Appendix A:
Additional Site Information

APPENDIX A – ADDITIONAL SITE INFORMATION

This appendix provides an overview of the study site and the individual stormwater control and treatment facilities. In addition, photos are included to illustrate changes in vegetation over the study period and some of the wildlife that utilized the facilities. Additional information about the history of the South 356th Street Regional Detention Facility (RDF) retrofit is included in the project Quality Assurance Project Plan (King County 2016).

Overview

In 2013-2014, the City of Federal Way (the City) expanded the South 356th Street RDF to increase capacity and provide additional stormwater treatment (Figure 1). The City incorporated stormwater best management practices and followed design guidelines to the extent possible when designing the retrofit. However, like many facilities in highly developed watersheds, the limited available space and design of the existing RDF imposed constraints on the new design and construction. The resulting facility was designed to be effective at this site, and the components of this facility (two combined detention stormwater treatment wetlands [CDSTWs] and the bioretention facilities) do not necessarily represent other facilities with the same components. The CDSTWs and the bioretention facilities meet some of the specifications outlined in Ecology's and King County's stormwater manuals (Ecology 2012, King County 2009) (Tables 1 and 2), but not all designs criteria could be incorporated for the retrofit.

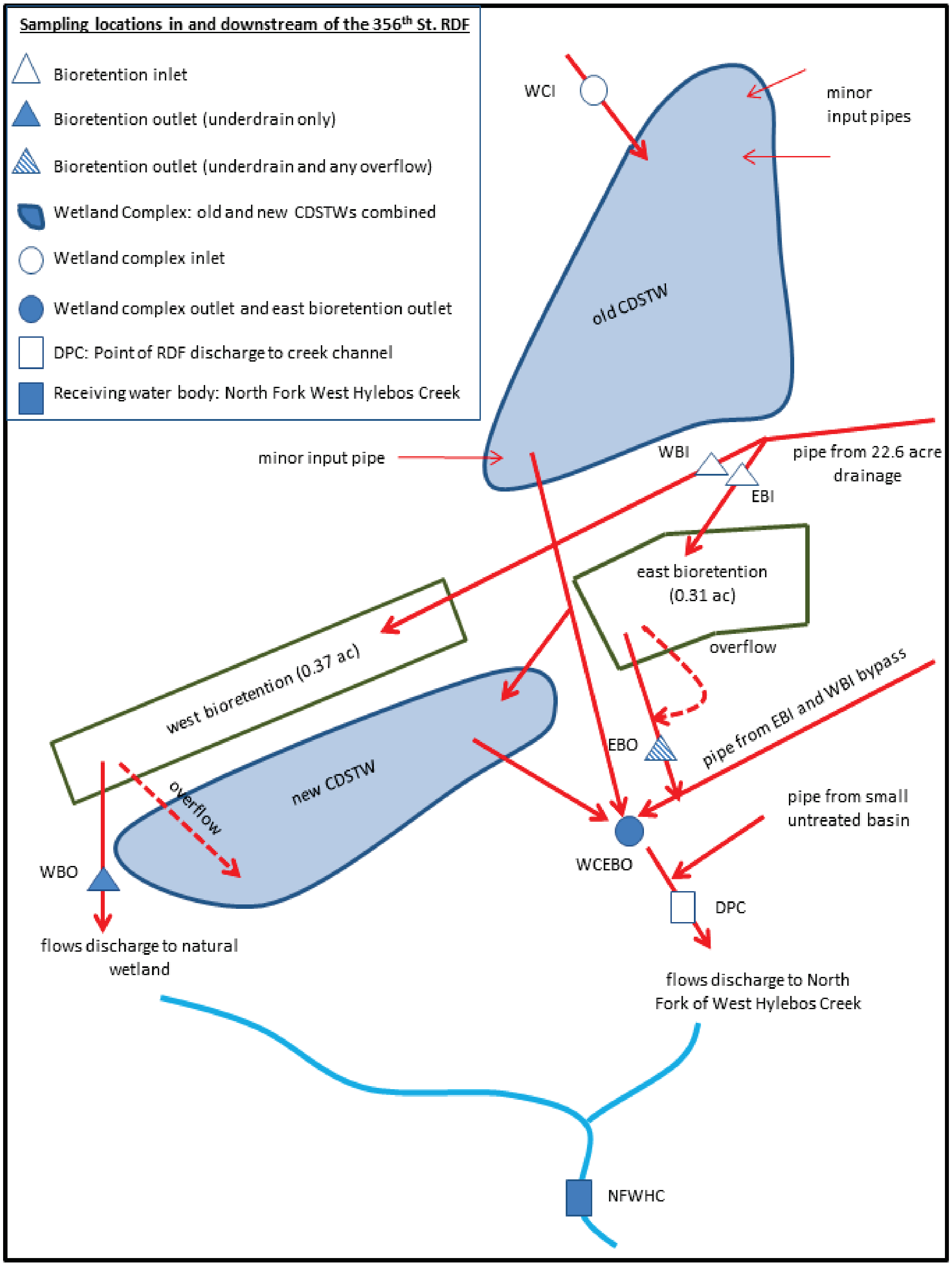


Figure 1. South 356th Street RDF flow paths, project sampling locations and general facility information (not to scale).

Summary of Flow Paths through the RDF

The majority of stormwater runoff delivered to the retrofitted and expanded South 356th Street RDF enters via two inlet pipes, one from the north and one from the east (Figure 1). The northern inlet drains approximately 189 acres of highly developed commercial, industrial, and residential areas within the City. Stormwater from this inlet is delivered to the northwest corner of the original combined detention and stormwater treatment wetland (old CDSTW) which is undersized given the growth in the City.

There are several additional pipes drain stormwater into the old CDSTW (labeled "minor input pipes" in Figure 1). The pipes were frequently checked during the study period and were typically dry or had minimal flows. A few instances there were turbid flows observed (Figure 2). Due to these minor flow inputs, samples collected at the inlet (WCI) may underestimate pollutants and flowing into the RDF. Likewise, flow volume estimates (calculated from WCI alone) may underestimate the total flow entering the wetland complex.

The new CDSTW (Figure 1) was designed to provide additional detention volume and treatment to a portion of the discharge from the old CDSTW (Table 1). Inputs to the new CDSTW are exclusively from the old CDSTW, and a hydraulic model (XP-Storm) was used to size the new wetland. Outflows from the old CDSTW enter a catch basin via a large (48") pipe. Stormwater flows from the catch basin to either the new CDSTW, via a deep and relatively small (18") pipe, or away from the new CDSTW and towards the creek via another large (48") pipe (Figure 1). The catch basin and pipes were designed to direct low-to-moderate flows to the small pipe and thus to the new CDSTW. In contrast, under high flow conditions, the catch basin is designed to direct most of the water away from the new CDSTW and to the conveyance system leading to the discharge point to the stream (DPC). This design was intended to minimize the chance of flooding the new CDSTW and the adjacent streets. Therefore, stormwater treated by the RDF is a combination of water flowing from the north to the old CDSTW and water from the east that flows to the bioretention facilities. Some, but not all, of the water flowing through the old CDSTW will also flow through the new CDSTW. The CDSTWs effluents mix with the effluent from the east bioretention facility prior to discharging to the North Fork of West Hylebos Creek. The effluent from the west bioretention facility flows to the wetland downstream of the RDF (Figure 1).

Table 1. Properties of the old and new combined detention and stormwater treatment wetlands (CDSTW) at the RDF.

Properties	Old CDSTW (built 1997)	New CDSTW (built 2013–2014)
Applicable design manual codes	Most similar to Ecology T10.40 (2012 SMMWW, amended in 2014) and King County 6.4.4 (2009 and 2016 Surface Water Design Manuals)	Most similar to Ecology T10.40 (2012 SMMWW, amended in 2014) and King County 6.4.4 (2009 and 2016 Surface Water Design Manuals)
Surface area at weir overflow	2.5 acre (ac.)	1.07 ac.
Active storage	21 acre-feet (AF)	3.8 AF
Dead storage	Approximately 1 to 2 AF	1.05 AF
Average depth	7.8 feet (ft.)	6 ft.
Max depth	Does not exceed 8 ft.	Does not exceed 8 ft.
Infiltration expected?	No; lined	No; not lined but minimal infiltration expected due to highly impermeable native soils
Designed for detention	Yes, live storage is above seasonal high groundwater level	Yes, live storage is above seasonal high groundwater level
Designed for sediment storage	Sedimentation forebay that is >1 ft. deep	No, but because this is in series with old CDSTW, sediment loads are expected to be small
Wetland plants	Diverse community of native plants currently present	Native grass seed planted; other plants have become established and may be removed as needed (e.g., cattails)
Ratio of flow path length to width	At least 3:1	At least 3:1
Outlet control structure	Present, with grate	Present, with back slope
Additional features	• Oil/water separator • Low-flow channel • Outlet micropool • Low islands to support diverse community of native vegetation	• Small separator berm helps direct inflow away from outlet and avoid short circuiting
Deviations from current codes	• There is no distinct second cell • Inlets are not submerged • Undersized	• Small separator berm was not designed to promote plug flow or help create a distinct second cell • No area designed specifically for sediment storage • Inlet is not submerged but is designed to minimize resuspension of settled sediments • Undersized

Figure 2. Turbid discharge from a minor pipe to old CDSTW on October 20, 2016.

The eastern pipe delivers previously untreated stormwater runoff to two bioretention facilities. Prior to the RDF expansion, runoff from a 22.6 acre area to the east bypassed the RDF and discharged to a catch basin just upstream of the discharge point to the creek (DPC) (Figure 1). This runoff now drains to two bioretention facilities. The bioretention facilities are underdrained, and filtered water is eventually discharged to the creek (from the east bioretention facility) or surrounding natural wetlands (from the west bioretention facility).

Description of Retrofitted BMP Design

Combined Detention and Stormwater Treatment Wetlands in Series
The City designed both the old and new CDSTWs to attenuate flows and provide stormwater treatment. Although neither CDSTW was designed to meet all specifications of the combined detention and stormwater treatment wetlands, they meet many of the current specifications for this type of BMP (Table 1). The “as built” drawings of the old and new CDSTWs are included in Appendix B of the QAPP.

Constructed in 2013-2014, the new CDSTW increased capacity of the entire RDF by approximately 5 acre-feet (AF) (Table 1). The old CDSTW provides effective pretreatment for stormwater entering the new CDSTW, therefore the required “first cell” per the Ecology design manual was eliminated for the new CDSTW. Design of the new CDSTW was constrained by limited available space and the existing BMPs, but was designed to meet as a number of the specifications described in Ecology’s Stormwater Management Manual for Western Washington (SWMMWW; Fei Tang [City of Federal Way, Engineer] consulted Washington State University (2012) which was later incorporated into the amended 2012 Ecology SWMMWW) and King County’s Surface Water Design Manual (2009) (Table 1). The new CDSTW is not lined and due to impermeable native soils, it has low infiltration rates. These conditions result in standing water throughout the year. After several failed attempts, the slopes of the new CDSTW were successfully seeded with a marsh seed mix in fall 2015 and grasses were thriving during the 2016-2017 monitoring period (Figure 3 and 4).

Figure 3. The new CDSTW under construction, March 31, 2014.

Figure 4. Established plants and prolific algae in the new CDSTW, July 7, 2016.

Bioretention Facilities

The bioretention facilities were constructed in 2013-2014 according to the Draft 2012 Low Impact Development Technical Guidance Manual for Puget Sound (WSU, 2012). The east and west bioretention facilities are similar except for differences in some of the plant types and the west bioretention underdrain does not extend over the whole bioretention facility (Table 2, Figures 5-9). In addition, overflow from the east bioretention facility drains into an overflow pipe and then into the same pipe that the underdrain flows into (Figure 1). In contrast, overflow from the west bioretention facility flows into the new CDSTW (Figure 1). The outlet of the west bioretention facility drains to a natural wetland (Figure 1).

Table 2. Physical description of east and west bioretention facilities at the South 356th Street RDF.

Properties	West Bioretention Facility	East Bioretention Facility
Size (acre)	0.37	0.31
Storage Capacity (AF)	0.28 before overflow, 0.6 max.	0.25 before overflow, 0.69 max.
Max Depth (ft.)	1 before overflow, 2 max.	1 before overflow, 2.5 max.
Soil	In eastern half: 30 in of BSM[1], topped with 3 in. of coarse compost[2]; In western half: 33 in of top soil Type A BSM (60%sand/40% compost), topped with native swale seed mix and soil amendment A BSA[3]	30 in of BSM[1], topped with 3 in of coarse compost[2]
Vegetation Types	In eastern half: Pacific crabapple, Pacific wax myrtle, dwarf arctic willow, salmonberry, Douglas spirea, redtwig dogwood, black gum; In the western half: native swale grasses	Pacific crabapple, black gum, redtwig dogwood, salmonberry, dwarf arctic willow, black twinberry, daggerleaf rush
Extent of Underdrain	Underdrain installed in west half only; material used included 8 in. wide Smart Drain™ belts that connect to PVC pipes	Underdrain installed throughout; west half is made of standard PVC underdrain; east half is made of 8-in. wide Smart Drain™ belts that connect to PVC pipes

[1] All specifications in section 8-02.3(4)A for Bioretention Soil Media (BSM) quality and application (WSDOT, 2010) were met.

[2] All specifications in Section 9-14.4(8) Special Provisions for compost (WSDOT, 2010) were met.

[3] All specifications in Section 8-02.3(6) Special Provisions for BSA (WSDOT, 2010) were met.

Figure 5. The west bioretention facility pre-planting, March 31, 2014.

Figure 6. Established vegetation in west bioretention facility (on left) and new CDSTW (on right), March 24, 2016.

Figure 7. Immature vegetation in east bioretention facility prior to initiation of stormwater sampling, February 16, 2016.

Figure 8. Mature vegetation in east bioretention facility, April 27, 2017.

Figure 9. Mature grasses in the west bioretention facility, April 27, 2017.

Both bioretention facilities were originally built using Smart Drain™ underdrains, which are designed to facilitate draining without clogging (www.smartdrain.com). The entire east bioretention facility is underdrained. Originally, the entire underdrain network was constructed using Smart Drain™ strips connected with PVC collector pipes. The PVC pipes are not perforated except where the Smart Drain material is joined to them. However, initial observations indicated the facility was not draining and in summer 2015, the Smart Drain™ underdrain in the western half of the facility was replaced with a traditional perforated pipe underdrain. The facility drained much more quickly after the change, and it typically drained much more quickly than the west bioretention (see Appendix J).

The west bioretention facility, a network of Smart Drain™ strips were used in combination with PVC collector pipes in the western half of the facility. The Smart Drain™ strips direct water to the centerline PVC pipe. The eastern half of the west bioretention facility is not underdrained. During the study period, water was retained in the west bioretention facility for hours to days following storm events. It is unclear if the held water is because Smart Drain™ strips were used or because half of the system has no underdrain.

Due to space limitations at the site, the bioretention facilities were undersized. Ecology recommends that 91% of the stormwater in this basin be treated for flow control (using WWHM). A WWHM model was not developed; however, the City ran a single event model (XP Storm) on an expanded time scale and estimated that approximately 89% of stormwater would be treated (Fei Tang, personal communication).

Site as a habitat for wildlife

Wildlife, including a diverse assemblage of birds, inhabited the RDF during the study period. Waste from some of the larger and more abundant birds (Canada geese, ducks; Figure 10) may have been a significant source of nutrients within the South 356th St. RDF during the study period.

Figure 10. Canada geese in the new CDSTW, July 7, 2016.

Changes to the RDF following the study

Road construction in the spring and summer of 2017 altered the pathway for water flowing to the bioretention facilities. Instead of flowing through several grass ditches before reaching the facilities, the water now flows through pipes under a sidewalk (Figure 11 and 12). The sidewalk construction also made it much more difficult or impossible to access the EBO, WCEBO and WBO sampling locations.

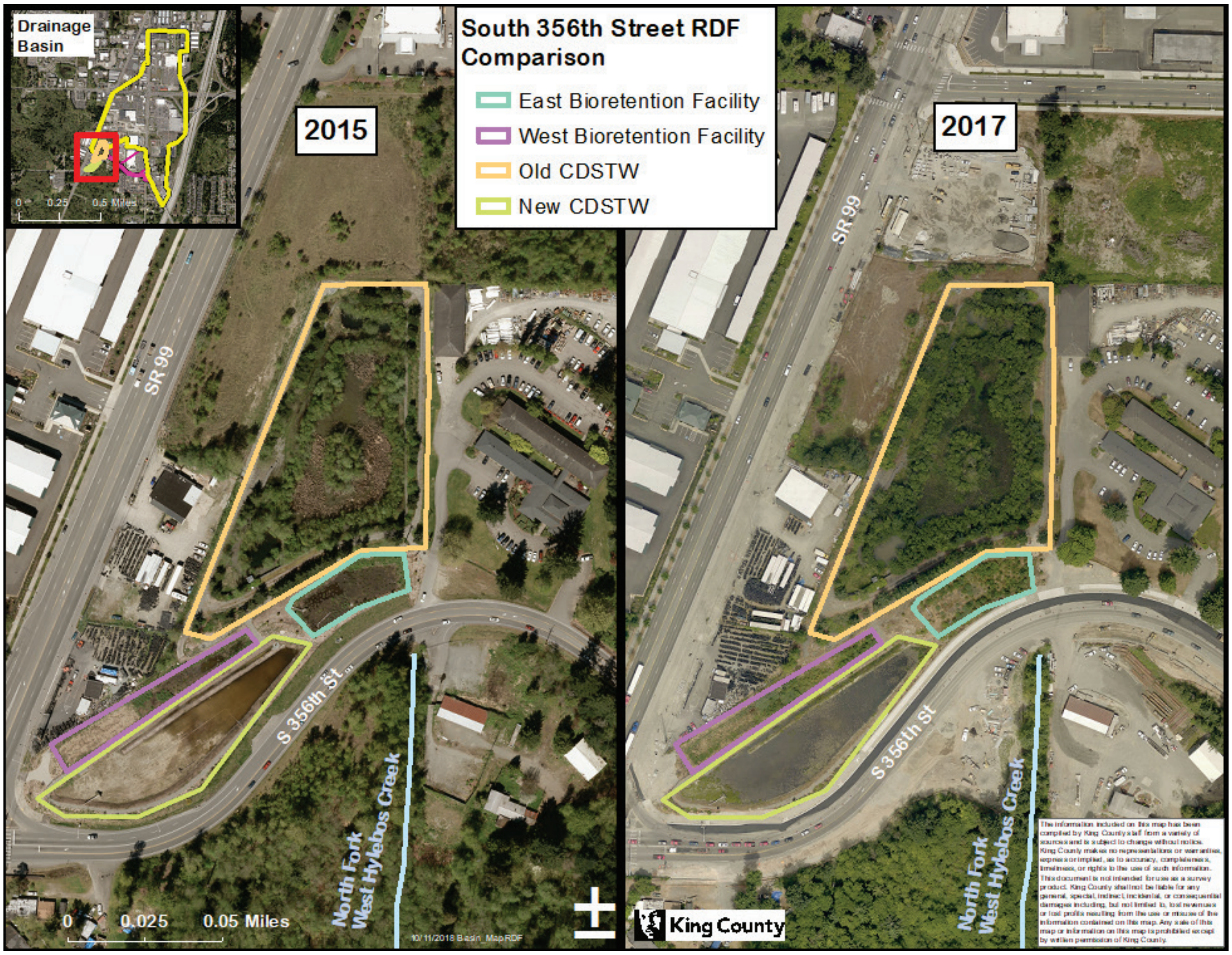


Figure 11. Aerial photos of the South 356th St. RDF in 2015 and 2017. Note new sidewalk on north side of S. 356th St. in 2017.

Figure 12. Ditch along South 356th Street that carried stormwater runoff to bioretention facilities during the study period. In summer 2017 the ditch was replaced by pipes and a sidewalk after the study.

Appendix A References

Ecology. 2012. Stormwater Management Manual for Western Washington (SWMMWW). Publication No. 12-10-030.

King County. 2009. King County, Washington Surface Water Design Manual. Prepared by King County Department of Natural Resources and Parks.

King County. 2016. King County, Washington Surface Water Design Manual. Prepared by King County Department of Natural Resources and Parks.

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

WSDOT (Washington State Department of Transportation). 2010. Standard Specifications for Road, Bridge, and Municipal Construction. M 41-10.

WSU (Washington State University). 2012. Draft 2012 Low Impact Development Technical Guidance Manual for Puget Sound. Written by Curtis Hinman (WSU Puyallup Research and Extension Center) with support from the Puget Sound Partnership.

Appendix B:
Chain of Custody Sheets

Login: P65007

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by [signature]	*Date* 3/10/16	*Time* 1630
Received by Jori Bailey	*Date* 3/10/16	*Time* 1630
Sample Numbers 1-8, 15		*[All]*

Sample Number	**P65007-1**	**P65007-2**	**P65007-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments	~~3/9/16~~ ~~1410~~	→	→ ~~1408~~
Start Date/Time	3/9/16 1400	→ 1451	→ 1357
End Date/Time	3/10/16 SAMP 0035 PU 1100	3/10/16 0416 1125	3/10/16 0241 1100
Time Span	10:35	13 hr 25 min	12 hr 44 min
Sample Depth			
PERSONNEL	HF, JD	→	→
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Add Cerio daphnia - Chronic → X

Daphnia - Acute →

SAMPLES SPLIT @ KCEL @ 1400-1600 ON 3/10/16

145-062 WG ~~144894~~

Login: P65007 **Federal Way Stormwater Effectiveness** **Personnel:** ________________

Project: 421879-240

Sample Number	**P65007-4**	**P65007-5**	**P65007-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/16 1314	→ 1318	→ 1354
End Date/Time	3/10/16 HF ~~0235~~ 0804 1130	3/10/16 0652 1030	3/10/16 1052 1115
Time Span	18 hr 50 min	17 hr 34 min	21 hr 0 min
Sample Depth			
PERSONNEL	HF JD	HF JD	HF JD
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	+pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

+ ceriodaphnia - chronic →

+ daphnia - acute →

Login: P65007

Project: 421879-240

Federal Way Stormwater Effectiveness

Personnel: HF

RELINQUISHED BY [signature] 3/9/16 Time 1710

RECEIVED BY [signature] 3/9/16 Time 1710

Sample Number(s) 9-15

Sample Number	P65007-7	P65007-8	P65007-9
QC Link			
Locator	FW-NFWHC	FW-WBI	FW-EBI
Short Loc Desc	NFWHC	WBI	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	WEST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments		FREP	
Start Date/Time	3/9/16 1439 ~~3/10/16~~ ~~1145~~	3/9/16 1417 ~~3/10/16~~ ~~3/9/16~~ ~~1050~~ ~~1408~~	3/9/16 1410
End Date/Time	3/10/16 0921	3/10/16 0240	
Time Span	18 hr. 42 min 1145	12 hr 23 min 1105	
Sample Depth			
PERSONNEL	HF JD	HF JD	HF
PH, FIELD		**********	**********
SAMP FUNC	**********		**********
SAMP INFO		FREP MISSED FIRST SAMPLE PULSE @ 1357	
Dept, Matrix, Prod	+ pH 3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	+pH 3 LG ALK 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

+ ceriodaphnia - chronic

\+ daphnia acute

Login: P65007 Federal Way Stormwater Effectiveness Personnel: HF

Project: 421879-240

Sample Number	P65007-10	P65007-11	P65007-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments	3/9/16 1454	→ 1408	→ 1514
Start Date/Time			
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P65007 **Federal Way Stormwater Effectiveness** **Personnel:** HF

Project: 421879-240

Sample Number	**P65007-13**	**P65007-14**	**P65007-15**
QC Link			
Locator	**FW-WPCI**	**FW-WPCEPO**	**FW-NFWHC**
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/16 1402	→ 1452	→ 1528
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P65007 | Federal Way Stormwater Effectiveness | Personnel: ______________

Project: 421879-240

Sample Number	P65007-7	P65007-8	P65007-16
QC Link			
Locator	FW-NFWHC	FW-WBI	FFBLANK
Short Loc Desc	NFWHC	WBI	FFBLANK
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	WEST BIORETENTION FACILITY INLET	FIELD FILTER BLANK
Site	KING COUNTY	KING COUNTY	METRO
Comments		FREP	
Start Date/Time			
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			**********
SAMP FUNC	**********		**********
SAMP INFO			**********
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 4 LG CERIODAPHNIA-CHRONIC 4 LG DAPHNIA-ACUTE 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LN NH3 3 LN NO23 3 LN ORTHOP

Login: P65095 | Federal Way Stormwater Effectiveness | Personnel: HF

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 3/24/16	*Time* 1638
Received by	*Date* 3/24/16	*Time* 1638
Sample Numbers		*All*

Sample Number	**P65095-1**	**P65095-2**	**P65095-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/23/16 1745	→ 2006	3/24/16 0004
End Date/Time	3/24/16 0610	→ 0655	→ 0509
Time Span	12 hr 25 min	10 hr 49 min	5 hr 5 min
Sample Depth			
PERSONNEL	HF, CB	→	→
~~PH, FIELD~~			
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	~~3 LG ALK~~ ~~3 LG COND~~ 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP ~~3 LG PH~~ 3 LG TOC ~~3 LG TOTN~~ ~~3 LG TOTP~~ 3 LG TSS ~~3 LG TURB~~ 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS ~~7 LG PAH-SIM~~ ~~10 LG EPA1668PCB~~

*pH done in lab

WG 145~~39~~ ~~360~~ 426

Login: P65095 **Federal Way Stormwater Effectiveness** **Personnel:** ________________

Project: 421879-240

Sample Number	**P65095-4**	**P65095-5**	**P65095-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/24/16 1150	3/23/16 1613	→ 2131
End Date/Time		3/24/16 0909	→ 1045
Time Span	GRAB SAMPLE	16 hr 56 min	13 hr 14 min
Sample Depth			
PERSONNEL	HF, CB	→	→
~~PH, FIELD~~			
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 ~~LG EPA1668PCB~~	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

*GRAB SAMPLE

Login: P65095 **Federal Way Stormwater Effectiveness** Personnel: ________________

Project: 421879-240

Sample Number	P65095-7		
QC Link			
Locator	FW-NFWHC		
Short Loc Desc	NFWHC		
Locator Desc	NORTH FORK WEST HYLEBOS CREEK		
Site	KING COUNTY		
Comments			
Start Date/Time	3/24/16 0028		
End Date/Time	3/24/16 1218		
Time Span	11 hr 50 min		
Sample Depth			
PERSONNEL	HF, CB		
PH, FIELD			
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB		

Login: P66385

Federal Way Stormwater Effectiveness

Personnel: HF, JD

Project: 421879-240

9-15 deleted - no micro collected ME 10/27/16

CHAIN OF CUSTODY

Relinquished by	Date 10/27/16	Time 1530
Received by Meghan Ely	Date 10/27/16	Time 1530
Sample Numbers 1-8		[All]

Sample Number	P66385-1	P66385-2	P66385-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/26/16 0839	→ 0901	→ 0843
End Date/Time	10/26/16 1227	→ 2141	→ 1632
Time Span	3.8	12.67	7.82
Sample Depth			
PERSONNEL			
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG148808

Login: P66385 Federal Way Stormwater Effectiveness **Personnel:** ______________

Project: 421879-240

Sample Number	P66385-4	P66385-5	P66385-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/26/16 0949	→ 0608	→ 0827
End Date/Time	10/27/16 1145	10/26/16 1626	→ 1650
Time Span	25.93	10.3	8.38
Sample Depth			
PERSONNEL			
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P66385 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P66385-7**	**P66385-8**	**P66385-9**
QC Link			
Locator	**FW-NFWHC**	**TEMP**	**FW-EBI**
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	10/26/16 0832	~~10/27/16~~ HF ~~1400~~ HF 10/26/16 0843	
End Date/Time	10/26/16 1725	→10/26/16 1632	
Time Span	8.88	7.82	
Sample Depth			
PERSONNEL			
PH, FIELD		**********	**********
SAMP FUNC	**********	FREP@ WBI	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P66385 **Federal Way Stormwater Effectiveness** **Personnel:** ________________

Project: 421879-240

Sample Number	**P66385-10**	**P66385-11**	**P66385-12**
QC Link			
Locator	**FW-EBO**	**FW-WBI**	**FW-WBO**
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time			
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66385 **Federal Way Stormwater Effectiveness** **Personnel:** ____________

Project: 421879-240

Sample Number	**P66385-13**	**P66385-14**	**P66385-15**
QC Link			
Locator	**FW-WPCI**	**FW-WPCEPO**	**FW-NFWHC**
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time			
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66385 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	**P66385-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	10/27/16 1400		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
PH, FIELD	**********		
SAMP FUNC			
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P66453 | **Federal Way Stormwater Effectiveness** | **Personnel:** HF

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 10/20/16	*Time* 1500
Received by	*Date* 10/20/16	*Time* 1500
Sample Numbers		[All]

Sample Number	**P66453-1**	**P66453-2**	**P66453-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/20/16 0717	→ 0233	→ 0044
End Date/Time	10/20/16 1225	→ 1256	→ 0503
Time Span	5.13	10.38	4.32
Sample Depth			
PERSONNEL	HF, KM	→	→
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG6 WG148626

Login: P66453 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P66453-4	P66453-5	P66453-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/20/16 0257	10/19/16 2044	→ 1653
End Date/Time	10/20/16 1250	→ 0708	→ 1307
Time Span	9.98	10.4	20.23
Sample Depth	~~9.90~~ HF		
PERSONNEL	HF, KM	→	→
PH, FIELD			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P66453 | Federal Way Stormwater Effectiveness | Personnel: ________________

Project: 421879-240

Sample Number	P66453-7	P66453-8	P66453-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	10/19/16 2204	10/20/16 0044	10/20/16 1245
End Date/Time	10/20/16 1258	→ 0504	
Time Span	14.9	4.33	
Sample Depth			
PERSONNEL	HF, KM	→	→
PH, FIELD		**********	**********
SAMP FUNC	**********		**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P66453 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P66453-10	P66453-11	P66453-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/20/16 1307	→ ~~1248~~ 1241	→ 1330
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, KM	→	→
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66453 **Federal Way Stormwater Effectiveness** Personnel: ______________

Project: 421879-240

Sample Number	**P66453-13**	**P66453-14**	**P66453-15**
QC Link			
Locator	**FW-WPCI**	**FW-WPCEPO**	**FW-NFWHC**
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/20/16 1215	→ 1314	→ 1340
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, KM	→	→
PH, FIELD	**********	**********	**********
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66453 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P66453-16**	**P66453-17**	**P66453-18**
QC Link			
Locator	**FFBLANK**	**NONE**	**NONE**
Short Loc Desc	FFBLANK	UNKNOWNLOC	UNKNOWNLOC
Locator Desc	FIELD FILTER BLANK	UNKNOWN LOCATOR	UNKNOWN LOCATOR
Site	METRO	NONE	NONE
Comments		NE PIPE	EAST PIPE
Start Date/Time	10/20/16 1500	10/20/16 1230	10/20/16 1225
End Date/Time			
Time Span			
Sample Depth			
CLIENT LOC	**********		
PERSONNEL	**********	**********	**********
PH, FIELD	**********	**********	**********
SAMP FUNC		**********	**********
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP	3 LG TSS	3 LG TSS

Login: P66540 | Federal Way Stormwater Effectiveness | Personnel: ____________

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by J. Dr[illegible]	*Date* 11/1/16	*Time* 1430
Received by E Howell	*Date* 11/1/16	*Time* 1430
Sample Numbers 66540	*Date* ~~1-16~~ 9-15	*[All]*
Sample Numbers		*[All]*

Sample Number	P66540-1	P66540-2	P66540-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/31/16 2227	10/31/16 2146	10/31/16 2205
End Date/Time	11/1/16 1129	11/1/16 1210	11/1/16 1129
Time Span	13.03	14.4	13.4
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

CHAIN OF CUSTODY

RELINQUISHED BY [signature]	Date 11/1/16	Time 1530
RECEIVED BY [signature]	Date 11/1/16	Time 1530
Sample Number(s) 1-8, 16		(All)

WG148815

Login: P66540 | Federal Way Stormwater Effectiveness | Personnel: ________________

Project: 421879-240

Sample Number	P66540-4	P66540-5	P66540-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	10/31/16 2130	10/31/16 2110	10/31/16 2340
End Date/Time	11/1/16 1224	11/1/16 1153	11/1/16 1210
Time Span	14.9	14.72	12.5
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P66540 | Federal Way Stormwater Effectiveness | Personnel: ________________

Project: 421879-240

Sample Number	P66540-7	P66540-8	P66540-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	11/1/16 ~~2340~~ 0701	10/31/16 ~~0701~~ 2228	11/1/16 1126
End Date/Time	11/1/16 1230	11/1/16 1130	
Time Span	5.48	13.03	
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	FREP @ EBI	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P66540 | Federal Way Stormwater Effectiveness | Personnel: ______________

Project: 421879-240

Sample Number	P66540-10	P66540-11	P66540-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	11/1/16 1216	→ 1126	→ 1224
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66540 | Federal Way Stormwater Effectiveness | Personnel: ______________

Project: 421879-240

Sample Number	P66540-13	P66540-14	P66540-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	11/1/16 1154	→ 1210	→ 1235
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66540 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P66540-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	11/1/16 1435		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC			
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P66811 | Federal Way Stormwater Effectiveness | Personnel: HF, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	Date 12-20-16	Time 1530
Received by	Date 12/20/16	Time 1530
Sample Numbers		[All]

Sample Number	P66811-1	P66811-2	P66811-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	12/19/16 2240	→ 2250	→ 2231
End Date/Time	12/20/16 0256	→ 1058	→ 0606
Time Span	4.27	12.13	7.58
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM

Note: email Houston for sample times
ME 12/20/16

WG 149593

Login: P66811 **Federal Way Stormwater Effectiveness** **Personnel:** ____________

Project: 421879-240

Sample Number	**P66811-4**	**P66811-5**	**P66811-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	12/19/16 2145	→ 2004	→ 2227
End Date/Time	12/20/16 0014	→ 0917	→ 1050
Time Span	2.48	13.22	12.38
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM

Login: P66811 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P66811-7**	**P66811-8**	
QC Link			
Locator	**FW-NFWHC**	**FFBLANK**	
Short Loc Desc	NFWHC	FFBLANK	
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	FIELD FILTER BLANK	
Site	KING COUNTY	METRO	
Comments			
Start Date/Time	12/19/16 2151	12/20/16 1429	
End Date/Time	12/20/16 1138		
Time Span	13.78		
Sample Depth			
PERSONNEL	HF, JD	**********	
SAMP FUNC	**********		
SAMP INFO		**********	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LN NH3 3 LN NO23 3 LN ORTHOP	

Run: P66937 **Federal Way Stormwater Effectiveness** Personnel: HF, JP

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 1/18/17	*Time* 1315
Received by	*Date* 1/18/17	*Time* 1315
Sample Numbers 9-15		*[All]*

