthracene particulates (>0.45 µm)



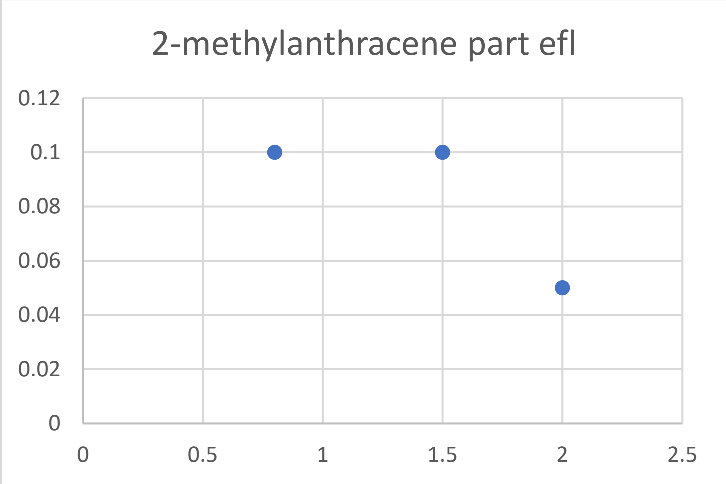
Sedimentation

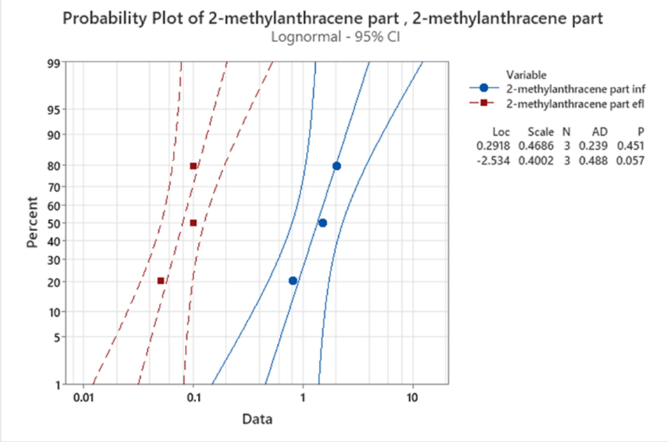






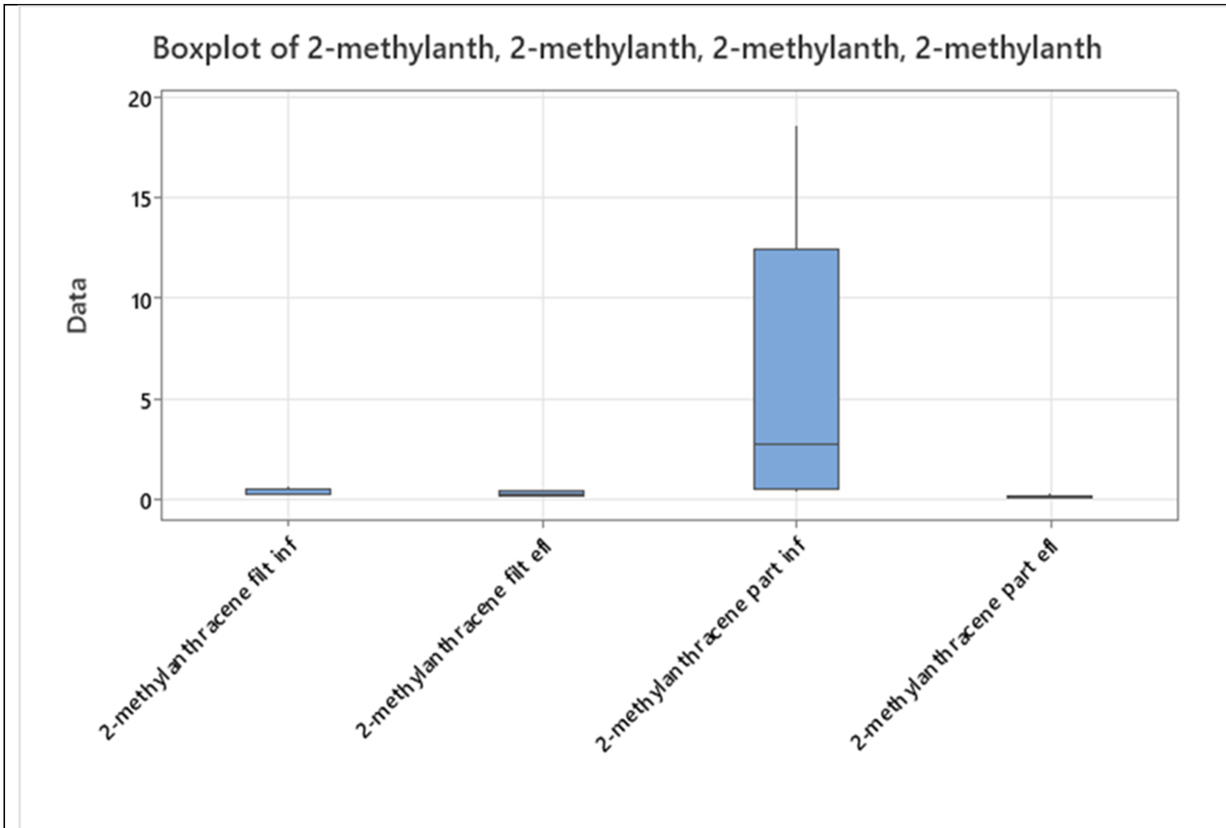
Media Filters



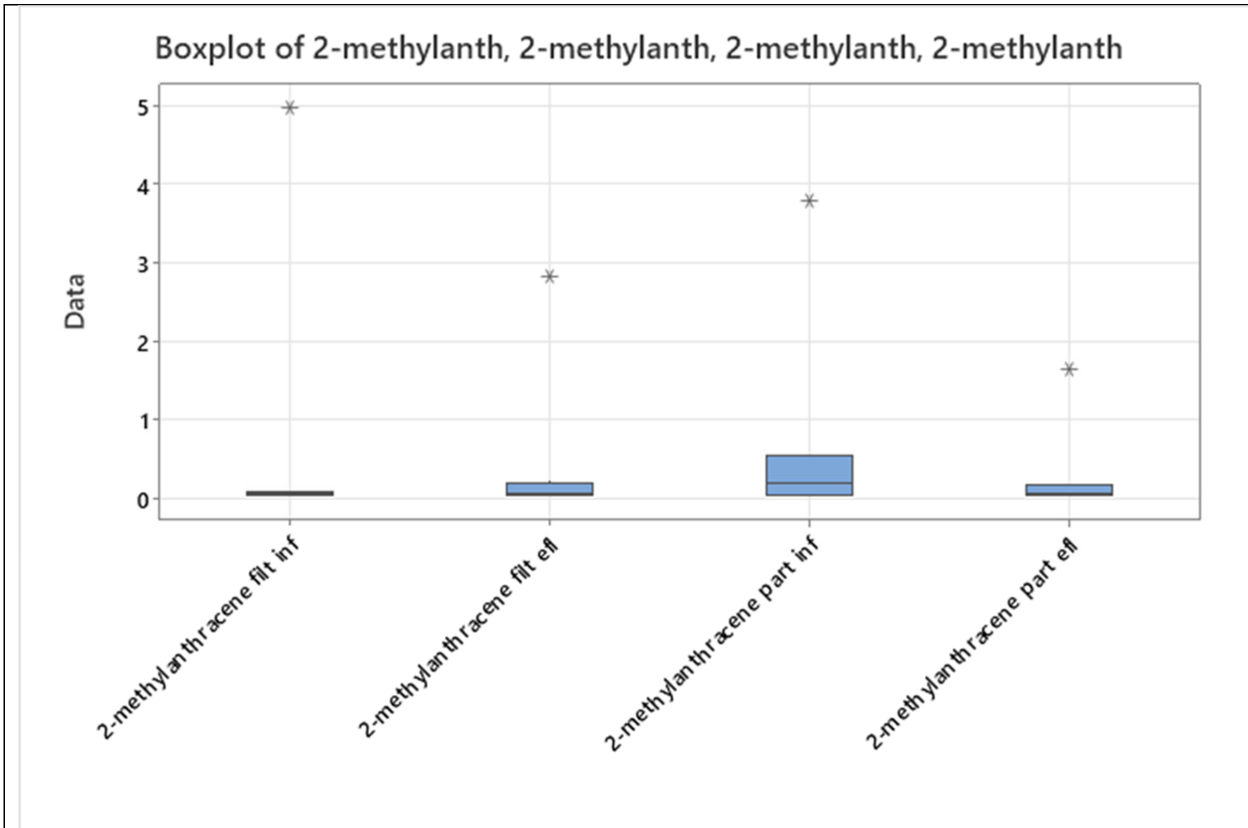


Biofilters and bioswales

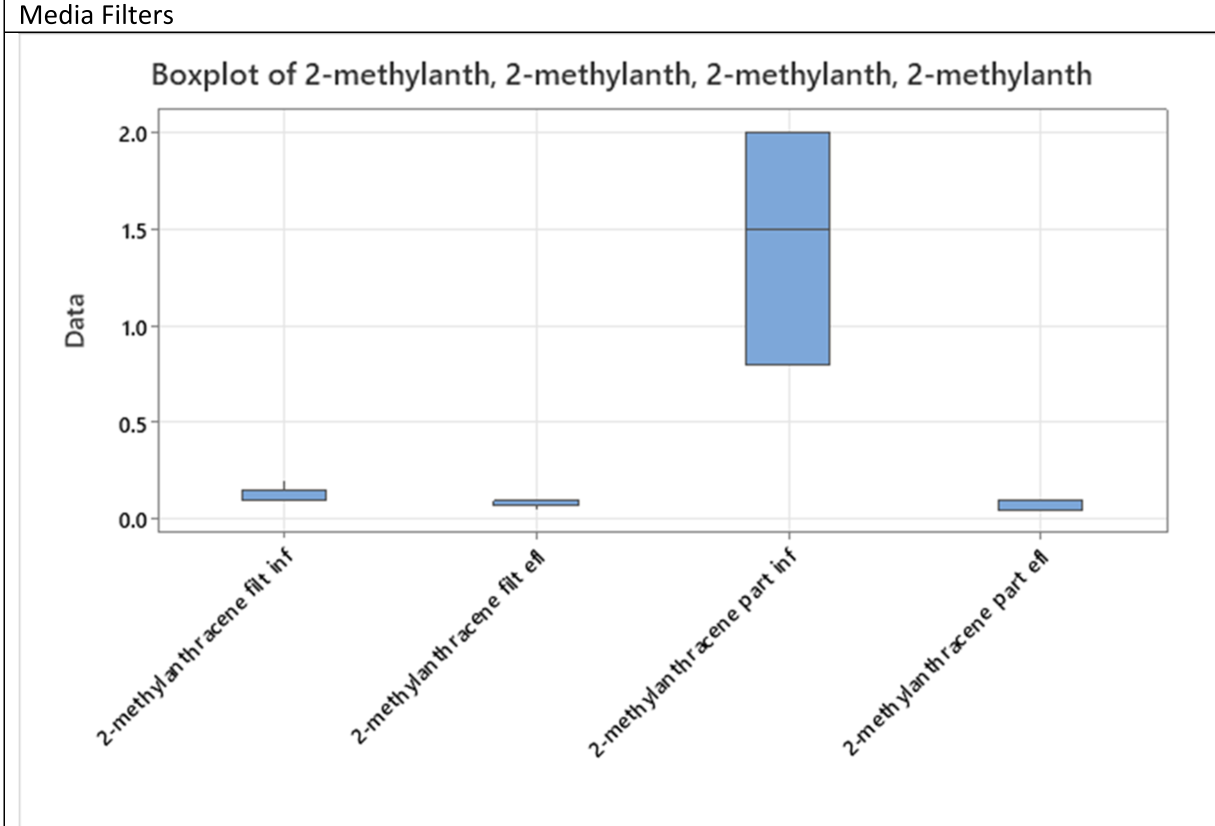
2-methylanthracene box and whisker plots



Sedimentation

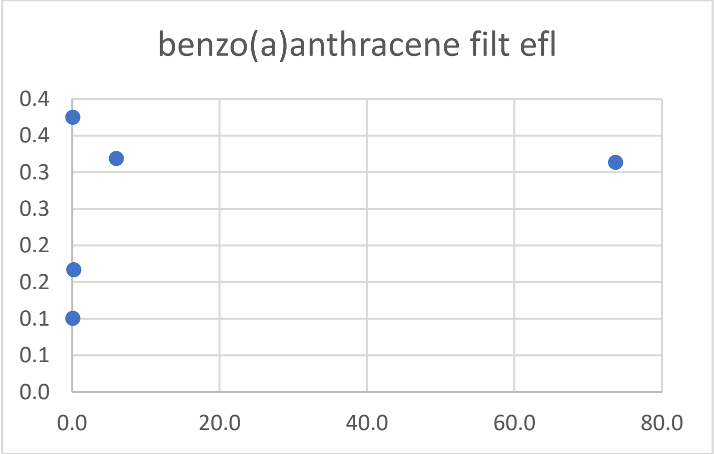


Media Filters

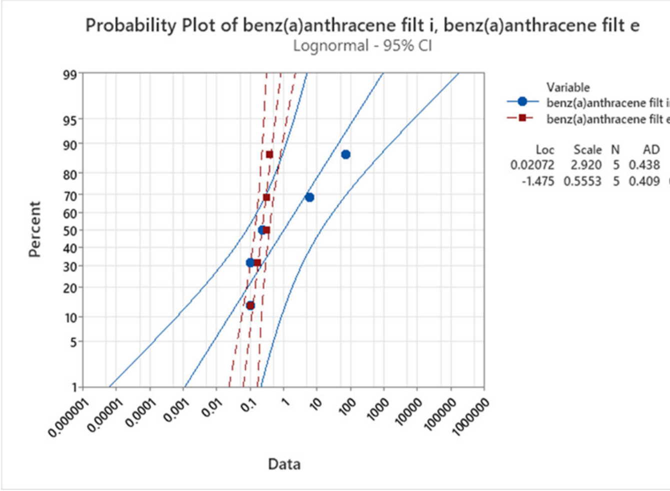


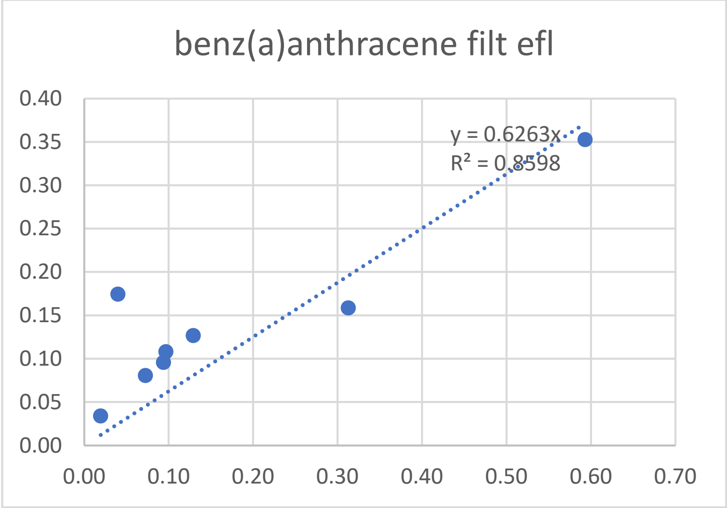
Biofilters and bioswales

Benzo(a)anthracene filtered (<0.45 µm)