Sample Number	**P66937-1**	**P66937-2**	**P66937-3**
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	1/17/17 1654	→ 1707	→ 1436
End Date/Time	1/17/17 2132	1/18/17 1127	1/18/17 0329
Time Span	4.63	18.42	12.88
Sample Depth			
PERSONNEL	HF, JD, JP	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

CHAIN OF CUSTODY

RELINQUISHED BY	Date 1/18/17	Time 1530
RECEIVED BY	1/18/17	Time 1530
Sample Number(s) 1-8		(All)

WG 149962

Login: P66937 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P66937-4	P66937-5	P66937-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	1/17/17 1710	→ 1430	→ 1450
End Date/Time	1/18/17 1146	→ 0312	→ 1041
Time Span	18.6	12.7	19.85
Sample Depth			
PERSONNEL	HF, JD, JP →	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P66937 Federal Way Stormwater Effectiveness Personnel: ____________

Project: 421879-240

Sample Number	P66937-7	P66937-8	P66937-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	1/17/17 1502	1/17/17 1656 ~~1/18/17~~ ~~1/18/17~~ ~~1400~~	1/18/17 1028
End Date/Time	1/18/17 1024	1/17/17 2133	
Time Span	19.37	4.62	
Sample Depth			
PERSONNEL			
SAMP FUNC	**********		**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P66937 | Federal Way Stormwater Effectiveness | Personnel: ____________

Project: 421879-240

Sample Number	P66937-10	P66937-11	P66937-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	1/18/17 1121	→ 1029	→ 1153
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66937 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P66937-13	P66937-14	P66937-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	1/18/17 1037	→ 1124	→ 1205
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P66937 | Federal Way Stormwater Effectiveness | Personnel: ______________

Project: 421879-240

Sample Number	**P66937-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	1/18/17 1400		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC			
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67069

Federal Way Stormwater Effectiveness

Personnel: HF, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	Date 2/9/17	Time 1645
Received by	Date 2/9/17	Time 1645
Sample Numbers 1-8, 10		[All]

Sample Number	P67069-1	P67069-2	P67069-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/8/17 1548	→ 1924	→ 1603
End Date/Time	2/9/17 1253	→ 1321	→ 1311
Time Span	21.15	17.95	21.13
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG150445

Login: P67069 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P67069-4	P67069-5	P67069-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/8/17 1828	→ 1609	→ 1644
End Date/Time	2/9/17 1403	→ 1258	→ 1339
Time Span	19.58	20.82	20.92
Sample Depth			
PERSONNEL	HF, SD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67069   Federal Way Stormwater Effectiveness   Personnel: ________

Project: 421879-240

Sample Number	P67069-7	P67069-8	P67069-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	2/8/17 1700	→ 1547	2/9/17 1310
End Date/Time	2/9/17 1043	→ 1257	
Time Span	17.72	21.17	
Sample Depth			
PERSONNEL	HF, JD	→	HF, JD
SAMP FUNC	**********	FREP @ EBI	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

CHAIN OF CUSTODY

RELINQUISHED	[signature] 2/9/17	Time 1550
RECEIVED	[signature] 2/9/17	Time 1550
Sample Number(s)	-9 - 15	(All)

Login: P67069 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	P67069-10	P67069-11	P67069-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/9/17 1354	→ 1311	→ 1411
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67069 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P67069-13	P67069-14	P67069-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/9/17 1332	→ 1353	→ 1417
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67069 | Federal Way Stormwater Effectiveness | Personnel: ________________

Project: 421879-240

Sample Number	**P67069-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	2/9/17 1600		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC	FFB		
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67141 | Federal Way Stormwater Effectiveness | Personnel: HF, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 2/16/17	*Time* 1520
Received by Meghan Ely	*Date* 2/16/17	*Time* 1520
Sample Numbers 1-8, 16, 17		*[All]*

Sample Number	P67141-1	P67141-2	P67141-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/15/17 0654	→ 0730	→ 0703
End Date/Time	2/16/17 0359	→ 0710	→ 0501
Time Span	21.08	23.67	21.97
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG150446

Login: P67141 | Federal Way Stormwater Effectiveness | Personnel: ________________

Project: 421879-240

Sample Number	P67141-4	P67141-5	P67141-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/15/17 0736	→ 0707	→ 0748
End Date/Time	2/16/17 0316	→ 0240	→ 0525
Time Span	19.67	19.55	21.62
Sample Depth			
PERSONNEL			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67141 Federal Way Stormwater Effectiveness Personnel: ________________

Project: 421879-240

CHAIN OF CUSTODY

RELINQUISHED BY	Date	Time
[signature]	2/16/17	1330
RECEIVED BY	Date	Time
[signature]	2/16/17	1330
Sample Number(s) 67141 9-15		

Sample Number	P67141-7	P67141-8	P67141-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	2/15/17 0803	→ 0711	2/16/17 930
End Date/Time	2/16/17 0571	→ 0359	
Time Span	21.13	20.80	
Sample Depth			
PERSONNEL			
SAMP FUNC	**********	FREP	**********
SAMP INFO		@ EBI	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P67141 | Federal Way Stormwater Effectiveness | Personnel: JD HF

Project: 421879-240

Sample Number	P67141-10	P67141-11	P67141-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/16/17 1105	→ 930	→ 1107
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL			
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67141 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P67141-13	P67141-14	P67141-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	2/16/17 1024	→ 1105	→ 1004
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	JD HF	JD HF	JD HF
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Sample: P67141-17

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date*	*Time*
Received by	*Date*	*Time*
Sample Numbers		*[All]*

Sample Number	P67141-17		
QC Link			
Locator	FW-WBO		
Short Loc Desc	WBO		
Locator Desc	WEST BIORETENTION FACILITY OUTLET		
Site	KING COUNTY		
Comments			
Start Date/Time	2/16/17 0950		
End Date/Time	2/16/17 1035		
Time Span	0.75		
Sample Depth			
PERSONNEL	HF, JD		
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB		

Login: P67141 Federal Way Stormwater Effectiveness Personnel: ____________

Project: 421879-240

Sample Number	**P67141-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	2/16/17 1345		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC			
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67231 | Federal Way Stormwater Effectiveness | Personnel: HF, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by [signature]	*Date* 3/8/17	*Time* 1500
Received by [signature]	*Date* 3/8/17	*Time* 1500
Sample Numbers 1-8, 16		*[All]*

Sample Number	**P67231-1**	**P67231-2**	**P67231-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/7/17 0742	→ 0949	→ 0749
End Date/Time	3/7/17 2008	3/8/17 0712	3/7/17 2100
Time Span	12.43	21.38	13.18
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Initial / Date

S. Plan: T-FW_SW_Eff [initials] 3/3/17

#: I

#: G

Enter #:

Approved by:

Moved by:

WG150874

Login: P67231 **Federal Way Stormwater Effectiveness** **Personnel:** ________________

Project: 421879-240

Sample Number	**P67231-4**	**P67231-5**	**P67231-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/7/17 0739	→ 0745	→ 0927
End Date/Time	3/7/17 1355	3/8/17 0203	3/8/17 0713
Time Span	6.27	18.30	21.77
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67231

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

Sample Number	P67231-7	P67231-8	P67231-9
QC Link			
Locator	**FW-NFWHC**	**TEMP**	**FW-EBI**
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	3/7/17 1047
Start Date/Time	3/7/17 0940	→ 0743	
End Date/Time	3/8/17 0717	3/7/17 2008	
Time Span	21.62	12.42	
Sample Depth			
PERSONNEL	HF, JD	→	JD
SAMP FUNC	**********	FREP	**********
SAMP INFO		@EBI	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

CHAIN OF CUSTODY

RELINQUISHED BY	Date	Time
J. Drake	3/7/17	1208
RECEIVED BY	Date	Time
[signature]	3/7/17	1208
Sample Number(s) 67231 9-15 (All)		

Login: P67231

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

Sample Number	P67231-10	P67231-11	P67231-12
QC Link			
Locator	FW-EBO	FW-WBI	FW-WBO
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/7/17 1058	3/7/17 1045	3/7/17 1105
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	JD	JD	JD
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67231

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

Sample Number	**P67231-13**	**P67231-14**	**P67231-15**
QC Link			
Locator	**FW-WPCI**	**FW-WPCEPO**	**FW-NFWHC**
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/7/17 1040	3/7/17 1057	3/7/17 1111
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	JD	JD	JD
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67231

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	**P67231-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	3/8/17 1325		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC	FFB		
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67283

Federal Way Stormwater Effectiveness

Personnel: HF

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 3/9/17	*Time* 1450
Received by	*Date* 3/9/17	*Time* 1450
Sample Numbers 9-15		*[All]*

Sample Number	**P67283-1**	**P67283-2**	**P67283-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/17 1240	→ 1353	→ 1240
End Date/Time	3/10/17 0534	→ 0904	→ 0704
Time Span	16.90	19.18	18.40
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG 150876

Initial / Date

S. Plan: T_FW_SW_Eff ... 3/8/17

#

#

...tser #:

Approved by:

...oved by:

CHAIN OF CUSTODY

RELINQUISHED BY	Date 3/10/17	Time 1530
RECEIVED BY	3/10/17	Time 1530
Sample Number(s) 1-7		(All)

Login: P67283 | Federal Way Stormwater Effectiveness | Personnel: ____________

Project: 421879-240

Sample Number	P67283-4	P67283-5	P67283-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/17 1402	→ 1234	→ 1444
End Date/Time	3/10/17 1214	→ 943	→ 1200
Time Span	22.20	21.15	21.27
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67283 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P67283-7**	**P67283-8**	**P67283-9**
QC Link			
Locator	**FW-NFWHC**	**TEMP**	**FW-EBI**
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	3/9/17 1521		3/9/17 1324
End Date/Time	3/10/17 1245		
Time Span	21.40	DELETE	
Sample Depth			
PERSONNEL	HF, KM		HF
SAMP FUNC	**********		**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

deleted 3/10/17
ME

Login: P67283

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

Sample Number	**P67283-10**	**P67283-11**	**P67283-12**
QC Link			
Locator	**FW-EBO**	**FW-WBI**	**FW-WBO**
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/17 1339	→ 1326	→ 1347
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67283 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P67283-13**	**P67283-14**	**P67283-15**
QC Link			
Locator	**FW-WPCI**	**FW-WPCEPO**	**FW-NFWHC**
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/9/17 1317	→ 1342	→ 1356
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67283 **Federal Way Stormwater Effectiveness** **Personnel:** ____________

Project: 421879-240

Sample Number	**P67283-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	3/10/17 1415		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC	FFB		
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67313

Project: 421879-240

Federal Way Stormwater Effectiveness

Personnel: HF, SD

CHAIN OF CUSTODY

Relinquished by [signature]	*Date* 3/14/17	*Time* 1545
Received by [signature]	*Date* 3/14/17	*Time* 1545
Sample Numbers 1-8, 16		*[All]*

Sample Number	**P67313-1**	**P67313-2**	**P67313-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/13/17 0940	→ 1155	→ 0943
End Date/Time	3/14/17 0804	→ 0821	→ 0843
Time Span	22.40	20.43	23.00
Sample Depth			
PERSONNEL	HF, SD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	~~3 LG ALK~~ HF ~~3 LG COND~~ ~~3 LG DOC~~ ~~3 LG NH3~~ ~~3 LG NO23~~ ~~3 LG ORTHOP~~ ~~3 LG PH~~ ~~3 LG TOC~~ ~~3 LG TOTN~~ ~~3 LG TOTP~~ ~~3 LG TSS~~ ~~3 LG TURB~~ 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS ~~7 LG PAH-SIM~~ ~~10 LG EPA1668PCB~~ HF DELETE ONLY METALS	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM ~~10 LG EPA1668PCB~~	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM ~~10 LG EPA1668PCB~~

DELETE

WG150877
(176)

deleted all prods crossed out by HF
ME 3/14/17

Login: P67313

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	P67313-4	P67313-5	P67313-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/13/17 1249	→ 0801	→ 1208
End Date/Time	3/14/17 0923	→ 0928	→ 0822
Time Span	20.57	25.45	20.23
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG ~~EPA1668PCB~~ HF DELETE	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG ~~EPA1668PCB~~ HF DELETE	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG ~~EPA1668PCB~~ HF DELETE

Login: P67313

Project: 421879-240

Federal Way Stormwater Effectiveness

CHAIN OF CUSTODY

RELINQUISHED BY	Date	Time
HF	3/13/17	1400
RECEIVED BY	Date	Time
E Howell	3/13/17	1400
Sample Number(s) 9-15		(All)

Personnel: HF

Sample Number	P67313-7	P67313-8	P67313-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	3/13/17 1201	→ 0944	3/13/17 1217
End Date/Time	3/14/17 1228	→ 0844	
Time Span	24.45	23.00	
Sample Depth			
PERSONNEL	HF, SD	→	HF
SAMP FUNC	**********	FREP	**********
SAMP INFO		@WBI	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG ~~EPA1668PCB~~ HF DELETE	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P67313 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P67313-10**	**P67313-11**	**P67313-12**
QC Link			
Locator	**FW-EBO**	**FW-WBI**	**FW-WBO**
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/13/17 1232	→ 1219	→ 1243
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67313

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	P67313-13	P67313-14	P67313-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/13/17 1208	→ 1234	→ 1249
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67313

Project: 421879-240

Federal Way Stormwater Effectiveness

Personnel: ______________

Sample Number	**P67313-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	3/14/17 1437		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC	FFB		
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67335

Federal Way Stormwater Effectiveness

Personnel: HF, KM

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 3/16/17	*Time* 1500
Received by	*Date* 3/16/17	*Time* 1500
Sample Numbers		*[All]*

Sample Number	**P67335-1**	**P67335-2**	**P67335-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/14/17 2235	3/14/17 2303	3/14/17 2235
End Date/Time	3/15/17 1543	→ 2238	→ 2038
Time Span	17.13	23.58	22.05
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG150878

Login: P67335 Federal Way Stormwater Effectiveness Personnel: ____________

Project: 421879-240

Sample Number	P67335-4	P67335-5	P67335-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/14/17 2304	→ 2236	→ 2302
End Date/Time	3/15/17 2248	→ ~~2~~1746	→ 2233
Time Span	23.73	HF 19.17	23.52
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67335

Project: 421879-240

Federal Way Stormwater Effectiveness

CHAIN OF CUSTODY

RELINQUISHED BY	Date	Time
[signature]	3/15/17	1240
RECEIVED BY	Date	Time
[signature]	3/15/17	1240
Sample Number(s) 9-15 (All)		

Personnel: ________________

Sample Number	P67335-7	P67335-8	P67335-9
QC Link			
Locator	FW-NFWHC	TEMP	FW-EBI
Short Loc Desc	NFWHC	TEMPLOC	EBI
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	EAST BIORETENTION FACILITY INLET
Site	KING COUNTY	TEMP	KING COUNTY
Comments		FREP	
Start Date/Time	3/14/17 2313	→ 2235	3/15/17 1124
End Date/Time	3/15/17 2007	→ 2038	
Time Span	20.90	22.05	
Sample Depth			
PERSONNEL	HF, KM	→	HF
SAMP FUNC	**********		**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668 PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	5 LG FC-MF

Login: P67335

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	P67335-10	P67335-11	P67335-12
QC Link			
Locator	**FW-EBO**	**FW-WBI**	**FW-WBO**
Short Loc Desc	EBO	WBI	WBO
Locator Desc	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET	WEST BIORETENTION FACILITY OUTLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/15/17 1128	→ 1127	→ 1134
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67335

Federal Way Stormwater Effectiveness

Personnel: ________________

Project: 421879-240

Sample Number	P67335-13	P67335-14	P67335-15
QC Link			
Locator	FW-WPCI	FW-WPCEPO	FW-NFWHC
Short Loc Desc	WPCI	WPCEPO	NFWHC
Locator Desc	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI	NORTH FORK WEST HYLEBOS CREEK
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/15/17 1108	→ 1130	→ 1141
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	AF	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	5 LG FC-MF	5 LG FC-MF	5 LG FC-MF

Login: P67335

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	**P67335-16**		
QC Link			
Locator	**FFBLANK**		
Short Loc Desc	FFBLANK		
Locator Desc	FIELD FILTER BLANK		
Site	METRO		
Comments			
Start Date/Time	3/16/17 1415		
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	**********		
SAMP FUNC	FFB		
SAMP INFO	**********		
Dept, Matrix, Prod	3 LN NH3 3 LN NO23 3 LN ORTHOP		

Login: P67398 | Federal Way Stormwater Effectiveness | Personnel: HF, KM

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	Date 3-27-17	Time 1500
Received by	Date 3/27/17	Time 1800
Sample Numbers 1-7, 16		[All]

Sample Number	P67398-1	P67398-2	P67398-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/26/17 1435	→ 1508	→ 1202
End Date/Time	3/27/17 0014	3/27/17 0844	3/26/17 2311
Time Span	9.65	17.60	11.15
Sample Depth			
PERSONNEL	HF, KM		
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG151292

Login: P67398 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P67398-4**	**P67398-5**	**P67398-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/26/17 1417	→ 1231	→ 1419
End Date/Time	3/27/17 1117	→ 1012	→ 1111
Time Span	21.00	21.68	20.87
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Sample Number	P67398-7	P67398-8	P67398-16
QC Link			
Locator	**FW-NFWHC**	**TEMP**	**FFBLANK**
Short Loc Desc	NFWHC	TEMPLOC	FFBLANK
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	TEMPORARY LOCATOR	FIELD FILTER BLANK
Site	KING COUNTY	TEMP	METRO
Comments		FREP	
Start Date/Time	3/26/17 1421	DELETE	3/27/17 1336
End Date/Time	3/27/17 1130		
Time Span	21.15		
Sample Depth			
PERSONNEL	HF, KM		**********
SAMP FUNC	**********		FFB
SAMP INFO			**********
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM	3 LN NH3 3 LN NO23 3 LN ORTHOP

Login: P67443

Federal Way Stormwater Effectiveness

Personnel: HF, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by [signature]	*Date* 3/30/17	*Time* 1240
Received by E. Howell	*Date* 3/30/17	*Time* 1240
Sample Numbers		[All]

Sample Number	P67443-1	P67443-2	P67443-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/29/17 0116	→ 0301	→ 0049
End Date/Time	3/29/17 1237	3/30/17 0054	3/29/17 1228
Time Span	11.35	21.88	11.65
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG 15573

Login: P67443 **Federal Way Stormwater Effectiveness** **Personnel:** ________________

Project: 421879-240

Sample Number	**P67443-4**	**P67443-5**	**P67443-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	3/29/17 0156	→ 1035	→ 0235
End Date/Time	3/29/17 1426		3/29/17 2236
Time Span	12.50		20.02
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67443 Federal Way Stormwater Effectiveness Personnel: ________________

Project: 421879-240

Sample Number	P67443-7	P67443-8	
QC Link			
Locator	FW-NFWHC	FFBLANK	
Short Loc Desc	NFWHC	FFBLANK	
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	FIELD FILTER BLANK	
Site	KING COUNTY	METRO	
Comments			
Start Date/Time	3/29/17 0318	3/30/17 1040	
End Date/Time	3/30/17 0007		
Time Span	2082		
Sample Depth			
PERSONNEL	HF, JD	**********	
SAMP FUNC	**********	FFB	
SAMP INFO		**********	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LN NH3 3 LN NO23 3 LN ORTHOP	

Login: P67499 | Federal Way Stormwater Effectiveness | Personnel: HF, SD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 4/6/17	*Time* 1440
Received by	*Date* 4/6/17	*Time* 1440
Sample Numbers		*[All]*

Sample Number	P67499-1	P67499-2	P67499-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/5/17 0641	→ 0840	→ 0638
End Date/Time	4/5/17 1557	4/6/17 0559	4/5/17 1222
Time Span	9.27	21.32	5.73
Sample Depth			
PERSONNEL	HF SD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

WG151293

Login: P67499 | Federal Way Stormwater Effectiveness | Personnel: ______

Project: 421879-240

Sample Number	P67499-4	P67499-5	P67499-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/5/17 0857	→ 0754	→ 0848
End Date/Time	4/6/17 0113	4/5/17 1615	0622
Time Span	16.27	8.35	21.57
Sample Depth			
PERSONNEL	HF, JD	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB

Login: P67499 **Federal Way Stormwater Effectiveness** **Personnel:** ______________

Project: 421879-240

Sample Number	**P67499-7**	**P67499-8**	
QC Link			
Locator	**FW-NFWHC**	**FFBLANK**	
Short Loc Desc	NFWHC	FFBLANK	
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	FIELD FILTER BLANK	
Site	KING COUNTY	METRO	
Comments	4/5/17		
Start Date/Time	~~4/6/17~~ HF 0930	4/6/17 1333	
End Date/Time	4/6/17 0616		
Time Span	20.77		
Sample Depth			
PERSONNEL	HF, JD	**********	
SAMP FUNC	**********	FFB	
SAMP INFO		**********	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM 10 LG EPA1668PCB	3 LN NH3 3 LN NO23 3 LN ORTHOP	

Login: P67594 | Federal Way Stormwater Effectiveness | Personnel: HF, KM, JD

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 4/20/17	*Time* 1530
Received by	*Date* 4/20/17	*Time* 1530
Sample Numbers		*[All]*

Sample Number	**P67594-1**	**P67594-2**	**P67594-3**
QC Link			
Locator	**FW-EBI**	**FW-EBO**	**FW-WBI**
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/19/17 1315	→ 1612	→ 1306
End Date/Time	4/20/17 0053	→ 0710	→ 0057
Time Span	11.63	14.97	11.85
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO	composite	→	→
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB

WG157594

Login: P67594 Federal Way Stormwater Effectiveness Personnel: ________________

Project: 421879-240

Sample Number	P67594-4	P67594-5	P67594-6
QC Link			
Locator	FW-WBO	FW-WPCI	FW-WPCEPO
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/19/17 1549	→ 1223	→ 1610
End Date/Time	4/20/17 0646	→ 0556	→ 0634
Time Span	14.95	17.55	14.40
Sample Depth			
PERSONNEL	HF, KM	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO	composite	→	→
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB

Login: P67594 Federal Way Stormwater Effectiveness Personnel: ______________

Project: 421879-240

Sample Number	P67594-7	P67594-8	
QC Link			
Locator	FW-NFWHC	FFBLANK	
Short Loc Desc	NFWHC	FFBLANK	
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	FIELD FILTER BLANK	
Site	KING COUNTY	METRO	
Comments			
Start Date/Time	4/19/17 1622	4/20/17 1435	
End Date/Time	4/20/17 0653		
Time Span	14.52		
Sample Depth			
PERSONNEL	HF, KM	**********	
SAMP FUNC	**********	FFB	
SAMP INFO	composite	**********	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LN NH3 3 LN NO23 3 LN ORTHOP	

Login: P67617

Federal Way Stormwater Effectiveness

Personnel: HF

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by	*Date* 4/24/17	*Time* 1620
Received by	*Date* 4/24/17	*Time* 1020
Sample Numbers		(All)

Sample Number	P67617-1	P67617-2	P67617-3
QC Link			
Locator	FW-EBI	FW-EBO	FW-WBI
Short Loc Desc	EBI	EBO	WBI
Locator Desc	EAST BIORETENTION FACILITY INLET	EAST BIORETENTION FACILITY OUTLET	WEST BIORETENTION FACILITY INLET
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/~~24~~ 23 HF/17 1657	→ 1917	→ HF ~~1657~~ 1646
End Date/Time	4/24/17 0649	→ 1212	→ HF ~~0649~~ 0840
Time Span	13.87	16.92	HF ~~13.87~~ 15.90
Sample Depth			
PERSONNEL	HF, DH	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB

WG151595

Login: P67617 | Federal Way Stormwater Effectiveness | Personnel: ____________

Project: 421879-240

Sample Number	**P67617-4**	**P67617-5**	**P67617-6**
QC Link			
Locator	**FW-WBO**	**FW-WPCI**	**FW-WPCEPO**
Short Loc Desc	WBO	WPCI	WPCEPO
Locator Desc	WEST BIORETENTION FACILITY OUTLET	WET POND CONPLEXT INLET	COMBINED WET POND COMPLEX AND EAST BIORETENTI
Site	KING COUNTY	KING COUNTY	KING COUNTY
Comments			
Start Date/Time	4/~~24~~ 23 HF/17 2037	→ 1528	→ 1947
End Date/Time	4/24/17 1329	→ 1136	→ 1328
Time Span	16.87	20.13	17.68
Sample Depth			
PERSONNEL	HF, DH	→	→
SAMP FUNC	**********	**********	**********
SAMP INFO			
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB

Login: P67617

Federal Way Stormwater Effectiveness

Personnel: ______________

Project: 421879-240

Sample Number	P67617-7	P67617-8	
QC Link			
Locator	FW-NFWHC	FFBLANK	
Short Loc Desc	NFWHC	FFBLANK	
Locator Desc	NORTH FORK WEST HYLEBOS CREEK	FIELD FILTER BLANK	
Site	KING COUNTY	METRO	
Comments			
Start Date/Time	4/23/17 1957	4/24/17 1305	
End Date/Time	4/24/17 1308		
Time Span	17.18		
Sample Depth			
PERSONNEL		**********	
SAMP FUNC	**********	FFB	
SAMP INFO		**********	
Dept, Matrix, Prod	3 LG ALK 3 LG COND 3 LG DOC 3 LG NH3 3 LG NO23 3 LG ORTHOP 3 LG PH 3 LG TOC 3 LG TOTN 3 LG TOTP 3 LG TSS 3 LG TURB 6 LG CA-ICPMS 6 LG CD-ICPMS 6 LG CD-ICPMS, DISS 6 LG CU-ICPMS 6 LG CU-ICPMS, DISS 6 LG ICPMS-HARDNESS 6 LG MG-ICPMS 6 LG PB-ICPMS 6 LG PB-ICPMS, DISS 6 LG ZN-ICPMS 6 LG ZN-ICPMS, DISS 7 LG PAH-SIM-QL 10 LG EPA1668PCB	3 LN NH3 3 LN NO23 3 LN ORTHOP	

Login: P67724 | Federal Way SWE Equipment Blank | Personnel: HF

Project: 421879-240

CHAIN OF CUSTODY

Relinquished by [signature]	*Date* 5-8-17	*Time* 1400
Received by [signature]	*Date* 5/9/17	*Time* 1400
Sample Numbers		[All]

Sample Number	**P67724-1**	**P67724-2**	
QC Link			
Locator	**EQUIPBLANK**	**FFBLANK**	
Short Loc Desc	EQUIPBLANK	FFBLANK	
Locator Desc	EQUIPMENT BLANK	FIELD FILTER BLANK	
Site	METRO	METRO	
Comments			
Start Date/Time	5/8/17 1135	→ 1343	
End Date/Time			
Time Span			
Sample Depth			
PERSONNEL	HF	**********	
SAMP FUNC	**********	FFB	
SAMP INFO	@EB1	**********	
Dept, Matrix, Prod	3 LN ALK 3 LN COND 3 LN DOC 3 LN NH3 3 LN NO23 3 LN ORTHOP 3 LN PH 3 LN TOC 3 LN TOTN 3 LN TOTP 3 LN TSS 3 LN TURB 6 LN CA-ICPMS 6 LN CD-ICPMS 6 LN CD-ICPMS, DISS 6 LN CU-ICPMS 6 LN CU-ICPMS, DISS 6 LN ICPMS-HARDNESS 6 LN MG-ICPMS 6 LN PB-ICPMS 6 LN PB-ICPMS, DISS 6 LN ZN-ICPMS 6 LN ZN-ICPMS, DISS 7 LN PAH-SIM-QL 10 LN EPA1668PCB	3 LN NH3 3 LN NO23 3 LN ORTHOP	

* THERE WAS ONE LITTLE CHUNK OF ALGAE FLOATING AROUND IN THIS EQ BLANK.

WG152217

Appendix C:
Field Sampling Methods

APPENDIX C - FIELD SAMPLING METHODS: DEVIATIONS FROM QAPP

All field sampling methods are described in the Quality Assurance Project Plan (QAPP) (King County 2016). This appendix describes field sampling activities that deviated from or were not described in the QAPP (King County 2016). Sampling locations referenced here are described in the main report and in the QAPP.

C.1 Flow measurement

C.1.1 General Flow Measurement Considerations

As described in the QAPP, flow rate was continuously monitored at the seven sampling sites. Each site posed its own challenges to flow measurement as the stormwater pipes were 1) not engineered for easy installation of flow meters, 2) prone to blockages by debris and other organic matter, and 3) not installed to precisely match the original design drawings. Notes about specific sampling locations are listed below.

- The wetland complex inlet (WCI) required confined-space entry, where an ISCO 750 area-velocity meter (AVM) was installed. During one high flow event, large chunks of concrete lodged up against the meter, which caused irregular velocity measurements. This site was also vandalized, which caused a malfunction/failure in the AVM.
- The QAPP specified the type of flow meter to be installed at each site; however, following observations at each site and consulting with ISCO Environmental Service support, it was determined that the type of flow meters specified in the QAPP would not be effective at some sites. The 750 AVMs were replaced with 730 Bubblers at east and west bioretention outlets (EBO and WBO) due to low and intermittent flow conditions. In addition, the 730 Bubbler specified for the combined outlet of the wetland complex and east bioretention facility (WCEBO) was replaced with a 750 AVM due to the continuous, higher flow rate at this site.
- The inlets to the east and west bioretention facilities (EBI and WBI) were only accessible at the upslope end of the pipe, which was not an ideal location for a flow meter. Also, because there was nowhere to install primary flow devices, these two pipes required the use of the Manning Formula to calculate flow rates. Initially, AVMs were installed at these sites and flow data were collected for a few storms (at higher flow rates), but it was decided that a 730 bubbler flow meter would be more effective to capture low flow rates at these sites. When the bubblers were installed, field personnel were then able to compare the new flow data (using the Manning equation) with flow data collected by the AVMs. This allowed field personnel adjust the Manning equation to match the flow recorded by the AVM.
- The EBO flow meter was initially installed in the end of a pipe that emptied to the same catch basin as WCEBO. However, it was later discovered that in addition to EBO effluent, untreated street runoff flowed into the pipe and interfered with the EBO flow measurement. The EBO flow meter was moved to a pipe that only drained the east bioretention facility. This pipe emptied to a catch basin that was small and prone to

filling, making it challenging to measure flow. To address this challenge a Thel-mar weir was installed to prevent backflow into the pipe. The weir also improved accuracy of the flow measurement. All of these changes were completed before any chemistry samples were collected.

- Conditions at WBO were similar to EBO in that it drained to a catch basin that had the potential for backflow (Figure 1); thus, a Thel-mar weir was also installed at this site. Additionally, at both EBO and WBO organic matter growth was prominent in the tubing, especially during the warmer months, and required constant maintenance to keep the bubbler flow meters from clogging. The clogging of the bubbler tube caused the meter to report high biased flow measurements, which resulted in unusable data.

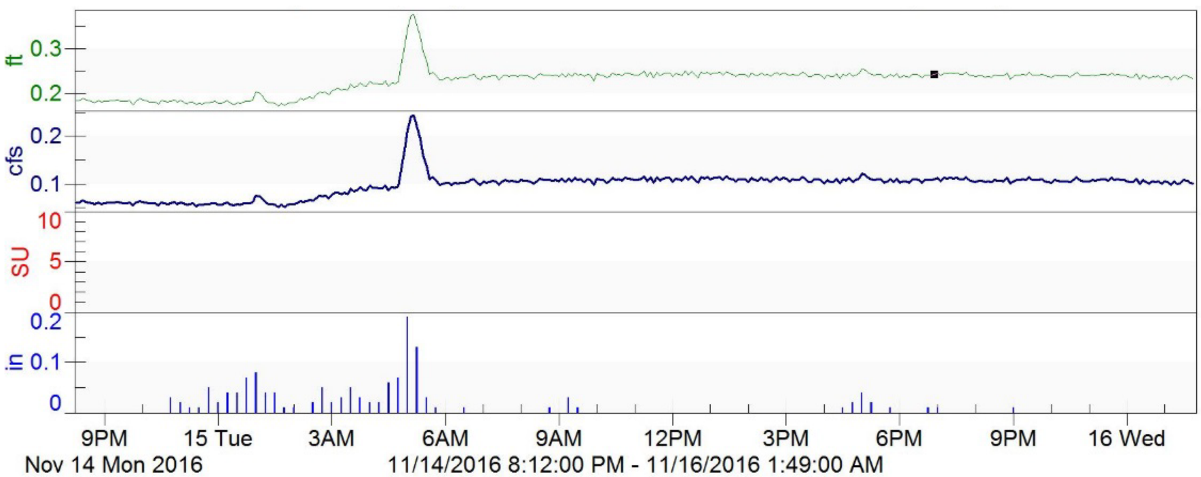


Figure 1. Example of an erroneous spike in water level and flow rate due to backflow in the catch basin that WBO flows to.

- Installation of the AVMs was more straightforward at WCEBO and at the creek site (North Fork West Hylebos Creek; NWFHC). As with the other outlet sites, WCEBO was prone to organic matter fouling and required regular cleaning. Occasionally during high flows, the AVM at NWFHC became blocked by cobblestones moving down the creek, which resulted in erroneous velocity values.

C.1.2 Development of Flow Charts

The QAPP specified that flow-weighted composite samples would be collected over the same time period in which 50% or more of the volume from a particular storm flowed through that location or the hydrograph peaked. These criteria were particularly challenging to meet at WBO and EBO due to the extended retention time within these facilities (over 72 hours in some cases). In order to collect a representative sample and minimize hold-times to the extent possible, storm criteria were altered to indicate that post-sampling criteria were met for samples in which 50% or more of the volume *from the first 24 hours of storm flow* was collected or the hydrograph peaked.

The revised sampling criteria were met for most samples and most locations, thanks to the excellent flow charts and “cheat sheets” developed by field personnel. After installing and calibrating the flow meters at each site, flow data were collected from a series of storms (up to 16 different storms at some sites). Using ISCO Flowlink software, total flow volumes for each storm were calculated at each site and MS Excel was used to chart volume against total rainfall for the storm, along with a line of best fit equation with the R^2 value. For example, the relationship for WCI is shown in Figure 2.