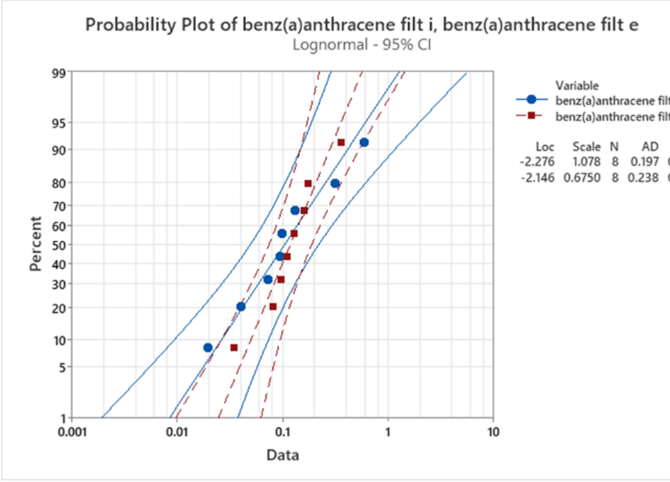


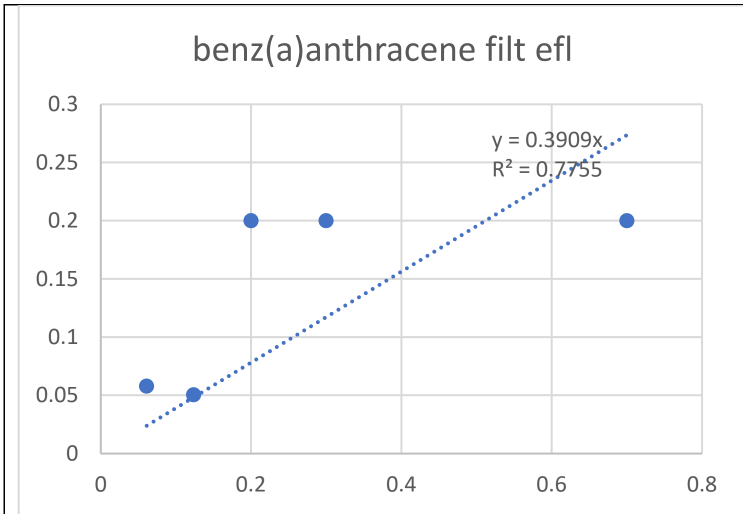
Sedimentation



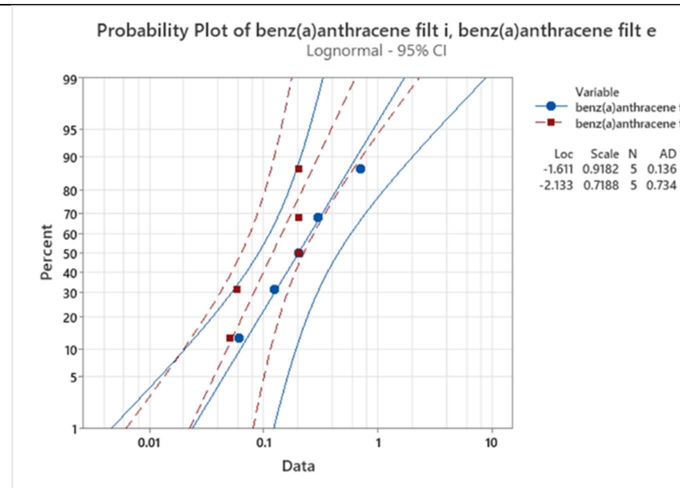


Media Filters

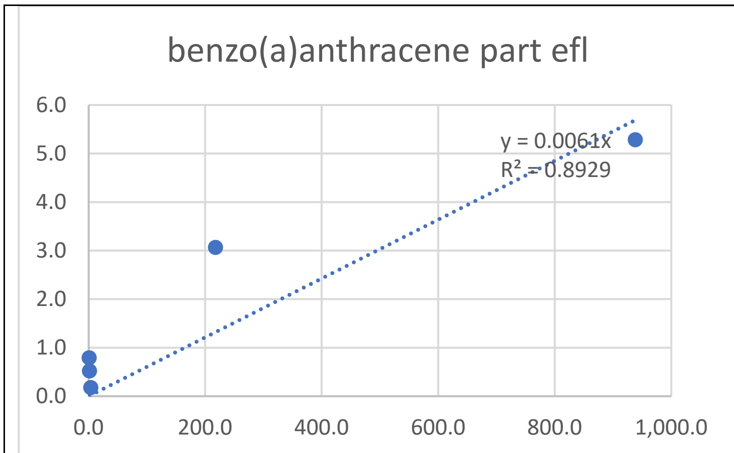




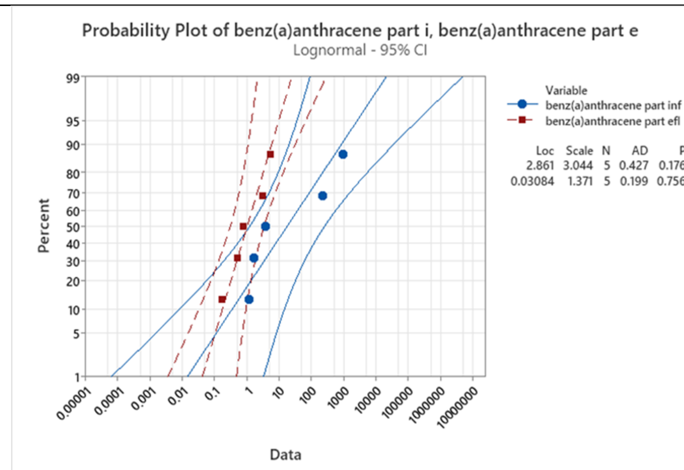
Biofilters and bioswales

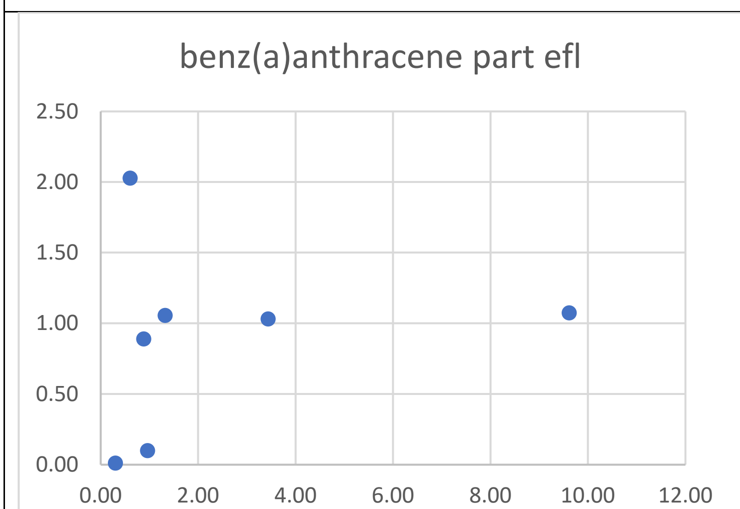


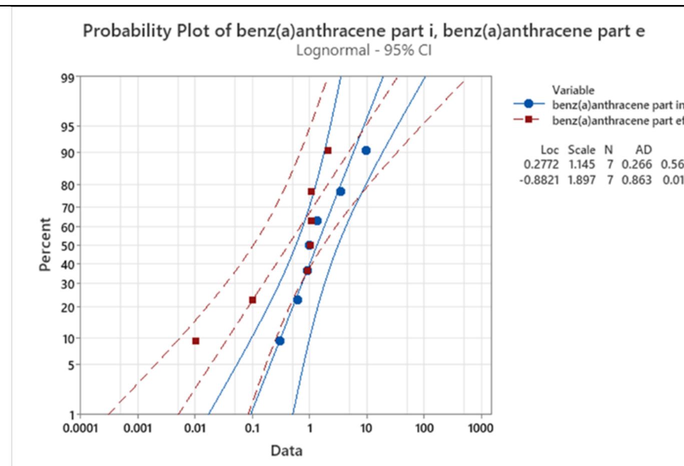
Benzo(a)anthracene particulates (>0.45 µm)



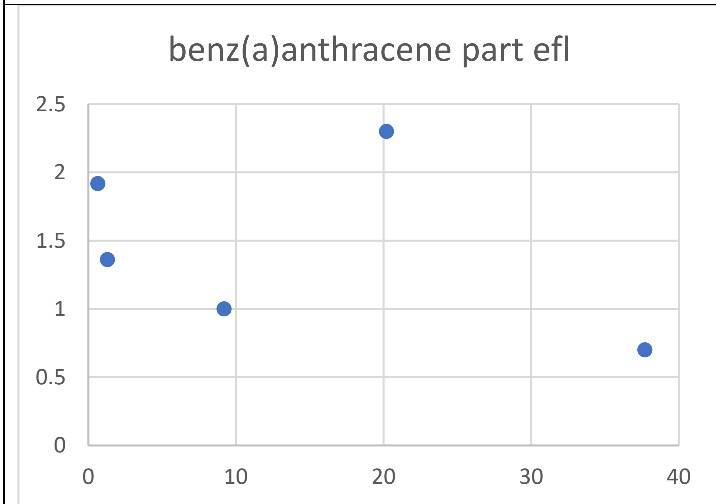
Sedimentation



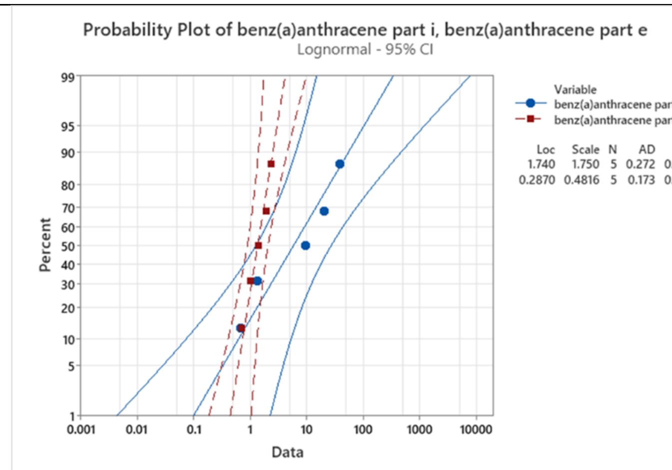




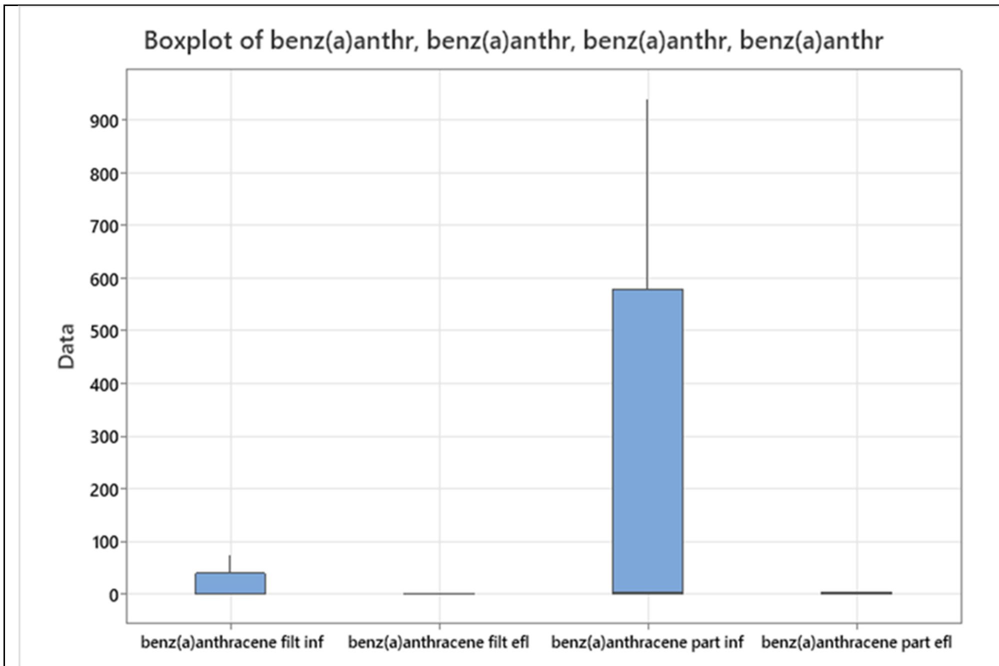
Media Filters



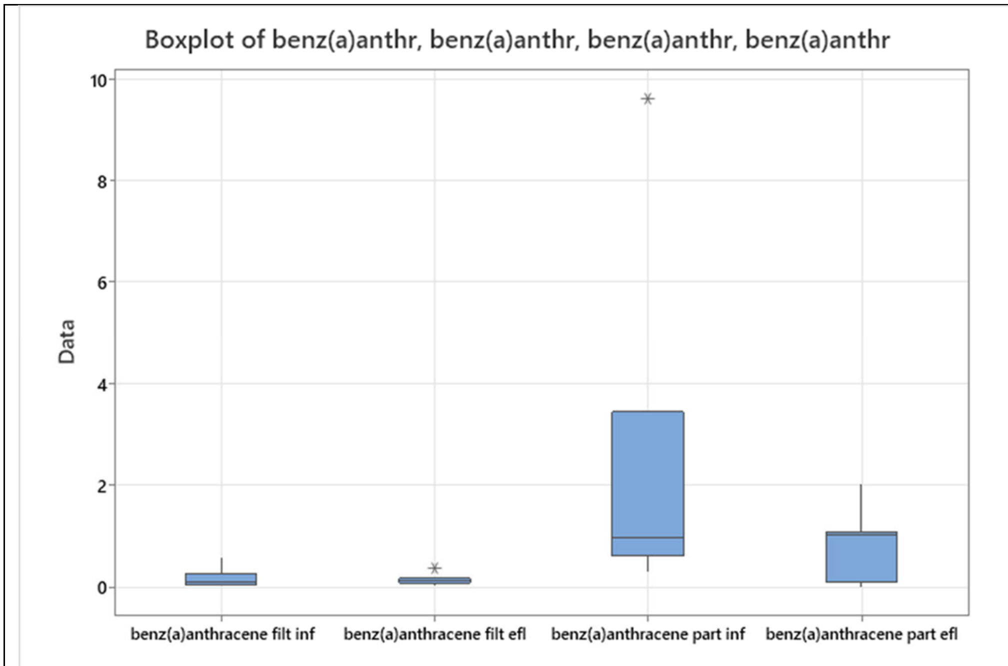
Biofilters and bioswales



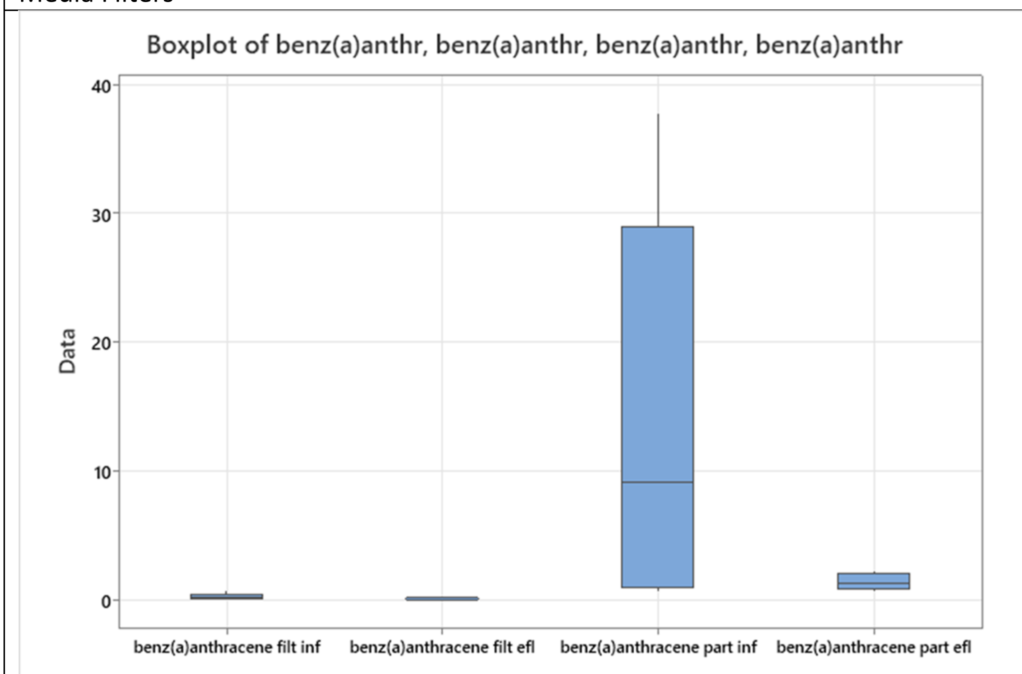
Benzo(a)anthracene box and whisker plots



Sedimentation

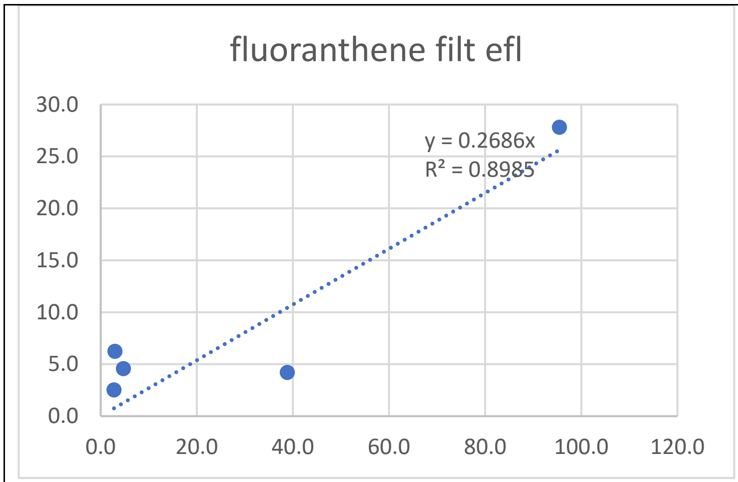


Media Filters

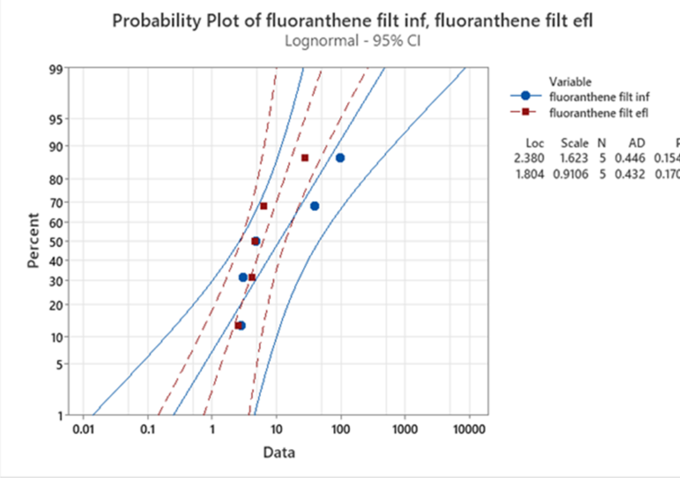


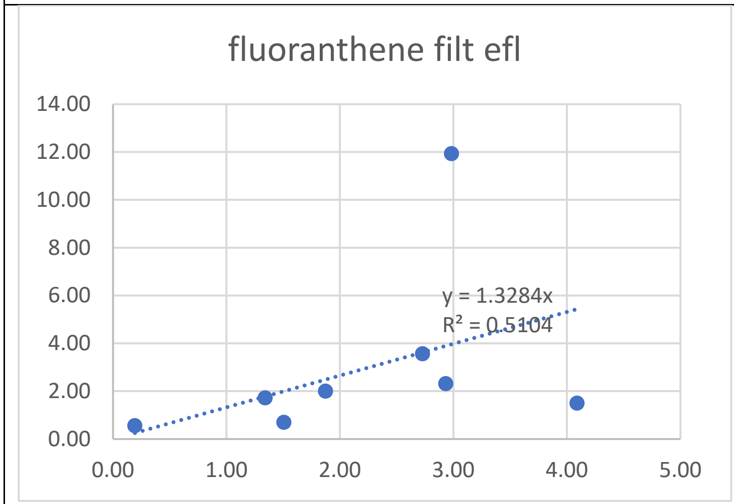
Biofilters and bioswales

Fluoranthene filtered (<0.45 µm)

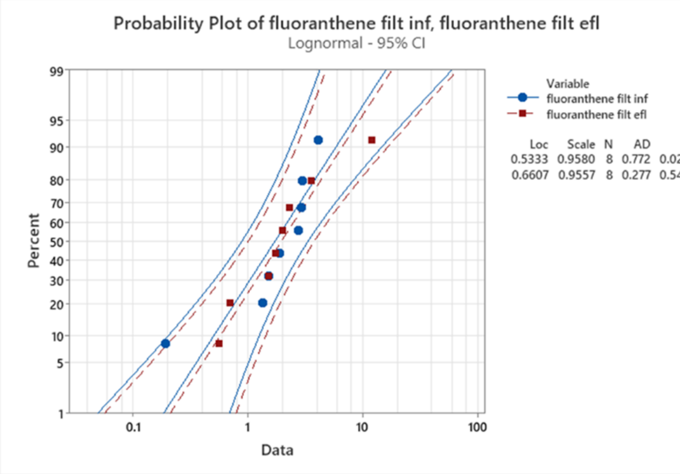


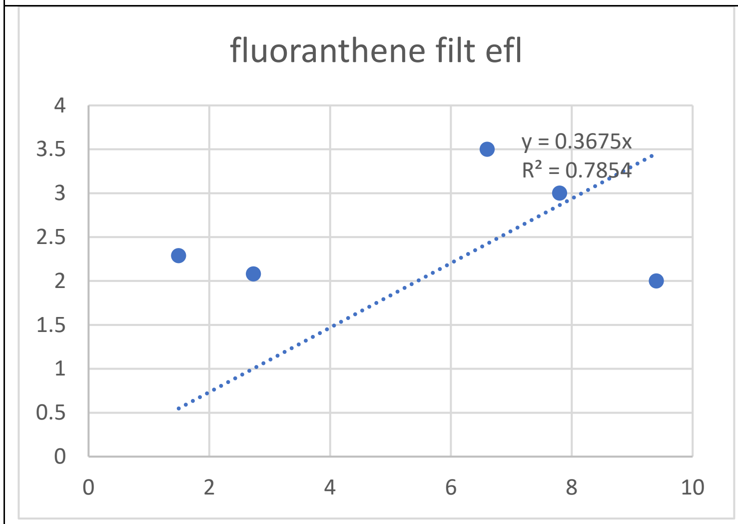
Sedimentation



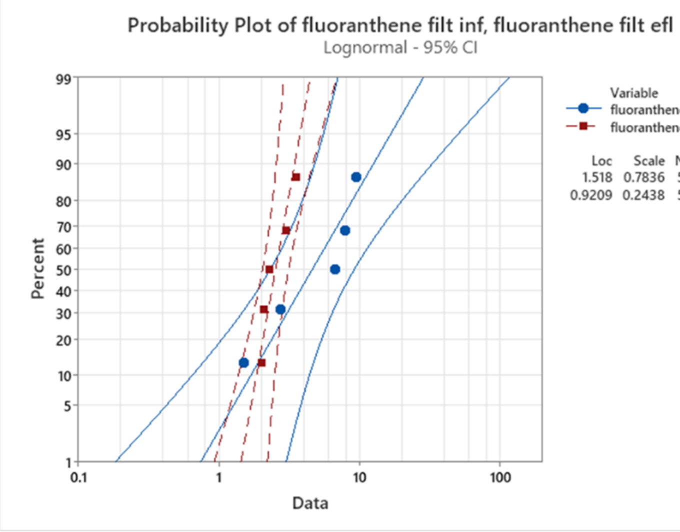


Media Filters

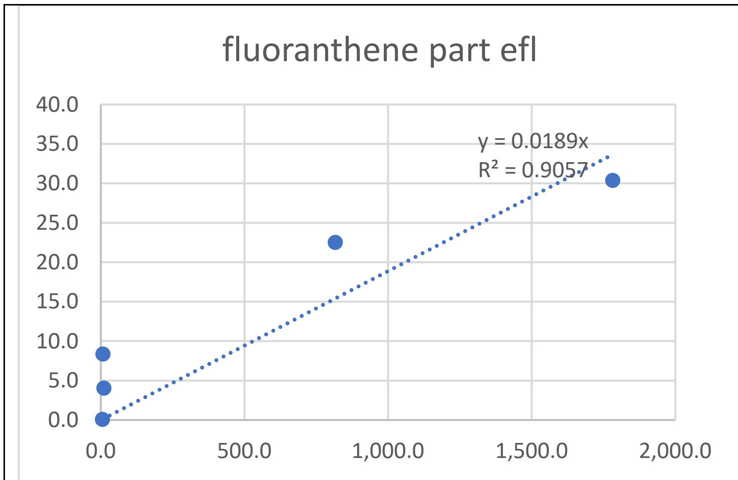




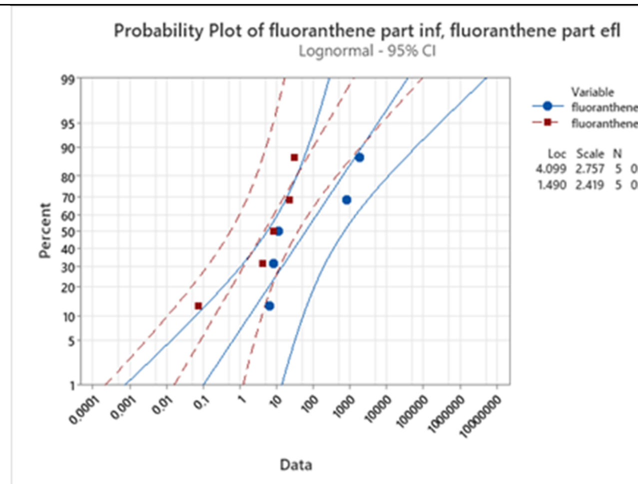
Biofilters and bioswales

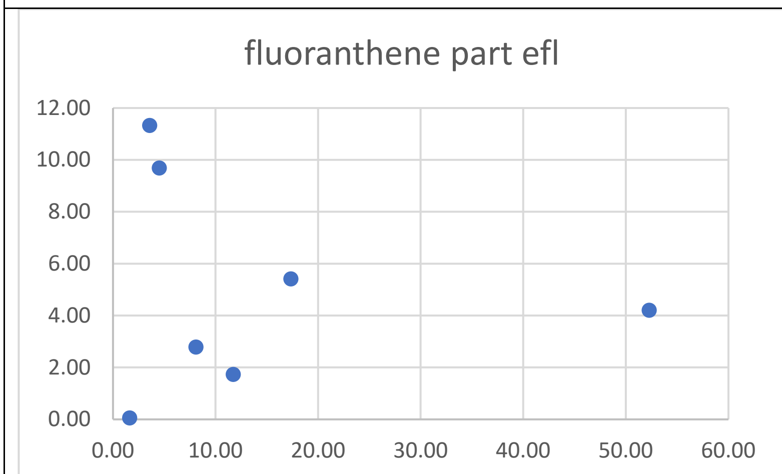


Fluoranthene particulates (>0.45 µm)