Rain	WCI
0.28	83653.47
0.36	94766.74
0.42	147110
0.58	145623.9
0.81	269995.2
1.1	357002.9
1.12	299672.1
1.28	416370.9
0.86	230000
0.53	114000
0.29	52405

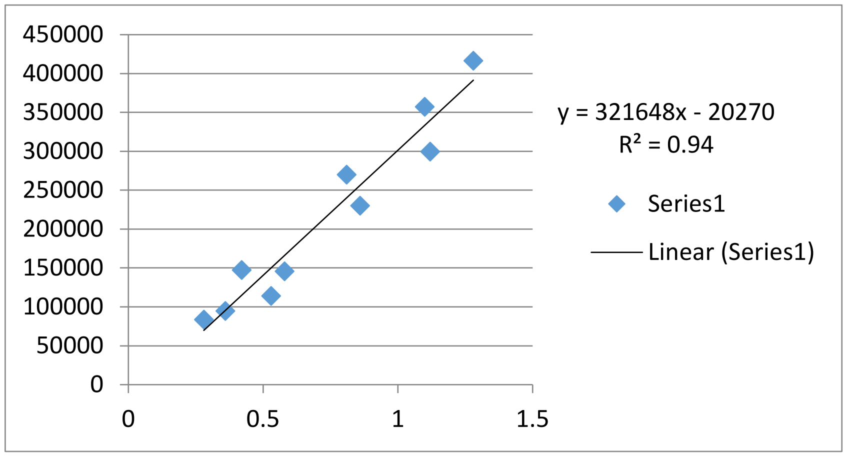


Figure 2. Example of flow data used to generate the flow chart described below. The plot illustrates rainfall during the storm event (inches [in.]) vs. flow volume (cubic feet [cf]) at the WCI location. Each dot represents a single storm event.

Using this equation, a “cheat sheet” was created to help determine how to pace the autosampler at each site to insure a representative flow-weighted composite sample was collected at each location during each storm. Autosamplers for this project were programmed to collect up to 36 aliquots of 500 milliliters (ml) per storm. Therefore, for each rainfall scenario (Table 1), total flow volume expected at each location was divided by 36. This volume was then programmed into the autosamplers to insure a sufficient number of representative aliquots were collected during the runoff event. For example, if the forecast called for 0.5 in. of rain, the autosampler at WCI was programmed to collect an aliquot every 4151 cf (Table 2). These relationships were critical to meet sample criteria and collection of a sufficient and representative composite sample.

Table 1. Estimated expected flow volume, to pass through the WCI facility between each of 36 aliquot collections under different forecast scenarios.

Rain Forecast (in.)	Total flow volume (cf) passing through location between sampling intervals						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
0.15	-3.20	-1.64	21.53	21.53	1067.47	1125.13	1561.90
0.2	9.43	14.01	33.71	33.71	1508.04	1614.17	2188.94
0.25	22.06	29.66	45.90	45.90	1948.61	2103.22	2815.98
0.3	34.69	45.31	58.08	58.08	2389.19	2592.27	3443.03
0.35	47.32	60.96	70.26	70.26	2829.76	3081.32	4070.07
0.4	59.95	76.61	82.45	82.45	3270.34	3570.37	4697.11
0.45	72.57	92.25	94.63	94.63	3710.91	4059.42	5324.15
0.5	85.20	107.90	106.82	106.82	4151.49	4548.47	5951.19
0.55	97.83	123.55	119.00	119.00	4592.06	5037.52	6578.24
0.6	110.46	139.20	131.18	131.18	5032.64	5526.57	7205.28
0.65	123.09	154.85	143.37	143.37	5473.21	6015.62	7832.32
0.7	135.71	170.50	155.55	155.55	5913.79	6504.67	8459.36
0.75	148.34	186.15	167.74	167.74	6354.36	6993.72	9086.41
0.8	160.97	201.79	179.92	179.92	6794.94	7482.77	9713.45

C.2 Additional deviations from the QAPP

The QAPP specified that 20 samples would be collected at each site, but the timing of a construction project along S. 356th St. prematurely ended the sampling season in April 2017 after 18 samples had been collected. See Appendix A for more information about how the site changed after the study period.

Appendix D:
Analytical Methods

APPENDIX D - LABORATORY METHODS

A summary of analytical methods are presented in this section. Greater detail can be found in the project Quality Assurance Project Plan (QAPP) (King County 2016).

D.1 KCEL Analysis

The King County Environmental Laboratory (KCEL) analyzed the samples for all parameters except polychlorinated biphenyls (PCBs). Standard Method SM5310B was used for total organic carbon (TOC) and dissolved organic carbon (DOC) analysis, while Standard Method SM2540D was used for total suspended solids (TSS) analysis. Nutrients were analyzed using SM4500-P-F (orthophosphate phosphorus), SM4500-P-B, F (total phosphorus), SM4500-N-C (total nitrogen), SM4500-NO3-F (nitrate-nitrite nitrogen), and Kerouel & Aminot (1997; ammonia nitrogen). Bacteria was analyzed as fecal coliforms using Standard Method SM9222D.

Total and dissolved metals were analyzed and reported by EPA Method 200.8 (Inductively Coupled Plasma-Mass Spectrometry [ICP-MS]), KCEL SOP 624. The specific metals analyzed included: cadmium, copper, lead, and zinc.

Samples analyzed for polycyclic aromatic hydrocarbons (PAHs) were prepared by liquid-liquid extraction in general agreement with EPA method 3520C. Samples were analyzed by a modified EPA Method 8270 Gas Chromatography/Mass Spectrometry – Selected Ion Monitoring method (GC/MS-SIM; KCEL SOP 731v5). The specific PAHs included: 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(g,h,i)perylene, benzo(a)pyrene, benzo(b,j,k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluorene, fluoranthene, indeno (1,2,3-cd)perylene, naphthalene, phenanthrene, and pyrene.

Toxicity tests were conducted for ten events on samples collected at each site. For most events, two toxicity tests were conducted: (1) a 48-hour acute test with *Daphnia pulex* following KCEL SOP #412v2 and EPA Test Method 2021.0 (acute *Daphnia pulex*), and (2) a 7-day chronic test with *Ceriodaphnia dubia* following KCEL SOP #408v3 and EPA Method 1002.0 (chronic *Ceriodaphnia dubia*).

D.2 PCB Analysis

PCBs are found in up to 209 different chemical forms, called congeners, and were measured using high resolution PCB congener analysis. Analysis followed EPA Method 1668 Revision C (EPA 2010), which is a high-resolution gas chromatography/high-resolution mass spectroscopy (HRGC/HRMS) method using an isotope dilution internal standard quantification. This method provides reliable analyte identification and very low detection limits. An extensive suite of labeled surrogate standards are added before samples are extracted. Data are “recovery-corrected” for losses in extraction and cleanup, and analytes are quantified against their most similar labeled analogues. The analysis included all 209 PCB congeners. Pacific Rim Laboratories (PRL) performed the PCB congener analysis according to their SOP LAB02. The samples were extracted followed by standard method clean-up, which includes clean up in an acid silica gel column. Analysis is performed with an SGE HT-8 column.

Appendix D References

EPA. 2010. Method 1668C, Chlorinated biphenyl congeners in water, soil, sediment, biosolids, and tissue by HRGC/HRMS. U.S. Environmental Protection Agency, Office of Water, Office Science and Technology, Washington, D.C. EPA-820-R-10-005.

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

Appendix E:
Data Analysis Methods

APPENDIX E – DATA ANALYSIS METHODS

This appendix presents the methods used to prepare data for analysis, including the rules for: use of replicate data, significant figures, non-detect results, and determining sums for chemical groups (i.e., polycyclic aromatic hydrocarbons [PAHs] and polychlorinated biphenyls [PCBs]). Data analysis methods are also described, which include calculating the percent reduction between influent and effluent and associated statistical tests. Statistical test results are also presented.

Laboratory and Field Replicates

Laboratory and field replicate sample results were considered quality control data. These data were used as part of the data validation process and to assess quality control.

Significant Figures

Chemical data generated by the King County Environmental Laboratory (KCEL) are reported to three significant figures, unless the value is below the reporting detection limit (RDL). Results below the RDL have higher uncertainty and are reported to only two significant figures. Pacific Rim Laboratories reports PCB congener results to three significant figures. PCB congener sums were also rounded to three significant figures. Appendix F presents the concentration data with appropriate significant figures.

Summation for PAH and PCB Totals

Total PAHs are the sum of 16 PAH compounds (Table 1). Results for individual PAHs deemed non-detect by the laboratory or through the data validation process were not included in the sums. Some samples did not have any detected PAHs. In these cases, the highest MDL of the summed compounds was used as the level of detection and this value is reported as the total.

Total PCBs are the sum of all detected concentrations of the 209 congeners. Results for individual PCB congeners deemed non-detect by the laboratory or through the data validation process were not included in the sums. All samples had at least one PCB congener detected, and therefore sums were based only on detected levels.

Table 1. PAH compounds included in total PAH sums.

PAH Compounds			
2-Methylnaphthalene	Benzo(a)anthracene	Chrysene	Indeno(1,2,3-Cd)Pyrene
Acenaphthene	Benzo(a)pyrene	Dibenzo(a,h)anthracene	Naphthalene
Acenaphthylene	Benzo(b,j,k)fluoranthene	Fluoranthene	Phenanthrene
Anthracene	Benzo(g,h,i)perylene	Fluorene	Pyrene

Use of Non-detect Result Values

For each parameter, non-detect results were included in calculation of summary statistics (e.g., minimum, maximum, mean), report figures, percent reduction calculations, and statistical tests using the MDL as the sample value. This method results in a high bias for data summaries with non-detects and increases uncertainty in other calculations and statistical tests. All statistical tests for parameters with non-detects were repeated using half the MDL as the substituted value to determine the impact on statistical results. Statistical differences remained the same, except for total cadmium at WB where use of half the MDL resulted in statistical differences between influent and effluent concentrations, but substituting at the full MDL did not. Statistical tests were conducted for all parameters except dissolved cadmium for which there were very few detections in both influent and effluent at all sites.

Data Preparation

Sufficient sample volume for all planned analytical tests was collected during most events. However, in a few cases there was insufficient sample volume to analyze both an influent and effluent sample. These unpaired results were not used in the paired comparisons between influent and effluent results (i.e., the performance summary tables in Section 2.1 of the main report and the scatter plots in Appendix H, Section H1). All sample results (including unpaired samples) were included in the statistical comparison of influent and effluent concentrations, and the data summary tables and box plots in Appendix H1.

Testing for Differences between Influent and Effluent – Paired Permutation Tests

A permutation test was used to assess if differences between influent and effluent concentrations, across storms at individual sites (i.e., EB, WB, and WC), were significant (Sections 2.1 and 2.2 in the main report). This test was conducted in R (version 3.2.1; R Core Team 2017) using "oneway_test" from the "coin" package. The p-values generated for the one-way test were then multiplied by two to approximate a two-way test. The two-way test determines whether the difference in mean concentration (between influent and effluent) is less than or greater than would be expected by chance. This is accomplished by calculating many permutations of the dataset by randomly assigning an influent or effluent designation to each sample result and recalculating the difference between the means for each permutation. The observed difference between the means (calculated using the original data) is then compared to the distribution of mean differences generated by the permutations. If the observed mean difference is within the top or bottom 2.5% of the permutation results, then the difference is greater than would be expected by chance – the difference in mean influent and effluent concentrations is statistically significant with p-value <0.05 (Figure 1).

This test is similar to a two-tailed t-test, except it is does not require the assumption of normal distribution. Instead, it uses the sampled distribution by resampling from the actual dataset. This test is also favorable because it tests on means, unlike the two-tailed Wilcoxon signed-rank test, which is used to determine if population mean ranks differ (recommended in Technology Assessment Protocol – Ecology [TAPE]; Ecology 2011). Permutation test results are presented in Table 2.

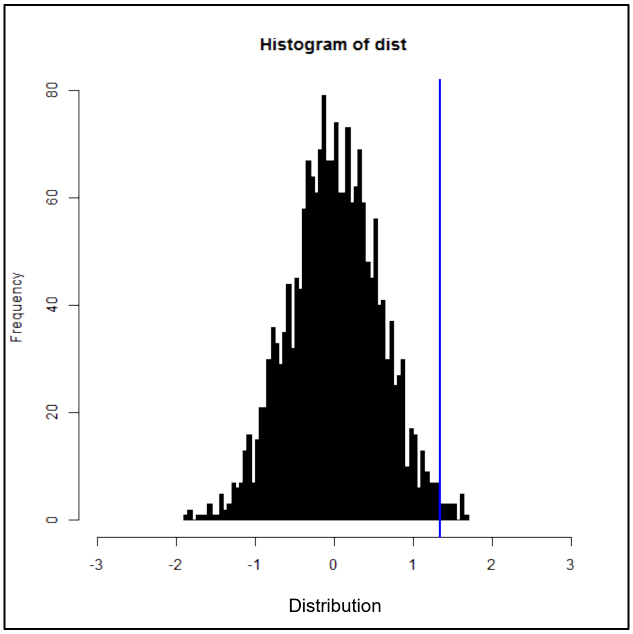


Figure 1. Example of permutation results. Black bars indicate frequency of permutated difference and blue line signifies the observed difference.

Table 2. Results of permutation tests to analyze differences between inlet and outlet concentrations of sampled parameters at the east (EB) and west (WB) bioretention facilities and the wetland complex (WC). Green check next to the z value indicates the difference between the inlet and outlet concentration is in the desired direction; red x indicates difference is in the undesired direction. Green shading = p<0.01; yellow shading = p<0.05.

Asymptotic Two-Sample Fisher-Pitman Permutation Test							
		Non-detect = MDL			Non-detect = 0.5MDL		
Parameter	Site	z	one way p-value	two way p-value	z	one way p-value	two way p-value
Turbidity	EB	✓ -2.00	4.60E-02	0.09204			
	WB	✓ -0.45	6.56E-01	1.3114			
	WC	✓ -3.09	0.001986	0.003972			
TSS	EB	✓ -3.08	0.002066	0.004132			
	WB	✓ -0.79	0.4321	0.8642	✓ -0.81	0.4205	0.841
	WC	✓ -4.63	3.59E-06	0.00000717			
Conductivity	EB	✗ 1.74	8.20E-02	0.16398			
	WB	✗ 3.26	1.12E-03	0.00223			
	WC	✗ 2.00	0.04512	0.09024			
Total Phosphorus	EB	✗ 5.27	1.39E-07	0.000000277			
	WB	✗ 5.38	7.34E-08	1.4686E-07			
	WC	✓ -0.53	0.5934	1.1868			
Ortho-phosphate	EB	✗ 5.35	8.60E-08	1.7202E-07			
	WB	✗ 5.51	3.55E-08	7.098E-08			
	WC	✗ 5.22	1.82E-07	3.646E-07			
Total Nitrogen	EB	✗ 4.72	2.41E-06	0.000004826			
	WB	✗ 4.89	1.03E-06	0.000002058			
	WC	✓ -3.59	0.0003368	0.0006736			
Nitrate + Nitrite	EB	✗ 4.42	9.74E-06	0.000019478			
	WB	✗ 3.62	0.0002981	0.0005962			
	WC	✓ -1.38	0.1662	0.3324			
Ammonia	EB	✗ 2.33	0.02003	0.04006	✗ 2.33	0.01993	0.03986
	WB	✗ 4.66	3.14E-06	0.000006278	✗ 4.66	3.14E-06	0.000006272
	WC	✓ -3.66	0.0002536	0.0005072			
Fecal Coliforms	EB	✓ -1.48	0.138	0.276			
	WB	✓ -1.39	0.1655	0.331			
	WC	✓ -2.14	0.03208	0.06416			

Asymptotic Two-Sample Fisher-Pitman Permutation Test, continued							
		Non-detect = MDL			Non-detect = 0.5MDL		
Parameter	Site	z	one way p-value	two way p-value	z	one way p-value	two way p-value
Total Cadmium	EB	✗ 1.18	0.2382	0.4764	✗ 1.37	0.171	0.342
	WB	✗ 1.87	0.06146	0.12292	✗ 2.31	0.02091	0.04182
	WC	✓ -2.29	0.02182	0.04364	✓ -2.78	0.005496	0.010992
Total Copper	EB	✗ 1.22	0.2215	0.443			
	WB	✗ 2.59	0.009494	0.018988			
	WC	✓ -4.35	1.34E-05	0.00002684			
Dissolved Copper	EB	✗ 2.84	0.004528	0.009056			
	WB	✗ 3.45	0.0005634	0.0011268			
	WC	✗ 0.46	0.6445	1.289			
Total Lead	EB	✓ -2.27	0.02338	0.04676			
	WB	✗ 2.03	0.0422	0.0844			
	WC	✓ -4.46	8.22E-06	0.000016434			
Dissolved Lead	EB	✗ 3.87	0.0001094	0.0002188	✗ 4.18	0.00002921	0.00005842
	WB	✗ 4.89	1.00E-06	0.000002	✗ 5.01	5.58E-07	1.1158E-06
	WC	✗ 1.01	0.3108	0.6216	✗ 1.19	0.2355	0.471
Total Zinc	EB	✓ -5.57	2.55E-08	5.106E-08			
	WB	✓ -5.35	8.59E-08	1.7184E-07			
	WC	✓ -3.64	0.0002771	0.0005542			
Dissolved Zinc	EB	✓ -5.63	1.81E-08	3.626E-08			
	WB	✓ -5.30	1.13E-07	2.256E-07			
	WC	✗ 2.28	0.02282	0.04564			
PAHs	EB	✓ -1.78	0.07489	0.14978	✓ -2.17	0.03024	0.06048
	WB	✓ -2.24	0.0248	0.0496	✓ -2.63	0.008488	0.016976
	WC	✓ -4.42	1.01E-05	0.00002018	✓ -4.43	9.53E-06	0.000019066
PCBs (not including samples impacted by method blank issue)	EB	✓ -1.77	7.62E-02	0.15246			
	WB	✓ -2.80	0.005115	0.01023			
	WC	✓ -3.01	2.58E-03	0.00515			
PCBs (all samples included)	EB	✓ -1.71	0.08785	0.1757			
	WB	✓ -2.71	6.76E-03	0.013518			
	WC	✓ -3.03	0.002452	0.004904			

Asymptotic Two-Sample Fisher-Pitman Permutation Test, continued								
		Non-detect = MDL			Non-detect = 0.5MDL		
Parameter	Site	z	one way p-value	two way p-value	z	one way p-value	two way p-value
Dissolved organic carbon	EB	4.44	9.06E-06	0.00001812			
	WB	5.17	2.31E-07	4.624E-07			
	WC	1.42	0.156	0.312			
Total organic carbon	EB	4.42	1.01E-05	0.00002012			
	WB	5.00	5.64E-07	0.000001128			
	WC	-3.41	0.0006521	0.0013042			
Hardness	EB	3.90	9.70E-05	0.00019402			
	WB	4.48	7.60E-06	0.000015192			
	WC	2.89	0.003802	0.007604			
pH	EB	-2.16	3.10E-02	0.06192			
	WB	-2.46	1.40E-02	0.02806			
	WC	0.24	0.8085	1.617			

Testing for Mean Percent Reductions with 95% Confidence Intervals - Bootstrapping

The 95% confidence intervals around mean percent reductions were calculated using R for EB, WB and WC using bootstrapping as described in TAPE (Ecology 2011) (Table 3). The "boot" function in the "boot" package for R was used (Canty and Ripley 2017). This test was performed for parameters included in TAPE (Table 2 in Ecology 2011).

Table 3. Bootstrapped confidence intervals for average percent reduction by each facility.

Parameter	Site	95% Lower Confidence Interval	95% Upper Confidence Interval
Dissolved Zinc	EB (all samples)	0.80	0.84
	EB (only including EBI samples >20 ug/L)	0.83	0.88
	WB (all samples)	0.52	0.67
	WB (only including WBI samples >20 ug/L)	0.67	0.74
	WC	-0.27	-0.13
Total Suspended Solids	EB	-0.14	0.70
	WB	-0.72	0.37
	WC	0.66	0.77

Toxicity Test Results – CETIS Statistical Analysis

Toxicity tests were conducted to address Goal 1 described in the main report (Section 2.1). Appendix H3 includes a brief summary of the results with full reports included in Appendix F3.

The King County Environmental Laboratory Aquatic Toxicology Unit uses the Comprehensive Environmental Toxicity Information System (CETIS) statistical package to assess toxicity (CETIS V1.8.7.16). This program compares toxicity endpoints[1] between environmental samples and negative control samples for each toxicity test. When available, the low hardness negative control was used for this comparison. To meet the project objectives, statistical comparisons were run between influent and effluent sample pairs for each sample event and then between the control and the creek site.

The specific statistical tests used for these data were based on dataset characteristics such as normal-distribution, equal variance, and equal number of replicates. The United States Environmental Protection Agency (EPA) methods for interpreting toxicity data provide flow charts to determine which statistical test to use (acute test: Figure 12 in EPA 2002a, and chronic test: Figure 2 in EPA 2002b). Appendix A of the CETIS User's Guide describes the statistical tests used by the program (Tidepool Scientific 2011). The statistical results are presented in the reports for each toxicity test (Appendix F3).

Appendix E References

Angelo Canty and Brian Ripley (2017). Boot: Bootstrap R (S-Plus) Functions. R package version 1.3-20.

Ecology. 2011. Guidance for Evaluating Emerging Stormwater Treatment Technologies. Technology Assessment Protocol – Ecology. Publication No. 11-10-061.

EPA. 2002a. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. United States Environmental Protection Agency, Office of Water, Washington D.C. EPA-821-R-02-012.

EPA. 2002b. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fourth Edition. United States Environmental Protection Agency, Office of Water, Washington D.C. EPA-821-R-02-013.

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

[1] Percent survival is the acute toxicity test endpoint (*Daphnia pulex*), while both percent survival and mean reproduction are used as chronic toxicity tests endpoints (*Ceriodaphnia dubia*).

R Core Team. (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Tidepool Scientific, LLC. 2011. CETIS-Comprehensive Environmental Toxicity Information System: User's Guide.

Appendix F:
Raw Validated Data and PCB Congener Sums

APPENDIX F

Contents:

Section F1 –Validated KCEL Analytical Data *(Excel spreadsheet)*

Table 1. Federal Way S. 356th St Project Effectiveness Monitoring - KCEL Analytical Results

Table 2. Federal Way S. 356th St Project Effectiveness Monitoring – Quality Control Samples KCEL Analytical Results

Link: http://your.kingcounty.gov/dnrp/library/2019/kcr3020/kcr3020AppF1.xlsx

Section F2 – Validated PCB Data and Sums *(Excel spreadsheet)*

Table 3. Federal Way S. 356th St Project Effectiveness Monitoring - PCB Sums

Table 4. Federal Way S. 356th St Project Effectiveness Monitoring - PCB Congener Results

Table 5. Federal Way S. 356th St Project Effectiveness Monitoring - Quality Control Sample PCB Sums

Table 6. Federal Way S. 356th St Project Effectiveness Monitoring - Quality Control Sample PCB Congener Results

Link: http://your.kingcounty.gov/dnrp/library/2019/kcr3020/kcr3020AppF2.xlsx

Section F3 – Toxicity Reports

July 20, 2016

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
Seattle, WA 98104-3855

Dear Kate:

A summary of 48-hour acute (*Daphnia*) and 7-day chronic (*Ceriodaphnia*) tests conducted with storm water samples collected from Federal Way Bioretention sites on March 9, 2016 is listed in the following table. The tests were initiated on March 11, 2016. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

			Daphnia	*Ceriodaphnia*	
		Test #/ Date →	7898/ 3-11-16	7897/ 3-11-16	
Sample #↓	Station	Site	Mean % Surv	Mean Surv	Mean Reprod
Control	---	WW (*D.p.*); LWW (*C.d*)	100	100	17.4
L65007-1	FW-EBI	East Bioretention Facility- Inlet	90	100	22.7$^{\phi}$
-2	FW-EBO	East Bioretention Facility- Outlet	100	100	22.6
-3	FW-WBI	West Bioretention Facility- Inlet	100	100	20.2$^{\phi}$
-4	FW-WBO	West Bioretention Facility- Outlet	100	80	28.4 (n = 9)
-5	FW-WPCI	Wet Pond Complex- Inlet	75*$^{\phi}$	100	25.1^{+}
-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	95	100	20.2$^{\phi+}$
-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100	100	24.9

*Significantly different from the control $^{\phi}$ from receiving water $^{+}$Outlet and Inlet sample differ significantly
($p < 0.05$; 2-sample 1-tailed t-Test; Wilcoxon Rank-Sum test; Tukey's Pairwise Comparison as appropriate)

If you would like additional information, please contact me at 477-7118 or Francis Sweeney at 477-7117.

Sincerely,

Julie Alaimo
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR THE

Federal Way Bioretention Pond Storm Water Tests
March 2016

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date:	**7898 *Daphnia* Acute**	**3/11/2016**
	7897 *Ceriodaphnia* Chronic	**3/11/2016**

Report Date: **July 20, 2016**

METHODS

SAMPLES

Seven storm water samples were collected at Federal Way Bioretention Pond sites on March 10, 2016. Approximately 3 to 4 L of each sample was delivered to the King County Environmental Laboratory (KCEL) in 4-L glass flasks with minimal headspace and tested as received. The samples were stored in the dark at 4 ± 2ºC and used to initiate the *Daphnia pulex* acute and the *Ceriodaphnia dubia* chronic toxicity tests, as well as for *C. dubia* test renewals.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L65007-1	L65007-2	L65007-3	L65007-4	L65007-5	L65007-6	L65007-7
Collect Date/Time	3-10-16/ 1100h	3-10-16/ 1125h	3-10-16/ 1100h	3-10-16/ 1130h	3-10-16/ 1030h	3-10-16/ 1115h	3-10-16/ 1145h
Rec'd Date/Time	3-10-16/ 1620h	3-10-16/ 1620h	3-10-16/ 1620h	3-10-16/ 1620h	3-10-16/ 1620h	3-10-16/ 1620h	3-10-16/ 1620h
Volume (L)	3.4	3.5	3.5	3.6	3.5	3.5	3.5
Temp (ºC)	13.4	14.1	12.5	13.0	13.0	11.9	9.9
pH	7.10	6.80	7.02	6.76	7.07	6.99	7.43
D.O. (mg/L)	9.9	9.5	10.1	8.8	9.9	10.0	10.2
Tot. Alk (mg/L as $CaCO_3$)	7.0	13	6.8	47	9.0	12	35
Tot. Hard (mg/L as $CaCO_3$)	6.5	10	6.2	33	11	13	35
Cond (µmhos/cm)	23	38	21	127	28	38	90
Turbidity (NTU)	7.53	4.59	7.42	7.63	21.4	12.6	16.6
Tot. Susp. Solids (mg/L)	5.4	2.47	7.1	4.53	38.4	7.7	19.4
Ortho-P (mg/L)	0.00429	0.324	0.00445	2.76	0.00389	0.0134	0.0129
NO_2 + NO_3 (mg/L)	0.0714	0.123	0.0719	0.747	0.0909	0.889	0.253
Tot N (mg/L)	0.219	0.445	0.226	2.49	0.439	0.306	0.637
Tot P (mg/L)	0.0246	0.407	0.0272	3.32	0.0556	0.0439	0.0619
Tot NH_3 (mg/L)	0.0109	0.0436	0.0125	0.240	0.0668	0.0338	0.0164

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 µm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C.

Water used for testing and culturing with *Ceriodaphnia* is fresh water obtained monthly from Lake Washington at a site midway between the I-90 and 520 bridges and filtered through 60 µm Nitex screen before use.

Metals by ICP are measured monthly (last analysis: 5-2016); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: 02 & 03-2016). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW and LWW are listed in the following table:

Parameter	WW 1-18-16	LWW 2-29-16	Units
Temperature	16.9	NA	°C, adjusted as necessary
Conductivity	160	98.2	µmhos/cm
pH	7.90	7.71	
Total Hardness (calc.)	62	39	mg/L as $CaCO_3$
Total Alkalinity	54	37	mg/L as $CaCO_3$
Total Cd	< 2	< 2	µg/L
Total Cr	< 3	< 3	µg/L
Total Cu	< 4	< 4	µg/L
Total Ni	< 5	< 5	µg/L
Total Pb	< 20	< 20	µg/L
Total Zn	< 5	< 5	µg/L
Total Mercury	< 0.05	< 0.05	µg/L
Volatile Organics	*	+	
Organic Analysis (BNA'S):	**	++	
Bis(2-Ethylhexyl)Phthalate	7.1	0.56 < RDL	µg/L
Di-N-Butyl Phthalate	< MDL	< MDL	µg/L
Pesticides & PCB's:	***	+++	

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detected

\+ 45 cmpds not detectable
++ 68 cmpds not detectable
+++ 28 cmpds not detected

ACUTE TOXICITY TEST

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

The *Daphnia* acute toxicity test followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digital thermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
7898	L65007-1 to -7	3-11-16/ 1255h	3-13-16/ 1300h	0 (WW control), 100%	< 24 hr	4	5

CHRONIC TOXICITY TEST

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

The *Ceriodaphnia dubia* 7-day static renewal chronic toxicity test was conducted as outlined in US EPA (2002b). Samples were tested as received at one undiluted (100%) concentration. Ten replicates containing one animal each were tested at each treatment, including the control. Test organisms were 3rd or 4th-brood neonates (< 24 hours old) taken from an in-house individual brood board of adults started from mass culture. Individual broods were blocked across treatments, and each replicate represented a different brood. The test was incubated at 25 ± 1.0°C for 7 days on a 16:8 h light:dark cycle. All test solutions were renewed daily. Reproduction, survival, temperature and water quality measurements were recorded every 24 hours. Temperature was measured daily in six test board temperature blanks (4 outer corner + 2 center) and at 15-minute intervals using an Onset "Tidbit" data logger placed in a beaker of water in the incubator. The pH and D.O. values measured during testing can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
7897	L65007-1 to -7	3-11-16/ 1120h	3-18-16/ 1130h	0 (LWW control), 100%	< 24 hr	10	1

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

	Daphnia	*Ceriodaphnia*
Test #:	7905	7904
Control Survival (%)	100	100
Criteria	≥ 90	≥ 80
Acceptable?	**Yes**	**Yes**
Survival LC50 (g/L)	3.17	
Lab Control Limits	2.43 – 4.36	
Acceptable?	**Yes**	
Control Reprod (# neos/adult)		36.8
Criteria		≥ 15
Acceptable?		**Yes**
PMSD for Reproduction (%)*		24.4
Criteria		13 - 47
Acceptable?		**Yes**
Reproduction IC25 (µg/L)		6.71
Lab Control Limits		0 – 6.07
Acceptable?		**No**

*Percent Minimum Significant Difference; determined by Dunnett's Multiple Comparison test (Steels Many-One Rank Test for unequal variance); ($\alpha = 0.05$)

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#7905) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

Cadmium nitrate was used as a reference toxicant in the chronic toxicity test with *Ceriodaphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Ceriodaphnia* (#7904) (US EPA 2002b). In addition, the chronic test met acceptability criteria regarding control survival and mean control reproduction (US EPA 2002b). The reproduction IC25 for #7904 slightly exceeded the upper control limit. Because it met all other QC criteria, the test was retained. Reference toxicant tests with *Ceriodaphnia* were re-started in 2015 following a three-year hiatus. It is possible that a change in diet or culture health may have affected the response to the toxicant.

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA’s (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

Survival results for the 48-hour *Daphnia* acute test #7898 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours					# *Daphnia* Tested
			% Survival in each rep. (n=5 *Daphnia*/rep)					
			Rep 1	Rep 2	Rep 3	Rep 4	Mean	
----	Well Water Control	0	100	100	100	100	**100**	20
L65007-1	FW-EBI East Bioretention Facility (Inlet)	100	80	100	100	80	**90**	20
L65007-2	FW-EBO East Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L65007-3	FW-WBI West Bioretention Facility (Inlet)	100	100	100	100	100	**100**	20
L65007-4	FW-WBO West Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L65007-5	FW-WPCI Wet Pond Complex (Inlet)	100	80	60	60	100	**75*ᶲ**	20
L65007-6	FW-WPCEPO Wet Pond Complex + East Bioretention Facility (Outlet)	100	80	100	100	100	**95**	20
L65007-7	FW-NFWHC Hylebos Creek (Receiving Water)	100	100	100	100	100	**100**	20

*Significantly different from WW control ($p < 0.05$; homoscedastic 2-sample 1-tailed t-Test)
ᶲSignificantly different from receiving water ($p < 0.05$; homoscedastic 2-sample 1-tailed t-Test)

Survival was 100 % in the well water-only control, the East Bioretention Outlet, the West Bioretention Outlet and the Hylebos Creek receiving water samples. Survival was 90% in the East Bioretention Inlet, 95% in the Wet Pond Complex Outlet and 75% in the Wet Pond Complex Inlet samples. Survival in the East Bioretention Inlet and Wet Pond Complex/East Facility Outlet samples was not significantly reduced from the control ($p > 0.05$; 1-tailed homoscedastic t-Test or Wilcoxon Rank Sum test, respectively). In the Wet Pond Complex Inlet sample, survival was significantly reduced from both the control and the receiving water ($p < 0.05$; 1-tailed homoscedastic t-Test).

Survival between Inlet and Outlet samples did not differ significantly in East Bioretention and Wet Pond Complex samples (1-tailed homoscedastic t-Test and Tukey's Pairwise Comparison, respectively). Survival was the same for the West Bioretention Inlet and Outlet samples.

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L65007-1	L65007-2	L65007-3	L65007-4	L65007-5	L65007-6	L65007-7
NH_3-N (mg/L)	< 0.001	0.001	< 0.001	0.008	0.001	0.001	< 0.001

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

Reproduction and survival results over the 7-day chronic *Ceriodaphnia* test #7897 with 100% bioretention pond storm water samples are shown in the table below.

Sample #	Station	% Sample	Reproduction (Mean #Neonates/Adult in 7 Days) 1	2	3	4	5	6	7	8	9	10	Mean Reprod	Mean % Surv
---	LWW Control	0	19	16	20	17	20	18	18	9	19	18	**17.4**	100
L65007-1	FW-EBI	100	23	25	22	22	23	21	22	24	23	22	**22.7**$^{\phi}$	100
L65007-2	FW-EBO	100	24	25	23	23	23	25	23	26	12	22	**22.6**	100
L65007-3	FW-WBI	100	25	17	16	10	22	23	21	22	21	25	**20.2**$^{\phi}$	100
L65007-4	FW-WBO	100	34	30	30	30	23	0^{Ω}	30	21	29	29	**28.4** $^{(n = 9)}$	80
L65007-5	FW-WPCI	100	28	25	33	21	25	22	24	22	26	25	**25.1**$^{+}$	100
L65007-6	FW-WPCEPO	100	15	22	30	25	24	11	9	21	26	19	**20.2**$^{\phi+}$	100
L65007-7	FW-NFWHC	100	26	24	29	26	24	25	22	27	24	22	**24.9**	100

$^{\phi}$Significantly different from receiving water ($p < 0.05$; equal (for -1, -3) or unequal (for -6) variance 1-tailed t-Test)
$^{+}$Outlet differs significantly from Inlet sample ($p < 0.05$; homoscedastic 1-tailed t-Test) $^{\Omega}$Outlier omitted from reproduction analysis

As shown in the table above, survival was 100% in the LWW-only control and all samples except for the West Bioretention Outlet, where survival was 80%. Survival in the West Bioretention sample was not significantly less than in the control ($p > 0.05$; Fisher Exact Test).