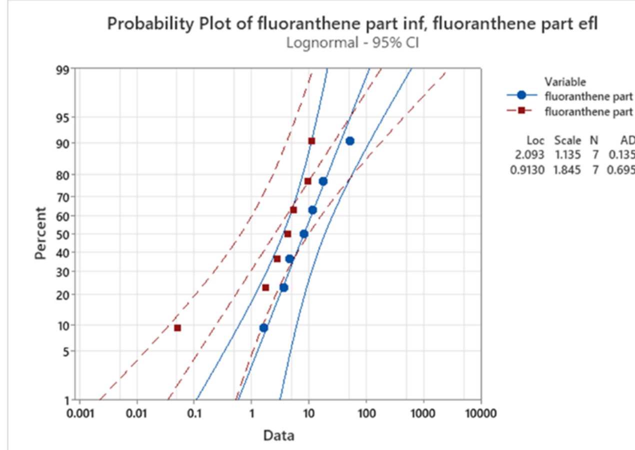


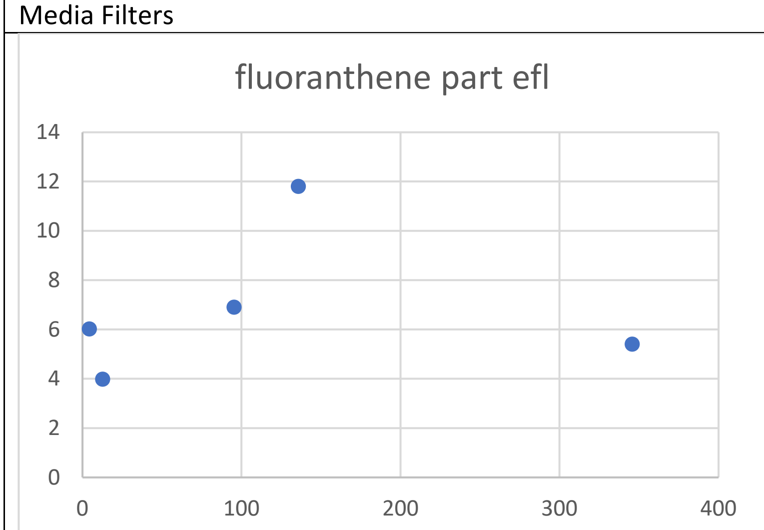
Sedimentation



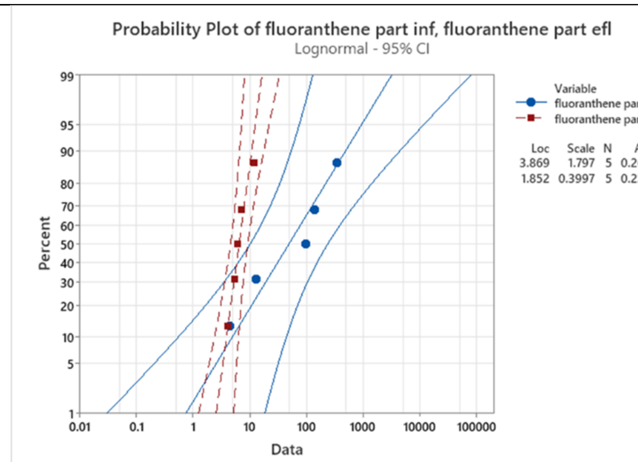


Media Filters

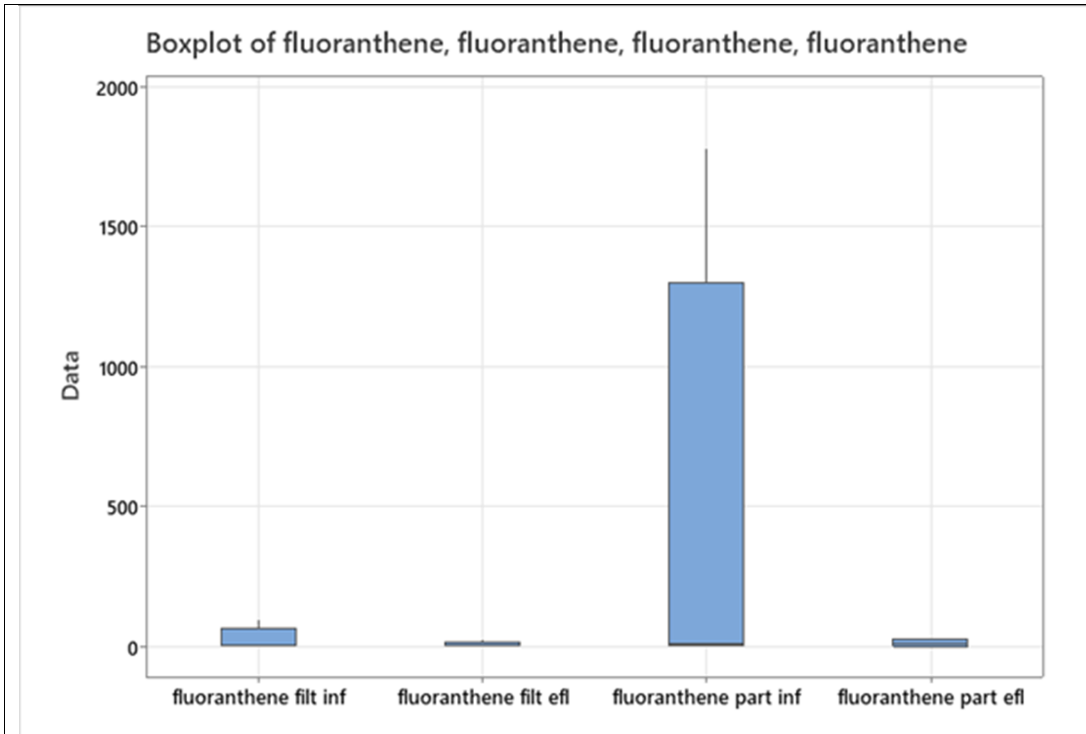




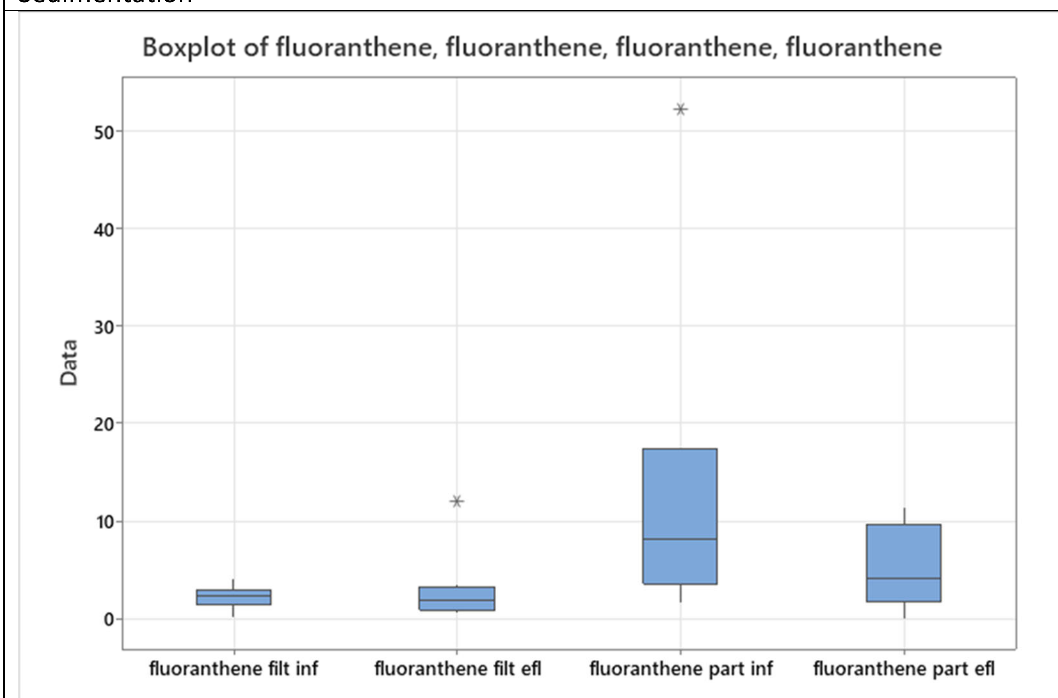
Biofilters and bioswales



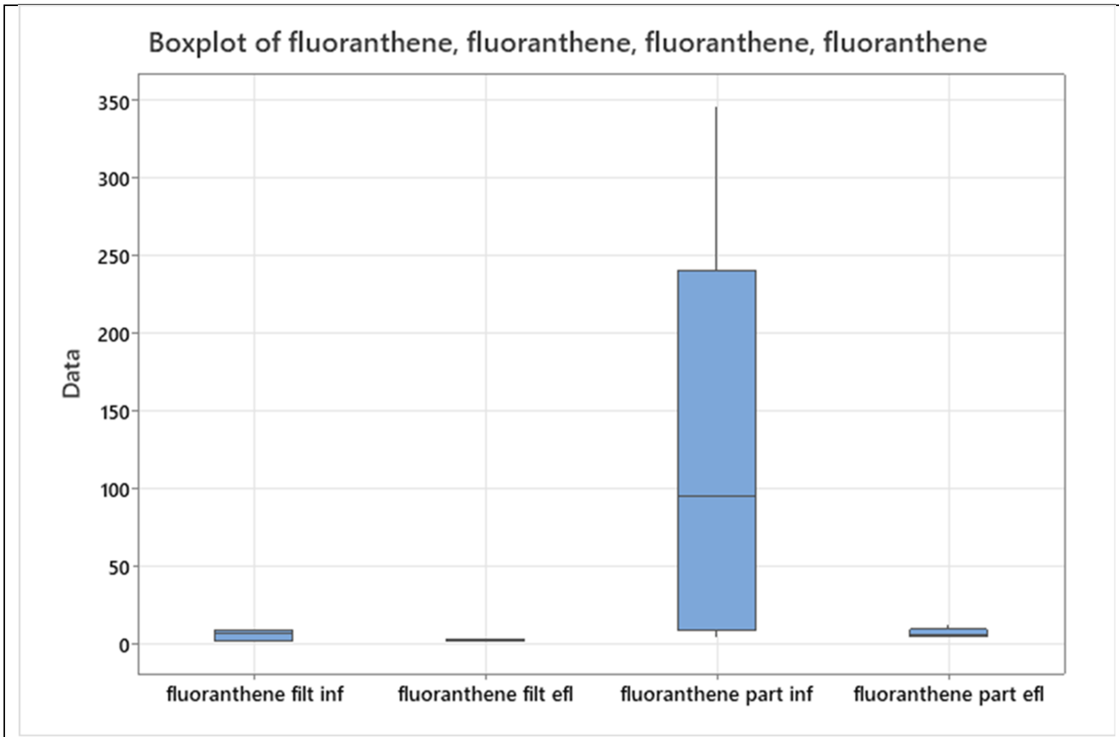
Fluoranthene box and whisker plots



Sedimentation

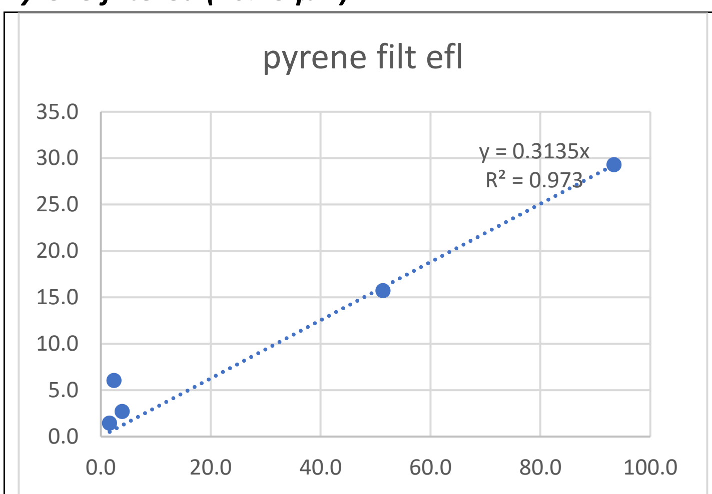


Media Filters

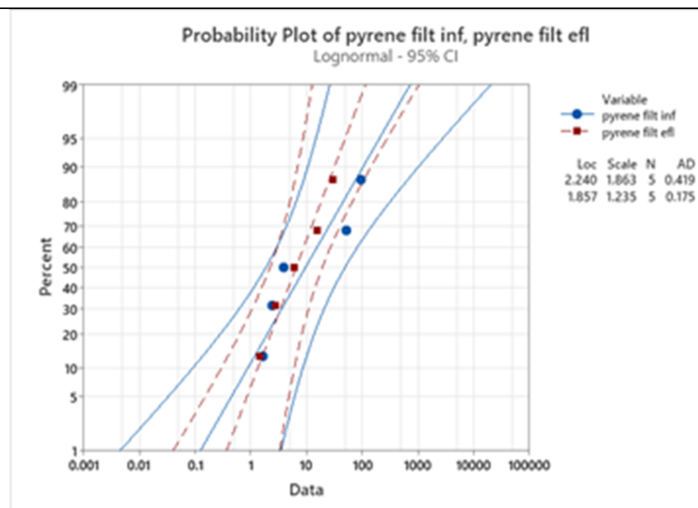


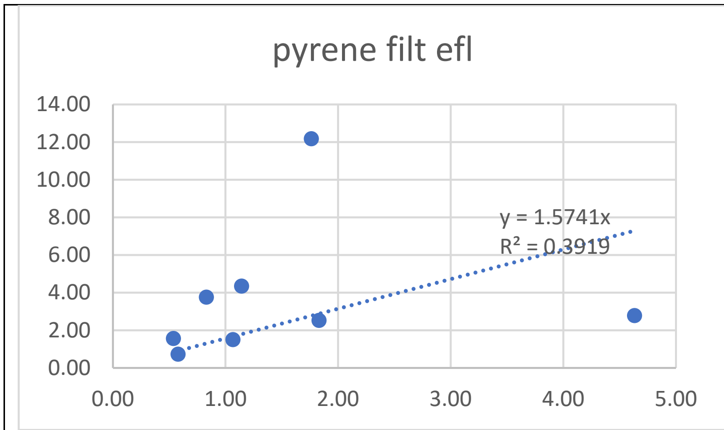
Biofilters and bioswales

Pyrene filtered (<0.45 µm)

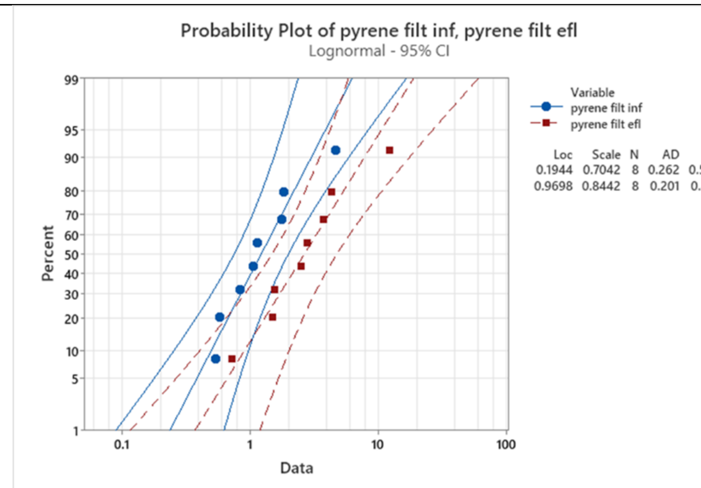


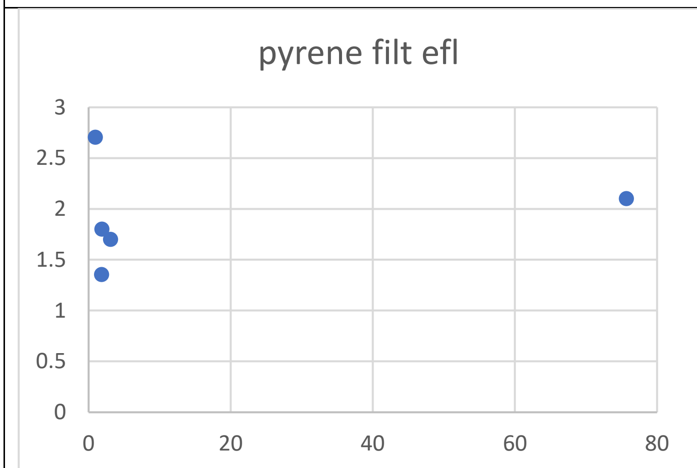
Sedimentation



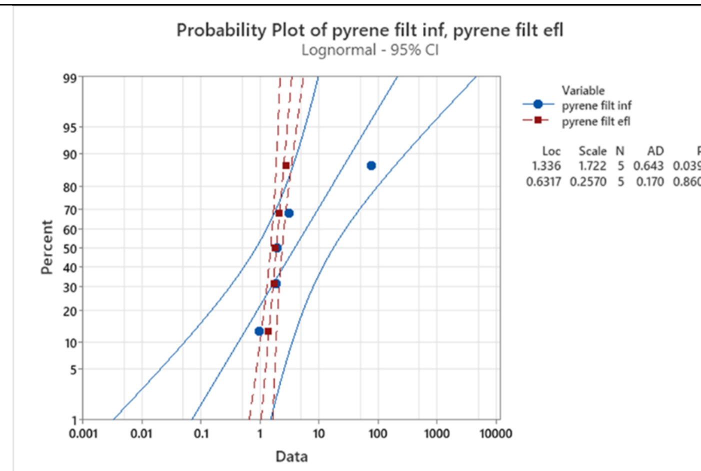


Media Filters

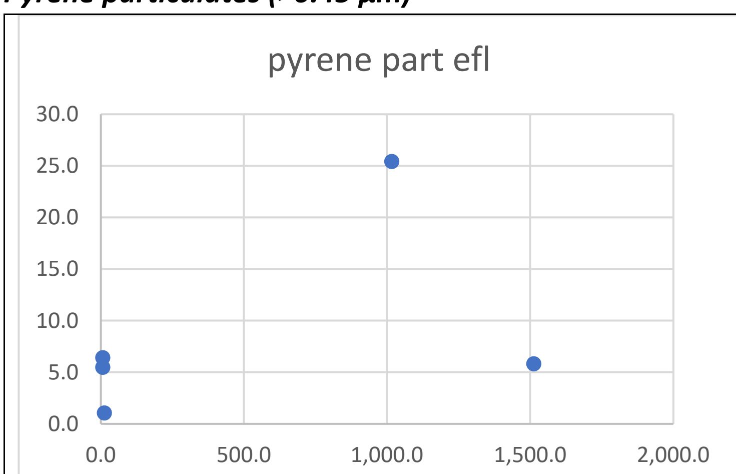




Biofilters and bioswales



Pyrene particulates (>0.45 µm)



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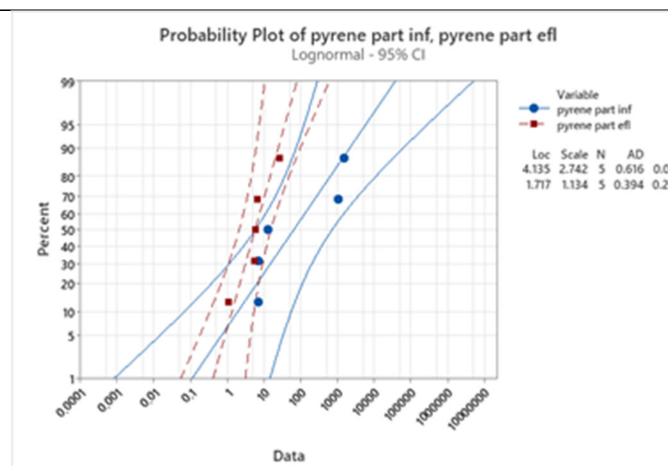
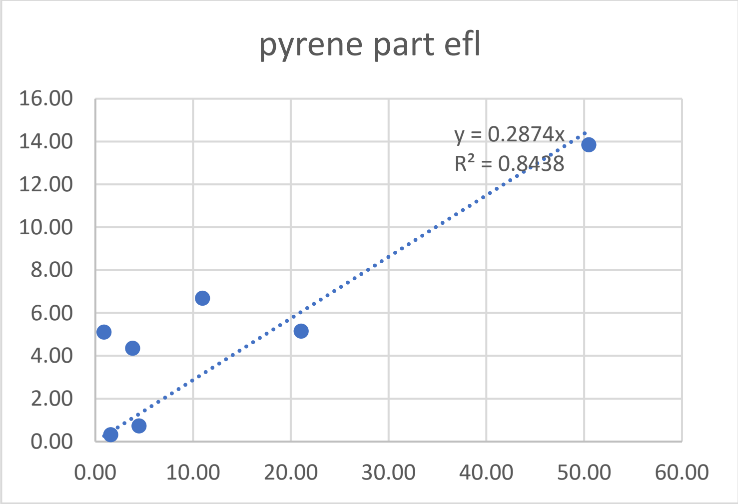
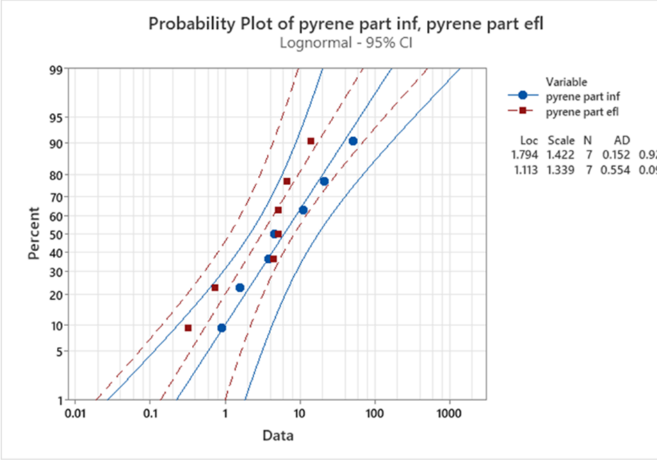
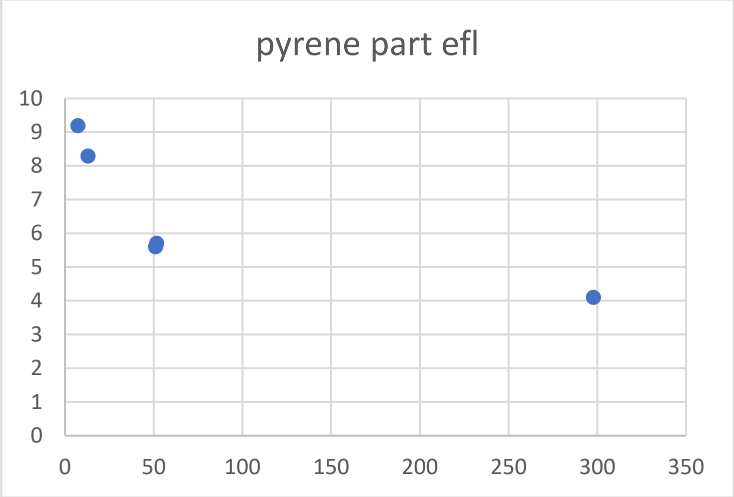
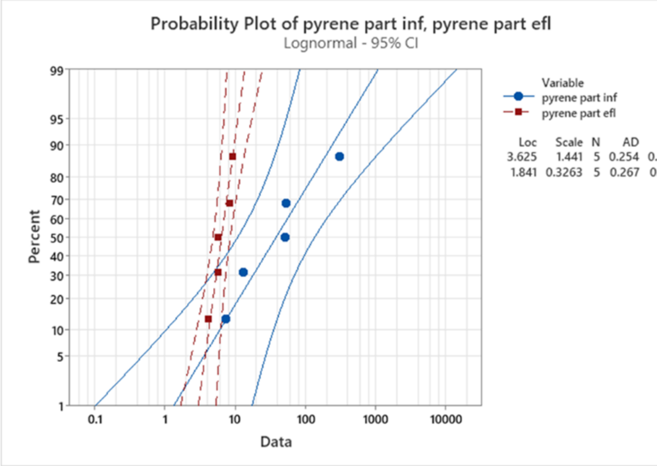