Reproduction was not decreased relative to the LWW-only control in any sample. For samples L65007-1, -3 and -6, reproduction was significantly reduced from the Hylebos Creek receiving water ($p < 0.05$; equal (for -1, -3) or unequal (for -6) variance 1-tailed t-Test). Reproduction in both East Bioretention Inlet and Outlet samples was not significantly reduced from the Hylebos Creek receiving water ($p > 0.05$; homoscedastic t-tailed t-Tests). Reproduction in the Wet Pond Complex Outlet sample was significantly reduced from the corresponding Inlet sample ($p < 0.05$; homoscedastic 1-tailed t-Test). Reproduction did not differ significantly between corresponding Inlet and Outlet samples for East Bioretention and West Bioretention samples ($p > 0.05$; 1-tailed t-Tests).

The maximum un-ionized ammonia levels reached in the 100% storm samples during the 7-day chronic test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L65007-1	L65007-2	L65007-3	L65007-4	L65007-5	L65007-6	L65007-7
NH_3-N (mg/L)	< 0.001	0.001	< 0.001	0.013	0.002	0.001	0.001

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Ceriodaphnia*	*Daphnia*
Test #:	7897	7898
Control Survival (%)	100	100
Criteria	≥ 80	≥ 90
Acceptable?	**Yes**	**Yes**
Control Reproduction (# neos/adult)	17.4	
Criteria	≥ 15	
Acceptable?	**Yes**	
PMSD for Reproduction (%)*	17.3 (IN)	
Criteria	13-47	
Acceptable?	**Yes**	

*Percent Minimum Significant Difference; determined by Dunnett's Multiple Comparison test ($\alpha = 0.05$)

As shown in the table above, both the acute and chronic effluent tests met acceptability criteria regarding control performance and test variability, including survival, reproduction and PMSD (US EPA, 2002a & 2002b).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute and chronic tests (US EPA, 2002a & 2002b). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Effluent Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 2002b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition (EPA-821-R-02-013).

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

March 20, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
Seattle, WA 98104-3855

Dear Kate:

A summary of 48-hour acute (*Daphnia*) and 7-day chronic (*Ceriodaphnia*) tests conducted with storm water samples collected from Federal Way Bioretention sites on October 20, 2016 is listed in the following table. The tests were initiated on October 21 and 25, 2016. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

			Daphnia	*Ceriodaphnia*	
		Test #/ Date →	8170/ 10-25-16	8160/ 10-21-16	
Sample #↓	Station	Site	Mean % Surv	Mean % Surv	Mean Reprod
Control	---	WW (*D.p.*); LWW (*C.d*)	100	90	27.1
Low Hardness	---	WW (*D.p.*); LWW (*C.d*)	0	100	31.1
L66453-1	FW-EBI	East Bioretention Facility- Inlet	10*	100	31.8
L66453-2	FW-EBO	East Bioretention Facility- Outlet	100	100	34.7
L66453-3	FW-WBI	West Bioretention Facility- Inlet	70	100	29.2*
L66453-4	FW-WBO	West Bioretention Facility- Outlet	100	100	41.8
L66453-5	FW-WPCI	Wet Pond Complex- Inlet	95	100	30.6*
L66453-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	100	100	35.1
L66453-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	95	100	35.1

($p < 0.05$; Both the Equal Variance t Two-Sample test and Wilcoxon Rank-Sum Two-Sample test were run for Survival and Reproduction). * Statistically significant result compared to outlet.

If you would like additional information, please contact me at 477-7170 or Francis Sweeney at 477-7117.

Sincerely,

Robin Revelle

Robin Revelle
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR THE

Federal Way Bioretention Pond Storm Water Tests
October 2016

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date:	**8170 *Daphnia* Acute**	**10/25/2016**
	8160 *Ceriodaphnia* Chronic	**10/21/2016**

Report Date: March 20, 2017

METHODS

SAMPLES

Seven storm water samples were collected at Federal Way Bioretention Pond sites on October 20, 2016. Approximately 3 to 4 L of each sample was delivered to the King County Environmental Laboratory (KCEL) in 4-L glass flasks with minimal headspace and tested as received. The samples were stored in the dark at 4 ± 2°C and used to initiate the *Daphnia pulex* acute and the *Ceriodaphnia dubia* chronic toxicity tests, as well as for *C. dubia* test renewals.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66453-1	L66453-2	L66453-3	L66453-4	L66453-5	L66453-6	L66453-7
Collect Date/Time	10/20/16 07:17	10/20/16 02:33	10/20/16 00:44	10/20/16 02:51	10/19/16 20:44	10/19/16 16:53	10/19/16 22:04
Rec'd Date/Time	10/20/16 15:00	10/20/16 15:00	10/20/16 15:00	10/20/16 15:00	10/20/16 15:00	10/20/16 15:00	10/20/16 15:00
Volume (L)	~ 2 gal	~ 2.5 gal	~ 2.5 gal	~ 2.5 gal	~ 2.5 gal	~ 2.5 gal	~ 2 gal
Temp (°C)	*	*	*	*	*	*	*
pH	6.990	6.863	7.213	6.772	7.205	7.095	7.448
D.O. (mg/L)	10.0	10.4	10.6	9.5	10.5	10.5	10.7
Tot. Alk (mg/L as $CaCO_3$)	6.28	27.1	9.75	51.4	9.01	14.1	34.3
Tot. Hard (mg/L as $CaCO_3$)	5.68	22.7	7.73	47	10.4	14.7	40.4
Cond (μmhos/cm)	19.1	86.8	27.1	154	28.4	43.4	94.9
Turbidity (NTU)	2.38	9.23	2.85	9.24	14.1	9.16	13.5
Tot. Susp. Solids (mg/L)	2.1	6.24	3.6	9.46	21.2	7.41	18.4
Ortho-P (mg/L)	0.0128	0.561	0.0156	1.98	0.0131	0.033	0.0246
$NO_2 + NO_3$ (mg/L)	0.0526	0.734	0.0693	1.31	0.153	0.186	0.287
Tot N (mg/L)	0.161	2.38	0.246	5.29	0.445	0.517	0.837
Tot P (mg/L)	0.026	0.71	0.0354	2.21	0.048	0.0698	0.0828
Tot NH_3 (mg/L)	0.0114	0.0532	0.0188	0.206	0.0746	0.0371	0.013

*Samples held in Walk-In cooler 4 ± 2°C.

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 μm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C.

Water used for testing and culturing with *Ceriodaphnia* is fresh water obtained monthly from Lake Washington at a site midway between the I-90 and 520 bridges and filtered through 60 μm Nitex screen before use.

Metals by ICP are measured monthly (last analyses: October 2016); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: February and March 2016). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical and chemical characteristics of the WW and LWW are listed in the following tables:

Parameter	LWW	Low Hardness LWW	WW	Low Hardness WW	Units
Sample Number:	L66410-1	L66410-2	L66410-3	L66410-4	
Temperature:	*	*	*	*	°C, adjusted as necessary
Conductivity:	102.3	27.9	227	25.6	μmhos/cm
pH:	7.880	7.599	8.017	7.423	
Total Hardness (calc.):	40.3	10.4	93.5	10.3	mg/L as $CaCO_3$
Total Alkalinity:	38.1	9.94	67.1	7.59	mg/L as $CaCO_3$

*Water held at 0-5°C cooler until needed.

Metals and Organics:

Parameter	LWW	WW	Units
Total Cd:	< 2	< 2	μg/L
Total Cr:	< 3	< 3	μg/L
Total Cu:	< 4	< 4	μg/L
Total Ni:	< 5	< 5	μg/L
Total Pb:	< 20	< 20	μg/L
Total Zn:	< 5	< 5	μg/L
Total Mercury:	< 0.05	< 0.05	μg/L
Volatile Organics:	*	+	μg/L
Organic Analysis (BNA'S):	**	++	μg/L
Bis(2-Ethylhexyl)Phthalate:	0.56#	7.1	μg/L
Di-N-Butyl Phthalate:	< 0.47	< 0.47	μg/L
Pesticides & PCB's:	***	+++	μg/L

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detectable
# < RDL; RDL = 1.89

+ 45 cmpds not detectable
++ 68 cmpds not detectable
+++ 28 cmpds not detectable

ACUTE TOXICITY TEST

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

The *Daphnia* acute toxicity test followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with two WW-only controls; the hardness was adjusted for one control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digital thermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8170	L66453-1 to -7	10-25-16/ 11:15	10-27-16/ 11:40	0 (WW control), 0 (Low Hardness control), 100%	< 24 hr	4	5

CHRONIC TOXICITY TEST

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

The *Ceriodaphnia dubia* 7-day static renewal chronic toxicity test was conducted as outlined in US EPA (2002b). Samples were tested as received at one undiluted (100%) concentration along with two WW-only controls; the hardness was adjusted for one control. Ten replicates containing one animal each were tested at each treatment, including the controls. Test organisms were 3rd or 4th-brood neonates (< 24 hours old) taken from an in-house individual brood board of adults started from mass culture. Individual broods were blocked across treatments, and each replicate represented a different brood. The test was incubated at 25 ± 1.0°C for 7 days on a 16:8 h light: dark cycle. All test solutions were renewed daily. Reproduction, survival, temperature and water quality measurements were recorded every 24 hours. Temperature was measured daily in six test board temperature blanks (4 outer corner + 2 center) and at 15-minute intervals using an Onset "Tidbit" data logger placed in a beaker of water in the incubator. The pH and D.O. values measured during testing can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8160	L66453-1 to -7	10-21-16/ 10:40	10-28-16/ 11:30	0 (WW control), 0 (Low Hardness control), 100%	< 24 hr	10	1

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

Test #:	*Daphnia* 8199	*Ceriodaphnia* 8178
Control Survival (%)	100	100
Criteria	≥ 90	≥ 80
Acceptable?	**Yes**	**Yes**
Survival LC50 (g/L)	3.8	
Lab Control Limits	3.4 – 4.2	
Acceptable?	**Yes**	
Control Reprod (# neos/adult)		37.8
Criteria		≥ 15
Acceptable?		**Yes**
PMSD for Reproduction (%)*		8.58
Criteria		13 - 47
Acceptable?		**Yes***
Reproduction IC25 (µg/L)		2.76
Lab Control Limits		0-7.29
Acceptable?		**Yes**

*Percent Minimum Significant Difference; PMSD slightly low, however all other QC is acceptable.

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8199) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

Cadmium nitrate was used as a reference toxicant in the chronic toxicity test with *Ceriodaphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Ceriodaphnia* (#8178) (US EPA 2002b). In addition, the chronic test met acceptability criteria regarding control survival and mean control reproduction (US EPA 2002b).

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

Survival results for the 48-hour *Daphnia* acute test #8170 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours					# *Daphnia* Tested
			% Survival in each rep. (n=5 *Daphnia*/rep)				Mean % Survival	
			Rep 1	Rep 2	Rep 3	Rep 4		
----	Well Water Control	0	100	100	100	100	**100**	20
----	Low Hardness Control	0	0	0	0	0	**0**	20
L66453-1	FW-EBI East Bioretention Facility (Inlet)	100	0	0	40	0	**10**	20
L66453-2	FW-EBO East Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66453-3	FW-WBI West Bioretention Facility (Inlet)	100	80	0	100	100	**70**	20
L66453-4	FW-WBO West Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66453-5	FW-WPCI Wet Pond Complex (Inlet)	100	100	100	80	100	**95**	20
L66453-6	FW-WPCEPO Wet Pond Complex + East Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66453-7	FW-NFWHC Hylebos Creek (Receiving Water)	100	80	100	100	100	**95**	20

Mean % Survival was 100 % in the well water-only control, the East Bioretention Outlet, the West Bioretention Outlet and the West Pond Complex/East Facility Outlet; 95% in the West Pond Complex Inlet and the Hylebos Creek receiving water samples; 70% in the West Bioretention Inlet; and 10% in the East Bioretention Inlet. There were no survivors in the Low Hardness Control.

The Wilcoxon Rank Sum Two-Sample Test (Nonparametric-Two Sample) was used to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.). A statistically significant effect was determined for FW-EBI compared to FW-EBO. There was a Non-Significant Effect in all remaining pairings.

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66453-1	L66453-2	L66453-3	L66453-4	L66453-5	L66453-6	L66453-7
NH_3-N (mg/L)	**< 0.001**	**0.001**	**< 0.001**	**0.006**	**0.001**	**0.001**	**< 0.001**

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

Reproduction and survival results over the 7-day chronic *Ceriodaphnia* test #8160 with 100% bioretention pond storm water samples are shown in the table below.

Sample #	Station	% Sample	Reproduction (#Neonates/Adult in 7 Days) 1	2	3	4	5	6	7	8	9	10	Mean Reprod	Mean % Surv
---	LWW Control	0	36	21	0*	0	38	38	37	37	33	31	**27.1**	90
---	Low Hardness Control	0	29	32	33	32	31	32	28	34	28	32	**31.1**	100
L66453-1	FW-EBI	100	30	33	35	31	27	31	31	38	31	31	**31.8**	100
L66453-2	FW-EBO	100	35	36	0*	44	43	38	40	36	36	39	**34.7**	100
L66453-3	FW-WBI	100	30	31	0*	34	28	34	34	35	31	35	**29.2**	100
L66453-4	FW-WBO	100	40	40	43	45	37	39	47	40	44	43	**41.8**	100
L66453-5	FW-WPCI	100	37	33	0*	33	36	28	38	33	30	38	**30.6**	100
L66453-6	FW-WPCEPO	100	38	37	0*	37	42	39	43	37	42	46	**35.1**	100
L66453-7	FW-NFWHC	100	43	38	0*	39	21	43	44	46	34	43	**35.1**	100

*Possible male

As shown in the table above, survival was 100% in all samples except for the LWW Control, where survival was 90%. Replicate #3 in six of the samples, including one in the control was characteristically male.

The Wilcoxon Rank Sum Two-Sample Test (Nonparametric-Two Sample) was used to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.) for both survival and reproduction. A significant reproduction effect was found between pairings.

The maximum un-ionized ammonia levels reached in the 100% storm samples during the 7-day chronic test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66453-1	L66453-2	L66453-3	L66453-4	L66453-5	L66453-6	L66453-7
NH_3-N (mg/L)	**< 0.001**	**0.002**	**< 0.001**	**0.012**	**0.002**	**0.001**	**0.001**

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Ceriodaphnia*	*Daphnia*
Test #:	8160	8170
Control Survival (%)	90	100
Criteria	≥ 80	≥ 90
Acceptable?	**Yes**	**Yes**
Control Reproduction (# neos/adult)	27.1	
Criteria	≥ 15	
Acceptable?	**Yes**	
PMSD* for Reproduction (%)	**NA**	
Criteria	**NA**	
Acceptable?	**NA**	

*Percent Minimum Significant Difference

As shown in the table above, both the acute and chronic effluent tests met acceptability criteria regarding control, performance and test variability; including survival, and reproduction. (US EPA, 2002a & 2002b).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute and chronic tests (US EPA, 2002a & 2002b). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Effluent Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 2002b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition (EPA-821-R-02-013).

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

April 7, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
Seattle, WA 98104-3855

Dear Kate:

A summary of 48-hour acute (*Daphnia*) and 7-day chronic (*Ceriodaphnia*) tests conducted with storm water samples collected from Federal Way Bioretention sites on October 31, 2016 and November 1, 2016 are listed in the following table. The tests were initiated on November 4, 2016 and November 8, 2016. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

Sample #↓	Station	Site	Mean % Surv	Mean Surv	Mean Reprod**
			Daphnia	*Ceriodaphnia*	
		Test #/ Date →	8203/ 11-08-16	8202/ 11-04-16	
Control	---	WW (*D.p.*); LWW (*C.d*)	100	100	30.5
Low Hardness	---	WW (*D.p.*); LWW (*C.d*)	50	90	25.8
L66540-1	FW-EBI	East Bioretention Facility- Inlet	100	100	31.9
L66540-2	FW-EBO	East Bioretention Facility- Outlet	100	90	34.6
L66540-3	FW-WBI	West Bioretention Facility- Inlet	90*	100	32.1
L66540-4	FW-WBO	West Bioretention Facility- Outlet	100	100	33.1
L66540-5	FW-WPCI	Wet Pond Complex- Inlet	95	100	30.4
L66540-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	100	100	30.9
L66540-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100	100	30.7

* n=21
** Based off of 3rd brood

Both the Equal Variance t Two-Sample test and the Wilcoxon Rank-Sum Two-Sample test were run for Survival and Reproduction ($p < 0.05$). There was a significant effect between L66540-1 (FW-EBI) and L66540-2 (FW-EBO) for reproduction in the *Ceriodaphnia*.

If you would like additional information, please contact me at 477-71170 or Francis Sweeney at 477-7117.

Sincerely,

Robin C. Revelle

Robin Revelle
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR THE

Federal Way Bioretention Pond Storm Water Tests
November 2016

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date:	**8203 *Daphnia* Acute**	**11/08/2016**
	8202 *Ceriodaphnia* Chronic	**11/04/2016**

Report Date: April 7, 2017

METHODS

SAMPLES

Seven storm water samples were collected at Federal Way Bioretention Pond sites on October 31 and November 1, 2016. Approximately 3 to 4 L of each sample was delivered to the King County Environmental Laboratory (KCEL) in 4-L glass flasks with minimal headspace and tested as received. The samples were stored in the dark at 4 ± 2°C and used to initiate the *Daphnia pulex* acute and the *Ceriodaphnia dubia* chronic toxicity tests, as well as for *C. dubia* test renewals.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66540-1	L66540-2	L66540-3	L66540-4	L66540-5	L66540-6	L66540-7
Collect Date/Time	10/31/16 22:27	10/31/16 21:46	10/31/16 22:05	10/31/16 21:30	10/31/16 21:10	10/31/16 23:40	11/01/16 07:01
Rec'd Date/Time	11/01/16 14:30	11/01/16 14:30	11/01/16 14:30	11/01/16 14:30	11/01/16 14:30	11/01/16 14:30	11/01/16 14:30
Volume (L)	~ 4.5	~ 4.5	~ 3	~ 3	~ 4.5	~ 5.5	~ 4.5
Temp (°C)*	11.6	12.5	12.6	12.2	12.8	11.9	12.4
pH	7.011	6.820	7.135	6.780	7.113	6.908	7.349
D.O. (mg/L)	10.3	9.3	10.1	8.9	10.0	9.5	10.0
Tot. Alk (mg/L as $CaCO_3$)	6.98	42.9	7.21	43.7	11.1	13.7	35.3
Tot. Hard (mg/L as $CaCO_3$)	7.42	34.9	7.74	41.6	13.1	15.2	40.6
Cond (µmhos/cm)	20.4	114	20.6	122	34.8	41.5	95.7
Turbidity (NTU)	2.54	5.63	2.97	3.44	10.5	6.95	4.94
Tot. Susp. Solids (mg/L)	1.22	3.56	1.68	5	9.79	3.89	3.33
Ortho-P (mg/L)	0.0143	1.01	0.0155	2.22	0.0104	0.0254	0.0168
$NO_2 + NO_3$ (mg/L)	0.0543	0.27	0.0539	0.809	0.171	0.15	0.212
Tot N (mg/L)	0.174	1.93	0.18	3.31	0.696	0.443	0.561
Tot P (mg/L)	0.0343	1.3	0.0332	2.8	0.0452	0.0555	0.0416
Tot NH_3 (mg/L)	<MDL	0.11	<MDL	0.221	0.0644	0.0175	0.0052

*In Aquatox Lab at receipt

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 µm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C.

Water used for testing and culturing with *Ceriodaphnia* is fresh water obtained monthly from Lake Washington at a site midway between the I-90 and 520 bridges and filtered through 60 µm Nitex screen before use.

Metals by ICP are measured monthly (last analysis: 5-2016); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: 02 & 03-2016). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW and LWW are listed in the following table:

Parameter	LWW	Low Hardness LWW	WW	Low Hardness WW	Units
Sample Number:	L66580-1	L66580-2	L66580-3	L66580-4	
Temperature:	*	*	*	*	°C, adjusted as necessary
Conductivity:	102.1	26.9	241	37.5	µmhos/cm
pH (0 hour):	7.901	7.546	8.112	7.408	
Total Hardness (calc.):	42.4	11.3	97.4	9.7	mg/L as $CaCO_3$
Total Alkalinity:	37.2	9.32	70.7	7.25	mg/L as $CaCO_3$

*Water held at 0-5°C cooler until needed.

Metals and Organics:

Parameter	LWW	WW	Units
Total Cd:	< 2	< 2	µg/L
Total Cr:	< 3	< 3	µg/L
Total Cu:	< 4	< 4	µg/L
Total Ni:	< 5	< 5	µg/L
Total Pb:	< 20	< 20	µg/L
Total Zn:	< 5	< 5	µg/L
Total Mercury:	< 0.05	< 0.05	µg/L
Volatile Organics:	*	+	µg/L
Organic Analysis (BNA'S):	**	++	µg/L
Bis(2-Ethylhexyl)Phthalate:	0.56#	7.1	µg/L
Di-N-Butyl Phthalate:	< 0.47	< 0.47	µg/L
Pesticides & PCB's:	***	+++	µg/L

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detectable
#< RDL: RDL = 1.89

\+ 45 cmpds not detectable
++ 68 cmpds not detectable
+++ 28 cmpds not detectable

ACUTE TOXICITY TEST

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

The *Daphnia* acute toxicity test followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digitalthermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8203	L66540-1 to -7	11-8-16/ 1340h	11-10-16/ 1300h	0 (WW control), 100%	< 24 hr	4	5

CHRONIC TOXICITY TEST

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

The *Ceriodaphnia dubia* 7-day static renewal chronic toxicity test was conducted as outlined in US EPA (2002b). Samples were tested as received at one undiluted (100%) concentration. Ten replicates containing one animal each were tested at each treatment, including the control. Test organisms were 3rd or 4th-brood neonates (< 24 hours old) taken from an in-house individual brood board of adults started from mass culture. Individual broods were blocked across treatments, and each replicate represented a different brood. The test was incubated at 25 ± 1.0°C for 7 days on a 16:8 h light:dark cycle. All test solutions were renewed daily. Reproduction, survival, temperature and water quality measurements were recorded every 24 hours. Temperature was measured daily in six test board temperature blanks (4 outer corner + 2 center) and at 15-minute intervals using an Onset "Tidbit" data logger placed in a beaker of water in the incubator. The pH and D.O. values measured during testing can be found on the attached photocopied pages from the laboratory notebook in the 'Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8202	L66540-1 to -7	11-4-16/ 0930h	11-11-16/ 1030h	0 (LWW control), 100%	< 24 hr	10	1

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

Test #:	*Daphnia* 8199	*Ceriodaphnia* 8178
Control Survival (%)	100	100
Criteria	≥ 90	≥ 80
Acceptable?	**Yes**	**Yes**
Survival LC50 (g/L)	3.8	
Lab Control Limits	2.5 – 4.7	
Acceptable?	**Yes**	
Control Reprod (# neos/adult)		37.8
Criteria		≥ 15
Acceptable?		**Yes**
PMSD for Reproduction (%)*		8.58
Criteria		13 - 47
Acceptable?		**Yes**
Reproduction IC25 (µg/L)		2.76
Lab Control Limits		0 – 7.29
Acceptable?		**Yes**

*Percent Minimum Significant Difference; PMSD slightly low, however all other QC is acceptable.

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8199) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

Cadmium nitrate was used as a reference toxicant in the chronic toxicity test with *Ceriodaphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Ceriodaphnia* (#8178) (US EPA 2002b). In addition, the chronic test met acceptability criteria regarding control survival and mean control reproduction (US EPA 2002b).

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

Survival results for the 48-hour *Daphnia* acute test #8203 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours: % Survival in each rep. (n=5 *Daphnia*/rep)				Mean % Survival	# *Daphnia* Tested
			Rep 1	Rep 2	Rep 3	Rep 4		
L66580-3	Well Water Control	0	100	100	100	100	**100**	20
L66580-4	Low Hardness Control	0	60	20	20	100	**50**	20
L66540-1	FW-EBI East Bioretention Facility (Inlet)	100	100	100	100	100	**100**	20
L66540-2	FW-EBO East Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66540-3	FW-WBI West Bioretention Facility (Inlet)	100	80	100	80	100	**90**	21*
L66540-4	FW-WBO West Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66540-5	FW-WPCI Wet Pond Complex (Inlet)	100	100	100	80	100	**95**	20
L66540-6	FW-WPCEPO Wet Pond Complex + East Bioretention Facility (Outlet)	100	100	100	100	100	**100**	20
L66540-7	FW-NFWHC Hylebos Creek (Receiving Water)	100	100	100	100	100	**100**	20

*There were 6 animals in Rep 4 in L66540-3.

Survival was 100 % in the well water-only control, the East Bioretention Inlet, the East Bioretention Outlet, the West Bioretention Outlet, the Wet Pond Complex Outlet and the Hylebos Creek receiving water samples. Survival was 90% in the West Bioretention Inlet (based off of 6 animals) and 95% in the Wet Pond Complex Inlet samples. The Low Hardness control had a survival rate of 50%.

The Wilcoxon Rank Sum Two-Sample Test (Nonparametric-Two Sample) and an Equal Variance Two-Sample t-test (Parametric) were used to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.). The receiving water was compared to the Well Water Control. There was a Non-Significant Effect in all pairings.

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66540-1	L66540-2	L66540-3	L66540-4	L66540-5	L66540-6	L66540-7
NH_3-N (mg/L)*	**< 0.001**	**0.004**	**< 0.001**	**0.007**	**0.001**	**< 0.001**	**< 0.001**

*MDL = 0.001

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

Reproduction and survival results over the 7-day chronic *Ceriodaphnia* test #7897 with 100% bioretention pond storm water samples are shown in the table below.

Sample #	Station	% Sample	Reproduction (#Neonates/Adult in 7 Days)										Mean Reprod*	Mean % Surv
			1	2	3	4	5	6	7	8	9	10		
L66580-1	LWW Control	0	32	33	33	31	9	34	36	36	26	35	**30.5**	100
L66580-2	Low Hardness	0	29	3	34	28	25	32	32	21	21	33	**25.8**	90
L66540-1	FW-EBI	100	33	31	34	36	31	31	27	36	27	33	**31.9**	100
L66540-2	FW-EBO	100	32	34	32	35	33	35	35	35	37	38	**34.6**	90
L66540-3	FW-WBI	100	29	31	34	34	30	34	31	30	34	34	**32.1**	100
L66540-4	FW-WBO	100	30	33	33	34	31	33	34	36	32	35	**33.1**	100
L66540-5	FW-WPCI	100	32	29	34	31	23	34	32	32	26	31	**30.4**	100
L66540-6	FW-WPCEPO	100	32	25	33	30	31	37	37	35	35	14	**30.9**	100
L66540-7	FW-NFWHC	100	33	35	34	37	33	35	0	34	33	33	**30.7**	100

* Numbers based on 3rd brood

As shown in the table above, survival was 100% in the LWW-only control and all samples except for the East Bioretention Outlet and the Low Hardness Control, where survival was 90%.

The Wilcoxon Rank Sum Two-Sample Test (Nonparametric-Two Sample) and an Equal Variance Two-Sample t-test (Parametric) were used to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.) for both survival and reproduction. The receiving water was compared to the Well Water Control. There was a Significant Effect between L66540-1 (FW-EBI) and L66540-2 (FW-EBO) for reproduction. There was a Non-Significant Effect in all other pairings.

The maximum un-ionized ammonia levels reached in the 100% storm samples during the 7-day chronic test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66540-1	L66540-2	L66540-3	L66540-4	L66540-5	L66540-6	L66540-7
NH_3-N (mg/L)*	**< 0.001**	**0.007**	**< 0.001**	**0.012**	**0.003**	**0.001**	**< 0.001**

*MDL = 0.001

QUALITY CONTROL

Storm water sample and control performance results are summarized in the followingtable:

Test Organism:	*Ceriodaphnia*	*Daphnia*
Test #:	8202	8203
Control Survival (%)	100	100
Criteria	≥ 80	≥ 90
Acceptable?	**Yes**	**Yes**
Control Reproduction (# neos/adult)	30.5	
Criteria	≥ 15	
Acceptable?	**Yes**	
PMSD for Reproduction (%)*	**NA**	
Criteria	**NA**	
Acceptable?	**NA**	

*Percent Minimum Significant Difference

As shown in the table above, both the acute and chronic effluent tests met acceptablity criteria regarding: control performance and test variability, including survivaland reproduction. PMSD does not apply for these tests (US EPA, 2002a & 2002b).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute and chronic tests (US EPA, 2002a & 2002b). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Effluent Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 2002b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition (EPA-821-R-02-013).

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

#4

March 24, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
MS KSC-NR-0600
Seattle, WA 98104-3855

Dear Kate:

A summary of 48-hour acute (*Daphnia*) and 7-day chronic (*Ceriodaphnia*) tests conducted with storm water samples collected from Federal Way Bioretention Inlet and Outlet sites on January 17-18, 2017 is listed in the following table. The tests were initiated on January 20 and 19, respectively. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

		Test #/ Date →	*Daphnia* 8246/ 1-20-17	*Ceriodaphnia* 8245/ 1-19-17	
Sample #↓	Station	Site	Mean % Surv	Mean Surv	Mean Reprod
Control	---	WW (*Daphnia*)	95		
		LWW (*Ceriodaphnia*)		100	31.0
L66937-1	FW-EBI	East Bioretention Facility- Inlet	100	90	34.6
-2	FW-EBO	East Bioretention Facility- Outlet	100	90	35.0
-3	FW-WBI	West Bioretention Facility- Inlet	100	100	37.7
-4	FW-WBO	West Bioretention Facility- Outlet	100	100	41.5
-5	FW-WPCI	Wet Pond Complex- Inlet	95	100	39.2
-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	100	100	38.9
-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100	100	38.1*

*Significantly greater than the control ($p < 0.05$; Tukey-Kramer Test)

No significant difference in survival and/or reproduction was found between Inlet and Outlet samples ($p > 0.05$; 2-Sample 1-Tailed t-Test; Wilcoxon Rank Sum 2-Sample t-Test; or Tukey-Kramer Test) in both the *Daphnia* and *Ceriodaphnia* tests. Reproduction in the *Ceriodaphnia* test was significantly greater in the receiving water than in the control.

If you would like additional information, please contact me at 477-7118 or Francis Sweeney at 477-7117.

Sincerely,

Julie Alaimo

Julie Alaimo
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR

Federal Way Bioretention Pond Storm Water Tests
January 2017

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date:	**8246 *Daphnia* Acute**	**1/20/2017**
	8245 *Ceriodaphnia* Chronic	**1/19/2017**

Report Date: March 24, 2017

METHODS

SAMPLES

Seven storm water samples were collected by time-paced composite at Federal Way Bioretention Pond Inlet and Outlet sites on January 17-18, 2017. In addition, a receiving water sample was collected at Hylebos Creek. Approximately 3 to 4 L of each sample was split from a larger container and delivered to the King County Environmental Laboratory (KCEL) in 9-L glass jars with Teflon-lined screw-cap lids and tested as-received. The samples were stored in the dark at 4 ± 2°C and used to initiate the *Daphnia pulex* acute and the *Ceriodaphnia dubia* chronic toxicity tests, as well as for *C. dubia* test renewals.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66937-1	L66937-2	L66937-3	L66937-4	L66937-5	L66937-6	L66937-7
Coll Date/ Time From:	1-17-17/ 1654h	1-17-17/ 1707h	1-17-17/ 1436h	1-17-17/ 1710h	1-17-17/ 1430h	1-17-17/ 1450h	1-17-17/ 1502h
to:	1-17-17/ 2132h	1-18-17/ 1127h	1-18-17/ 0329h	1-18-17/ 1146h	1-18-17/ 0312h	1-18-17/ 1041h	1-18-17/ 1024h
Rec'd Date/Time	1-18-17/ 1530h	1-18-17/ 1530h	1-18-17/ 1530h	1-18-17/ 1530h	1-18-17/ 1530h	1-18-17/ 1530h	1-18-17/ 1530h
pH**	7.33	6.82	7.00	6.57	6.94	6.90	7.26
Tot. Alk (mg/L as $CaCO_3$)	8.5	12	8.6	21	8.6	11	28
Tot. Hard (mg/L as $CaCO_3$)	8.6	16	8.5	64	17	20	37
Cond (µmhos/cm)	196	149	182	255	100	137	144
Turbidity (NTU)	7.64	3.29	9.24	13.7	45.7	26.4	35.7
Tot. Susp. Solids (mg/L)	9.4	2.0	10.7	10.8	54.1	22.4	27.3
Ortho-P (mg/L)	0.0128	0.284	0.0127	1.08	0.0106	0.0187	0.0178
$NO_2 + NO_3$ (mg/L)	0.0962	0.661	0.101	4.25	0.150	0.167	0.403
Tot N (mg/L)	0.488	1.14	0.423	6.52	0.628	0.513	1.00
Tot P (mg/L)	0.0483	0.369	0.0424	2.01	0.0977	0.0744	0.107
Tot NH_3 (mg/L)	0.0906	0.0526	0.0901	0.477	0.139	0.115	0.0778

**Measured in Conventionals section

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 µm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C. The well water is diluted by approximately 25% with MilliQ SuperQ de-ionized water to bring the total hardness to usual levels.

Water used for testing and culturing with *Ceriodaphnia* is fresh water obtained monthly from Lake Washington at a site midway between the I-90 and 520 bridges and filtered through 60 µm Nitex screen before use.

For both WW and LWW, low-hardness controls were prepared by diluting 1:10 with MilliQ water to approximate the hardness of the storm samples and receiving water.