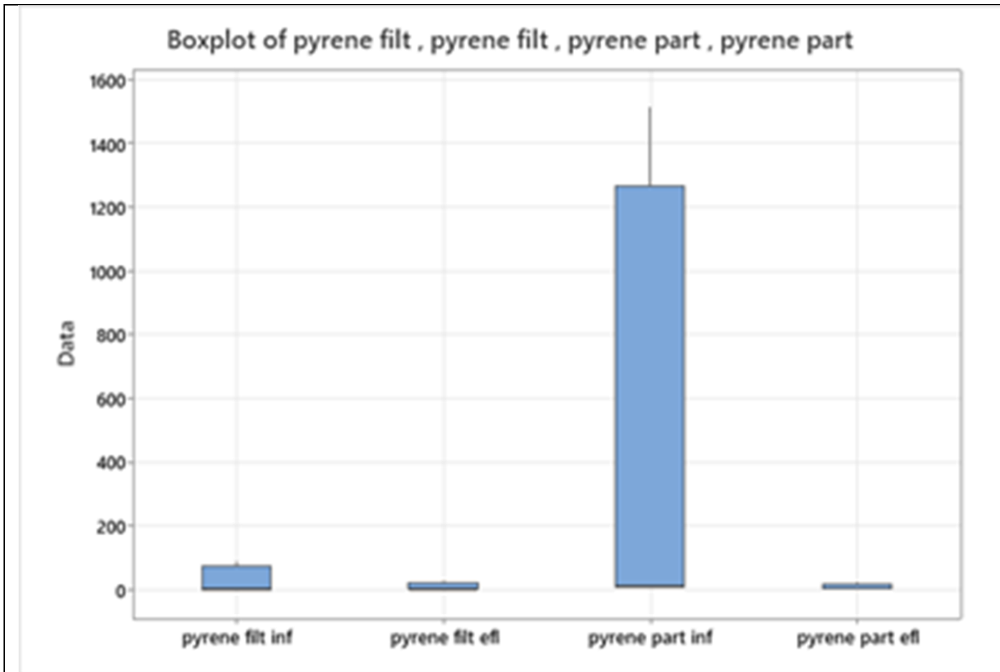
Media Filters



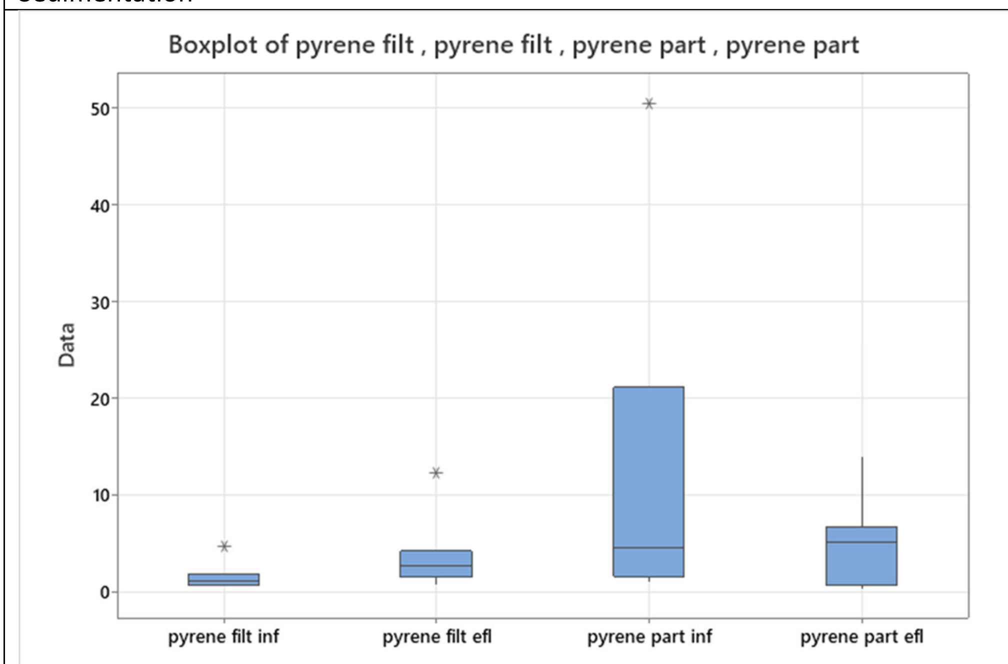


Biofilters and bioswales

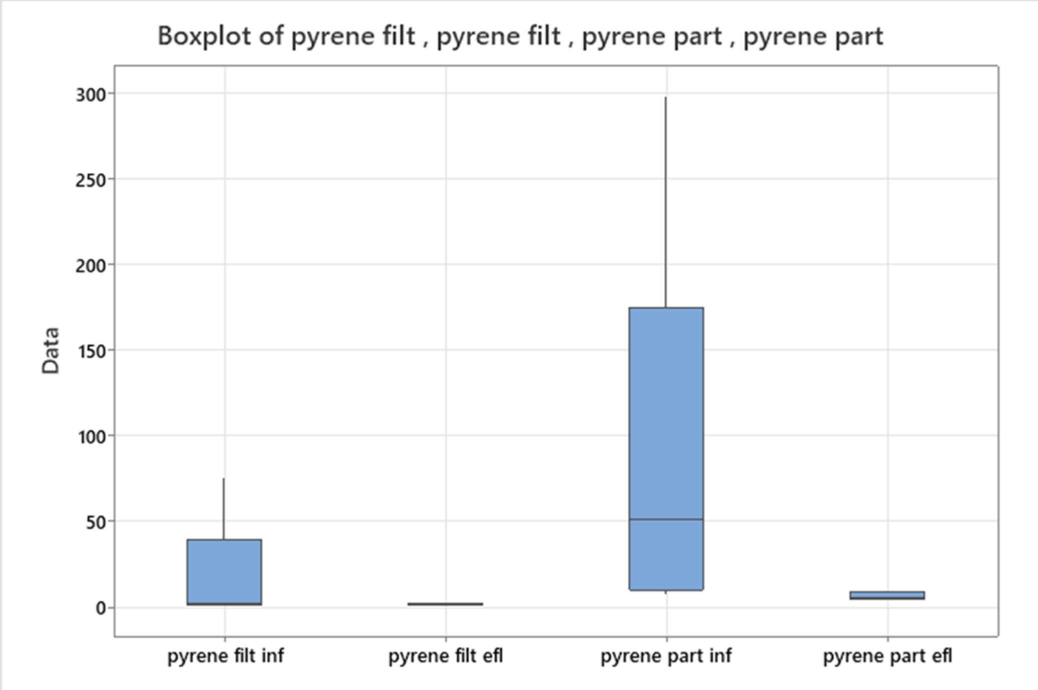
Pyrene box and whisker plots



Sedimentation

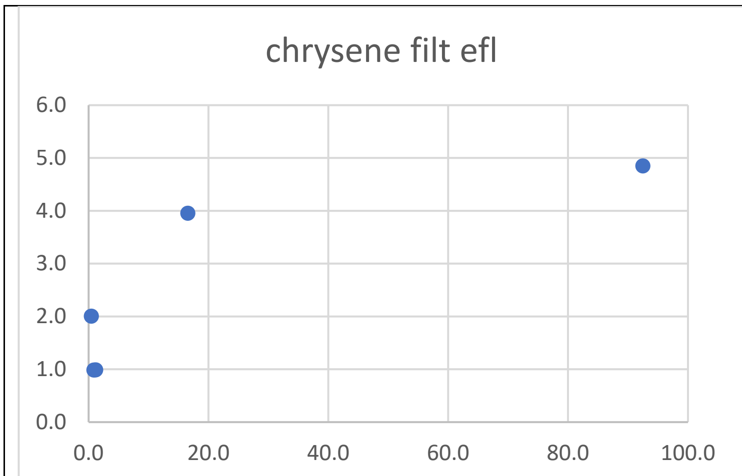


Media Filters

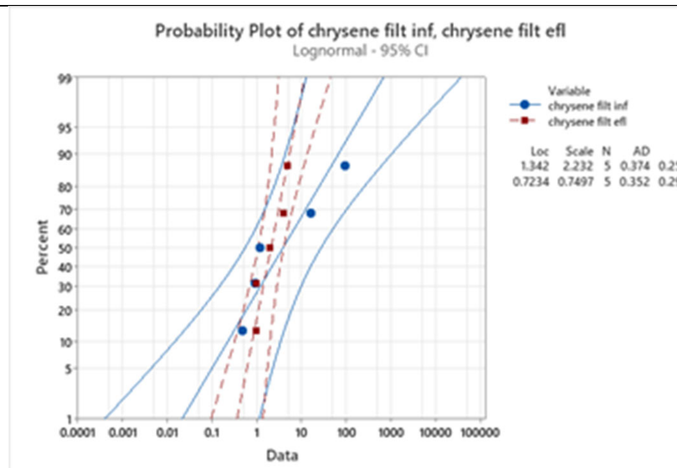


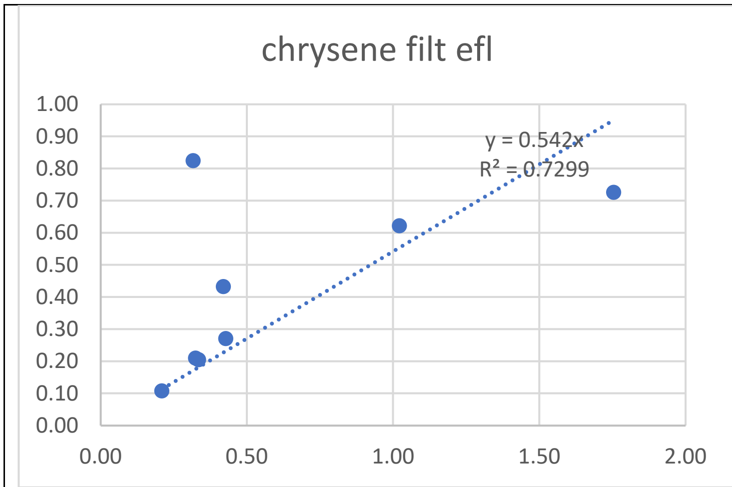
Biofilters and bioswales

Chrysene filtered (<0.45 µm)

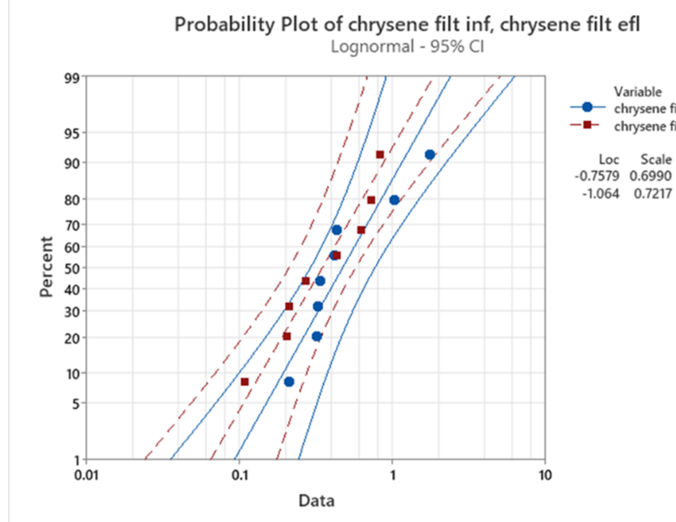


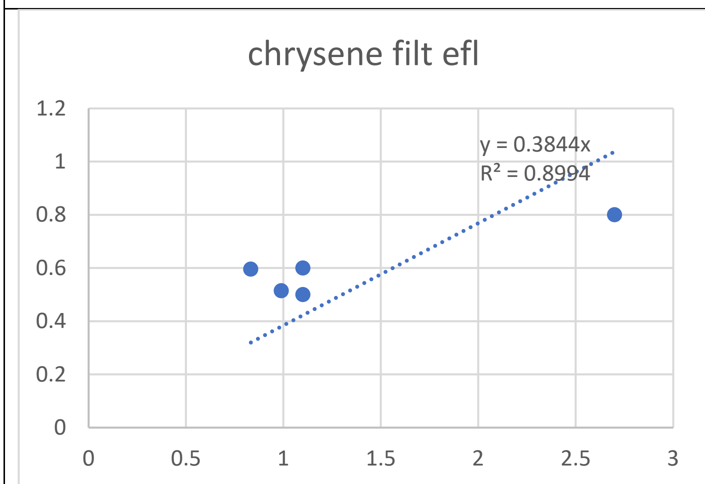
Sedimentation



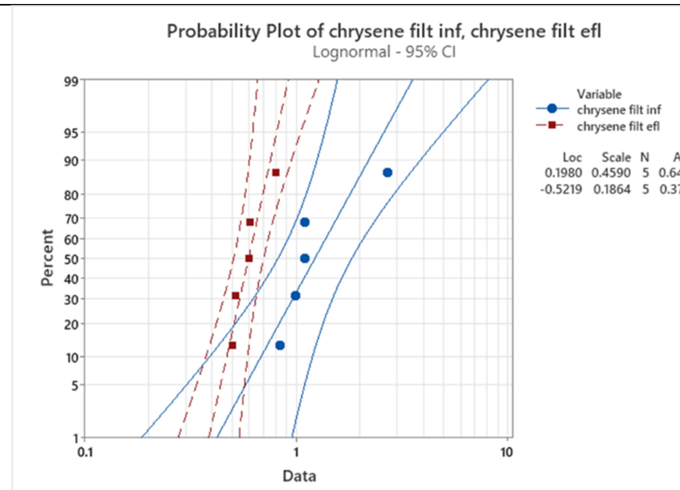


Media Filters

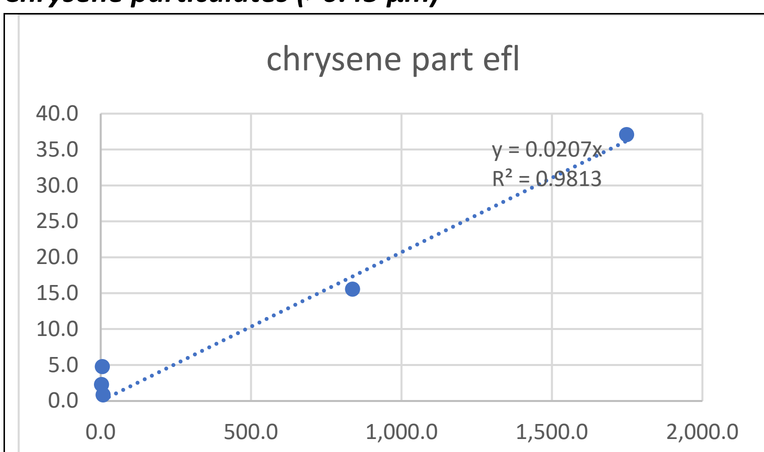




Biofilters and bioswales



Chrysene particulates (>0.45 µm)



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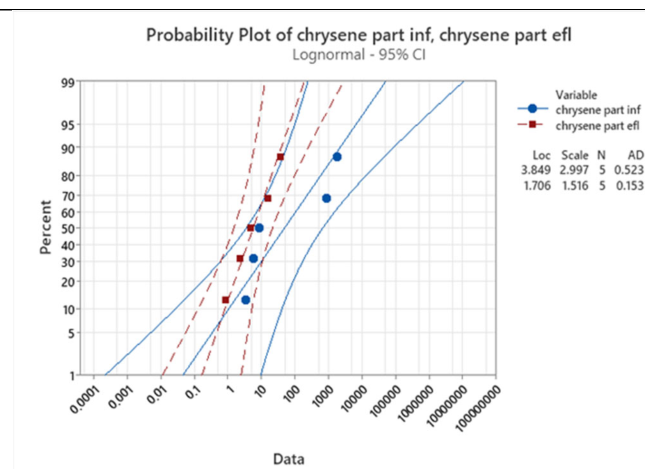
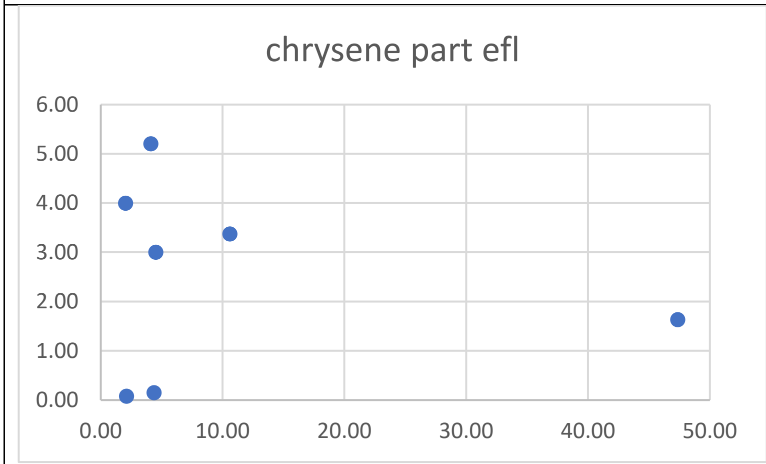
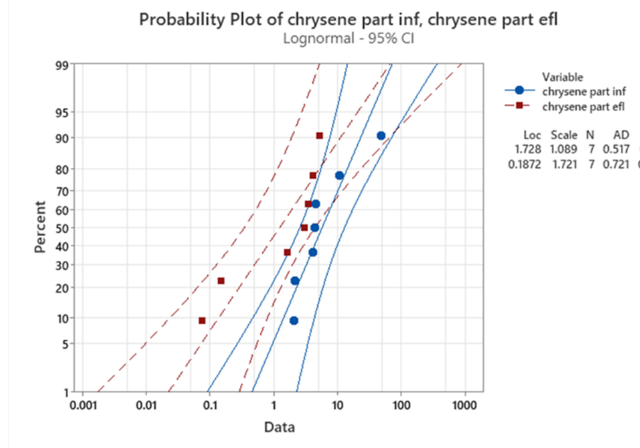
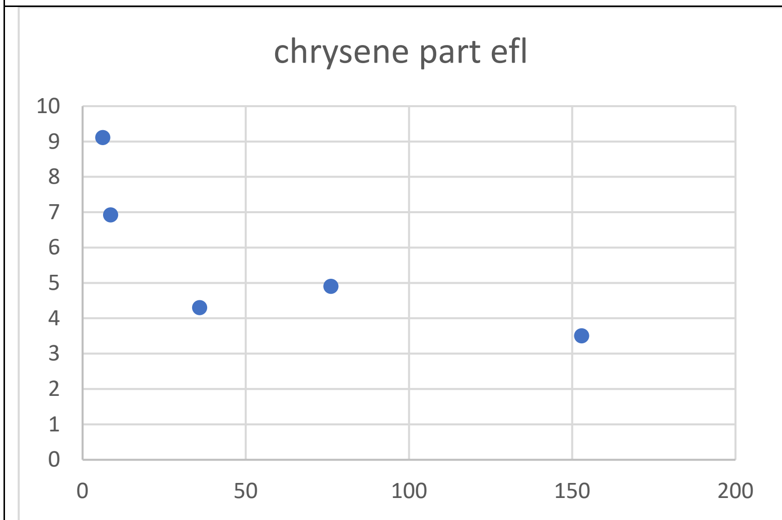