Metals by ICP are measured monthly (last analysis: 1-2017); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: 2-2017). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW and LWW are listed in the following table:

Parameter	WW 1-18-17	WW (adjusted TH)	LWW 1-9-17	Units
Temperature	13.8	---	NA	°C, adjusted as necessary
Conductivity	328	242	98.6	µmhos/cm
pH	8.05	8.08	7.72	
Total Hardness (calc.)	131	94.6	36	mg/L as $CaCO_3$
Total Alkalinity	72	45	100	mg/L as $CaCO_3$
Total Cd	< 2		< 2	µg/L
Total Cr	< 3		< 3	µg/L
Total Cu	< 4		< 4	µg/L
Total Ni	< 5		< 5	µg/L
Total Pb	< 20		< 20	µg/L
Total Se	< 0.05		< 0.05	µg/L
Total Zn	< 5		< 5	µg/L
Total Mercury	< 0.05		< 0.05	µg/L
Volatile Organics	*		+	
Organic Analysis (BNA'S):	**		++	
Bis(2-Ethylhexyl)Phthalate	7.1		0.56 < 1.89 (RDL)	µg/L
Di-N-Butyl Phthalate	< 0.47		< 0.47	µg/L
Pesticides & PCB's:	***		+++	

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detected

\+ 45 cmpds not detectable
++ 68 cmpds not detectable
+++ 28 cmpds not detected

ACUTE TOXICITY TEST

Daphnia pulex – 48-Hour Static Acute Test #8246

The water flea *Daphnia* acute toxicity test #8246 followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only and low-hardness WW control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digital thermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8246	L66937-1 to -7	1-20-17/ 1708h	1-22-17/ 1615h	0 (WW controls), 100%	< 24 hr	4	5

CHRONIC TOXICITY TEST

Ceriodaphnia dubia - 7-Day Chronic Static Renewal Test #8245

The water flea *Ceriodaphnia dubia* 7-day static renewal chronic toxicity test #8245 was conducted as outlined in US EPA (2002b). Samples were tested as received at one undiluted (100%) concentration. Ten replicates containing one animal each were tested at each treatment, including a LWW-only control and a low-hardness LWW control. Test organisms were 3rd or 4th-brood neonates (< 24 hours old) taken from an in-house individual brood board of adults started from mass culture. Individual broods were blocked across treatments, and each replicate represented a different brood. The test was incubated at 25 ± 1.0°C for 7 days on a 16:8 h light:dark cycle. All test solutions were renewed daily. Reproduction, survival, temperature and water quality measurements were recorded every 24 hours. Temperature was measured daily in six test board temperature blanks (4 outer corner + 2 center) and at 15-minute intervals using an Onset "Tidbit" data logger placed in a beaker of water in the incubator. The pH and D.O. values measured during testing can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8245	L66937-1 to -7	1-19-17/ 1435h	1-26-17/ 1510h	0 (LWW controls), 100%	< 24 hr	10	1

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

	Daphnia	*Ceriodaphnia*
Test #:	8249	8250
Test Date:	2-1-17	2-3-17
Control Survival (%)	100	90
Criteria	≥ 90	≥ 80
Acceptable?	**Yes**	**Yes**
Survival LC50 (g/L)	3.42	
Lab Control Limits	2.39 – 4.65	
Acceptable?	**Yes**	
Control Reprod (# neos/adult)		39.8
Criteria		≥ 15
Acceptable?		**Yes**
PMSD for Reproduction (%)*		18.1
Criteria		13 - 47
Acceptable?		**Yes**
Reproduction IC25 (µg/L)		1.97
Lab Control Limits		0 – 7.25
Acceptable?		**Yes**

*Percent Minimum Significant Difference; determined by Dunnett's Multiple Comparison test (Steels Many-One Rank Test for unequal variance); ($\alpha = 0.05$)

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8249) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

Cadmium nitrate was used as a reference toxicant in the chronic toxicity test with *Ceriodaphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Ceriodaphnia* (#8250) (US EPA 2002b). In addition, the chronic test met acceptability criteria regarding control survival and mean control reproduction (US EPA 2002b).

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Daphnia pulex – 48-Hour Static Acute Test #8246

Survival results for the 48-hour *Daphnia* acute test #8246 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours: % Survival in each rep. (n=5 *Daphnia*/rep)					# *Daphnia* Tested
			Rep 1	Rep 2	Rep 3	Rep 4	Mean	
-----	Well Water Control	0	100	100	100	80	**95**	20
L66937-1	FW-EBI	100	100	100	100	80	**100**	20
L66937-2	FW-EBO	100	100	100	100	100	**100**	20
L66937-3	FW-WBI	100	100	100	100	100	**100**	20
L66937-4	FW-WBO	100	100	100	100	100	**100**	21
L66937-5	FW-WPCI	100	80	100	100	100	**95**	20
L66937-6	FW-WPCEPO	100	100	100	100	100	**100**	20
L66937-7	FW-NFWHC	100	100	100	100	100	**100**	20

Survival was 95 % in the well water-only control and West Pond Complex Inlet and 100% in the remaining samples (East Bioretention Inlet/Outlet, West Bioretention Inlet/Outlet, and Hylebos Creek). Survival in the Wet Pond Complex Inlet was not significantly reduced from that in the WPCEBO sample ($p > 0.05$; Wilcoxon Rank Sum 2-Sample t-Test). Survival in the Hylebos Creek receiving water sample was not significantly less than in the WW-only control ($p > 0.05$; Wilcoxon Rank Sum 2-Sample t-Test).

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66937-1	L66937-2	L66937-3	L66937-4	L66937-5	L66937-6	L66937-7
NH_3-N (mg/L) (calc)*	0.001	0.001	0.001	0.007	0.002	0.001	0.002

*Calculations listed in the "Storm Water Tests" section (p. 11)

Ceriodaphnia dubia - 7-Day Chronic Static Renewal Test #8245

Reproduction and survival results over the 7-day chronic *Ceriodaphnia* test #8245 with 100% bioretention pond storm water samples are shown in the table below. Reproduction was calculated using the 6-day data after 60% or greater of control organisms produced 3 or more broods (US EPA 2002b; WA DOE 2016).

Sample #	Station	% Sample	Reproduction (#Neonates/Adult in 6 Days) 1	2	3	4	5	6	7	8	9	10	Mean 6d Reprod	Mean 7d % Surv
---	LWW Control (Low-Hardness)	0	30	30	31	30	30	33	33	34	29	30	**31.0**	100
---	LWW (unadjusted)	0	37	36	37	38	31	31	37	35	36	36	**35.4**	100
L66937-1	FW-EBI	100	38	40	0	36	42	34	42	39	39	36	**34.6**	90
L66937-2	FW-EBO	100	35	37	39	6	39	41	31	37	42	43	**35.0**	90
L66937-3	FW-WBI	100	41	26	36	40	36	41	42	37	41	37	**37.7**	100
L66937-4	FW-WBO	100	39	35	40	38	46	47	41	45	39	45	**41.5**	100
L66937-5	FW-WPCI	100	37	39	42	41	36	36	39	41	42	39	**39.2**	100
L66937-6	FW-WPCEPO	100	35	38	32	38	40	42	36	44	41	43	**38.9**	100
L66937-7	FW-NFWHC	100	39	36	35	32	39	38	40	40	39	43	**38.1***	100

*Significantly greater than the control ($p < 0.05$; Tukey-Kramer Test)

As shown in the table above, survival was 100% in the hardness-adjusted and non-adjusted LWW-only controls as well as in the WBI, WPCI, WPCO and WHC samples. Survival was 90% in both the EBI and EBO samples.

Reproduction did not differ significantly in the Outlet samples (East Bioretention, West Bioretention, Wet Pond Complex) from the respective Inlet samples ($p > 0.05$; Equal Variance 2-Sample t-Test; Wilcoxon Rank-Sum 2-Sample t-Test; or Tukey-Kramer Test). In addition, reproduction was greater in the Hylebos Creek receiving water sample than in the low-hardness LWW control ($p < 0.05$; Tukey-Kramer Test).

The maximum un-ionized ammonia levels reached in the 100% storm samples during the 7-day chronic test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L66937-1	L66937-2	L66937-3	L66937-4	L66937-5	L66937-6	L66937-7
NH_3-N (mg/L) (calc)*	0.002	0.014	0.002	0.015	0.003	0.003	0.004

*Calculations listed in the "Storm Water Tests" section (p. 11)

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Ceriodaphnia*	*Daphnia*
Test #:	8245	8246
Control Survival (%)	100	95
Criteria	≥ 80	≥ 90
Acceptable?	**Yes**	**Yes**
Control Reproduction (# neos/adult)	31.0	
Criteria	≥ 15	
Acceptable?	**Yes**	

As shown in the table above, both the acute and chronic effluent tests met acceptability criteria regarding control performance, including survival and reproduction (US EPA, 2002a & 2002b).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute and chronic tests (US EPA, 2002a & 2002b). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 2002b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition (EPA-821-R-02-013).

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

WA DOE. 2016. Whole Effluent Toxicity Testing Guidance and Test Review Criteria. DOE Pub. #WQ-R-95-80, revised June 2016. Washington State Department of Ecology, Water Quality Program, Olympia, WA.

June 15, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
Seattle, WA 98104-3855

Dear Kate:

A summary of 48-hour acute (*Daphnia*) and 7-day chronic (*Ceriodaphnia*) tests conducted with storm water samples collected from Federal Way Bio-retention sites on March 7, 2017 are listed in the following table. The tests were initiated on March 8, 2017 and March 9, 2017. Detailed findings and method descriptions are in the "Results" and "Methods" sections of the attached report.

			Daphnia	*Ceriodaphnia*	
		Test #/ Date →	8262/ 03-08-17	8261/ 03-09-17	
Sample #↓	Station	Site	Mean % Surv	Mean Surv	Mean Reprod
Control	---	WW (*D.p.*); LWW (*C.d*)	60	100	33.7
Low Hardness	---	WW (*D.p.*); LWW (*C.d*)	0	100	33.2
L67231-1	FW-EBI	East Bio-retention Facility-Inlet	30*	100	35.5
L67231-2	FW-EBO	East Bio-retention Facility-Outlet	100	100	40.2
L67231-3	FW-WBI	West Bio-retention Facility-Inlet	5*	100	35.4
L67231-4	FW-WBO	West Bio-retention Facility-Outlet	100	100	32.1
L67231-5	FW-WPCI	Wet Pond Complex- Inlet	85	100	34.9*
L67231-6	FW-WPCEPO	Wet Pond Complex & East Bio-retention- Outlet	100	100	45.3
L67231-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100	100	49

*Statistically significant effect compared to outlet

For the Daphnia, both the Equal Variance t Two-Sample test and the Wilcoxon Rank-Sum Two-Sample test were run for Survival. There was a significant effect between L67231-1 (FW-EBI) and L67231-2 (FW-EBO); and L67231-3 (FW-WBI) and L67231-4 (FC-WBO).

For the *Ceriodaphnia*, the Fisher Exact Test was used for Survival, and both the Equal Variance t Two-Sample test and the Wilcoxon Rank-Sum Two-Sample test were run for Reproduction. There was a Significant Effect for reproduction between L67231-5 (FW-WPCI) and L67231-6 (FW-WPCEPO).

If you would like additional information, please contact me at 477-7170 or Francis Sweeney at 477-7117.

Sincerely,

Robin Revelle

Robin Revelle
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section

322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR THE

Federal Way Bio-retention Pond Storm Water Tests
March 2017

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date:	**8262 *Daphnia* Acute**	**03/08/2017**
	8261 *Ceriodaphnia* Chronic	**03/09/2017**

Report Date: June 15, 2017

METHODS

SAMPLES

Seven storm water samples were collected at Federal Way Bio-retention Pond sites on March 7, 2017. Approximately 3-4 L of each sample was delivered to the King County Environmental Laboratory (KCEL) in 4-L glass flasks with minimal headspace and tested as received. The samples were stored in the dark at 4 ± 2°C and used to initiate the *Daphnia pulex* acute and the *Ceriodaphnia dubia* chronic toxicity tests, as well as for *C. dubia* test renewals.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bio-retention Facility (Inlet)	East Bio-retention Facility (Outlet)	West Bio-retention Facility (Inlet)	West Bio-retention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bio-retention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67231-1	L67231-2	L67231-3	L67231-4	L67231-5	L67231-6	L67231-7
Collect Date/Time	03/07/17 07:42	03/07/17 09:49	03/07/17 07:49	03/07/17 07:39	03/07/17 07:45	03/07/17 09:27	03/07/17 09:40
Rec'd Date/Time	03/08/17 15:00	03/08/17 15:00	03/08/17 15:00	03/08/17 15:00	03/08/17 15:00	03/08/17 15:00	03/08/17 15:00
Volume (L)	~ 2.0 L	~ 2.0 L	~ 2.0 L	~ 2.0 L	~ 2.0 L	~ 2.0 L	~ 2.0 L
pH**	6.98	6.8	6.93	6.75	7.12	7.07	7.49
Tot. Alk (mg/L as $CaCO_3$)	8.07	20.7	8.05	52.5	12.2	17.5	42.4
Tot. Hard (mg/L as $CaCO_3$)	5.26	12.4	5.21	43.8	16.4	21.5	47.1
Cond (µmhos/cm)	34.9	72.7	34.4	179.8	59.4	85.4	134.8
Turbidity (NTU)	6.79	5.87	7.39	17.9	56.8	41.1	24.3
Tot. Susp. Solids (mg/L)	4.74	1.79	4.6	14.8	51.3	21.6	14.6
Ortho-P (mg/L)	0.00823	0.579	0.00828	2.21	0.00581	0.0198	0.0154
$NO_2 + NO_3$ (mg/L)	0.102	0.562	0.102	0.975	0.136	0.164	0.32
Tot N (mg/L)	0.301	1.3	0.288	3.95	0.537	0.476	0.698
Tot P (mg/L)	0.0252	0.639	0.0237	3.83	0.0714	0.0696	0.0535
Ammonia Nitrogen (mg/L)	0.0609	0.0529	0.0615	0.586	0.127	0.0619	0.0277

*Sample kept in cooler until needed.
** pH taken by Conventionals section

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 µm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C.

Water used for testing and culturing with *Ceriodaphnia* is fresh water obtained monthly from Lake Washington at a site midway between the I-90 and 520 bridges and filtered through 60 µm Nitex screen before use.

Metals by ICP are measured monthly (last analysis: Feb 2017); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: Feb and Mar. 2016). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW and LWW are listed in the following table:

Parameter	LWW	Low Hardness LWW	WW	Low Hardness WW	Units
Sample Number:	L67076-1	L67304-1	L67303-1	L67322-1	
Temperature:	*	*	*	*	°C, adjusted as necessary
Conductivity:	100	----	258	39.7	µmhos/cm
pH (0 hour):	8.130	7.588	8.010	7.634	
Total Hardness (calc.):	39.5	9.74	103	11.3	mg/L as $CaCO_3$
Total Alkalinity:	37.4	9.41	74.7	8.46	mg/L as $CaCO_3$

*Water held at 0-5°C cooler until needed.

Metals and Organics:

Parameter	LWW	WW	Units
Total Cd:	< 2	< 2	µg/L
Total Cr:	< 3	< 3	µg/L
Total Cu:	< 4	< 4	µg/L
Total Ni:	< 5	< 5	µg/L
Total Pb:	< 20	< 20	µg/L
Total Zn:	< 5	< 5	µg/L
Total Mercury:	< 0.05	< 0.05	µg/L
Volatile Organics:	*	+	µg/L
Organic Analysis (BNA'S):	**	++	µg/L
Bis(2-Ethylhexyl)Phthalate:	0.56#	0.82#	µg/L
Di-N-Butyl Phthalate:	< 0.47	< 0.47	µg/L
Pesticides & PCB's:	***	+++	µg/L

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detectable
#< RDL: RDL = 1.89

\+ 45 cmpds not detectable
++ 68 cmpds not detectable
+++ 28 cmpds not detectable

ACUTE TOXICITY TEST

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

The *Daphnia* acute toxicity test followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digitalthermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8262	L67231-1 to -7	03-08-17/ 1720h	03-10-17/ 1620h	0 (WW control), 100%	< 24 hr	4	5

CHRONIC TOXICITY TEST

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

The *Ceriodaphnia dubia* 7-day static renewal chronic toxicity test was conducted as outlined in US EPA (2002b). Samples were tested as received at one undiluted (100%) concentration. Ten replicates containing one animal each were tested at each treatment, including the control. Test organisms were 3rd or 4th-brood neonates (< 24 hours old) taken from an in-house individual brood board of adults started from mass culture. Individual broods were blocked across treatments, and each replicate represented a different brood. The test was incubated at 25 ± 1.0°C for 7 days on a 16:8 h light:dark cycle. All test solutions were renewed daily. Reproduction, survival, temperature and water quality measurements were recorded every 24 hours. Temperature was measured daily in six test board temperature blanks (4 outer corner + 2 center) and at 15-minute intervals using an Onset "Tidbit" data logger placed in a beaker of water in the incubator. The pH and D.O. values measured during testing can be found on the attached photocopied pages from the laboratory notebook in the 'Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8261	L67231-1 to -7	03-09-17/ 0910h	03-16-17/ 1045h	0 (LWW control), 100%	< 24 hr	10	1

QUALITY CONTROL

Reference Toxicant control results are summarized in the following table.

Test #:	*Daphnia* 8255	*Ceriodaphnia* 8256
Control Survival (%)	100	90
Criteria	≥ 90	≥ 80
Acceptable?	**Yes**	**Yes**
Survival LC50 (g/L)	3	
Lab Control Limits	2.4 – 4.7	
Acceptable?	**Yes**	
Control Reprod (# neos/adult)		27
Criteria		≥ 15
Acceptable?		**Yes**
PMSD for Reproduction (%)*		27.4
Criteria		13 - 47
Acceptable?		**Yes**
Reproduction IC25 (µg/L)		4.1
Lab Control Limits		0 – 7.28
Acceptable?		**Yes**

*Percent Minimum Significant Difference

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8199) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

Cadmium nitrate was used as a reference toxicant in the chronic toxicity test with*Ceriodaphnia.* Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for*Ceriodaphnia* (#8178) (US EPA 2002b). In addition, the chronic test met acceptability criteria regarding control survival and mean control reproduction (US EPA 2002b).

The precision tables located at the end of this report are constructed to monitor the sensitivity ofthe organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Water Flea - *Daphnia pulex* – 48-Hour Static Acute Test

Survival results for the 48-hour *Daphnia* acute test #8262 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours					# *Daphnia* Tested
			% Survival in each rep. (n=5 *Daphnia*/rep)				Mean % Survival	
			Rep 1	Rep 2	Rep 3	Rep 4		
L67303-1	Well Water Control	0	60	60	40	80	**60**	20
L67322-1	Low Hardness Control	0	0	0	0	0	**0**	20
L67231-1	FW-EBI East Bio-retention Facility (Inlet)	100	0	20	0	100	**30**	20
L67231-2	FW-EBO East Bio-retention Facility (Outlet)	100	100	100	100	100	**100**	20
L67231-3	FW-WBI West Bio-retention Facility (Inlet)	100	20	0	0	0	**5**	20
L67231-4	FW-WBO West Bio-retention Facility (Outlet)	100	100	100	100	100	**100**	20
L67231-5	FW-WPCI Wet Pond Complex (Inlet)	100	40	100	100	100	**85**	20
L67231-6	FW-WPCEPO Wet Pond Complex + East Bio-retention Facility (Outlet)	100	100	100	100	100	**100**	20
L67231-7	FW-NFWHC Hylebos Creek (Receiving Water)	100	100	100	100	100	**100**	20

Survival was 100 % in the East Bio-retention Outlet, the West Bio-retention Outlet, the Wet Pond Complex Outlet and the Hylebos Creek receiving water samples. Survival was85% in the Wet Pond Complex Inlet; 30% in the East Bio-retention Inlet and only 5% in the West Bio-retention Inlet. Survival in the Well Water Control and Low Hardness Control was 60% and 0% respectively.

The Wilcoxon Rank Sum Two-Sample Test (Nonparametric-Two Sample) and an Equal Variance Two-Sample t-test (Parametric) were used to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.). The receiving water was compared to the Well Water Control. There was a significant effect between L67231-1 (FW-EBI) and L67231-2 (FW-EBO); and L67231-3 (FW-WBI) and L67231-4 (FC-WBO).

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bio-retention Facility (Inlet)	E. Bio-retention Facility (Outlet)	West Bio-retention Facility (Inlet)	West Bio-retention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bio-retention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67231-1	L67231-2	L67231-3	L67231-4	L67231-5	L67231-6	L67231-7
NH_3-N (mg/L)*	**0.001**	**0.001**	**0.001**	**0.017**	**0.001**	**0.001**	**0.001**

*MDL = 0.001

Water Flea - *Ceriodaphnia dubia* - 7-Day Chronic Static Renewal Test

Reproduction and survival results over the 7-day chronic *Ceriodaphnia* test #8261 with 100% bio-retention pond storm water samples are shown in the table below.

Sample #	**Station**	**% Sample**	**Reproduction (#Neonates/Adult in 7 Days)**										**Mean Reprod**	**Mean % Surv**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
L67076-1	LWW Control	0	23	24	30	32	25	31	44	50	42	36	**33.7**	100
L67304-1	Low Hardness	0	27	25	30	31	33	27	41	37	45	36	**33.2**	100
L67231-1	FW-EBI	100	29	32	31	32	35	36	42	46	32	40	**35.5**	100
L67231-2	FW-EBO	100	35	25	40	41	11	35	56	54	43	62	**40.2**	100
L67231-3	FW-WBI	100	36	25	35	30	35	36	39	42	45	31	**35.4**	100
L67231-4	FW-WBO	100	29	27	30	26	26	23	38	35	46	41	**32.1**	100
L67231-5	FW-WPCI	100	35	28	37	40	27	0	51	46	44	41	**34.9***	100
L67231-6	FW-WPCEPO	100	36	40	47	39	38	39	53	51	58	52	**45.3**	100
L67231-7	FW-NFWHC	100	43	41	40	42	44	34	63	55	65	63	**49**	100

*Statistically significant effect compared to outlet

Survival was 100% in both controls and all samples.

The Fisher Exact Test was run for Survival, and both the Equal Variance t Two-Sample test and the Wilcoxon Rank-Sum Two-Sample test were run for Reproduction to compare all inlet and outlet pairs (FW-EBI vs. FW-EBO, FW-WBI vs. FW-WBO, etc.) The receiving water was compared to the Well Water Control. There was a Significant Effect between L67231-5 (FW-WPCI) and L67231-6 (FW-WPCEPO) for reproduction. There was a Non-Significant Effect in all other pairings.

The maximum un-ionized ammonia levels reached in the 100% storm samples during the 7-day chronic test are listed in the table below.

Site:	East Bio-retention Facility (Inlet)	E. Bio-retention Facility (Outlet)	West Bio-retention Facility (Inlet)	West Bio-retention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bio-retention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67231-1	L67231-2	L67231-3	L67231-4	L67231-5	L67231-6	L67231-7
NH_3-N (mg/L)*	**0.002**	**0.003**	**0.002**	**0.048**	**0.006**	**0.003**	**0.003**

*MDL = 0.001

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Ceriodaphnia*	*Daphnia*
Test #:	8261	8262
Control Survival (%)	100	60
Criteria	≥ 80	≥ 90
Acceptable?	**Yes**	**No**
Control Reproduction (# neos/adult)	33.7	
Criteria	≥ 15	
Acceptable?	**Yes**	
PMSD for Reproduction (%)*	**NA**	
Criteria	**NA**	
Acceptable?	**NA**	

*Percent Minimum Significant Difference

As shown in the table above, the *Ceriodaphnia* test met acceptability criteria regarding: control performance and test variability, including survival and reproduction. The *Daphnia* test did not meet acceptability criteria for Control Survival. PMSD does not apply for these tests (US EPA, 2002a & 2002b).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute and chronic tests (US EPA, 2002a & 2002b). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Effluent Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 2002b. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. 4th Edition (EPA-821-R-02-013).

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

June 30, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
MS KSC-NR-0600
Seattle, WA 98104-3855

Dear Kate:

A summary of the 48-hour acute (*Daphnia*) conducted with storm water samples collected from Federal Way Bioretention Inlet and Outlet sites on April 19th and 20th, 2017 is listed in the following table. The test was initiated on April 21, 2017. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

Sample #↓	Station	Site Test #/ Date →	*Daphnia* 8283/ 4-21-17 Mean % Surv
Control	---	WW (*Daphnia)*	100
		Low Hardness WW	0
L67594-1	FW-EBI	East Bioretention Facility- Inlet	65
-2	FW-EBO	East Bioretention Facility- Outlet	100
-3	FW-WBI	West Bioretention Facility- Inlet	75
-4	FW-WBO	West Bioretention Facility- Outlet	90
-5	FW-WPCI	Wet Pond Complex- Inlet	95
-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	95
-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100

A significant difference in survival was found between the East Bioretention Facility Inlet and Outlet samples ($p < 0.05$; Equal Variance 2-Sample t-Test) in the *Daphnia* test.

If you would like additional information, please contact me at 477-7121 or Francis Sweeney at 477-7117.

Sincerely,

Lyndsey Swanson
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR

Federal Way Bioretention Pond Storm Water Tests
April 2017

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date: **8283 *Daphnia* Acute** **4/21/2017**

Report Date: **June 30, 2017**

METHODS

SAMPLES

Seven storm water samples were collected by time-paced composite at Federal Way Bioretention Pond Inlet and Outlet sites on April 19 and 20, 2017. In addition, a receiving water sample was collected at Hylebos Creek. Approximately 3 to 4 L of each sample was split from a larger container and delivered to the King County Environmental Laboratory (KCEL) in 9-L glass jars with Teflon-lined screw-cap lids and tested as-received. The samples were stored in the dark at 4 ± 2^{o}C and used to initiate the *Daphnia pulex* acute test.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67594-1	L67594-2	L67594-3	L67594-4	L67594-5	L67594-6	L67594-7
Coll Date/ Time From:	4-19-17/ 1315h	4-19-17/ 1612h	4-19-17/ 1306h	4-19-17/ 1549h	4-19-17/ 1223h	4-19-17/ 1610h	4-19-17/ 1622h
to:	4-20-17/ 0053h	4-20-17/ 0710h	4-20-17/ 0057h	4-20-17/ 0646h	4-20-17/ 0556h	4-20-17/ 0634h	4-20-17/ 0653h
Rec'd Date/Time	4-20-17/ 1530h	4-20-17/ 1530h	4-20-17/ 1530h	4-20-17/ 1530h	4-20-17/ 1530h	4-20-17/ 1530h	4-20-17/ 1530h
pH	6.95	6.84	6.95	6.76	7.04	7.25	7.67
Tot. Alk (mg/L as $CaCO_3$)	8.28	23.5	8.38	38.3	10.8	24.1	57
Tot. Hard (mg/L as $CaCO_3$)	8.88	19.3	9.41	34.4	14.8	26	62.5
Cond (μmhos/cm)	28.3	67.9	28.9	115	37	76	151
Turbidity (NTU)	9.98	3.65	12.5	5.01	25.4	9.92	8.93
Tot. Susp. Solids (mg/L)	8.32	2.8	9.3	8.2	38.2	5.6	9
Ortho-P (mg/L)	0.102	0.741	0.0101	2.1	0.00455	0.0343	0.0187
NO_2 + NO_3 (mg/L)	0.134	0.31	0.141	1.75	0.169	0.0777	0.275
Tot N (mg/L)	0.459	1.15	0.476	4.03	0.686	0.394	0.634
Tot P (mg/L)	0.0431	0.873	0.0444	2.61	0.0683	0.0767	0.052
Tot NH_3 (mg/L)	0.0792	0.0768	0.0701	0.357	0.11	0.0254	0.0048

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 μm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C. The well water is diluted by approximately 25% with MilliQ SuperQ de-ionized water to bring the total hardness to usual levels.

For WW, low-hardness controls were prepared by diluting 1:10 with MilliQ water to approximate the hardness of the storm samples and receiving water.

Metals by ICP are measured monthly (last analysis: 4-18-2017); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: 2-2017). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW are listed in the following table:

Parameter	WW	WW (adjusted TH)	Units
Temperature	4	4	°C, adjusted as necessary
Conductivity	250	29.8	µmhos/cm
pH	7.988	8.031	
Total Hardness (calc.)	134	10.7	mg/L as $CaCO_3$
Total Alkalinity	75.7	7.84	mg/L as $CaCO_3$
Total Cd	< 2		µg/L
Total Cr	< 3		µg/L
Total Cu	< 4		µg/L
Total Ni	< 5		µg/L
Total Pb	< 20		µg/L
Total Zn	< 5		µg/L
Total Mercury	< 0.05		µg/L
Volatile Organics	*		
Organic Analysis (BNA'S):	**		
Bis(2-Ethylhexyl)Phthalate	0.82		µg/L
Di-N-Butyl Phthalate	< 0.47		µg/L
Pesticides & PCB's:	***		

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detected

ACUTE TOXICITY TEST

Daphnia pulex – 48-Hour Static Acute Test #8283

The water flea *Daphnia* acute toxicity test #8283 followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only and low-hardness WW control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digital thermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8283	L67594-1 to -7	4-21-17/ 1220h	4-23-17/ 1200h	0 (WW controls), 100%	< 24 hr	4	5

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

Test #:	*Daphnia*
	8286
Control Survival (%)	100
Criteria	≥ 90
Acceptable?	**Yes**
Survival LC50 (g/L)	3.7
Lab Control Limits	2.3 – 4.7
Acceptable?	**Yes**

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8199) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Daphnia pulex – 48-Hour Static Acute Test #8283

Survival results for the 48-hour *Daphnia* acute test #8283 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours: % Survival in each rep. (n=5 *Daphnia*/rep) Rep 1	Rep 2	Rep 3	Rep 4	Mean	# *Daphnia* Tested
----	Well Water Control Low Hardness Con	0 0	100 0	100 0	100 0	100 0	**100** 0	20 20
L67594-1	FW-EBI	100	60	100	60	40	**65**	20
L67594-2	FW-EBO	100	100	100	100	100	**100**	20
L67594-3	FW-WBI	100	60	60	80	100	**75**	20
L67594-4	FW-WBO	100	80	80	100	100	**90**	20
L67594-5	FW-WPCI	100	80	100	100	100	**95**	20
L67594-6	FW-WPCEPO	100	80	100	100	100	**95**	20
L67594-7	FW-NFWHC	100	100	100	100	100	**100**	20

Survival was 100 % in the well water-only control, West Hylebos Creek, and the East Bioretention Outlet. Survival was 95% in the Combination Wetpond Complex/East Bioretention Outlet and the West Pond Complex Inlet, 90% in the West Bioretention Outlet, 75% in the West Bioretention Inlet, and 65% in the East Bioretention Inlet. A significant difference in survival was found between the East Bioretention Facility Inlet (FW-EBI) and Outlet (FW-EBO) samples ($p < 0.05$; Equal Variance 2-Sample t-Test) in the *Daphnia* test.

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67594-1	L67594-2	L67594-3	L67594-4	L67594-5	L67594-6	L67594-7
NH_3-N (mg/L) (calc)*	0.0003	0.0002	0.0003	0.0008	0.0005	0.0002	0.0001

*Calculations listed in the “Storm Water Tests” section (p. 11)

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Daphnia*
Test #:	8283
Control Survival (%)	100
Criteria	≥ 90
Acceptable?	**Yes**

As shown in the table above, the acute test met acceptability criteria regarding control performance (US EPA, 2002a).

Dissolved oxygen, pH, temperature and/or salinity remained within acceptable limits throughout both the acute test (US EPA, 2002a). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

WA DOE. 2016. Whole Effluent Toxicity Testing Guidance and Test Review Criteria. DOE Pub. #WQ-R-95-80, revised June 2016. Washington State Department of Ecology, Water Quality Program, Olympia, WA.

July 20, 2017

Kate Macneale
King County Department of Natural Resources & Parks
Water and Land Resources Division/ Scientific and Technical Support
Watershed and Ecological Assessment Team
King Street Center
201 S. Jackson Street, Room 600
MS KSC-NR-0600
Seattle, WA 98104-3855

Dear Kate:

A summary of the 48-hour acute (*Daphnia*) conducted with storm water samples collected from Federal Way Bioretention Inlet and Outlet sites on April 24th, 2017 is listed in the following table. The test was initiated on April 25, 2017. Detailed findings and method descriptions are in the "RESULTS" and "Methods" sections of the attached report.

			Daphnia
		Test #/ Date →	8284/ 4-25-17
Sample #	Station	Site	Mean % Surv
Control	---	WW (*Daphnia)*	100
		Low Hardness WW	5
L67617-1	FW-EBI	East Bioretention Facility- Inlet	100
-2	FW-EBO	East Bioretention Facility- Outlet	100
-3	FW-WBI	West Bioretention Facility- Inlet	95
-4	FW-WBO	West Bioretention Facility- Outlet	100
-5	FW-WPCI	Wet Pond Complex- Inlet	100
-6	FW-WPCEPO	Wet Pond Complex & East Bioretention- Outlet	100
-7	FW-NFWHC	N. Fork West Hylebos Creek (Receiving Water)	100

No significant difference in survival was found between the East Bioretention Facility Inlet and Outlet samples, West Bioretention Facility Inlet and Outlet samples, nor between the Wet Pond Complex Inlet and Wet Pond and East Bioretention Outlet.

If you would like additional information, please contact me at 477-7121 or Francis Sweeney at 477-7117.

Sincerely,

Lyndsey Swanson
King County Dept. of Natural Resources and Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing St.
Seattle, WA 98119

BIOLOGICAL MONITORING REPORT FOR

Federal Way Bioretention Pond Storm Water Tests
April 2017

Program #421879-240

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test #/Date: 8284 *Daphnia* Acute 4/25/2017

Report Date: July 20, 2017

METHODS

SAMPLES

Seven storm water samples were collected by time-paced composite at Federal Way Bioretention Pond Inlet and Outlet sites on April 24, 2017. In addition, a receiving water sample was collected at Hylebos Creek. Approximately 3 to 4 L of each sample was split from a larger container and delivered to the King County Environmental Laboratory (KCEL) in 9-L glass jars with Teflon-lined screw-cap lids and tested as-received. The samples were stored in the dark at 4 ± 2^{o}C and used to initiate the *Daphnia pulex* acute test.

Collection information and chemical characteristics of the test samples are listed in the table below.

Site:	East Bioretention Facility (Inlet)	East Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67617-1	L67617-2	L67617-3	L67617-4	L67617-5	L67617-6	L67617-7
Coll Date/ Time From:	4-23-17/ 1657h	4-23-17/ 1917h	4-23-17/ 1646h	4-23-17/ 2037h	4-23-17/ 1528h	4-23-17/ 1947h	4-23-17/ 1957h
to:	4-24-17/ 0649h	4-24-17/ 1212h	4-24-17/ 0804h	4-24-17/ 1329h	4-24-17/ 1136h	4-24-17/ 1328h	4-24-17/ 1308h
Rec'd Date/Time	4-24-17/ 1620h	4-24-17/ 1620h	4-24-17/ 1620h	4-24-17/ 1620h	4-24-17/ 1620h	4-24-17/ 1620h	4-24-17/ 1620h
pH	7.00	6.96	6.99	6.95	7.00	7.22	7.7
Tot. Alk (mg/L as CaCO3)	8.5	24.2	8.53	37.8	10.9	21.3	52.4
Tot. Hard (mg/L as CaCO3)	8.66	20	8.62	30.6	17	22.8	59.1
Cond (µmhos/cm)	27.5	67.3	26.7	103	38.8	67.3	140
Turbidity (NTU)	6.7	4.26	5.35	8.8	31.3	8.65	10.7
Tot. Susp. Solids (mg/L)	5.5	1.77	4.1	2.11	61.2	4.84	11.7
Ortho-P (mg/L)	.0146	0.8	0.0135	2.14	0.00314	0.0172	0.0166
NO2 + NO3 (mg/L)	0.141	0.259	0.132	0.707	0.184	0.0851	0.259
Tot N (mg/L)	0.433	1.07	0.382	2.7	0.74	0.381	0.607
Tot P (mg/L)	0.0412	0.975	0.0364	2.88	0.0803	0.0541	0.054
Tot NH3 (mg/L)	0.0748	0.112	0.0536	0.388	0.108	0.0165	0.0064

CONTROL WATER

The control water for tests with *Daphnia pulex* is fresh water obtained from a 95 ft. deep well located at the KCEL and filtered to 60 µm with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at 20 ± 1°C. The well water is diluted by approximately 25% with MilliQ SuperQ de-ionized water to bring the total hardness to usual levels.