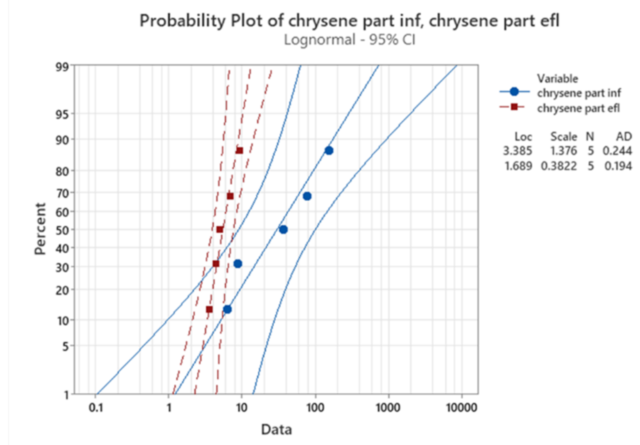


Media Filters

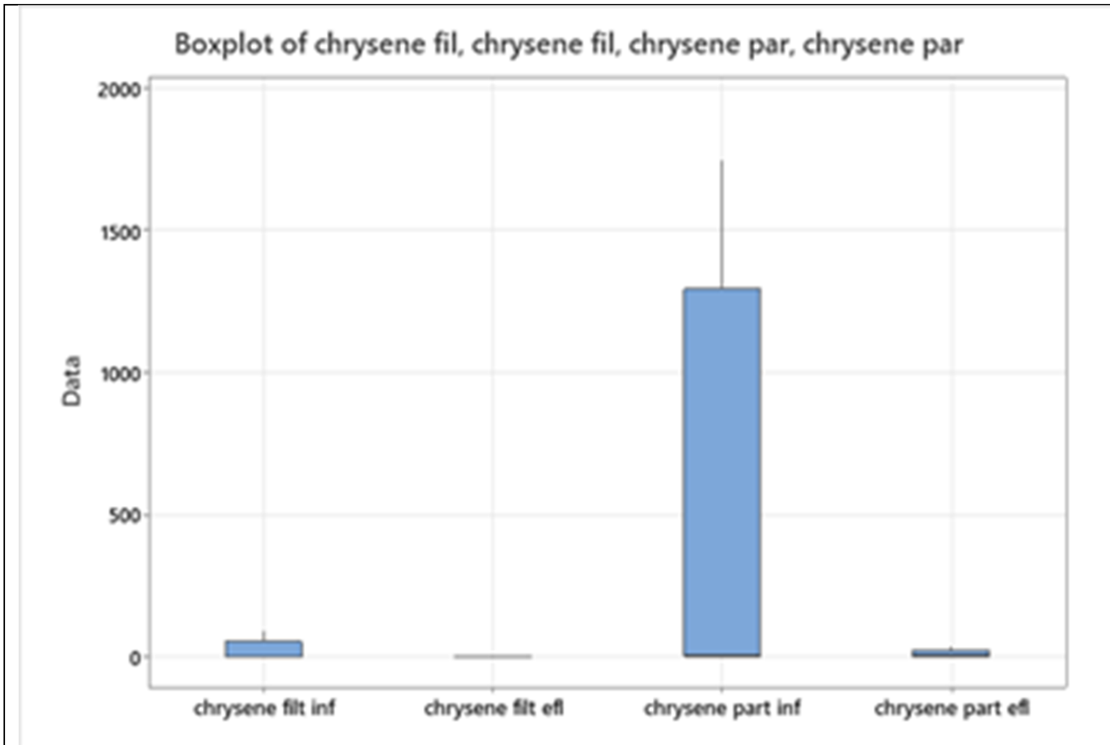




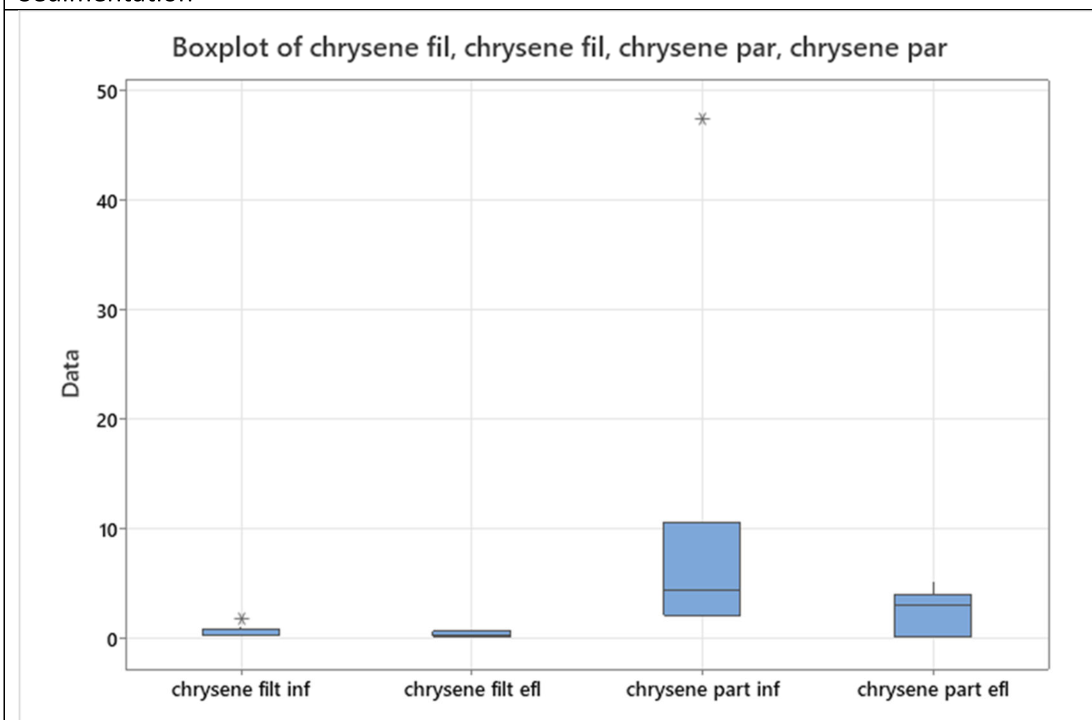
Biofilters and bioswales



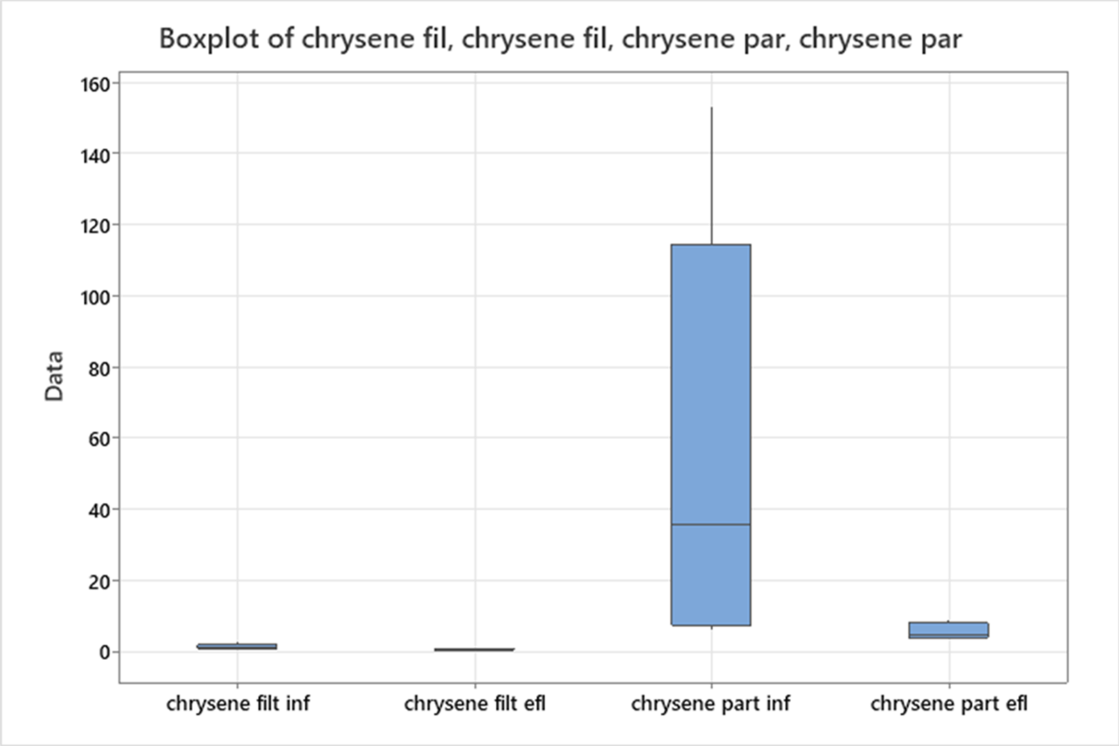
Chrysene box and whisker plots



Sedimentation

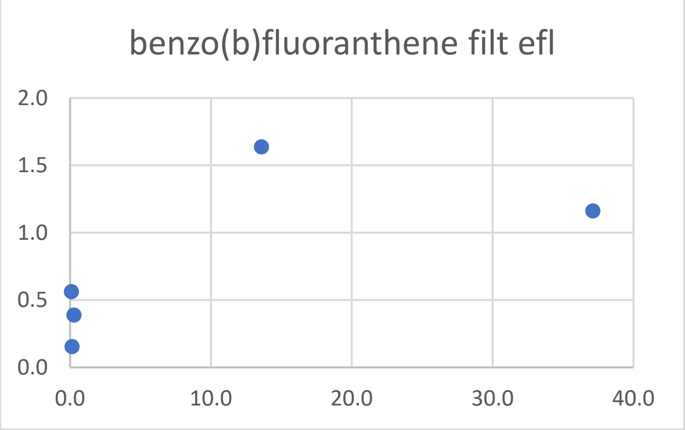


Media Filters

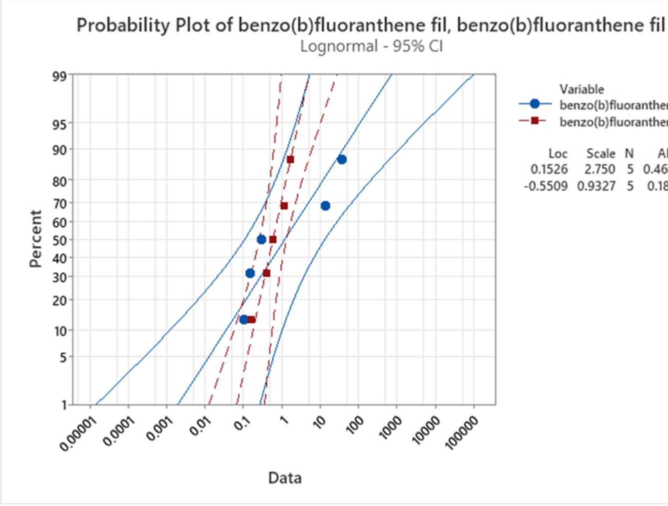


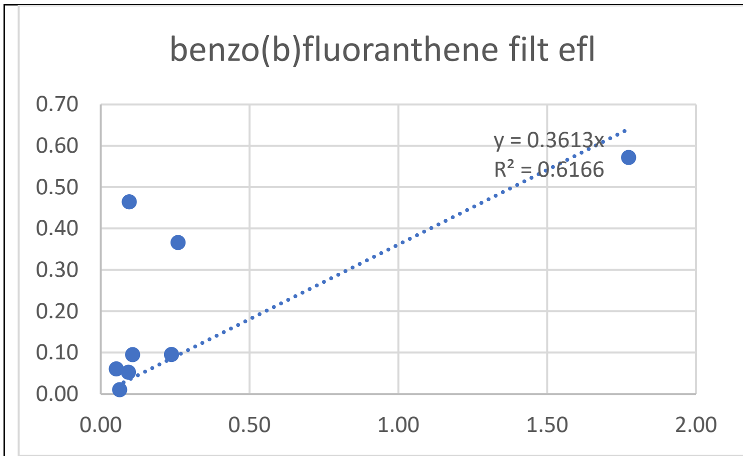
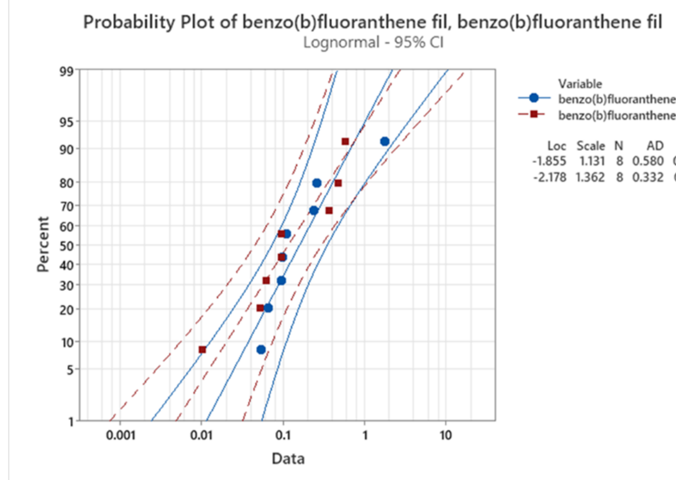
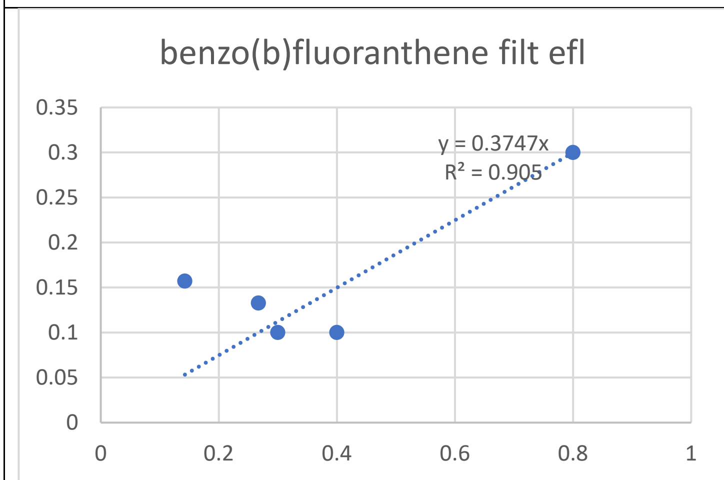
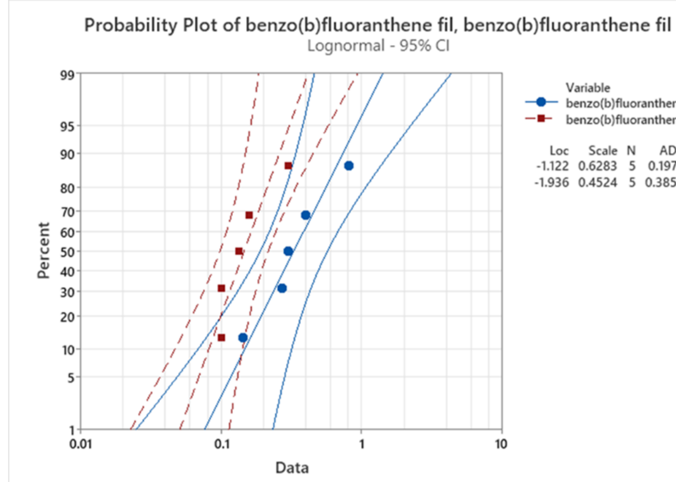
Biofilters and bioswales

Benzo(b)fluoranthene filtered (<0.45 µm)

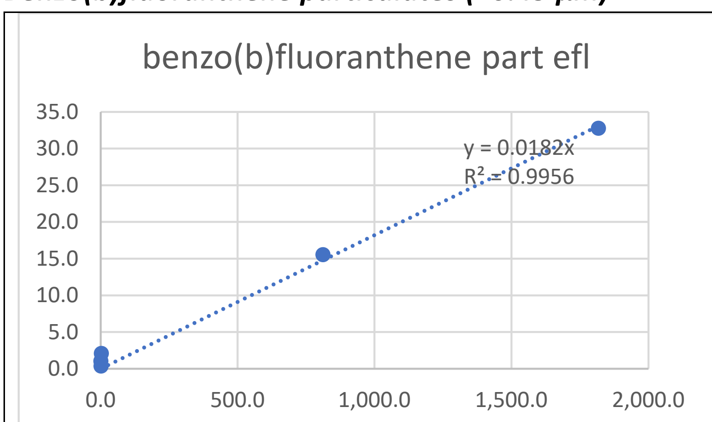
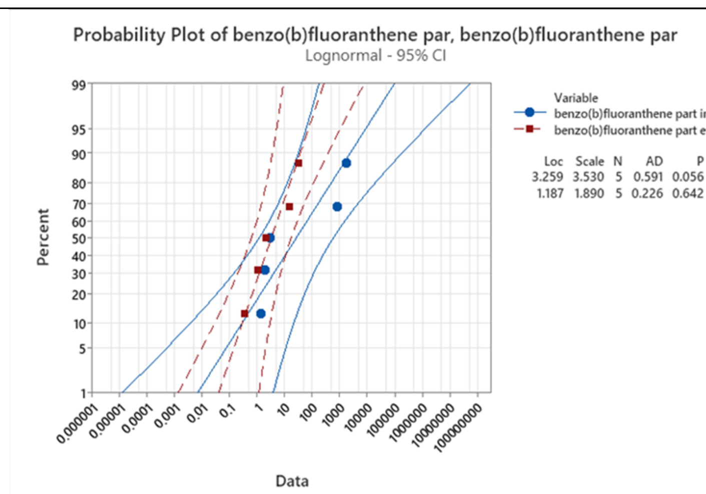