For WW, low-hardness controls were prepared by diluting 1:10 with MilliQ water to approximate the hardness of the storm samples and receiving water.

Metals by ICP are measured monthly (last analysis: 4-18-2017); metals by ICP/MS or CVAA and organic compounds are measured annually (last analyses: 2-2017). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the WW are listed in the following table:

Parameter	WW	WW (adjusted TH)	Units
Temperature	4	---	°C, adjusted as necessary
Conductivity	250	29.8	µmhos/cm
pH	7.988	8.031	
Total Hardness (calc.)	134	10.7	mg/L as $CaCO_3$
Total Alkalinity	75.7	7.84	mg/L as $CaCO_3$
Total Cd	< 2		µg/L
Total Cr	< 3		µg/L
Total Cu	< 4		µg/L
Total Ni	< 5		µg/L
Total Pb	< 20		µg/L
Total Zn	< 5		µg/L
Total Mercury	< 0.05		µg/L
Volatile Organics	*		
Organic Analysis (BNA'S):	**		
Bis(2-Ethylhexyl)Phthalate	0.82		µg/L
Di-N-Butyl Phthalate	< 0.47		µg/L
Pesticides & PCB's:	***		

* 45 cmpds not detectable
** 68 cmpds not detectable
*** 28 cmpds not detected

ACUTE TOXICITY TEST

Daphnia pulex – 48-Hour Static Acute Test #8284

The water flea *Daphnia* acute toxicity test #8284 followed the methods of US EPA (2002a). Test animals were neonates (< 24-hours old) taken from an overnight brood board; parent animals were adults isolated from in-house mass cultures. Samples were tested as received at one undiluted (100%) concentration along with a WW-only and low-hardness WW control. Test chambers were 30-mL beakers containing 25 mL of test solution. Individual broods were blocked across treatments such that each replicate contained representatives of five separate broods, with four replicates per treatment. Test chambers were randomized at the start of the test. The test was incubated at 20.0 ± 1.0°C for 48 hours on a 16:8 hour light:dark cycle. Survival and water quality measurements were recorded every 24 hours. Temperature was measured daily by digital thermometer in replicate blanks at six positions of the test tray (4 outer corner + 2 center). In addition, incubator temperature was measured at 15-minute intervals using an Onset Tidbit data logger. Temperature, pH and dissolved oxygen (D.O.) values can be found on the attached photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Test #	LIMS Sample #	Start Date/ Time	End Date/ Time	Sample Concentrations (%)	Daphnid Age	# Reps/ Trtmt	# Orgs/ Rep
8284	L67617-1 to -7	4-25-17/ 1000h	4-27-17/ 1015h	0 (WW controls), 100%	< 24 hr	4	5

QUALITY CONTROL

Reference toxicant control results are summarized in the following table.

Test #:	*Daphnia*
	8286
Control Survival (%)	100
Criteria	≥ 90
Acceptable?	**Yes**
Survival LC50 (g/L)	3.7
Lab Control Limits	2.3 – 4.7
Acceptable?	**Yes**

NaCl was used as a reference toxicant in the acute test with *Daphnia*. Temperature, pH and dissolved oxygen measurements remained within acceptable limits throughout the reference toxicant test for *Daphnia* (#8286) (US EPA 2002a). The acute positive control test met acceptability criteria regarding control survival, and the survival LC50 endpoint was within the control limits of the mean ± 2SD (US EPA, 2002a).

The precision tables located at the end of this report are constructed to monitor the sensitivity of the organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds.

WATER QUALITY MONITORING

Methods and method numbers for water quality tests are listed in the following table:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA’s (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

ACUTE TOXICITY TESTS

Daphnia pulex – 48-Hour Static Acute Test #8284

Survival results for the 48-hour *Daphnia* acute test #8284 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours: % Survival in each rep. (n=5 *Daphnia*/rep) Rep 1	Rep 2	Rep 3	Rep 4	Mean	# *Daphnia* Tested
----	Well Water Control Low Hardness Con	0 0	100 0	100 0	100 0	100 5	**100** 5	20 20
L67617-1	FW-EBI	100	100	100	100	100	**100**	20
L67617-2	FW-EBO	100	100	100	100	100	**100**	20
L67617-3	FW-WBI	100	80	100	100	100	**95**	20
L67617-4	FW-WBO	100	100	100	100	100	**100**	20
L67617-5	FW-WPCI	100	100	100	100	100	**100**	20
L67617-6	FW-WPCEPO	100	100	100	100	100	**100**	20
L67617-7	FW-NFWHC	100	100	100	100	100	**100**	20

Survival was 100 % in the well water-only control, 95% in the West Bioretention Inlet, and 100% in all other treatments (East Bioretention Inlet and Outlet, West Bioretention Outlet, West Pond Complex Inlet, West Pond Complex/East Bioretention Outlet, and North Fork Hylebos Creek).

The maximum un-ionized ammonia levels in the 100% storm samples during the 48-hour test are listed in the table below.

Site:	East Bioretention Facility (Inlet)	E. Bioretention Facility (Outlet)	West Bioretention Facility (Inlet)	West Bioretention Facility (Outlet)	Wet Pond Complex (Inlet)	Wet Pond Complex + East Bioretention (Outlet)	N. Fork Hylebos Creek (Receiving Water)
Station:	FW-EBI	FW-EBO	FW-WBI	FW-WBO	FW-WPCI	FW-WPCEPO	FW-NFWHC
KCEL Sample #:	L67617-1	L67617-2	L67617-3	L67617-4	L67617-5	L67617-6	L67617-7
NH_3-N (mg/L) (calc)*	0.0003	0.0004	0.0002	0.001	0.0004	0.0001	0.0001

*Calculations listed in the "Storm Water Tests" section (p. 11)

QUALITY CONTROL

Storm water sample and control performance results are summarized in the following table:

Test Organism:	*Daphnia*
Test #:	8284
Control Survival (%)	100
Criteria	≥ 90
Acceptable?	**Yes**

As shown in the table above, the acute test met acceptability criteria regarding control performance (US EPA, 2002a).

Dissolved oxygen, pH, temperature remained within acceptable limits throughout both the acute test (US EPA, 2002a). Water quality data recorded during testing is shown on the photocopied pages from the laboratory notebook in the "Storm Water Tests" section of this report.

Tested By:

King County Department of Natural Resources & Parks
Water and Land Resources Division
Environmental Laboratory Section
322 West Ewing Street
Seattle WA 98119
(206) 477-7123

Julie Alaimo, Gary Yoshida, Robin Revelle, Gabriela Hannach, Elizabeth Frame, Lyndsey Swanson, Fran Sweeney

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association, Washington D.C.

US EPA. 2002a. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October, 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

WA DOE. 2016. Whole Effluent Toxicity Testing Guidance and Test Review Criteria. DOE Pub. #WQ-R-95-80, revised June 2016. Washington State Department of Ecology, Water Quality Program, Olympia, WA.

Appendix G:
Data Quality Assessment

Contents:

Appendix G1:
Data Quality Summary

APPENDIX G1 – DATA QUALITY SUMMARY FOR CHEMISTRY SAMPLES

This appendix summarizes the findings of the data quality assessment, which followed the steps outlined in Section 10.0 of the project Quality Assurance Project Plan (QAPP; King County 2016). The data collected for this project were reviewed midway through the project and again when the dataset was complete. This summary describes how well the chemistry data met the general project objectives and the specific data quality objectives, as well as any implications this may have on data usage. Quality of flow data are discussed in Appendix G4. Quality of toxicity test results are discussed in Appendix H3. Quality of water level data from the east and west bioretention facilities is discussed in Appendix J.

G1.1 General Project Objectives

Project objectives were achieved with a few exceptions, which are listed below (see Section 1.1 of the main report for a list of project objectives):

- Flow was measured at each location to both enable flow-weighted sampling and estimate total flow volume per storm at each location. Flow data were of sufficient quality to estimate the beginning, peak and end of most storm events at most locations (see Appendix I), and thus, representative samples were collected from nearly all locations during each event. Flow volume data, however, were typically of lower quality. For most storms, storm volume data (as well as calculated pollutant loads) were flagged as estimates. Loads for the remaining storms were not calculated because flow volume data were rejected. See Appendix G4 for details.
- The project aimed to collect samples during 20 storm events. Eighteen storms were sampled successfully; however, the last two storms could not be sampled due to road construction near the facility (see Appendix A).

G1.2 Precision

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Precision was evaluated through analysis of field replicates, laboratory replicates and matrix spike duplicates according to the control limits specified in the QAPP.

- Section G2 describes a few instances where the King County Environmental Laboratory (KCEL) quality control (QC) results were outside precision control limits specified in the QAPP. The associated sample results were qualified as estimates, but no results were rejected.
- Precision control limits were met for polychlorinated biphenyl (PCB) analysis with the exception of several congeners in two laboratory duplicates. The associated sample results were qualified as estimates by the data validator. However, there were severe discrepancies between results for one of the duplicate/primary pairs (L66937-7). Total PCB concentration in the duplicate sample was more than 14 times higher than in the primary sample; 32 congeners were only detected in the duplicate. The primary sample results for PCBs were much more consistent with

results from other events at this location. PCB results in the primary sample were flagged, but were included in the data analysis. All other PCB laboratory duplicate data indicated excellent precision.

- Table 1 lists the 10 field replicate samples collected for the project, as specified in the QAPP. Results for most replicate pairs were very similar and the relative percent differences (RPDs) between primary and replicate samples were within control limits for laboratory replicates. Table 2 lists the exceptions. No field replicates were analyzed for PCBs.

Table 1. Collection and analysis of field replicate samples.

Site	Event	Sample IDs*	Conventional Parameters	Nutrients	Metals	PAHs
EBI	Storm 5	L66540-1 (-8)	X	✓	✓	✓
	Storm 7	L66937-1 (-8)	X	✓	✓	✓
	Storm 8	L67069-1 (-8)	X	✓	✓	✓
	Storm 9	L67141-1 (-8)	✓	✓	✓	✓
	Storm 10	L67231-1 (-8)	X	✓	✓	✓
WBI	Storm 1	L65007-3 (-8)	X	✓	✓	✓
	Storm 3	L66453-3 (-8)	X	X	✓	✓
	Storm 4	L66385-3 (-8)	✓	✓	✓	✓
	Storm 12	L67313-3 (-8)	✓	✓	✓	✓
	Storm 13	L67335-3 (-8)	X	✓	✓	✓

*Replicate sample IDs in parentheses.
✓ - all results within laboratory replicate control limits
X – some results outside laboratory replicate control limits (Table G1-2).
PAH – polycyclic aromatic hydrocarbons; PCB – polychlorinated biphenyls

Table 2. Results for field replicate samples that exceeded control limits.

Parameter	Control Limits	Field Replicate Results Outside Control Limits (RPD)*
Alkalinity	10%	WBI Storm 3 (25%)
Conductivity	10%	EBI Storm 8 (11%) WBI Storm 3 (20%)

Parameter	Control Limits	Field Replicate Results Outside Control Limits (RPD)*
TSS	25%	EBI Storm 5 (31%) EBI Storm 7 (29%)
TOC	20%	EBI Storm 7 (21%) EBI Storm 8 (31%) WBI Storm 13 (22%)
DOC	20%	EBI Storm 8 (39%) EBI Storm 10 (21%) WBI Storm 1 (27%)
Ammonia Nitrogen	20%	WBI Storm 3 (39%)

*Does not include pairs for which both results are less than the reporting detection limit (RDL), because of inherent analytical variability at lower concentrations.

Comparison of field replicate results to laboratory replicate control limits is a conservative measure of precision, and the slight variations do not indicate significant precision issues; however, the relatively greater difference between PCB results was investigated further.

G1.3 Bias

Bias is a measure of difference between an analytical result and the true value of an analyte due to a systematic factor. Bias was evaluated through analysis of equipment blanks, method blanks, spike blanks, matrix spikes, certified reference materials (CRM), laboratory control samples and/or surrogates, along with laboratory recovery sample control charts.

- No systematic bias was observed in the KCEL analysis based on method blanks and spiked QC samples. However, there were a few isolated instances of bias which are described in the data validation memo, and some sample results were qualified as estimates with high or low bias. The severity of bias was low and did not indicate results should be rejected.
- Method blank contamination is an expected issue for PCB congener analysis due to the ubiquitous nature of PCBs and the low detection limits required for analysis. However, Pacific Rim Laboratories experienced elevated levels of PCB blank contamination while analyzing several samples for this project. The samples were reanalyzed to address the method blank contamination; however, total PCB results for two method blanks associated with samples analyzed in June and July 2017 were greater than 200 pg/L, which exceeds the acceptable level of bias. As result, the PCB congener results for these samples were flagged as non-detects when detected concentrations were within five times the method blank concentration during the data validation process. This adjustment could result in biased low total PCB results for the samples associated with “dirtier” method blanks. In most cases, samples from a given storm were associated with the same method blank, and thus similarly impacted by any low bias. As such, analysis of treatment effectiveness for PCBs was likely minimally influenced. Total PCBs concentrations for all samples were included in the data analysis presented in the report and in the data summary tables and figures in Appendix H. However, statistical analyses to assess reduction in total PCB concentrations were calculated twice: once with all PCB results and a second analysis that did not include samples impacted by contaminated method blanks

(Appendix E). In both cases, there were statistically significant decreases in total PCBs at each facility (i.e., East Bioretention, West Bioretention, and Wetland Complex). PCB-11 was the most influential contaminant detected in the method blanks when total PCB concentrations were less than 200 pg/L.

- As detailed in Section G3, several laboratory control samples for PCB analysis indicated high bias for at least one congener. This resulted in the need to flag some sample results as estimates in the data validation process; no results were rejected.
- An autosampler equipment blank sample was collected at the East Bioretention inlet (EBI) sample location and analyzed for nutrients, conventional parameters, metals, and PAHs. Concentrations of all parameters were below detection limits, except DOC at 0.55 mg/L. Although DOC concentrations in other samples were similar (4 field sample concentrations were <RDL), 96% of the field sample concentrations were >1.0 mg/L. The slight high bias suggested by the equipment blank results is not expected to negatively impact the results.
- PCB-11 (48 pg/L) was the only congener detected in the autosampler equipment blank sample. PCB-11 was only detected in five project samples and always at concentrations less than 30% of the total PCB concentration. Overall, PCB contamination associated with equipment likely had negligible influence on project findings.

G1.4 Sensitivity

Sensitivity is a measure of the capability of an analytical method to meet the study goal. Detection limits were appropriate to assess differences between influent and effluent concentrations for almost all parameters. There was excellent frequency of detection (FOD) for TSS, nutrients, metals (except cadmium and dissolved lead), and total PCBs. Few PAHs were detected in samples collected from the inlet and outlet of the bioretention facilities (i.e., sites EBI, EBO, WBI, and WBO), limiting analysis of the effectiveness for PAH removal at these facilities. There is greater uncertainty in the statistical results for parameters with less than 100% FOD. Overall, sensitivity was sufficient to address the project objectives with the few exceptions described above.

G1.5 Accuracy

Accuracy is an estimate of the difference between the true and measured values. The accuracy of a result is affected by both systematic and random errors. Accuracy of the analytical results was evaluated using matrix spikes, CRMs and/or laboratory control samples, and ongoing recovery sample control charts. Equipment blanks, method blanks, spiked QC samples, and laboratory control samples can also impact accuracy, but these are discussed under bias (Section G1.3). Accuracy of field measurements were assessed by check standards and end checks, which were all within control limits. Interferences for several bacteria samples affected accuracy of bacteria counts (Section G2). The bacteria results were qualified as estimates, but were not rejected by the data validator.

G1.6 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point, or an environmental condition. Sample collection followed established sample handling and holding times required for each analytical test, with a few exceptions: 1) filtration outside the 15 minute holding time limit for orthophosphate and dissolved metals, and 2) non-sterile pumps used to collect some bacteria samples, for which results were flagged as estimates. The equipment blank results demonstrate that equipment decontamination methods were successful.

In addition, representativeness was assessed indirectly in one instance. During Storm 9 on 2/16/2017, the autosampler at the west bioretention outlet (WBO) was affected by backflow in the pipe (Appendix I). The spike in flow caused the autosampler to accelerate sampling and stop before the peak of the hydrograph. When the original sample was retrieved, staff collected a “confirmatory sample” due to a concern that road runoff in the catch basin had contaminated the original composite sample. At the time the confirmatory sample was collected, back flow had subsided but the West Bioretention facility (WB) was still discharging. Concentrations of all parameters were quite similar between the two samples. This suggests there was little to no effect of back flow in the catch basin on the chemistry results. Data from the original sample were used in the summary statistics and statistical analysis.

An assumption of this study was there were minimal inflows from unmeasured sources; however, flow monitoring suggests there are unmeasured inflows to the bioretention facilities, particularly at WB. Flows were higher at WB outlet than at WB inlet during several storm events. The WB also remained saturated during most of the wet season, further indicating that groundwater may have influenced sampling at this site. Under these conditions, groundwater would mix with WB effluent. Samples from the WB outlet are therefore representative of flows from WB, but not necessarily representative of the WB’s effectiveness in treating runoff entering through the WB inlet.

G1.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Standard collection and analysis methods were followed throughout the project to assure comparability of project data. The QAPP describes how the stormwater treatment evaluated for this project can be compared to stormwater treatment throughout the region (King County 2016) and how facilities evaluated in this study compare to specifications in the 2005 Stormwater Management Manual for Western Washington (Ecology 2005).

G1.8 Completeness

Completeness is defined as the total number of samples analyzed for which acceptable analytical data are generated, compared to the total number of samples submitted for analysis. The QAPP specified a goal of 20 samples per sampling location and 90% acceptable analytical data. Unfortunately, construction at the site necessitated that sampling conclude prematurely. Only 18 storm events were sampled at each location, and of these, volume in a few samples was insufficient for all analyses. Despite these shortcomings, study goals related to water quality improvements and toxicity reduction could still be met.

Appendix G References

Ecology. 2005. Stormwater Management Manual for Western Washington (SWMMWW). Publication No. 05-10-33.

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

Appendix G2:
KCEL Data Validation

King County

Water and Land Resources Division

Department of Natural Resources and Parks

King Street Center
201 South Jackson Street, Suite 600
Seattle, WA 98104-3855

206-477-4800 Fax 206-296-0192
TTY Relay: 711

TECHNICAL MEMORANDUM

March 15, 2018

TO: Kate Macneale, Science and Technical Support Section, Water and Land Resources Division, Department of Natural Resources and Parks

FM: Carly Greyell, Science and Technical Support Section, Water and Land Resources Division, Department of Natural Resources and Parks

RE: Data Validation Report: Federal Way Stormwater Monitoring – SAM Effectiveness Study

---

This technical memorandum summarizes the data validation review performed on 226 stormwater samples collected within the South 356th Street Retrofit and Expansion Project in Federal Way between March 9, 2016 and April 23, 2017. These samples included several field replicates and one grab sample that was collected to confirm the representativeness of a composite sample collected with sampling equipment failures (See Appendix G1 of the main report for details). Also included in the data validation are results from equipment blanks including one sample from an autosampler and 19 samples from filters used during processing of dissolved nutrient samples. These were collected between March 9, 2016 and May 8, 2017. The sampling and analysis of these samples are specified in the project Quality Assurance Project Plan (QAPP); *QAPP: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA* (King County 2016). Samples were analyzed for one or more of the following analyses: total and dissolved nutrients, total suspended solids (TSS), total and dissolved organic carbon (TOC/DOC), other conventional parameters (e.g., pH, turbidity, conductivity, and alkalinity), fecal coliforms, total and dissolved trace metals, and trace organics, mainly polycyclic aromatic hydrocarbons (PAHs). Table 1-1 provides an inventory of the samples included in this data validation review. All samples were collected and analyses performed by the King County Environmental Laboratory (KCEL).

Table 1-1. Sample Inventory

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-EBI	3/9/2016	1	L65007-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/9/2016	1	L65007-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/9/2016	1	L65007-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/9/2016	1	L65007-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/9/2016	1	L65007-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/9/2016	1	L65007-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/9/2016	1	L65007-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-WBI	3/9/2016	1	L65007-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/23/2016	2	L65095-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/23/2016	2	L65095-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/24/2016	2	L65095-3			X	X	X	X	X		
ES	FW-WBO	3/24/2016	2	L65095-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/23/2016	2	L65095-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/23/2016	2	L65095-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/24/2016	2	L65095-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	10/20/2016	3	L66453-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	10/20/2016	3	L66453-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	10/20/2016	3	L66453-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	10/20/2016	3	L66453-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	10/19/2016	3	L66453-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	10/19/2016	3	L66453-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	10/19/2016	3	L66453-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-WBI	10/20/2016	3	L66453-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	10/26/2016	4	L66385-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	10/26/2016	4	L66385-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	10/26/2016	4	L66385-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	10/26/2016	4	L66385-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	10/26/2016	4	L66385-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	10/26/2016	4	L66385-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	10/26/2016	4	L66385-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-WBI	10/26/2016	4	L66385-8	X	X	X	X	X	X	X	X	

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-EBI	10/31/2016	5	L66540-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	10/31/2016	5	L66540-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	10/31/2016	5	L66540-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	10/31/2016	5	L66540-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	10/31/2016	5	L66540-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	10/31/2016	5	L66540-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	11/1/2016	5	L66540-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-EBI	10/31/2016	5	L66540-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	12/19/2016	6	L66811-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	12/19/2016	6	L66811-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	12/19/2016	6	L66811-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	12/19/2016	6	L66811-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	12/19/2016	6	L66811-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	12/19/2016	6	L66811-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	12/19/2016	6	L66811-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	1/17/2017	7	L66937-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	1/17/2017	7	L66937-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	1/17/2017	7	L66937-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	1/17/2017	7	L66937-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	1/17/2017	7	L66937-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	1/17/2017	7	L66937-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	1/17/2017	7	L66937-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-EBI	1/17/2017	7	L66937-8	X	X	X	X	X	X		X	
ES	FW-EBI	2/8/2017	8	L67069-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	2/8/2017	8	L67069-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	2/8/2017	8	L67069-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	2/8/2017	8	L67069-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	2/8/2017	8	L67069-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	2/8/2017	8	L67069-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	2/8/2017	8	L67069-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-EBI	2/8/2017	8	L67069-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	2/15/2017	9	L67141-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	2/15/2017	9	L67141-2	X	X	X	X	X	X	X	X	

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-WBI	2/15/2017	9	L67141-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	2/15/2017	9	L67141-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	2/15/2017	9	L67141-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	2/15/2017	9	L67141-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	2/15/2017	9	L67141-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-EBI	2/15/2017	9	L67141-8	X	X	X	X	X	X	X	X	
ES-CONF	FW-WBO	2/16/2017	9	L67141-17	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/7/2017	10	L67231-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/7/2017	10	L67231-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/7/2017	10	L67231-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/7/2017	10	L67231-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/7/2017	10	L67231-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/7/2017	10	L67231-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/7/2017	10	L67231-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-EBI	3/7/2017	10	L67231-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/9/2017	11	L67283-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/9/2017	11	L67283-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/9/2017	11	L67283-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/9/2017	11	L67283-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/9/2017	11	L67283-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/9/2017	11	L67283-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/9/2017	11	L67283-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/13/2017	12	L67313-1						X	X		
ES	FW-EBO	3/13/2017	12	L67313-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/13/2017	12	L67313-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/13/2017	12	L67313-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/13/2017	12	L67313-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/13/2017	12	L67313-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/13/2017	12	L67313-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-WBI	3/13/2017	12	L67313-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/14/2017	13	L67335-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/14/2017	13	L67335-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/14/2017	13	L67335-3	X	X	X	X	X	X	X	X	

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-WBO	3/14/2017	13	L67335-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/14/2017	13	L67335-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/14/2017	13	L67335-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/14/2017	13	L67335-7	X	X	X	X	X	X	X	X	
ES-FREP	FW-WBI	3/14/2017	13	L67335-8	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/26/2017	14	L67398-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/26/2017	14	L67398-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/26/2017	14	L67398-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/26/2017	14	L67398-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/26/2017	14	L67398-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/26/2017	14	L67398-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/26/2017	14	L67398-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/29/2017	15	L67443-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	3/29/2017	15	L67443-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	3/29/2017	15	L67443-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	3/29/2017	15	L67443-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	3/29/2017	15	L67443-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	3/29/2017	15	L67443-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	3/29/2017	15	L67443-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	4/5/2017	16	L67499-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	4/5/2017	16	L67499-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	4/5/2017	16	L67499-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	4/5/2017	16	L67499-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	4/5/2017	16	L67499-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	4/5/2017	16	L67499-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	4/5/2017	16	L67499-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	4/19/2017	17	L67594-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	4/19/2017	17	L67594-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	4/19/2017	17	L67594-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	4/19/2017	17	L67594-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	4/19/2017	17	L67594-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	4/19/2017	17	L67594-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	4/19/2017	17	L67594-7	X	X	X	X	X	X	X	X	

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-EBI	4/23/2017	18	L67617-1	X	X	X	X	X	X	X	X	
ES	FW-EBO	4/23/2017	18	L67617-2	X	X	X	X	X	X	X	X	
ES	FW-WBI	4/23/2017	18	L67617-3	X	X	X	X	X	X	X	X	
ES	FW-WBO	4/23/2017	18	L67617-4	X	X	X	X	X	X	X	X	
ES	FW-WPCI	4/23/2017	18	L67617-5	X	X	X	X	X	X	X	X	
ES	FW-WPCEPO	4/23/2017	18	L67617-6	X	X	X	X	X	X	X	X	
ES	FW-NFWHC	4/23/2017	18	L67617-7	X	X	X	X	X	X	X	X	
ES	FW-EBI	3/9/2016	1	L65007-9									X
ES	FW-EBO	3/9/2016	1	L65007-10									X
ES	FW-WBI	3/9/2016	1	L65007-11									X
ES	FW-WBO	3/9/2016	1	L65007-12									X
ES	FW-WPCI	3/9/2016	1	L65007-13									X
ES	FW-WPCEPO	3/9/2016	1	L65007-14									X
ES	FW-NFWHC	3/9/2016	1	L65007-15									X
ES	FW-EBI	10/20/2016	3	L66453-9									X
ES	FW-EBO	10/20/2016	3	L66453-10									X
ES	FW-WBI	10/20/2016	3	L66453-11									X
ES	FW-WBO	10/20/2016	3	L66453-12									X
ES	FW-WPCI	10/20/2016	3	L66453-13									X
ES	FW-WPCEPO	10/20/2016	3	L66453-14									X
ES	FW-NFWHC	10/20/2016	3	L66453-15									X
ES	FW-EBI	11/1/2016	5	L66540-9									X
ES	FW-EBO	11/1/2016	5	L66540-10									X
ES	FW-WBI	11/1/2016	5	L66540-11									X
ES	FW-WBO	11/1/2016	5	L66540-12									X
ES	FW-WPCI	11/1/2016	5	L66540-13									X
ES	FW-WPCEPO	11/1/2016	5	L66540-14									X
ES	FW-NFWHC	11/1/2016	5	L66540-15									X
ES	FW-EBI	1/18/2017	7	L66937-9									X
ES	FW-EBO	1/18/2017	7	L66937-10									X
ES	FW-WBI	1/18/2017	7	L66937-11									X
ES	FW-WBO	1/18/2017	7	L66937-12									X
ES	FW-WPCI	1/18/2017	7	L66937-13									X

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-WPCEPO	1/18/2017	7	L66937-14									X
ES	FW-NFWHC	1/18/2017	7	L66937-15									X
ES	FW-EBI	2/9/2017	8	L67069-9									X
ES	FW-EBO	2/9/2017	8	L67069-10									X
ES	FW-WBI	2/9/2017	8	L67069-11									X
ES	FW-WBO	2/9/2017	8	L67069-12									X
ES	FW-WPCI	2/9/2017	8	L67069-13									X
ES	FW-WPCEPO	2/9/2017	8	L67069-14									X
ES	FW-NFWHC	2/9/2017	8	L67069-15									X
ES	FW-EBI	2/16/2017	9	L67141-9									X
ES	FW-EBO	2/16/2017	9	L67141-10									X
ES	FW-WBI	2/16/2017	9	L67141-11									X
ES	FW-WBO	2/16/2017	9	L67141-12									X
ES	FW-WPCI	2/16/2017	9	L67141-13									X
ES	FW-WPCEPO	2/16/2017	9	L67141-14									X
ES	FW-NFWHC	2/16/2017	9	L67141-15									X
ES	FW-EBI	3/7/2017	10	L67231-9									X
ES	FW-EBO	3/7/2017	10	L67231-10									X
ES	FW-WBI	3/7/2017	10	L67231-11									X
ES	FW-WBO	3/7/2017	10	L67231-12									X
ES	FW-WPCI	3/7/2017	10	L67231-13									X
ES	FW-WPCEPO	3/7/2017	10	L67231-14									X
ES	FW-NFWHC	3/7/2017	10	L67231-15									X
ES	FW-EBI	3/9/2017	11	L67283-9									X
ES	FW-EBO	3/9/2017	11	L67283-10									X
ES	FW-WBI	3/9/2017	11	L67283-11									X
ES	FW-WBO	3/9/2017	11	L67283-12									X
ES	FW-WPCI	3/9/2017	11	L67283-13									X
ES	FW-WPCEPO	3/9/2017	11	L67283-14									X
ES	FW-NFWHC	3/9/2017	11	L67283-15									X
ES	FW-EBI	3/13/2017	12	L67313-9									X
ES	FW-EBO	3/13/2017	12	L67313-10									X
ES	FW-WBI	3/13/2017	12	L67313-11									X

Sample Type	Locator	Collect Date	Storm #	Sample ID	Other Conv.	Total Nutrients	Dissolved Nutrients	TOC/ DOC	TSS	Total Metals	Dissolved Metals	Organics	Fecal Coliform
ES	FW-WBO	3/13/2017	12	L67313-12									X
ES	FW-WPCI	3/13/2017	12	L67313-13									X
ES	FW-WPCEPO	3/13/2017	12	L67313-14									X
ES	FW-NFWHC	3/13/2017	12	L67313-15									X
ES	FW-EBI	3/15/2017	13	L67335-9									X
ES	FW-EBO	3/15/2017	13	L67335-10									X
ES	FW-WBI	3/15/2017	13	L67335-11									X
ES	FW-WBO	3/15/2017	13	L67335-12									X
ES	FW-WPCI	3/15/2017	13	L67335-13									X
ES	FW-WPCEPO	3/15/2017	13	L67335-14									X
ES	FW-NFWHC	3/15/2017	13	L67335-15									X
FFB	FFBLANK	3/10/2016	1	L65007-16			X						
FFB	FFBLANK	10/20/2016	3	L66453-16			X						
FFB	FFBLANK	10/27/2016	4	L66385-16			X						
FFB	FFBLANK	11/1/2016	5	L66540-16			X						
FFB	FFBLANK	12/20/2016	6	L66811-8			X						
FFB	FFBLANK	1/18/2017	7	L66937-16			X						
FFB	FFBLANK	2/9/2017	8	L67069-16			X						
FFB	FFBLANK	2/16/2017	9	L67141-16			X						
FFB	FFBLANK	3/8/2017	10	L67231-16			X						
FFB	FFBLANK	3/10/2017	11	L67283-16			X						
FFB	FFBLANK	3/14/2017	12	L67313-16			X						
FFB	FFBLANK	3/16/2017	13	L67335-16			X						
FFB	FFBLANK	3/27/2017	14	L67398-16			X						
FFB	FFBLANK	3/30/2017	15	L67443-8			X						
FFB	FFBLANK	4/6/2017	16	L67499-8			X						
FFB	FFBLANK	4/20/2017	17	L67594-8			X						
FFB	FFBLANK	4/24/2017	18	L67617-8			X						
FFB	FFBLANK	5/8/2017	Blank	L67724-2			X						
EB	EQUIPBLANK	5/8/2017	Blank	L67724-1	X	X	X	X	X	X	X	X	

ES – environmental sample; EB – equipment blanks; FFB – field filter blanks; ES-FREP – field replicate, environmental sample; ES-CONF – confirmatory sample
X – analysis of full parameter list (QAPP); A – analysis of alkalinity only

1.0 INTRODUCTION

This data validation review was based, in part, on guidance in *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA 2016a) and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (EPA 2016b), as well as the project QAPP (King County 2016). Materials reviewed included Batch Reports and Analytical Quality Control (QC) Reports downloaded from the King County Laboratory Information Management System (LIMS) database and are available upon request. Also reviewed were data anomaly forms (DAF), which are available upon request. The QC parameters reviewed during this data validation include: holding time, method blanks, spike blanks, laboratory control samples, matrix spikes, matrix spike duplicates, laboratory duplicates, and surrogates, all of which are described below. Microbiology analyses include unique QC samples, which are described in Section 1.10.

1.1. Holding Time (HT)

The analytical HT is a method-specific timeframe, during which sample preparation and analysis should occur to provide valid data. All samples should be analyzed within this prescribed HT. For composite samples, the end of the composite period is considered the start of the HT period.

1.2. Method Blank (MB)

A MB is an aliquot of clean reference matrix that is typically processed through the entire analytical procedure. The MB is used to evaluate the levels of contamination that might be associated with the processing and analysis of samples. All MB results should be less than method detection limits (MDLs) or the quantitation limit (QL).

1.3. Spike Blank (SB)

A SB is an aliquot of the clean reference matrix used for the MB, to which a known concentration of target analyte(s) has been added. The SB is processed through the entire analytical procedure, and used as an indicator of method accuracy. SBs are not addressed in the *National Functional Guidelines*; however, King County has empirically-derived control limits for SB analytes, which are in QC reports that are available upon request. SB results should be within these control limits.

1.4. Spike Blank Duplicate (SBD)

A SBD is a second aliquot of the clean reference matrix used for the MB, to which a known concentration of target analyte(s) has been added. The SBD is used as an additional indicator of method accuracy as well as an indicator of method precision. The relative percent difference (RPD) between SB and SBD results should be within QAPP-specified control limits.

1.5. Matrix Spike (MS)

A MS is a sample aliquot fortified with a known concentration of a target analyte(s). The MS is processed through the entire analytical procedure. The MS is used as an indicator of sample matrix effect on the recovery of target analyte(s). The *National Functional Guidelines* specifies control limits of 75% to 125% MS recoveries for trace metals (EPA 2016b). For all other analytes, King County has empirically-derived control limits, which are shown in QC reports that are available upon request. MS recoveries should be within these control limits.