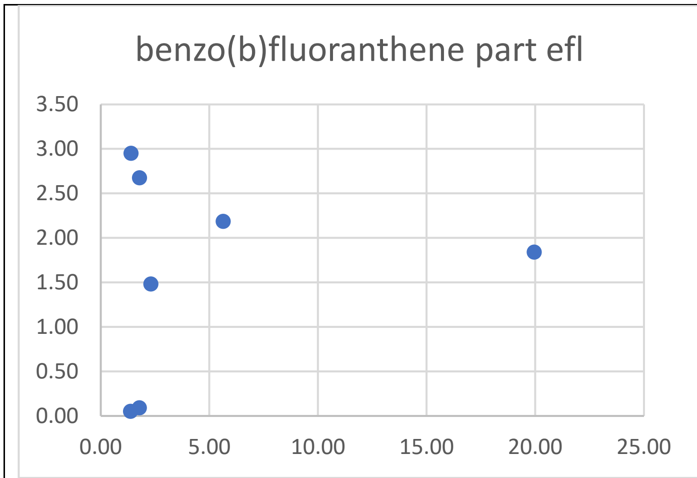
Sedimentation

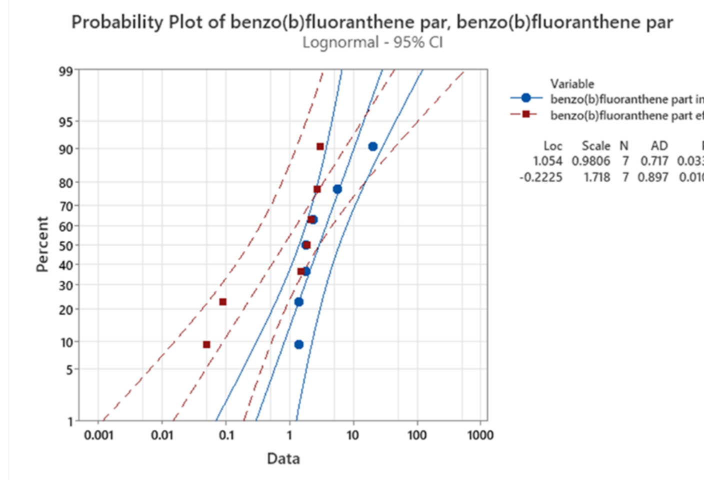


 Media Filters	
 Biofilters and bioswales	

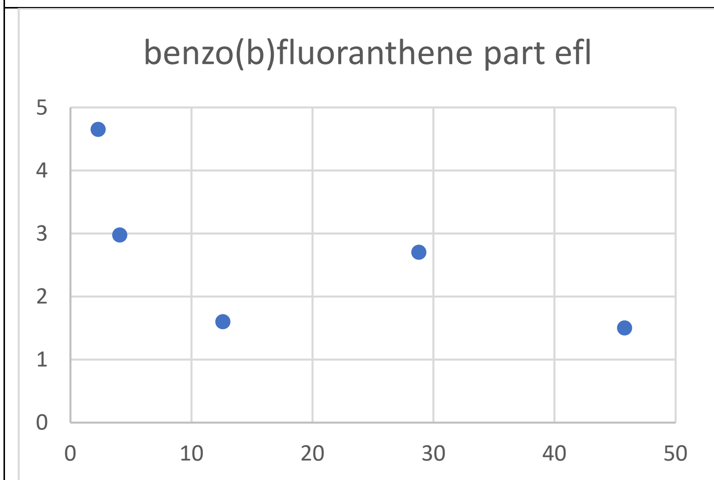
Benzo(b)fluoranthene particulates (>0.45 µm)

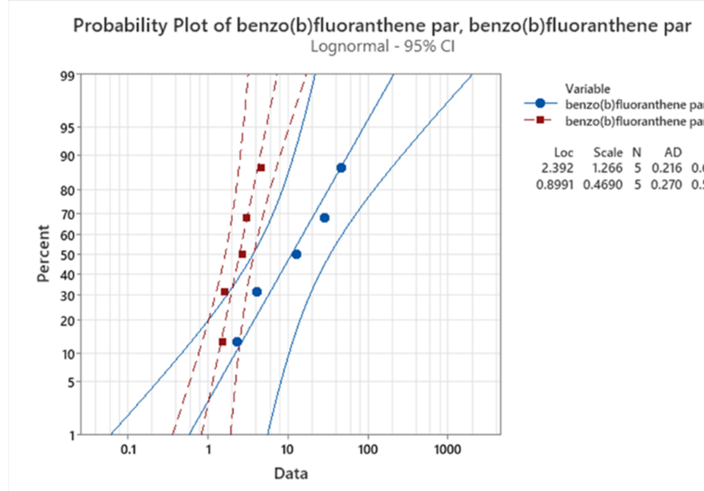
 Sedimentation	





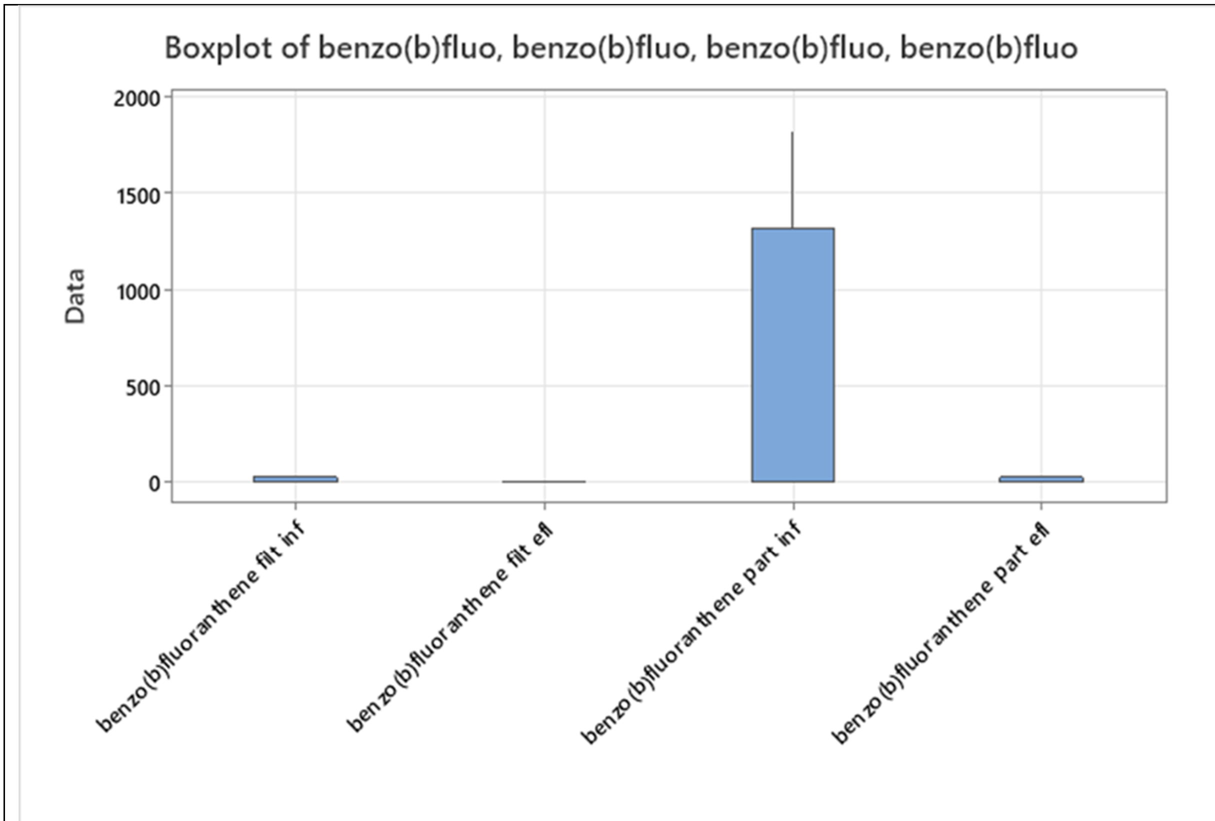
Media Filters



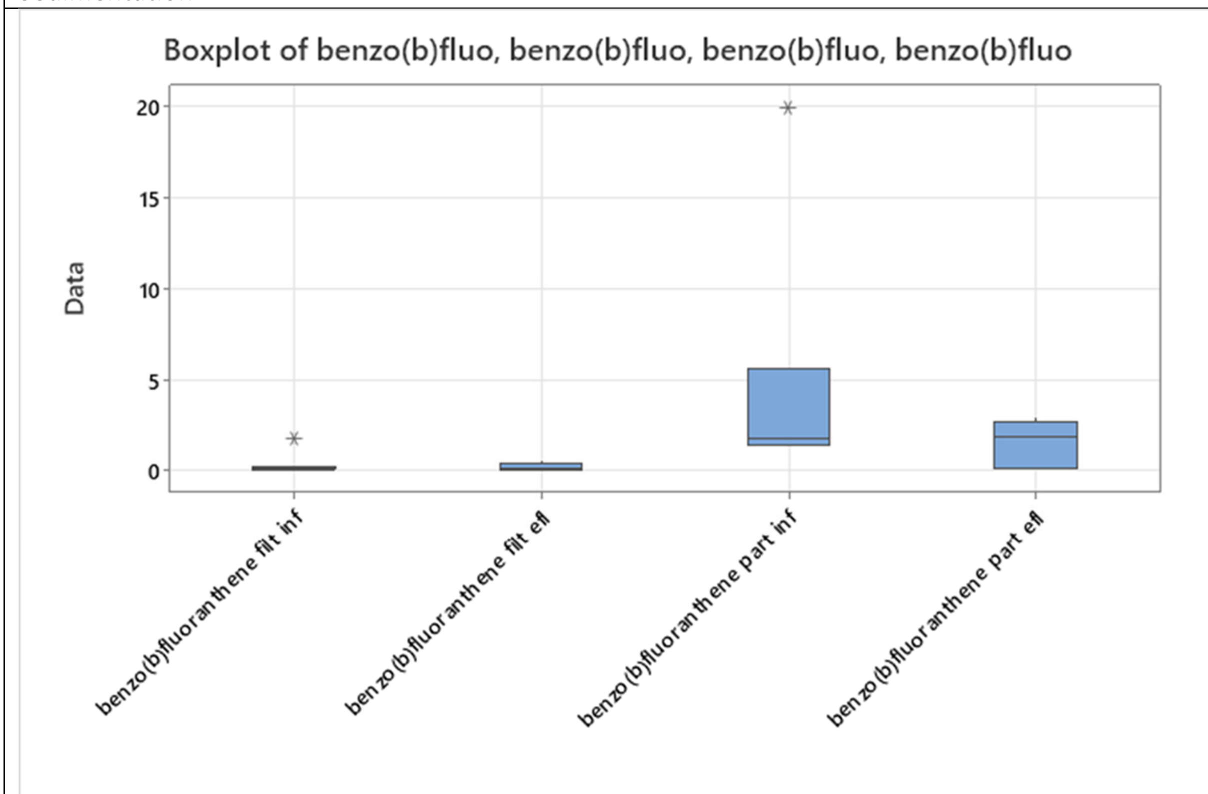


Biofilters and bioswales

Benzo(b)fluoranthene box and whisker plots



Sedimentation



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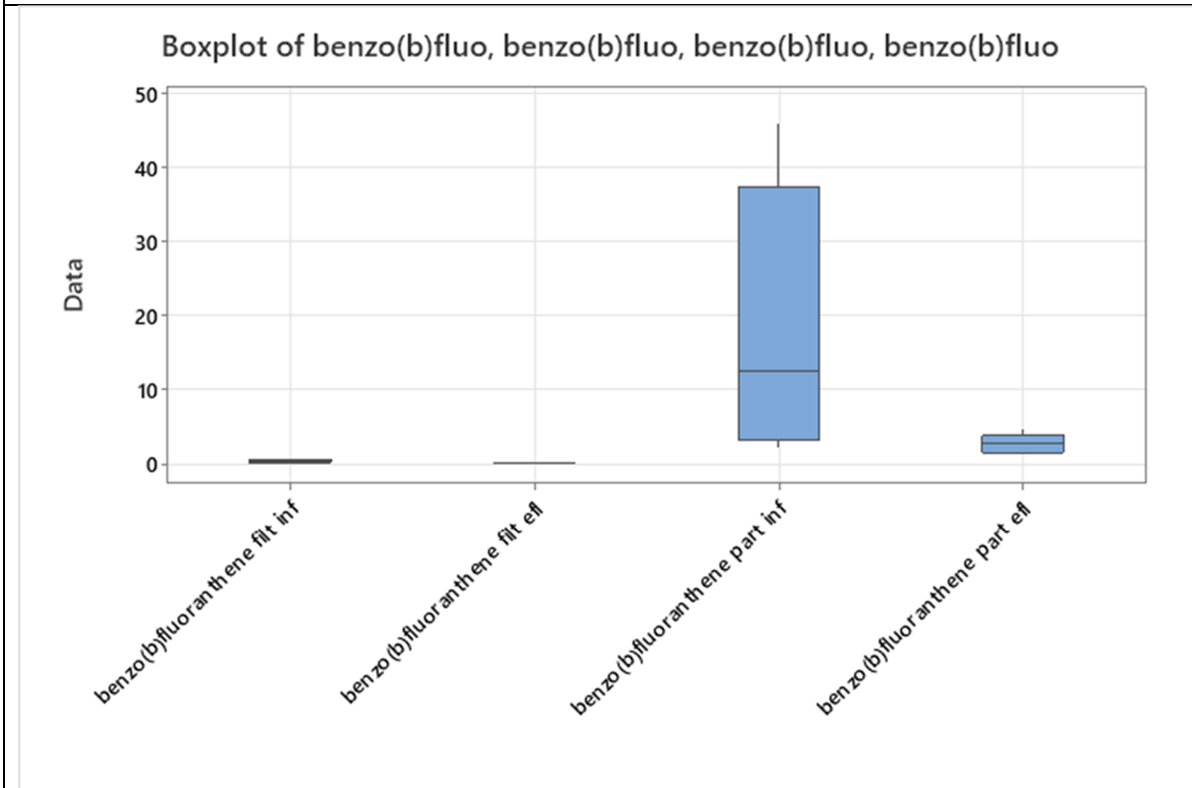
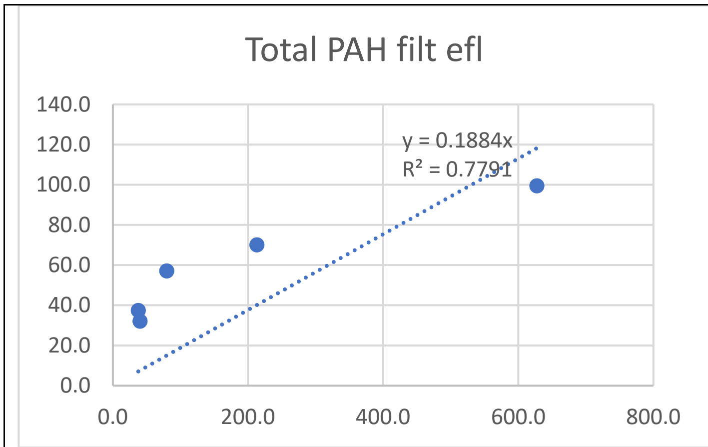
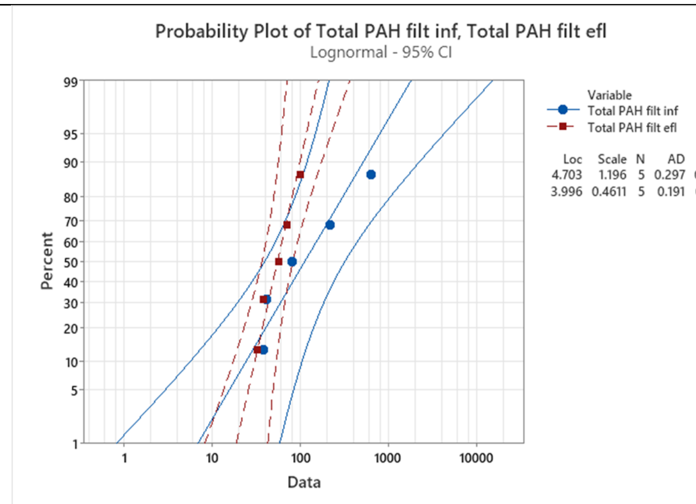
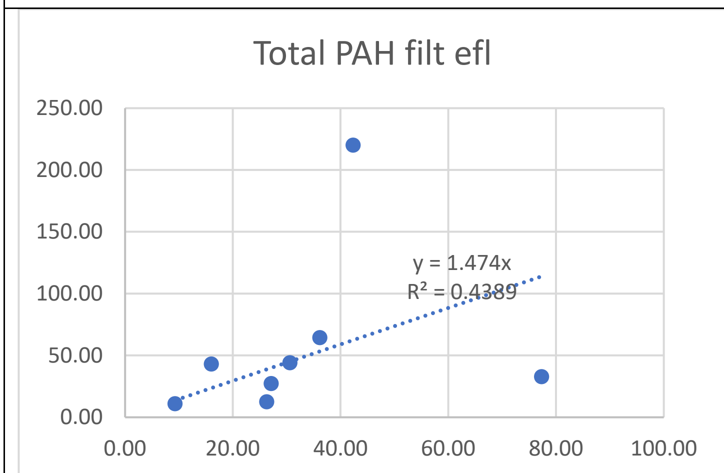
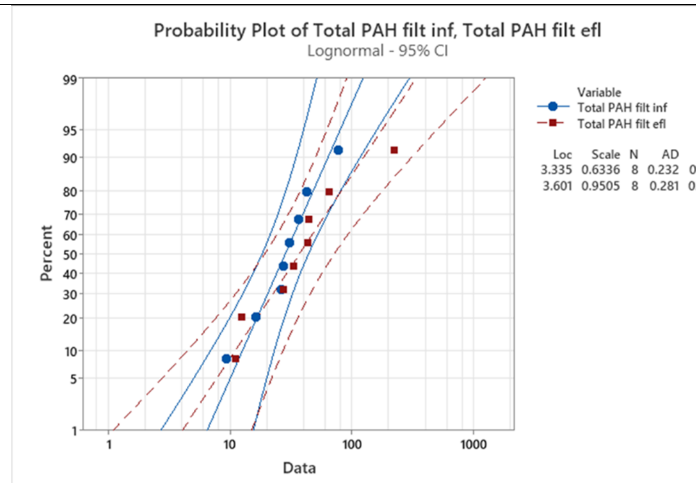
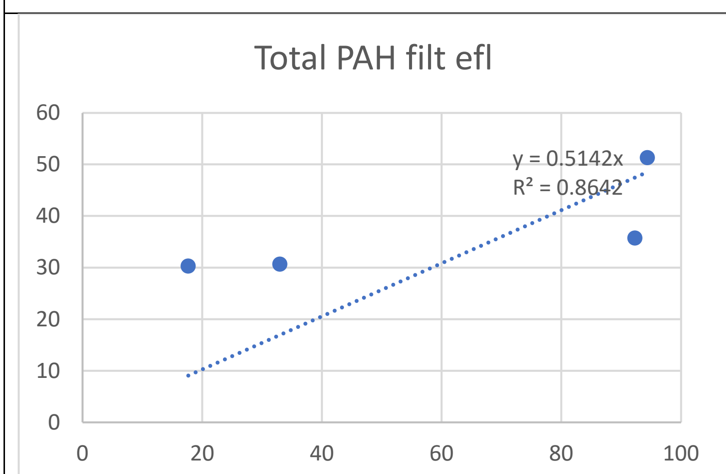
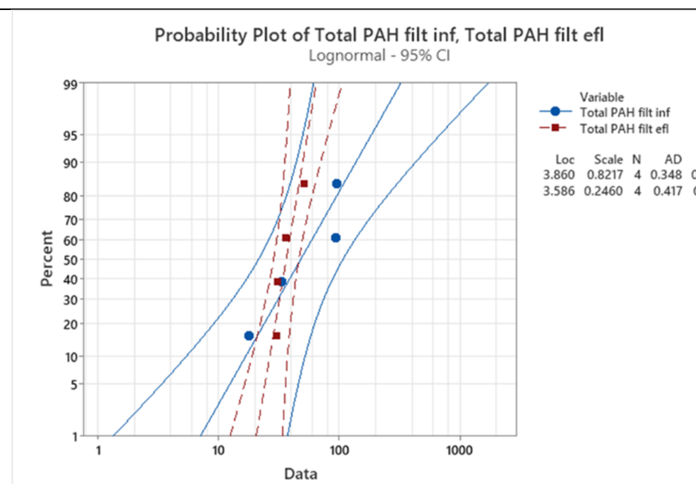
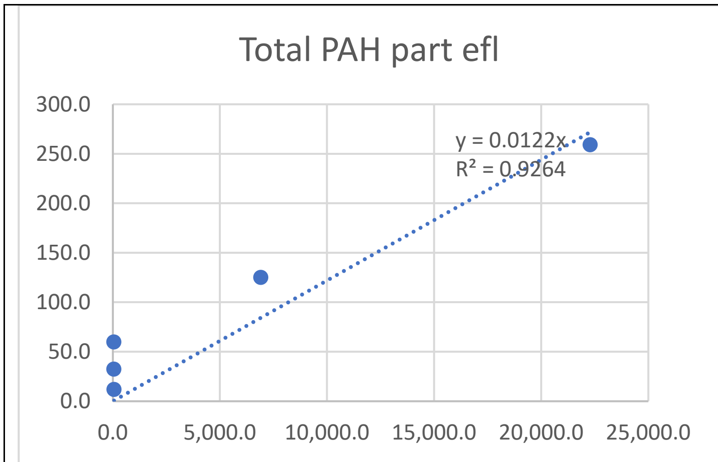

Biofilters and bioswales

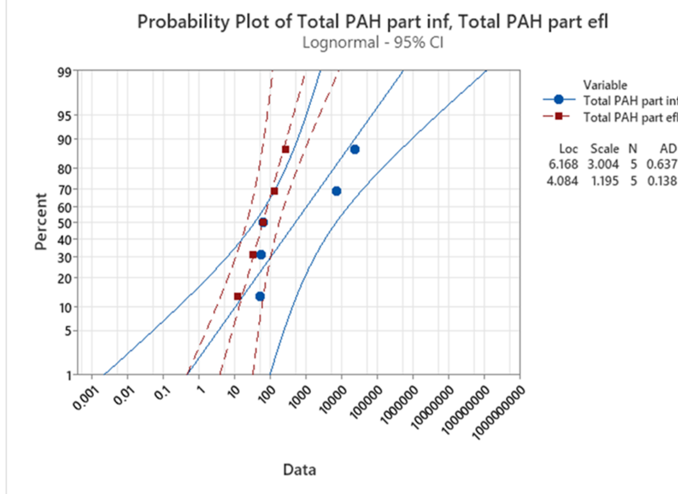
Total PAH filtered (<0.45 µm)

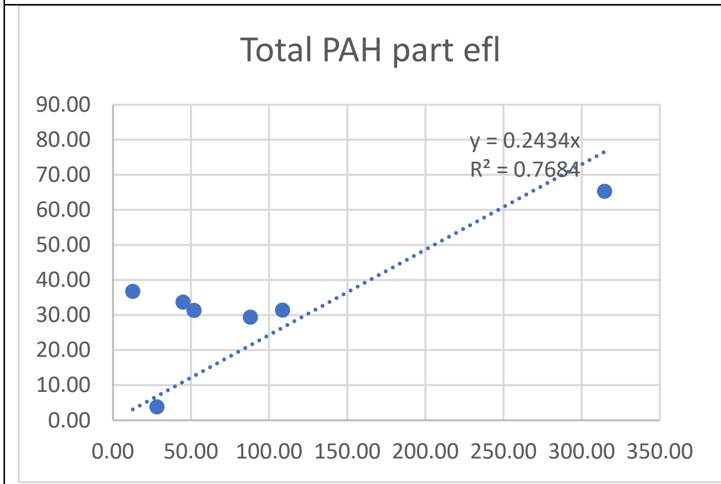
 Sedimentation	
 Media Filters	
 Biofilters and bioswales	

Total PAH particulates (>0.45 µm)

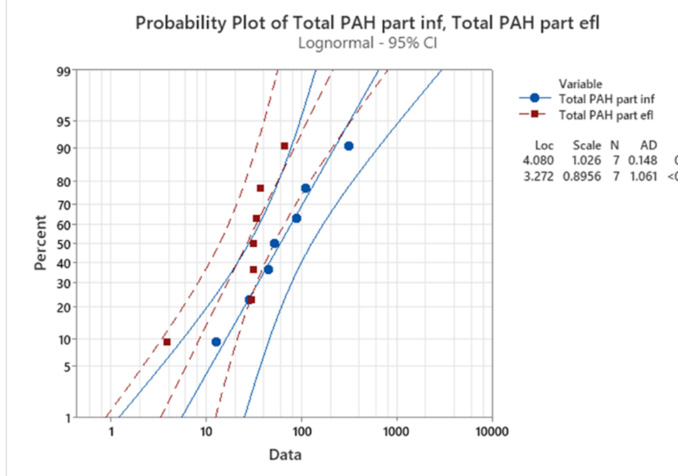


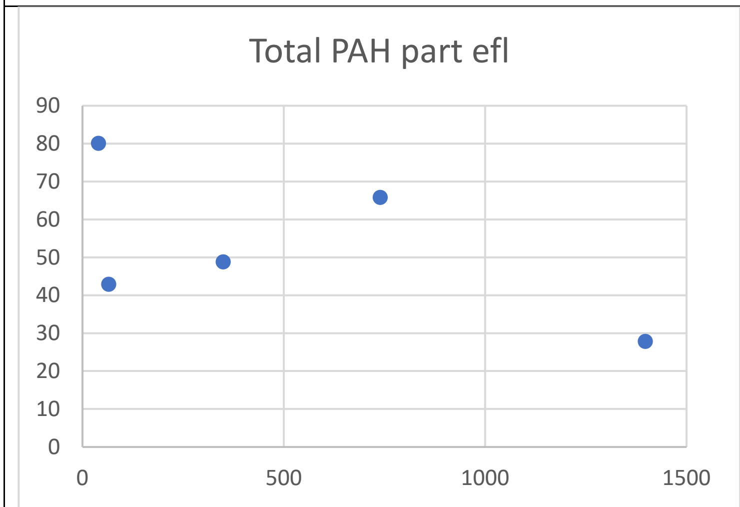
Sedimentation



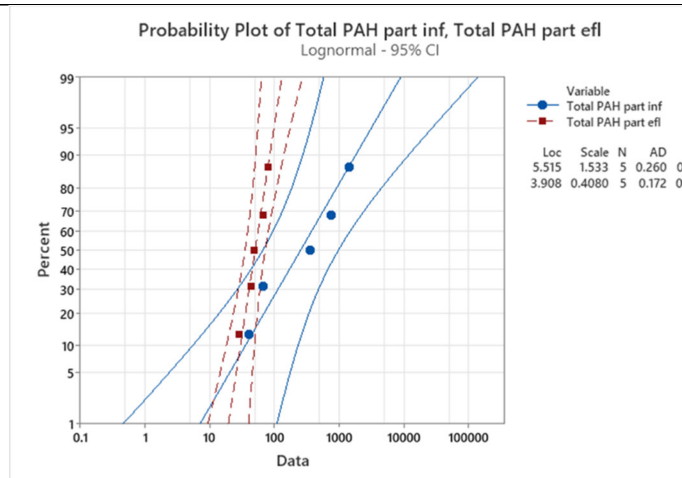


Media Filters

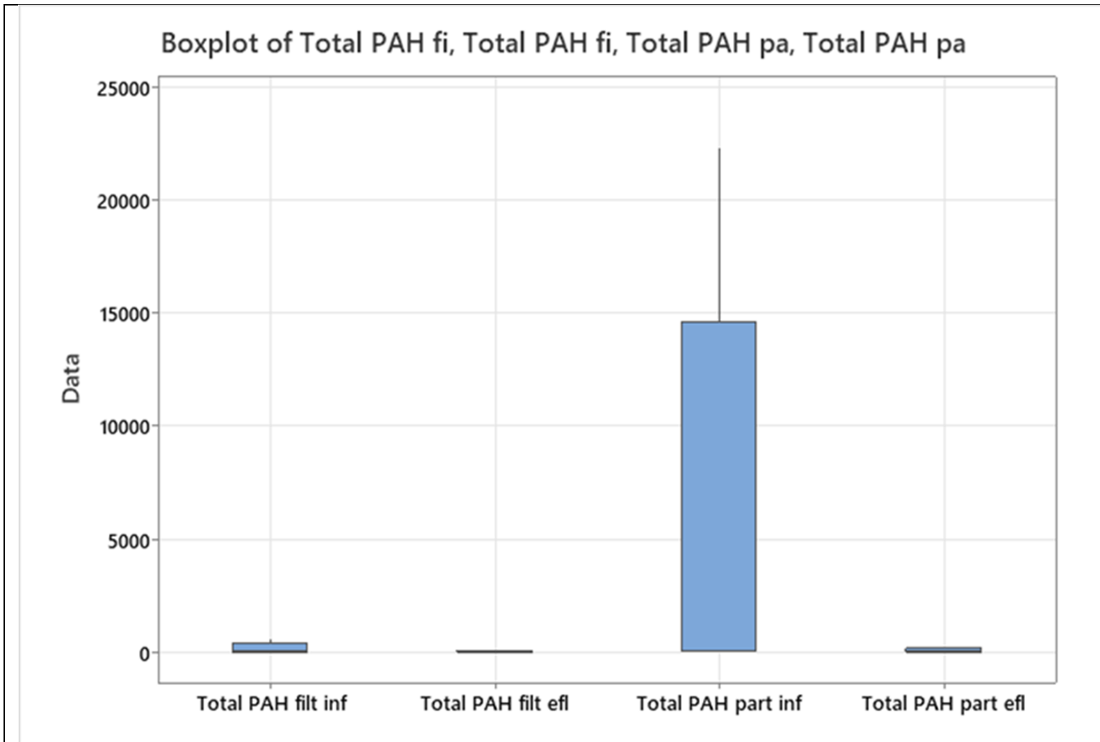




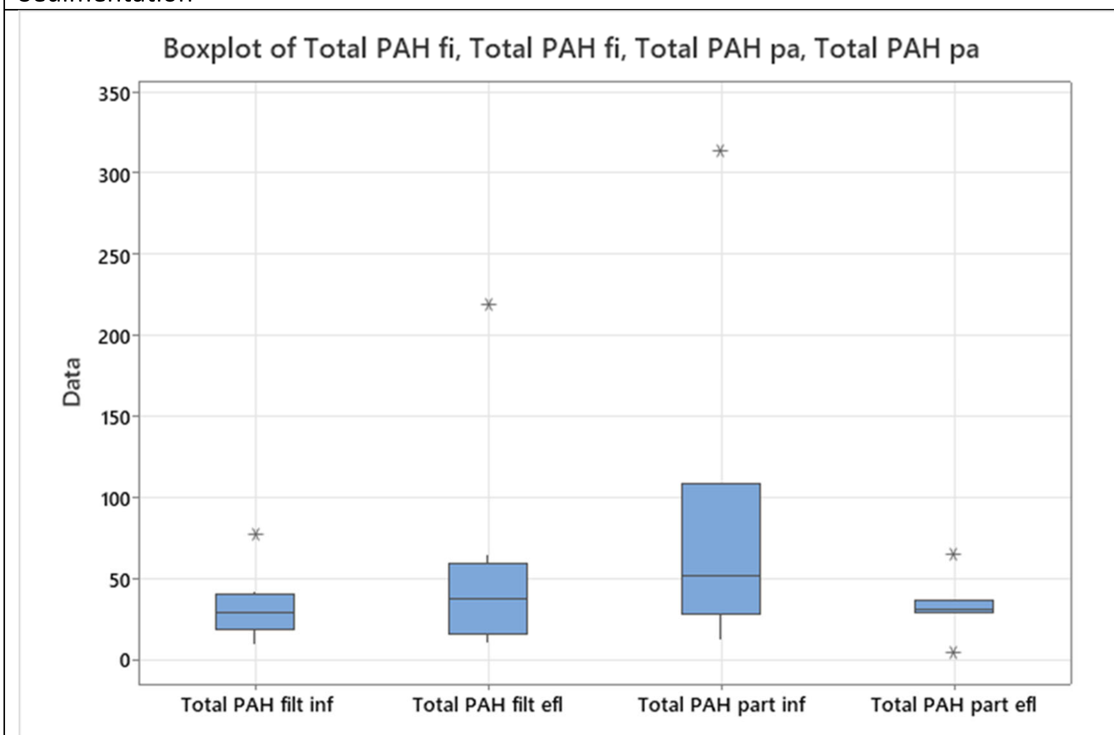
Biofilters and bioswales



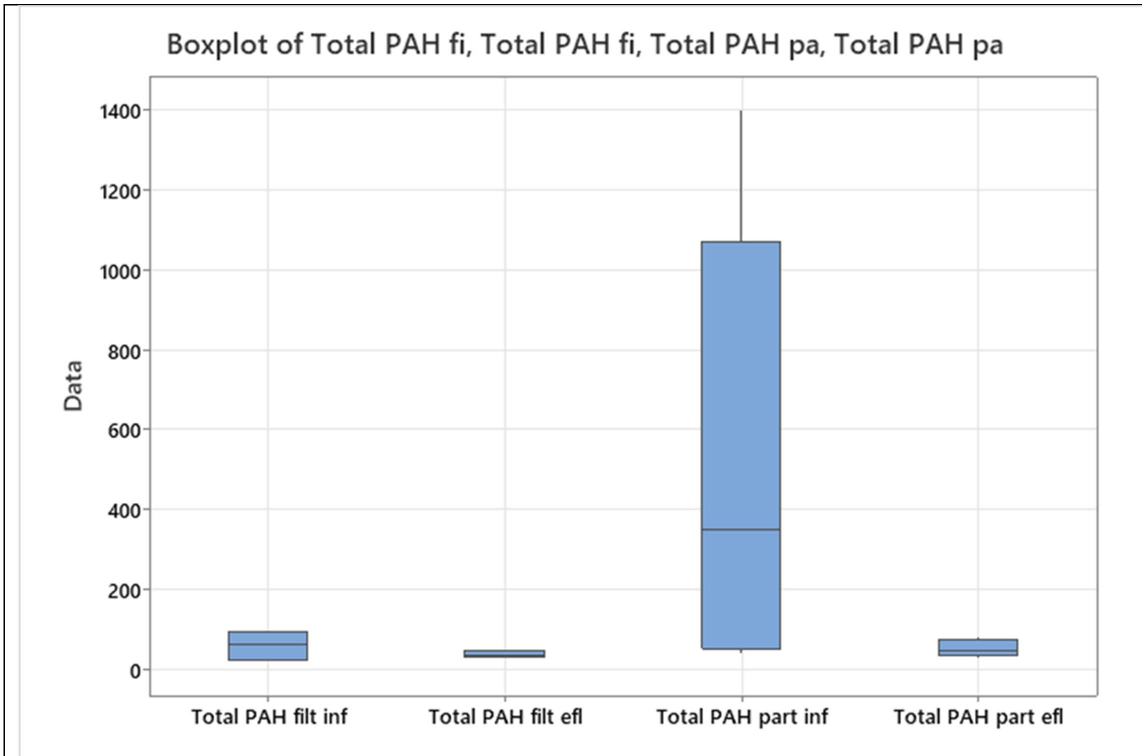
Total PAH box and whisker plots



Sedimentation



Media Filters



Biofilters and bioswales