1.6. Matrix Spike Duplicate (MSD)

A MSD is a second sample aliquot fortified with a known concentration of a target analyte(s). The MSD is used as an additional indicator of sample matrix effect on the recovery of target analyte(s) as well as an indicator of method precision. The relative percent difference (RPD) between MS and MSD results should be within QAPP-specified control limits.

1.7. Laboratory Control Sample (LCS)

A LCS is a sample of known analyte concentration(s) that is prepared in the lab from a separate source of analyte(s) relative to the calibration standards. The LCS analysis follows the entire analytical process and is stored and prepared following the same procedures as a field sample. The LCS is used as an indicator of method accuracy and long-term analytical precision. King County uses QAPP-specified percent recovery control limits, which are shown in QC reports that are available upon request. Percent recoveries for LCS results should be within these control limits.

1.8. Laboratory Duplicate (LD)

A LD is a second aliquot of a sample, processed concurrently and in an identical manner with the original sample. The LD is used as an indicator of method precision and laboratory subsampling procedures. The LD can also be used to provide information regarding the homogeneity of the sample matrix. QC results are reported as an RPD between the sample and LD results. The RPD between all trace metal LD results should be within 20% (EPA 2016b). QAPP-specified control limits are used for all other analytes. LD RPD results will not be qualified for samples in which the concentration is less than the reporting detection limit (RDL) or less than the QL, because of the inherent analytical variability at these concentrations, which are lower than the limit of practical quantitation.

1.9. Surrogates

A surrogate is a known concentration of non-target analyte which is added to each sample (both analytical and QC samples) prior to extraction and analysis for all trace organic analyses. Surrogate recovery is used as a sample-specific indication of method or matrix bias for target analytes. The surrogate is selected to behave in a similar manner to the target analytes. All surrogates and their control limits are listed in the QC report in Appendix A.

1.10. Microbiology-Specific QC Samples

A negative control sample is media streaked with a non-target organism and analyzed through the complete procedure. The negative control is expected to show no detectable target organisms thereby evaluating the specificity of the method.

A positive control is a QC sample prepared or obtained by the lab which is known or expected to yield a positive response. A positive control can be either a sample of contaminated water or media streaked with the target organism, which is analyzed through the complete procedure.

A "before membrane filtration blank" is an aliquot of sterile diluent added to challenge the testing apparatus and conditions prior to membrane filtration of samples. The before filtration blank is analyzed to evaluate the sterility of the materials, equipment and work area at the beginning of sample analysis.

An "after membrane filtration blank" is an aliquot of sterile diluent added to challenge the testing apparatus and conditions after membrane filtration of samples. The after filtration blank is analyzed to evaluate cross-contamination during sample analysis.

1.11. Validation Reporting

The following sections describe the data validation actions for each analyte group. This includes a table listing the HT and QC samples reviewed during the validation in each workgroup, a description of each result outside control limits, and the recommended actions for data validation. Any additional data quality issues are also discussed. Table A at the end of this memorandum lists all recommended validation qualifiers based on this review.

2.0 CONVENTIONALS

Conventional analytes included conductivity, alkalinity, pH, turbidity, TSS, TOC/DOC, and total and dissolved nutrients.

2.1. Conductivity

Conductivity was analyzed following Standard Method SM2510-B (APHA 1998) for 136 samples batched as 19 workgroups (Table 2-1). Each workgroup included analysis of two QC sample-types: LCS and LD. Results indicate acceptable data quality for all project samples (Table 2-1).

Table 2-1. Conductivity Workgroups and QC Samples

Workgroup	Samples	HT	LCS	LD
WG144854	L65007-1 through -8	✓	✓	✓
WG145203	L65095-1, -2, -4 through -7	✓	✓	✓
WG148770	L66385-1 through -8	✓	✓	✓
WG148642	L66453-1 through -8	✓	✓	✓
WG148816	L66540-1 through -8	✓	✓	✓
WG149618	L66811-1 through -7	✓	✓	✓
WG149930	L66937-1 through -8	✓	✓	✓
WG150224	L67069-1 through -8	✓	✓	✓
WG150340	L67141-1 through -8, -17	✓	✓	✓
WG150606	L67231-1 through -8	✓	✓	✓
WG150639	L67283-1 through -7	✓	✓	✓
WG150766	L67313-2 through -8	✓	✓	✓
WG150789	L67335-1 through -8	✓	✓	✓
WG150998	L67398-1 through -7	✓	✓	✓

Workgroup	Samples	HT	LCS	LD
WG151030	L67443-1 through -7	✓	✓	✓
WG151168	L67499-1 through -7	✓	✓	✓
WG151426	L67594-1 through -7	✓	✓	✓
WG151481	L67617-1 through -7	✓	✓	✓
WG151823	L67724-1	✓	✓	✓
	Control Limits:	28 days	90-110% Recovery	10% RPD

✓ – meets control limits

2.2. Alkalinity

Alkalinity was analyzed following Standard Method SM2320-B (APHA 1998) for 136 samples batched as 19 workgroups (Table 2-2). Each workgroup included analysis of two QC sample-types: LCS and LD. Results indicate acceptable data quality for all project samples (Table 2-2).

Table 2-2. Alkalinity Workgroups and QC Samples

Workgroup	Samples	HT	LCS	LD
WG144963	L65007-1 through -8	✓	✓	✓
WG145195	L65095-1, -2, -4 through -7	✓	✓	✓
WG148770	L66385-1 through -8	✓	✓	✓
WG148642	L66453-1 through -8	✓	✓	✓
WG148816	L66540-1 through -8	✓	✓	✓
WG149561	L66811-1 through -7	✓	✓	✓
WG149930	L66937-1 through -8	✓	✓	✓
WG150212	L67069-1 through -8	✓	✓	✓
WG150340	L67141-1 through -8, -17	✓	✓	✓
WG150606	L67231-1 through -8	✓	✓	✓
WG150639	L67283-1 through -7	✓	✓	✓
WG150766	L67313-2 through -8	✓	✓	✓
WG150789	L67335-1 through -8	✓	✓	✓
WG150998	L67398-1 through -7	✓	✓	✓
WG151030	L67443-1 through -7	✓	✓	✓
WG151168	L67499-1 through -7	✓	✓	✓
WG151426	L67594-1 through -7	✓	✓	✓
WG151481	L67617-1 through -7	✓	✓	✓
WG151823	L67724-1	✓	✓	✓
	Control Limits:	14 days	85-115% Recovery	10% RPD

✓ – meets control limits

2.3. pH

pH was analyzed following Standard Method SM4500-H-B (APHA 1998) for 136 samples batched as 19 workgroups (Table 2-3). Each workgroup included analysis of two QC sample-types: LCS and LD. Results indicate some data quality issues for all project samples (Table 2-3 and Section 2.3.1). Table A lists all recommended data qualifications.

Table 2-3. pH Workgroups and QC Samples

Workgroup	Samples	HT	LCS	LD
WG144925	L65007-1 through -8	X	✓	✓
WG145128	L65095-1, -2, -4 through -7	X	✓	✓
WG148745	L66385-1 through -8	X	✓	✓
WG148622	L66453-1 through -8	X	✓	✓
WG148889	L66540-1 through -8	X	✓	✓
WG149561	L66811-1 through -7	X	✓	✓
WG149906	L66937-1 through -8	X	✓	✓
WG150178	L67069-1 through -8	X	✓	✓
WG150301	L67141-1 through -8, -17	X	✓	✓
WG150606	L67231-1 through -8	X	✓	✓
WG150639	L67283-1 through -7	X	✓	✓
WG150765	L67313-2 through -8	X	✓	✓
WG150789	L67335-1 through -8	X	✓	✓
WG150969	L67398-1 through -7	X	✓	✓
WG151030	L67443-1 through -7	X	✓	✓
WG151168	L67499-1 through -7	X	✓	✓
WG151426	L67594-1 through -7	X	✓	✓
WG151481	L67617-1 through -7	X	✓	✓
WG151995	L67724-1	X	✓	X
	Control Limits:	15 minutes	98 - 102% Recovery	±0.2 unit Difference

✓ – meets control limits; X – outside control limits

2.3.1. Results Outside Control Limits

Holding time: all samples were analyzed for pH outside the prescribed 15-minute holding time. pH is usually measured in the field to meet this short holding time, but for this project, pH was measured after the samples were delivered to the lab. As a result, all pH results should be qualified with "J" flags and considered estimates with unknown bias.

Workgroup WG151995: The laboratory duplicate result associated with this workgroup was more than the QC limit of 0.2 pH units from the primary sample result (L67724-1). This sample was an equipment blank for the project, and so it is possible the low ionic strength of the sample resulted in greater than expected variability. The pH result in this sample should be qualified with a "J" flag and considered estimated with unknown bias.

2.4. Turbidity

Turbidity was analyzed following Standard Method SM2130-B (APHA 1998) for 136 samples batched as 19 workgroups (Table 2-4). Each workgroup included analysis of two QC sample-types: LCS and LD. Results indicate acceptable data quality for all project samples with the exception of one holding time exceedance (Table 2-4 and Section 2.4.1).

Table 2-4. Turbidity Workgroups and QC Samples

Workgroup	Samples	HT	LCS	LD
WG144877	L65007-1 through -8	✓	✓	✓
WG145129	L65095-1, -2, -4 through -7	✓	✓	✓

Workgroup	Samples	HT	LCS	LD
WG148705	L66385-1 through -8	✓	✓	✓
WG148548	L66453-1 through -8	✓	✓	✓
WG148772	L66540-1 through -8	✓	✓	✓
WG149594	L66811-1 through -7	X	✓	✓
WG149855	L66937-1 through -8	✓	✓	✓
WG150205	L67069-1 through -8	✓	✓	✓
WG150229	L67141-1 through -8, -17	✓	✓	✓
WG150592	L67231-1 through -8; L67283-1 through -7	✓	✓	✓
WG150640	L67313-2 through -8; L67335-1 through -8	✓	✓	✓
WG150971	L67398-1 through -7; L67443-1 through -7	✓	✓	✓
WG151103	L67499-1 through -7	✓	✓	✓
WG151424	L67594-1 through -7	✓	✓	✓
WG151451	L67617-1 through -7	✓	✓	✓
WG151694	L67724-1	✓	✓	✓
	Control Limits:	2 days	90-110% Recovery	25% RPD

✓ – meets control limits; X – outside control limits

2.4.1. Results Outside Control Limits

<u>Samples in workgroup WG149594</u> were analyzed for turbidity one day outside the holding time, and so all turbidity results in these samples should be qualified with "J" flags and considered estimates with unknown bias.

2.4.2. Other QC Information

Turbidity laboratory control samples should be run at two concentrations, 10 NTU and 100 NTU for each workgroup. However, in two workgroups (WG144877 and WG148548), only the 10 NTU laboratory control samples were analyzed due to analyst error. The sample results in these workgroups ranged from 2 to 21, and so the 10 NTU laboratory control sample is much closer to the environmental sample results and should be sufficient to evaluate accuracy. All recoveries in the laboratory control samples associated with all workgroups were within the 90 to 110% QC limits and can be used without qualification based on the laboratory control sample results.

2.5. Total Suspended Solids

TSS was analyzed following Standard Method SM2540-D (APHA 1998) for 139 samples batched as 19 workgroups (Table 2-5). Each workgroup included analysis of three QC sample-types: MB, LCS, and LD. Results indicate acceptable data quality for all project samples (Table 2-5).

Table 2-5. TSS Workgroups and QC Samples

Workgroup	Samples	HT	MB	LCS	LD
WG144865	L65007-1 through -8	✓	✓	✓	✓
WG145140	L65095-1 through -7	✓	✓	✓	✓
WG148748	L66385-1 through -8	✓	✓	✓	✓

Workgroup	Samples	HT	MB	LCS	LD
WG148582	L66453-1 through -8	✓	✓	✓	✓
WG148800	L66540-1 through -8	✓	✓	✓	✓
WG149578	L66811-1 through -7	✓	✓	✓	✓
WG149840	L66937-1 through -8	✓	✓	✓	✓
WG150226	L67069-1 through -8	✓	✓	✓	✓
WG150384	L67141-1 through -8, -17	✓	✓	✓	✓
WG150611	L67231-1 through -8	✓	✓	✓	✓
WG150665	L67283-1 through -7	✓	✓	✓	✓
WG150742	L67313-2 through -8	✓	✓	✓	✓
WG150845	L67335-1 through -8	✓	✓	✓	✓
WG150975	L67398-1 through -7	✓	✓	✓	✓
WG151018	L67443-1 through -7	✓	✓	✓	✓
WG151140	L67499-1 through -7	✓	✓	✓	✓
WG151431	L67594-1 through -7	✓	✓	✓	✓
WG151458	L67617-1 through -7	✓	✓	✓	✓
WG151784	L67724-1	✓	✓	✓	✓
	Control Limits:	7 days	<MDL	80-120% Recovery	25% RPD

✓ – meets control limits

2.6. Total and Dissolved Organic Carbon

TOC and DOC were analyzed following Standard Method SM5310-B (APHA 1998), which is a high-temperature combustion/infrared detection method. 137 samples were batched as 25 workgroups (Table 2-6). Each workgroup included analysis of five QC sample-types: MB, SB, LCS, MS, and LD. Results indicate acceptable data quality for all project samples, with a few exceptions (Table 2-6 and Section 2.6.1). Table A lists all recommended data qualifications.

Table 2-6. TOC/DOC Workgroups and QC Samples

Workgroup	Samples	HT	MB	SB	LCS	MS	LD
WG144901	L65007-1 through -8 (DOC)	✓	✓	✓	✓	✓	✓
WG145250	L65007-1 through -8 (TOC); L65095-1 through -7 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG148655	L66453-1 through -8 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG148873	L66385-1, -2, -3, -5 through -8 (TOC); L66540-1, -2, -3, -5 through -8 (TOC)	✓	✓	✓	✓	✓	✓
WG148983	L66385-4 (TOC); L66540-4 (TOC)	✓	✓	✓	✓	✓	✓
WG149032	L66385-1 through -8 (DOC); L66540-1, -2, -4 through -8 (DOC)	✓	✓	✓	✓	✓	✓
WG149205	L66540-3 (DOC)	✓	✓	✓	✓	✓	✓
WG149695	L66811-1 through -7 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG149959	L66937-1 through -8 (TOC)	✓	✓	✓	✓	✓	✓
WG150134	L66937-1 through -8 (DOC)	✓	✓	✓	✓	✓	✓
WG150290	L67069-1 through -8 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG150461	L67141-1 through -8, -17 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG150962	L67231-1 through -8 (TOC); L67335-2 through -8 (TOC)	✓	✓	✓	✓	✓	✓
WG150957	L67283-1 through -7 (TOC); L67313-2 through -8 (TOC)	✓	✓	✓	✓	✓	✓

Workgroup	Samples	HT	MB	SB	LCS	MS	LD
WG151028	L67231-1 through -8 (DOC); L67283-1 through -7 (DOC); L67313-2 through -6 (DOC)	✓	✓	✓	✓	✓	✓
WG151031	L67398-1 through -7 (TOC)	✓	✓	✓	✓	✓	✓
WG151122	L67313-7 and -8 (DOC); L67335-2 through -8 (DOC); L67398-1 through -7 (DOC)	✓	✓	✓	✓	✓	✓
WG151181	L67335-1 (TOC/DOC)	✓	✓	✓	✓	✓	✓
WG151433	L67443-1, -3 through -7 (TOC); L67499-1 through -7 (TOC)	✓	✓	✓	✓	✓	✓
WG151506	L67594-1 through -7 (TOC); L67617-1 through -7 (TOC)	✓	✓	✓	✓	✓	✓
WG151507	L67594-1 through -7 (DOC); L67617-1 through -7 (DOC)	✓	✓	✓	✓	✓	✓
WG151508	L67443-2 (TOC/DOC);	✓	✓	✓	✓	✓	✓
WG151556	L67443-1, -3 through -7 (DOC); L67499-1 through -7 (DOC)	✓	✓	✓	✓	✓	✓
WG151692	L67724-1 (TOC)	✓	✓	✓	✓	✓	✓
WG151870	L67724-1 (DOC)	✓	✓	✓	✓	✓	✓
	Control Limits:	28 days	<MDL	80-120% Recovery	85-115% Recovery	75-125% Recovery	20% RPD

✓ – project-specific samples meet control limits

2.6.1. Other QC Issues

Several samples had DOC results that were greater than the TOC result (L67283-1, L67283-3, and L67443-3). Reanalysis confirmed the original results. For sample L67283-1, the TOC and DOC results were relatively similar (i.e., <20% RPD). One possible explanation for this sample is that most of the TOC may be DOC and analytical and field variability resulted in slightly higher DOC results. These results may be used without qualification. However, the RPDs between DOC and TOC results in samples L67283-3 and L67443-3 were greater than 20%, indicating unacceptable levels of variability. DOC and TOC results for these samples were qualified with “J” flags and considered estimates with unknown bias.

Sample L67335-5 was not preserved at pH 2 until it was logged into the laboratory later on the day of collection. The sample aliquot was not preserved correctly for a relatively short window of time (<24 hours). The TOC and DOC results are not expected to be substantially affected. The results may be used without qualification.

2.7. Total Nutrients

Total nitrogen and total phosphorus were analyzed following Standard Methods SM4500-N-C and SM4500-P-B,F (APHA 1998), respectively, for 136 samples batched as 18 workgroups (Table 2-7). The QAPP specified each workgroup should include analysis of five QC sample-types for each analyte: MB, SB, MS, LCS, and LD. Results indicate acceptable data quality for all project samples (Table 2.7).

Table 2-7. Total Nitrogen and Total Phosphorus Workgroups and QC Assessment

Workgroup	Samples	Analysis	HT	MB	SB	MS	LCS	LD
WG144930	L65007-1 through -8	TN	✓	✓	✓	✓	✓	✓
	L65007-1, -2, -3, -5 through -8	TP	✓	✓	✓	✓	✓	✓
WG144998	L65007-4	TP	✓	✓	✓	✓	✓	✓
WG145150	L65095-1, -2, -4 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG148580	L66453-1 through -8	TN, TP	✓	✓	✓	✓	✓	✓
WG148823	L66385-1 through -8; L66540-1 through -8	TN, TP	✓	✓	✓	✓	✓	✓
WG149628	L66811-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG149845	L66937-1 through -8	TN, TP	✓	✓	✓	✓	✓	✓
WG150174	L67069-1 through -8	TN, TP	✓	✓	✓	✓	✓	✓
WG150306	L67141-1 through -8, and -17	TN, TP	✓	✓	✓	✓	✓	✓
WG150689	L67231-1 through -8; L67283-1 through -7	TN	✓	✓	✓	✓	✓	✓
	L67231-1, -2, -3, -5 through -8; L67283-1 through -7	TP	✓	✓	✓	✓	✓	✓
WG150720	L67313-2 through -8	TN, TP	✓	✓	✓	✓	✓	✓
WG150782	L67335-1 through -8	TN	✓	✓	✓	✓	✓	✓
	L67231-4; L67335-1 through -8	TP	✓	✓	✓	✓	✓	✓
WG150972	L67398-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG151120	L67443-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG151134	L67499-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG151402	L67594-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG151478	L67617-1 through -7	TN, TP	✓	✓	✓	✓	✓	✓
WG151712	L67724-1	TN, TP	✓	✓	✓	✓	✓	✓
		Control Limits:	28 days	<MDL	80-120% Recovery	75-125% Recovery	85-115% Recovery	20% RPD

✓ – meets control limits

2.8. Dissolved Nutrients

Nitrogen was analyzed as ammonia following Kerouel & Aminot (1997), as nitrite/nitrate following Standard Methods SM4500-NO3-F (APHA 1998) and phosphorus as orthophosphate following SM4500-P-F (APHA 1998). 155 samples were analyzed batched as 21 workgroups (Table 2-7). The QAPP specified each workgroup should include analysis of five QC sample-types for each analyte: MB, SB, MS, LCS, and LD. Results indicate acceptable data quality for all project samples, except for sample handling issues impacting orthophosphate phosphorus results (Table 2-8 and Section 2.8.1). Table A lists all recommended data qualifications.

Table 2-8. Dissolved Nutrients Workgroups and QC Assessment

Workgroup	Samples	Analysis	HT	MB	SB	MS	LCS	LD
WG144881	L65007-1 through -8, and -16	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG145131	L65095-1 through -7	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG148650	L66453-1 through -8, and -16	NH3, NO23,	X	✓	✓	✓	✓	✓

Workgroup	Samples	Analysis	HT	MB	SB	MS	LCS	LD
		OP						
WG148709	L66540-1 through -8, and -16	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG148713	L66385-1 through -8, and -16	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG149575	L66811-1 through -8	NH3, NO23	✓	✓	✓	✓	✓	✓
	L66811-1, -2, -3, -5 through -8	OP	X	✓	✓	✓	✓	✓
WG149582	L66811-4	OP	X	✓	✓	✓	✓	✓
WG149912	L66937-1 through -8, and -16	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG150208	L67069-1 through -8, and -16	NO23, OP	X	✓	✓	✓	✓	✓
WG150256	L67069-1 through -8, and -16	NH3	✓	✓	✓	✓	✓	✓
WG150439	L67141-1 through -8, -16, and -17	NH3, NO23	✓	✓	✓	✓	✓	✓
WG150471	L67141-1 through -8, -16, and -17	OP	X	✓	✓	✓	✓	✓
WG150613	L67231-1 through -8, and -16	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG150774	L67283-1 through -7, and -16; L67313-2 through -8, and -16	NH3	✓	✓	✓	✓	✓	✓
	L67283-1, -2, -3, -5, and -16; L67313-2, -3, -5 through -8, and -16	NO23	✓	✓	✓	✓	✓	✓
WG150821	L67283-1 through -7, and -16; L67313-2 through -8, and -16; L67335-1 through -8, and -16	OP	X	✓	✓	✓	✓	✓
	L67283-6 and -7	NO23	✓	✓	✓	✓	✓	✓
WG150892	L67283-4 and L67313-4	NO23	✓	✓	✓	✓	✓	✓
WG150938	L67335-1 through -8, and -16	NH3; NO23	✓	✓	✓	✓	✓	✓
WG150997	L67398-1 through -7, and -16; L67443-1 through -8	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG151139	L67499-1 through -8	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG151474	L67594-1 through -8; L67617-1 through -8	NH3, NO23, OP	X	✓	✓	✓	✓	✓
WG151744	L67724-1 and -2	NH3, NO23, OP	X	✓	✓	✓	✓	✓
	Control Limits:		14 days	<MDL	80-120% Recovery	75-125% Recovery	85-115% Recovery	20% RPD

✓ – meets control limits; X – outside control limits

2.8.1. Results Outside Control Limits

All orthophosphate phosphorus samples were filtered outside of 15-minutes as specified in the method. All detected results should be qualified with "J" flags and considered estimates with unknown bias. All non-detect results should be qualified with "UJ" flags and considered estimated non-detects with unknown bias.

3.0 TRACE METALS

Trace metals analysis, as specified in the QAPP, included total and dissolved cadmium, copper, lead and zinc. Hardness as $CaCO_3$ was analyzed in all workgroups.

3.1. Total ICP-MS Metals and Hardness

Total metals were analyzed by inductively coupled plasma mass spectroscopy (ICP-MS) following EPA Method 200.8 (EPA 1995) for 138 samples batched as 15 workgroups (Table 3-1). The QAPP specified that each workgroup include four QC sample-types: MB, LCS, MS, and LD. However, all workgroups included SB instead of LCS. Since both can be used to assess method accuracy, the SB results are sufficient to complete the data quality review. Results indicate acceptable data quality for all project samples (Table 3-1 and Section 3.1.1).

Table 3-1. Total ICP-MS and Hardness Workgroups and QC Samples

Workgroup	Samples	HT	MB	SB	MS	LD
WG145262	L65007-1 through -8	✓	✓	✓	✓	✓
WG145370	L65095-1 through -7	✓	✓	✓	✓	✓
WG148782	L66385-1 through -4; L66453-1 through -8	✓	✓	✓	✓	✓
WG148827	L66385-5 through -8	✓	✓	✓	✓	✓
WG148998	L66540-1 through -8	✓	✓	✓	✓	✓
WG149765	L66811-1 through -7	✓	✓	✓	✓	✓
WG150180	L66937-1 through -8	✓	✓	✓	✓	✓
WG150452	L67069-1 through -8	✓	✓	✓	✓	✓
WG150719	L67141-1 through -8, -17	✓	✓	✓	✓	✓
WG151093	L67231-1 through -8; L67283-1 through -7; L67313-1 through -5	✓	✓	✓	✓	✓
WG151154	L67313-6 through -8; L67335-1 through -8	✓	✓	✓	✓	✓
WG151216	L67398-1 through -7; L67443-1 through -5; L67499-1 through -7	✓	✓	✓	✓	✓
WG151662	L67443-6 through -7	✓	✓	✓	✓	✓
WG151944	L67594-1 through -7	✓	✓	✓	✓	✓
WG152049	L67617-1 through -7; L67724-1	✓	✓	✓	✓	✓
	Control Limits:	6 months	<MDL	85-115% Recovery	75-125% Recovery	20% RPD

✓ –meets control limits

3.1.1. MS Results

In seven workgroups, there were instances of low spike-to-sample concentration ratios for some total metals in the MS. The *National Function Guidelines* state that matrix influence on accuracy cannot be determined for trace metals when the sample concentration is greater than four times the spiked concentration (EPA 2016b). Almost all of the affected metals were part of the extended parameter list, and were not specified in the QAPP, or the MS was performed on a sample outside the project. No qualifications are recommended based on MS results.

3.2. Dissolved ICP-MS Metals

Dissolved metals were analyzed by inductively coupled plasma mass spectroscopy (ICP-MS) following EPA Method 200.8 (EPA 1995) for 137 samples batched as 17 workgroups (Table 3-2). The QAPP specified that each workgroup include four QC sample-types: MB, LCS, MS, and LD. However, all workgroups included SB instead of LCS. Since both can be used to assess method accuracy, the SB results are sufficient to complete the data quality review. QC results indicate acceptable data quality for all project samples; however, all samples were filtered outside 15-minutes (Table 3-2 and Sections 3.2.1 and 3.2.2). Table A lists all recommended data qualifications.

Table 3-2. Dissolved ICP-MS Workgroups and QC Samples

Workgroup	Samples	HT	MB	SB	MS	LD
WG145266	L65007-1 through -8	X	✓	✓	✓	✓
WG145305	L65095-1 through -7	X	✓	✓	✓	✓
WG148826	L66385-1, -2, -3, -5 through -8 L66453-1, -2, -3, -5 through -8	X	✓	✓	✓	✓
WG148971	L66453-4	X	✓	✓	✓	✓
WG149168	L66540-1, -3, -5 through -8	X	✓	✓	✓	✓
WG149178	L66385-4; L66540-2 and -4	X	✓	✓	✓	✓
WG149717	L66811-1 through -7	X	✓	✓	✓	✓
WG150217	L66937-1 through -7	X	✓	✓	✓	✓
WG150558	L67069-1 through -8	X	✓	✓	✓	✓
WG150618	L67141-4 and -17; L67231-4	X	✓	✓	✓	✓
WG150726	L67141-1, -2, -3, -5 through -8	X	✓	✓	✓	✓
WG151071	L67231-1, -3, -5 through -8; L67283-1, -3, -5 through -7; L67313-1, -3, -5 through -8; L67335-1, -3, and -5	X	✓	✓	✓	✓
WG151091	L67335-6 through -8 L67398-1, -3, -5 through -7; L67443-1, -3, -5 through -7	X	✓	✓	✓	✓
WG151118	L67231-2; L67283-2 and -4; L67313-2 and -4; L67335-2 and -4; L67398-2 and -4;	X	✓	✓	✓	✓

Workgroup	Samples	HT	MB	SB	MS	LD
	L67443-2 and -4					
WG151663	L67499-1, -3, -5 through -7	X	✓	✓	✓	✓
WG151685	L67499-2 and -4; L67594-2 and -4; L67617-2 and -4	X	✓	✓	✓	✓
WG152026	L67594-1, -3, -5 through -7; L67617-1, -3, -5 through -7; L67724-1	X	✓	✓	✓	✓
	Control Limits:	15 minute (filter) 6 months (analysis)	<MDL	85-115% Recovery	75-125% Recovery	20% RPD

✓ –meets control limits; X – outside control limits

3.2.1. Results Outside Control Limits

All dissolved metals samples were filtered outside of the method-specified 15-minute HT. As a result, all detected dissolved ICP-MS metals results should be qualified with a "J" flag and considered estimated with an unknown bias. All undetected results should be qualified with "UJ" flags and considered estimated non-detects with unknown bias.

3.2.2. MS Results

In two workgroups, there were instances of low spike-to-sample concentration ratios for a dissolved metal in the MS. The *National Function Guidelines* state that matrix influence on accuracy cannot be determined for trace metals when the sample concentration is greater than four times the spiked concentration (2016b). All of the affected metals were part of the extended parameter list, and were not specified in the QAPP. SB results can also be used to assess method accuracy, and so no qualifications are recommended based on MS results.

4.0 TRACE ORGANICS

Trace organics analysis, as specified in the QAPP, included PAHs analyzed following SW846-8270D-SIM. Trace organics were analyzed in 136 samples batched as 17 workgroups (Table 2-3). Ideally, the QC samples for each workgroup would include MB, SB, MS, MSD, and surrogates; however, the QAPP specified that SBD could be substituted for MSD when sample volume was limited. In one workgroup, SB was analyzed instead of MS to assess accuracy. Results indicate acceptable data quality with the exceptions listed below (Table 4-1 and Section 4.1.1). Table A lists all recommended data qualifications.

Table 4-1. Trace Organics Workgroups and QC Samples

Workgroup	Samples	HT	MB	SB	SBD	MS	MSD	Surrogates
WG144921	L65007-1 through -8	✓	X	✓	NA	✓	✓	✓
WG145139	L65095-1, -2, -4 through -7	✓	✓	✓	NA	✓	✓	X
WG148652	L66453-1 through -8	✓	✓	X	NA	X	X	✓

Workgroup	Samples	HT	MB	SB	SBD	MS	MSD	Surrogates
WG148779	L66385-1 through -8; L66540-1 through -8	✓	✓	X	NA	X	X	✓
WG149573	L66811-1 through -7	✓	X	✓	✓	✓	NA	✓
WG149895	L66937-1 through -8	✓	✓	✓	NA	✓	✓	✓
WG150221	L67069-1 through -8	✓	✓	✓	✓	✓	NA	✓
WG150370	L67141-1 through -8, -17	✓	✓	✓	NA	✓	✓	✓
WG150690	L67231-1 through -8; L67283-1 through -7	✓	✓	✓	✓	✓	NA	✓
WG150711	L67313-2 through -8	✓	✓	✓	✓	✓	NA	✓
WG150826	L67335-1 through -8	✓	✓	✓	✓	✓	NA	✓
WG150994	L67398-1 through -7	✓	✓	✓	✓	✓	NA	✓
WG151046	L67443-1 through -7	✓	✓	✓	NA	X	X	X
WG151189	L67499-1 through -7	✓	✓	✓	NA	✓	✓	✓
WG151422	L67594-1 through -7	✓	✓	✓	NA	X	X	X
WG151448	L67617-1 through -7	✓	✓	✓	NA	✓	✓	X
WG151691	L67724-1	✓	✓	✓	✓	NA	NA	✓
Control Limits:		7 day (extraction) 40 day (analysis)	<MDL or <QL	Variable†	40% RPD	Variable†	40% RPD	Variable†

✓ – meets control limits; X – outside control limits; NA – not analyzed in the workgroup; † - Control limits vary by compound.

4.1. MB Results Outside Control Limits

Workgroup WG144921:

- Naphthalene was detected at a concentration less than the RDL. Naphthalene was also detected in seven project samples associated with this workgroup (L65007-1, -2, -3, -5 through -8) at a concentration less than the RDL, and within five times the concentration detected in the MB. These sample results should be qualified with "U" flags and considered nondetects, using the RDL as the level of detection.

Workgroup WG149573:

- Benzo(g,h,i)perylene, dibenzo(a,h)anthracene, and indeno(1,2,3-Cd)pyrene were all detected at concentrations less than the RDL. All project sample results associated with this workgroup were detected within five times the concentrations detected in the MB. Sample results less than the RDL should be qualified with "U" flags and considered nondetects, using the RDL as the level of detection, while sample results greater than the RDL should be qualified with "U" flags and considered nondetects at the sample value.

4.2. SB/SBD Results Outside Control Limits

Workgroup WG148652:

- Recoveries of benzo(b,j,k)fluoranthene and chrysene in the SB (121% and 122%, respectively) exceeded the upper QC limits of 114% and 121%, respectively. These compounds were detected in only one sample associated with this workgroup (L66453-

5), and the results should be qualified with "J" flags and considered estimated with high bias.

Workgroup WG148779:

- Recoveries of chrysene, indeno(1,2,3-Cd)pyrene, and dibenzo(a,h)anthracene in the SB (126%, 158%, and 145%, respectively) exceeded the upper QC limits of 114% , 152%, and 140%, respectively. For the samples with detected concentrations of one or more of these compounds (L66385-5 and L66540-5), the results should be qualified with "J" flags and considered estimated with high bias.

4.3. MS/MSD Results Outside Control Limits

Workgroup WG148652:

- Recoveries of chrysene and benzo(b,j,k)fluoranthene exceeded the upper QC limits, in both the MS and MSD. This corroborates the high bias suggested by the SB results. The RPDs between the MS and MSD recoveries were within control limits. As stated above, the detected results of these compounds in project samples associated with this workgroup should be qualified with "J" flags and considered estimated with high bias.

Workgroup WG148779:

- Recoveries of chrysene, indeno(1,2,3-Cd)pyrene, and dibenzo(a,h)anthracene exceeded the upper QC limits, in both the MS and MSD. This corroborates the high bias suggested by the SB results. As stated above, the detected results of these compounds in project samples associated with this workgroup should be qualified with "J" flags and considered estimated with high bias.

Workgroup WG151046:

- Recoveries of acenaphthylene in the MS/MSD were both at 45%, which is below the 51% lower QC limit. Acenaphthylene was not detected in any samples in this workgroup. The surrogate results (Section 4.4) suggested there may be a systematic low bias for acenaphthylene in this workgroup, and so all acenaphthylene results in samples associated with this workgroup should be qualified with "UJ" flags and considered estimated non-detects with low bias.

Workgroup WG151422:

- Recoveries of 2-methylnaphtalene, acenaphthylene, acenaphthene, and fluorene were all below their respective lower QC limits in the MS, but within QC limits in the MSD. This resulted in RPDs that were outside the 40% QC limit for 2-methylnaphthalene and acenaphthene at 43% and 42%, respectively. A DAF for this workgroup states that the extraction for the matrix spike may have been too vigorous, resulting in loss of these early eluting compounds. The surrogate that is associated with these compounds also had low recovery in only the matrix spike sample, suggesting there was not systematic bias. No qualifications are recommended based on these results.

4.4. Surrogates

Workgroup WG145139:

- The surrogates analyzed with sample L65095-2 were slightly lower than the lower control limits at 31% for 2-fluorobiphenyl and 63% for d14-terphenyl. This was the sample on which the MS and MSD were performed. Since all parameters were recovered within QC limits in both the MS and MSD, no qualifications are recommended for this sample based on the surrogate results.

Workgroup WG151046:

- Recoveries of 2-fluorobiphenyl were below the lower QC limit for all but two environmental samples. This surrogate is associated with acenaphthylene, which also had low recovery in the MS and MSD for this workgroup. This suggests a systematic low bias for this compound in this workgroup. Acenaphthylene was never detected in the associated samples and so all results should be qualified with a "UJ" flag and considered estimated nondetects with low bias.

Workgroup WG151422:

- The recovery of surrogate 2-fluorobiphenyl was below the lower QC limit for the MS sample. As discussed above, it appears vigorous extraction of this QC sample resulted in loss of compounds associated with this surrogate, but systematic bias is not suspected. No qualifications are recommended based on these results.

Workgroup WG151448:

- Recovery of the surrogate d14-terphenyl was below the lower QC limit in one of seven environmental samples (L67617-7), at 56%. This surrogate is associated with benzo(a)anthracene, chrysene, pyrene, and fluoranthene. None of the results of these compounds in this environmental sample were detected, and so these results should be qualified with "UJ" flags and considered estimated nondetects with a low bias.

5.0 MICROBIOLOGY

Fecal coliform was analyzed in 80 samples batched as 10 workgroups following Standard Method SM9222D (Table 5-1) The QAPP-specified the microbiology QC samples should include a negative and positive control sample (NC/PC) and before and after filtration blanks (BF/AF). Five workgroups also included a LD, which was not specified in the QAPP. QC samples are run for each workgroup or for all samples received over a four-hour period. Therefore, QC samples can be used to evaluate more than one workgroup if received within a four-hour period. Results indicate acceptable data quality with the exceptions listed below (Table 5-1 and Sections 5.1.1 and 5.1.2). Table A lists all recommended data qualifications.

Table 5-1. Fecal Coliform Workgroups and QC Samples

Workgroup	Samples	HT	PC	NC	BF	AF	LD
WG144841	L65007-9 through -15	✓	✓	✓	✓	✓	NA
WG148542	L66453-9 through -15	✓	✓	✓	✓	✓	✓*
WG148766	L66540-9 through -15	✓	✓	✓	✓	✓	NA

Workgroup	Samples	HT	PC	NC	BF	AF	LD
WG149831	L66937-9 through -15	✓	✓	✓	✓	✓	✓*
WG150141	L67069-9 through -15	✓	✓	✓	✓	✓	NA
WG150293	L67141-9 through -15	✓	✓	✓	✓	✓	NA
WG150561	L67231-9 through -15	✓	✓	✓	✓	✓	NA
WG150605	L67283-9 through -15	✓	✓	✓	✓	✓	✓*
WG150661	L67313-9 through -15	✓	✓	✓	✓	✓	NA
WG150727	L67335-9 through -15	✓	✓	✓	✓	✓	NA
Control Limits:		24 hours	Pass	Pass	<MDL, Pass	<MDL, Pass	*

✓ – meets control limits; NA – not analyzed in the workgroup
* The LD assessment is based on precision calculations with at least 15 LDs in a project. Only three LDs were included in this project, so precision could not be confidently assessed using LDs. However, LD results were comparable to previous stormwater projects, suggesting acceptable precision.

5.1. Sample Handling Issues

All project samples in workgroups WG144841, WG148542, WG148766 were collected into sterile bottles using non-sterile peristaltic pumps. The project changed the sample collection protocol so that subsequent samples were collected using sterile equipment. All fecal coliform results associated with these workgroups should be qualified with "J" flags and considered estimated with unknown bias.

5.2. Interference

Three project sample results (L66453-11 and -12; L67069-11) were flagged with "C" flags by the laboratory due to interferences that inhibited accurate colony counts. These results should be qualified with "J" flags and considered estimated with unknown bias.

6.0 DATA USABILITY

As a general data reporting format, sample results that are reported as "<MDL" or "<QL" should be assigned a "U" flag in all cases. Results that are reported as "<RDL" or "<QL,J" should be qualified with a "J" flag and considered estimated with an unknown bias. All other analytical results for all samples included in this dataset may be used as reported, without qualification, with the exceptions summarized in the previous sections and Table A at the end of this memorandum.

7.0 REFERENCES

APHA 1998. *Standard Methods for the Examination of Water and Wastewater, 20th Edition.* American Public Health Association. Washington, D.C.

EPA 1995. *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry*. *Method 200.8, Revision 5.4*. United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio.

EPA. 2016a. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. OLEM 9355.0-133, USEPA-540-R-2016-001. United States Environmental Protection Agency. Washington, D.C. September 2016.

EPA. 2016b. *National Functional Guidelines for Superfund Organic Methods Data Review*. OLEM 9355.0-134, USEPA-540-R-2016-002. United States Environmental Protection Agency. Washington, D.C. September 2016.

Kérouel, R., and Aminot, A. 1997. Fluorometric determination of ammonia in sea and estuarine waters by direct segmented flow analysis. Journal of Marine Chemistry 57: 265–275.

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

• • •

Should you have questions regarding any of the information contained in this data validation memorandum, please don’t hesitate to contact me.

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG144881	FW-EBI	3/9/2016	1	L65007-1	Orthophosphate Phosphorus	0.00429	mg/L	H	0.0005	0.002	0.00429	J	unknown
WG144925	FW-EBI	3/9/2016	1	L65007-1	pH	6.73	pH	H			6.73	J	unknown
WG145266	FW-EBI	3/9/2016	1	L65007-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-EBI	3/9/2016	1	L65007-1	Copper, Dissolved, ICP-MS	1.8	ug/L	<RDL,H	0.2	2	1.8	J	unknown
WG145266	FW-EBI	3/9/2016	1	L65007-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145266	FW-EBI	3/9/2016	1	L65007-1	Zinc, Dissolved, ICP-MS	18.2	ug/L	H	0.5	2.5	18.2	J	unknown
WG144921	FW-EBI	3/9/2016	1	L65007-1	Naphthalene	0.0072	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144841	FW-EBO	3/9/2016	1	L65007-10	Fecal Coliform	25	CFU/100ml	SH,TA			25	J	unknown
WG144841	FW-WBI	3/9/2016	1	L65007-11	Fecal Coliform	1000	CFU/100ml	SH,TA			1000	J	unknown
WG144841	FW-WBO	3/9/2016	1	L65007-12	Fecal Coliform	25	CFU/100ml	SH,TA			25	J	unknown
WG144841	FW-WPCI	3/9/2016	1	L65007-13	Fecal Coliform	520	CFU/100ml	SH,TA			520	J	unknown
WG144841	FW-WPCEPO	3/9/2016	1	L65007-14	Fecal Coliform	10	CFU/100ml	SH,TA			10	J	unknown
WG144841	FW-NFWHC	3/9/2016	1	L65007-15	Fecal Coliform	50	CFU/100ml	SH,TA			50	J	unknown
WG144881	FFBLANK	3/10/2016	1	L65007-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG144881	FW-EBO	3/9/2016	1	L65007-2	Orthophosphate Phosphorus	0.324	mg/L	H	0.01	0.04	0.324	J	unknown
WG144925	FW-EBO	3/9/2016	1	L65007-2	pH	6.68	pH	H			6.68	J	unknown
WG145266	FW-EBO	3/9/2016	1	L65007-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-EBO	3/9/2016	1	L65007-2	Copper, Dissolved, ICP-MS	1.6	ug/L	<RDL,H	0.2	2	1.6	J	unknown
WG145266	FW-EBO	3/9/2016	1	L65007-2	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG145266	FW-EBO	3/9/2016	1	L65007-2	Zinc, Dissolved, ICP-MS	3.44	ug/L	H	0.5	2.5	3.44	J	unknown
WG144921	FW-EBO	3/9/2016	1	L65007-2	Naphthalene	0.0058	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144881	FW-WBI	3/9/2016	1	L65007-3	Orthophosphate Phosphorus	0.00445	mg/L	H	0.0005	0.002	0.00445	J	unknown
WG144925	FW-WBI	3/9/2016	1	L65007-3	pH	6.83	pH	H			6.83	J	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-3	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-3	Zinc, Dissolved, ICP-MS	17.7	ug/L	H	0.5	2.5	17.7	J	unknown
WG144921	FW-WBI	3/9/2016	1	L65007-3	Naphthalene	0.0078	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144881	FW-WBO	3/9/2016	1	L65007-4	Orthophosphate Phosphorus	2.76	mg/L	H	0.01	0.04	2.76	J	unknown
WG144925	FW-WBO	3/9/2016	1	L65007-4	pH	6.75	pH	H			6.75	J	unknown
WG145266	FW-WBO	3/9/2016	1	L65007-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-WBO	3/9/2016	1	L65007-4	Copper, Dissolved, ICP-MS	3.26	ug/L	H	0.2	2	3.26	J	unknown
WG145266	FW-WBO	3/9/2016	1	L65007-4	Lead, Dissolved, ICP-MS	0.524	ug/L	H	0.1	0.5	0.524	J	unknown
WG145266	FW-WBO	3/9/2016	1	L65007-4	Zinc, Dissolved, ICP-MS	6.29	ug/L	H	0.5	2.5	6.29	J	unknown
WG144881	FW-WPCI	3/9/2016	1	L65007-5	Orthophosphate Phosphorus	0.00389	mg/L	H	0.0005	0.002	0.00389	J	unknown
WG144925	FW-WPCI	3/9/2016	1	L65007-5	pH	6.94	pH	H			6.94	J	unknown
WG145266	FW-WPCI	3/9/2016	1	L65007-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-WPCI	3/9/2016	1	L65007-5	Copper, Dissolved, ICP-MS	3.02	ug/L	H	0.2	2	3.02	J	unknown
WG145266	FW-WPCI	3/9/2016	1	L65007-5	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145266	FW-WPCI	3/9/2016	1	L65007-5	Zinc, Dissolved, ICP-MS	24.9	ug/L	H	0.5	2.5	24.9	J	unknown
WG144921	FW-WPCI	3/9/2016	1	L65007-5	Naphthalene	0.0099	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG144881	FW-WPCEPO	3/9/2016	1	L65007-6	Orthophosphate Phosphorus	0.0134	mg/L	H	0.0005	0.002	0.0134	J	unknown
WG144925	FW-WPCEPO	3/9/2016	1	L65007-6	pH	6.87	pH	H			6.87	J	unknown
WG145266	FW-WPCEPO	3/9/2016	1	L65007-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-WPCEPO	3/9/2016	1	L65007-6	Copper, Dissolved, ICP-MS	2.71	ug/L	H	0.2	2	2.71	J	unknown
WG145266	FW-WPCEPO	3/9/2016	1	L65007-6	Lead, Dissolved, ICP-MS	0.13	ug/L	<RDL,H	0.1	0.5	0.13	J	unknown
WG145266	FW-WPCEPO	3/9/2016	1	L65007-6	Zinc, Dissolved, ICP-MS	30.5	ug/L	H	0.5	2.5	30.5	J	unknown
WG144921	FW-WPCEPO	3/9/2016	1	L65007-6	Naphthalene	0.0057	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144881	FW-NFWHC	3/9/2016	1	L65007-7	Orthophosphate Phosphorus	0.0129	mg/L	H	0.0005	0.002	0.0129	J	unknown
WG144925	FW-NFWHC	3/9/2016	1	L65007-7	pH	7.3	pH	H			7.3	J	unknown
WG145266	FW-NFWHC	3/9/2016	1	L65007-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-NFWHC	3/9/2016	1	L65007-7	Copper, Dissolved, ICP-MS	2.96	ug/L	H	0.2	2	2.96	J	unknown
WG145266	FW-NFWHC	3/9/2016	1	L65007-7	Lead, Dissolved, ICP-MS	0.2	ug/L	<RDL,H	0.1	0.5	0.2	J	unknown
WG145266	FW-NFWHC	3/9/2016	1	L65007-7	Zinc, Dissolved, ICP-MS	15.1	ug/L	H	0.5	2.5	15.1	J	unknown
WG144921	FW-NFWHC	3/9/2016	1	L65007-7	Naphthalene	0.0058	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144881	FW-WBI	3/9/2016	1	L65007-8	Orthophosphate Phosphorus	0.00429	mg/L	H	0.0005	0.002	0.00429	J	unknown
WG144925	FW-WBI	3/9/2016	1	L65007-8	pH	6.95	pH	H			6.95	J	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-8	Copper, Dissolved, ICP-MS	1.8	ug/L	<RDL,H	0.2	2	1.8	J	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145266	FW-WBI	3/9/2016	1	L65007-8	Zinc, Dissolved, ICP-MS	17.9	ug/L	H	0.5	2.5	17.9	J	unknown
WG144921	FW-WBI	3/9/2016	1	L65007-8	Naphthalene	0.0071	ug/L	<RDL,B	0.0047	0.0236	0.0236	U	
WG144841	FW-EBI	3/9/2016	1	L65007-9	Fecal Coliform	830	CFU/100ml	SH,TA			830	J	unknown
WG145131	FW-EBI	3/23/2016	2	L65095-1	Orthophosphate Phosphorus	0.0105	mg/L	H	0.0005	0.002	0.0105	J	unknown
WG145128	FW-EBI	3/23/2016	2	L65095-1	pH	7.01	pH	H			7.01	J	unknown
WG145305	FW-EBI	3/23/2016	2	L65095-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-EBI	3/23/2016	2	L65095-1	Copper, Dissolved, ICP-MS	3.16	ug/L	H	0.2	2	3.16	J	unknown
WG145305	FW-EBI	3/23/2016	2	L65095-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145305	FW-EBI	3/23/2016	2	L65095-1	Zinc, Dissolved, ICP-MS	23.1	ug/L	H	0.5	2.5	23.1	J	unknown
WG145131	FW-EBO	3/23/2016	2	L65095-2	Orthophosphate Phosphorus	0.775	mg/L	H	0.01	0.04	0.775	J	unknown
WG145128	FW-EBO	3/23/2016	2	L65095-2	pH	6.76	pH	H			6.76	J	unknown
WG145305	FW-EBO	3/23/2016	2	L65095-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-EBO	3/23/2016	2	L65095-2	Copper, Dissolved, ICP-MS	2.63	ug/L	H	0.2	2	2.63	J	unknown
WG145305	FW-EBO	3/23/2016	2	L65095-2	Lead, Dissolved, ICP-MS	0.17	ug/L	<RDL,H	0.1	0.5	0.17	J	unknown
WG145305	FW-EBO	3/23/2016	2	L65095-2	Zinc, Dissolved, ICP-MS	2.81	ug/L	H	0.5	2.5	2.81	J	unknown
WG145131	FW-WBI	3/24/2016	2	L65095-3	Orthophosphate Phosphorus	0.0122	mg/L	H	0.0005	0.002	0.0122	J	unknown
WG145305	FW-WBI	3/24/2016	2	L65095-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-WBI	3/24/2016	2	L65095-3	Copper, Dissolved, ICP-MS	4.8	ug/L	H	0.2	2	4.8	J	unknown
WG145305	FW-WBI	3/24/2016	2	L65095-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG145305	FW-WBI	3/24/2016	2	L65095-3	Zinc, Dissolved, ICP-MS	24.3	ug/L	H	0.5	2.5	24.3	J	unknown
WG145131	FW-WBO	3/24/2016	2	L65095-4	Orthophosphate Phosphorus	3.13	mg/L	H	0.025	0.1	3.13	J	unknown
WG145128	FW-WBO	3/24/2016	2	L65095-4	pH	7.16	pH	H			7.16	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG145305	FW-WBO	3/24/2016	2	L65095-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-WBO	3/24/2016	2	L65095-4	Copper, Dissolved, ICP-MS	3.43	ug/L	H	0.2	2	3.43	J	unknown
WG145305	FW-WBO	3/24/2016	2	L65095-4	Lead, Dissolved, ICP-MS	0.791	ug/L	H	0.1	0.5	0.791	J	unknown
WG145305	FW-WBO	3/24/2016	2	L65095-4	Zinc, Dissolved, ICP-MS	5.69	ug/L	H	0.5	2.5	5.69	J	unknown
WG145131	FW-WPCI	3/23/2016	2	L65095-5	Orthophosphate Phosphorus	0.00492	mg/L	H	0.0005	0.002	0.00492	J	unknown
WG145128	FW-WPCI	3/23/2016	2	L65095-5	pH	7.12	pH	H			7.12	J	unknown
WG145305	FW-WPCI	3/23/2016	2	L65095-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-WPCI	3/23/2016	2	L65095-5	Copper, Dissolved, ICP-MS	5.36	ug/L	H	0.2	2	5.36	J	unknown
WG145305	FW-WPCI	3/23/2016	2	L65095-5	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG145305	FW-WPCI	3/23/2016	2	L65095-5	Zinc, Dissolved, ICP-MS	33.8	ug/L	H	0.5	2.5	33.8	J	unknown
WG145131	FW-WPCEPO	3/23/2016	2	L65095-6	Orthophosphate Phosphorus	0.0245	mg/L	H	0.0005	0.002	0.0245	J	unknown
WG145128	FW-WPCEPO	3/23/2016	2	L65095-6	pH	7.2	pH	H			7.2	J	unknown
WG145305	FW-WPCEPO	3/23/2016	2	L65095-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-WPCEPO	3/23/2016	2	L65095-6	Copper, Dissolved, ICP-MS	5.24	ug/L	H	0.2	2	5.24	J	unknown
WG145305	FW-WPCEPO	3/23/2016	2	L65095-6	Lead, Dissolved, ICP-MS	0.17	ug/L	<RDL,H	0.1	0.5	0.17	J	unknown
WG145305	FW-WPCEPO	3/23/2016	2	L65095-6	Zinc, Dissolved, ICP-MS	33.5	ug/L	H	0.5	2.5	33.5	J	unknown
WG145131	FW-NFWHC	3/24/2016	2	L65095-7	Orthophosphate Phosphorus	0.0146	mg/L	H	0.0005	0.002	0.0146	J	unknown
WG145128	FW-NFWHC	3/24/2016	2	L65095-7	pH	7.7	pH	H			7.7	J	unknown
WG145305	FW-NFWHC	3/24/2016	2	L65095-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG145305	FW-NFWHC	3/24/2016	2	L65095-7	Copper, Dissolved, ICP-MS	2.8	ug/L	H	0.2	2	2.8	J	unknown
WG145305	FW-NFWHC	3/24/2016	2	L65095-7	Lead, Dissolved, ICP-MS	0.13	ug/L	<RDL,H	0.1	0.5	0.13	J	unknown
WG145305	FW-NFWHC	3/24/2016	2	L65095-7	Zinc, Dissolved, ICP-MS	12.4	ug/L	H	0.5	2.5	12.4	J	unknown
WG148713	FW-EBI	10/26/2016	4	L66385-1	Orthophosphate Phosphorus	0.0211	mg/L	H	0.0005	0.002	0.0211	J	unknown
WG148745	FW-EBI	10/26/2016	4	L66385-1	pH	6.74	pH	H			6.74	J	unknown
WG148826	FW-EBI	10/26/2016	4	L66385-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-EBI	10/26/2016	4	L66385-1	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG148826	FW-EBI	10/26/2016	4	L66385-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-EBI	10/26/2016	4	L66385-1	Zinc, Dissolved, ICP-MS	17.3	ug/L	H	0.5	2.5	17.3	J	unknown
WG148713	FFBLANK	10/27/2016	4	L66385-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG148713	FW-EBO	10/26/2016	4	L66385-2	Orthophosphate Phosphorus	0.684	mg/L	H	0.005	0.02	0.684	J	unknown
WG148745	FW-EBO	10/26/2016	4	L66385-2	pH	6.45	pH	H			6.45	J	unknown
WG148826	FW-EBO	10/26/2016	4	L66385-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-EBO	10/26/2016	4	L66385-2	Copper, Dissolved, ICP-MS	6.67	ug/L	H	0.2	2	6.67	J	unknown
WG148826	FW-EBO	10/26/2016	4	L66385-2	Lead, Dissolved, ICP-MS	0.29	ug/L	<RDL,H	0.1	0.5	0.29	J	unknown
WG148826	FW-EBO	10/26/2016	4	L66385-2	Zinc, Dissolved, ICP-MS	3.84	ug/L	H	0.5	2.5	3.84	J	unknown
WG148713	FW-WBI	10/26/2016	4	L66385-3	Orthophosphate Phosphorus	0.0207	mg/L	H	0.0005	0.002	0.0207	J	unknown
WG148745	FW-WBI	10/26/2016	4	L66385-3	pH	6.48	pH	H			6.48	J	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-3	Copper, Dissolved, ICP-MS	2	ug/L	<RDL,H	0.2	2	2	J	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-3	Zinc, Dissolved, ICP-MS	16.7	ug/L	H	0.5	2.5	16.7	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG148713	FW-WBO	10/26/2016	4	L66385-4	Orthophosphate Phosphorus	2.34	mg/L	H	0.025	0.1	2.34	J	unknown
WG148745	FW-WBO	10/26/2016	4	L66385-4	pH	6.46	pH	H			6.46	J	unknown
WG149178	FW-WBO	10/26/2016	4	L66385-4	Cadmium, Dissolved, ICP-MS	0.053	ug/L	<RDL,H	0.05	0.25	0.053	J	unknown
WG149178	FW-WBO	10/26/2016	4	L66385-4	Copper, Dissolved, ICP-MS	11.4	ug/L	H	0.2	2	11.4	J	unknown
WG149178	FW-WBO	10/26/2016	4	L66385-4	Lead, Dissolved, ICP-MS	0.866	ug/L	H	0.1	0.5	0.866	J	unknown
WG149178	FW-WBO	10/26/2016	4	L66385-4	Zinc, Dissolved, ICP-MS	10.9	ug/L	H	0.5	2.5	10.9	J	unknown
WG148713	FW-WPCI	10/26/2016	4	L66385-5	Orthophosphate Phosphorus	0.0124	mg/L	H	0.0005	0.002	0.0124	J	unknown
WG148745	FW-WPCI	10/26/2016	4	L66385-5	pH	6.58	pH	H			6.58	J	unknown
WG148826	FW-WPCI	10/26/2016	4	L66385-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WPCI	10/26/2016	4	L66385-5	Copper, Dissolved, ICP-MS	3.81	ug/L	H	0.2	2	3.81	J	unknown
WG148826	FW-WPCI	10/26/2016	4	L66385-5	Lead, Dissolved, ICP-MS	0.2	ug/L	<RDL,H	0.1	0.5	0.2	J	unknown
WG148826	FW-WPCI	10/26/2016	4	L66385-5	Zinc, Dissolved, ICP-MS	25.6	ug/L	H	0.5	2.5	25.6	J	unknown
WG148779	FW-WPCI	10/26/2016	4	L66385-5	Chrysene	0.047	ug/L	<RDL,JL	0.0094	0.0472	0.047	J	high
WG148779	FW-WPCI	10/26/2016	4	L66385-5	Indeno(1,2,3-Cd)Pyrene	0.019	ug/L	<RDL,JL	0.0094	0.0472	0.019	J	high
WG148713	FW-WPCEPO	10/26/2016	4	L66385-6	Orthophosphate Phosphorus	0.0257	mg/L	H	0.0005	0.002	0.0257	J	unknown
WG148745	FW-WPCEPO	10/26/2016	4	L66385-6	pH	6.66	pH	H			6.66	J	unknown
WG148826	FW-WPCEPO	10/26/2016	4	L66385-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WPCEPO	10/26/2016	4	L66385-6	Copper, Dissolved, ICP-MS	4.83	ug/L	H	0.2	2	4.83	J	unknown
WG148826	FW-WPCEPO	10/26/2016	4	L66385-6	Lead, Dissolved, ICP-MS	0.683	ug/L	H	0.1	0.5	0.683	J	unknown
WG148826	FW-WPCEPO	10/26/2016	4	L66385-6	Zinc, Dissolved, ICP-MS	32.2	ug/L	H	0.5	2.5	32.2	J	unknown
WG148713	FW-NFWHC	10/26/2016	4	L66385-7	Orthophosphate Phosphorus	0.017	mg/L	H	0.0005	0.002	0.017	J	unknown
WG148745	FW-NFWHC	10/26/2016	4	L66385-7	pH	7.09	pH	H			7.09	J	unknown
WG148826	FW-NFWHC	10/26/2016	4	L66385-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-NFWHC	10/26/2016	4	L66385-7	Copper, Dissolved, ICP-MS	2.8	ug/L	H	0.2	2	2.8	J	unknown
WG148826	FW-NFWHC	10/26/2016	4	L66385-7	Lead, Dissolved, ICP-MS	0.33	ug/L	<RDL,H	0.1	0.5	0.33	J	unknown
WG148826	FW-NFWHC	10/26/2016	4	L66385-7	Zinc, Dissolved, ICP-MS	13.9	ug/L	H	0.5	2.5	13.9	J	unknown
WG148713	FW-WBI	10/26/2016	4	L66385-8	Orthophosphate Phosphorus	0.0205	mg/L	H	0.0005	0.002	0.0205	J	unknown
WG148745	FW-WBI	10/26/2016	4	L66385-8	pH	6.51	pH	H			6.51	J	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-8	Copper, Dissolved, ICP-MS	2.04	ug/L	H	0.2	2	2.04	J	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-WBI	10/26/2016	4	L66385-8	Zinc, Dissolved, ICP-MS	16.3	ug/L	H	0.5	2.5	16.3	J	unknown
WG148650	FW-EBI	10/20/2016	3	L66453-1	Orthophosphate Phosphorus	0.0128	mg/L	H	0.0005	0.002	0.0128	J	unknown
WG148622	FW-EBI	10/20/2016	3	L66453-1	pH	6.7	pH	H			6.7	J	unknown
WG148826	FW-EBI	10/20/2016	3	L66453-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-EBI	10/20/2016	3	L66453-1	Copper, Dissolved, ICP-MS	2.16	ug/L	H	0.2	2	2.16	J	unknown
WG148826	FW-EBI	10/20/2016	3	L66453-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-EBI	10/20/2016	3	L66453-1	Zinc, Dissolved, ICP-MS	14.9	ug/L	H	0.5	2.5	14.9	J	unknown
WG148542	FW-EBO	10/20/2016	3	L66453-10	Fecal Coliform	200	CFU/100ml	SH,TA			200	J	unknown
WG148542	FW-WBI	10/20/2016	3	L66453-11	Fecal Coliform	1500	CFU/100ml	C,SH,TA			1500	J	unknown
WG148542	FW-WBO	10/20/2016	3	L66453-12	Fecal Coliform	410	CFU/100ml	C,SH,TA			410	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG148542	FW-WPCI	10/20/2016	3	L66453-13	Fecal Coliform	600	CFU/100ml	SH,TA			600	J	unknown
WG148542	FW-WPCEPO	10/20/2016	3	L66453-14	Fecal Coliform	900	CFU/100ml	SH,TA			900	J	unknown
WG148542	FW-NFWHC	10/20/2016	3	L66453-15	Fecal Coliform	410	CFU/100ml	SH,TA			410	J	unknown
WG148650	FFBLANK	10/20/2016	3	L66453-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG148650	FW-EBO	10/20/2016	3	L66453-2	Orthophosphate Phosphorus	0.561	mg/L	H	0.013	0.05	0.561	J	unknown
WG148622	FW-EBO	10/20/2016	3	L66453-2	pH	6.5	pH	H			6.5	J	unknown
WG148826	FW-EBO	10/20/2016	3	L66453-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-EBO	10/20/2016	3	L66453-2	Copper, Dissolved, ICP-MS	7.09	ug/L	H	0.2	2	7.09	J	unknown
WG148826	FW-EBO	10/20/2016	3	L66453-2	Lead, Dissolved, ICP-MS	0.35	ug/L	<RDL,H	0.1	0.5	0.35	J	unknown
WG148826	FW-EBO	10/20/2016	3	L66453-2	Zinc, Dissolved, ICP-MS	3.88	ug/L	H	0.5	2.5	3.88	J	unknown
WG148650	FW-WBI	10/20/2016	3	L66453-3	Orthophosphate Phosphorus	0.0156	mg/L	H	0.0005	0.002	0.0156	J	unknown
WG148622	FW-WBI	10/20/2016	3	L66453-3	pH	6.56	pH	H			6.56	J	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-3	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-3	Zinc, Dissolved, ICP-MS	16.4	ug/L	H	0.5	2.5	16.4	J	unknown
WG148650	FW-WBO	10/20/2016	3	L66453-4	Orthophosphate Phosphorus	1.98	mg/L	H	0.013	0.05	1.98	J	unknown
WG148622	FW-WBO	10/20/2016	3	L66453-4	pH	6.37	pH	H			6.37	J	unknown
WG148971	FW-WBO	10/20/2016	3	L66453-4	Cadmium, Dissolved, ICP-MS	0.09	ug/L	<RDL,H	0.05	0.25	0.09	J	unknown
WG148971	FW-WBO	10/20/2016	3	L66453-4	Copper, Dissolved, ICP-MS	14.1	ug/L	H	0.2	2	14.1	J	unknown
WG148971	FW-WBO	10/20/2016	3	L66453-4	Lead, Dissolved, ICP-MS	0.785	ug/L	H	0.1	0.5	0.785	J	unknown
WG148971	FW-WBO	10/20/2016	3	L66453-4	Zinc, Dissolved, ICP-MS	13.9	ug/L	H	0.5	2.5	13.9	J	unknown
WG148650	FW-WPCI	10/19/2016	3	L66453-5	Orthophosphate Phosphorus	0.0131	mg/L	H	0.0005	0.002	0.0131	J	unknown
WG148622	FW-WPCI	10/19/2016	3	L66453-5	pH	6.77	pH	H			6.77	J	unknown
WG148826	FW-WPCI	10/19/2016	3	L66453-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WPCI	10/19/2016	3	L66453-5	Copper, Dissolved, ICP-MS	2.64	ug/L	H	0.2	2	2.64	J	unknown
WG148826	FW-WPCI	10/19/2016	3	L66453-5	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG148826	FW-WPCI	10/19/2016	3	L66453-5	Zinc, Dissolved, ICP-MS	22.3	ug/L	H	0.5	2.5	22.3	J	unknown
WG148652	FW-WPCI	10/19/2016	3	L66453-5	Benzo(b,j,k)fluoranthene	0.032	ug/L	<RDL,JL	0.0094	0.0472	0.032	J	high
WG148652	FW-WPCI	10/19/2016	3	L66453-5	Chrysene	0.029	ug/L	<RDL,JL	0.0094	0.0472	0.029	J	high
WG148650	FW-WPCEPO	10/19/2016	3	L66453-6	Orthophosphate Phosphorus	0.033	mg/L	H	0.0005	0.002	0.033	J	unknown
WG148622	FW-WPCEPO	10/19/2016	3	L66453-6	pH	6.66	pH	H			6.66	J	unknown
WG148826	FW-WPCEPO	10/19/2016	3	L66453-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WPCEPO	10/19/2016	3	L66453-6	Copper, Dissolved, ICP-MS	5.94	ug/L	H	0.2	2	5.94	J	unknown
WG148826	FW-WPCEPO	10/19/2016	3	L66453-6	Lead, Dissolved, ICP-MS	0.17	ug/L	<RDL,H	0.1	0.5	0.17	J	unknown
WG148826	FW-WPCEPO	10/19/2016	3	L66453-6	Zinc, Dissolved, ICP-MS	28.7	ug/L	H	0.5	2.5	28.7	J	unknown
WG148650	FW-NFWHC	10/19/2016	3	L66453-7	Orthophosphate Phosphorus	0.0246	mg/L	H	0.0005	0.002	0.0246	J	unknown
WG148622	FW-NFWHC	10/19/2016	3	L66453-7	pH	7.12	pH	H			7.12	J	unknown
WG148826	FW-NFWHC	10/19/2016	3	L66453-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-NFWHC	10/19/2016	3	L66453-7	Copper, Dissolved, ICP-MS	3.13	ug/L	H	0.2	2	3.13	J	unknown
WG148826	FW-NFWHC	10/19/2016	3	L66453-7	Lead, Dissolved, ICP-MS	0.34	ug/L	<RDL,H	0.1	0.5	0.34	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG148826	FW-NFWHC	10/19/2016	3	L66453-7	Zinc, Dissolved, ICP-MS	13.7	ug/L	H	0.5	2.5	13.7	J	unknown
WG148650	FW-WBI	10/20/2016	3	L66453-8	Orthophosphate Phosphorus	0.0147	mg/L	H	0.0005	0.002	0.0147	J	unknown
WG148622	FW-WBI	10/20/2016	3	L66453-8	pH	6.75	pH	H			6.75	J	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-8	Copper, Dissolved, ICP-MS	1.7	ug/L	<RDL,H	0.2	2	1.7	J	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG148826	FW-WBI	10/20/2016	3	L66453-8	Zinc, Dissolved, ICP-MS	16.2	ug/L	H	0.5	2.5	16.2	J	unknown
WG148542	FW-EBI	10/20/2016	3	L66453-9	Fecal Coliform	1900	CFU/100ml	SH,TA			1900	J	unknown
WG148709	FW-EBI	10/31/2016	5	L66540-1	Orthophosphate Phosphorus	0.0143	mg/L	H	0.0005	0.002	0.0143	J	unknown
WG148889	FW-EBI	10/31/2016	5	L66540-1	pH	6.5	pH	H			6.5	J	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-1	Copper, Dissolved, ICP-MS	1.5	ug/L	<RDL,H	0.2	2	1.5	J	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-1	Zinc, Dissolved, ICP-MS	15.9	ug/L	H	0.5	2.5	15.9	J	unknown
WG148766	FW-EBO	11/1/2016	5	L66540-10	Fecal Coliform	48	CFU/100ml	SH,TA			48	J	unknown
WG148766	FW-WBI	11/1/2016	5	L66540-11	Fecal Coliform	110	CFU/100ml	SH,TA			110	J	unknown
WG148766	FW-WBO	11/1/2016	5	L66540-12	Fecal Coliform	150	CFU/100ml	SH,TA			150	J	unknown
WG148766	FW-WPCI	11/1/2016	5	L66540-13	Fecal Coliform	270	CFU/100ml	SH,TA			270	J	unknown
WG148766	FW-WPCEPO	11/1/2016	5	L66540-14	Fecal Coliform	180	CFU/100ml	SH,TA			180	J	unknown
WG148766	FW-NFWHC	11/1/2016	5	L66540-15	Fecal Coliform	55	CFU/100ml	SH,TA			55	J	unknown
WG148709	FFBLANK	11/1/2016	5	L66540-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG148709	FW-EBO	10/31/2016	5	L66540-2	Orthophosphate Phosphorus	1.01	mg/L	H	0.025	0.1	1.01	J	unknown
WG148889	FW-EBO	10/31/2016	5	L66540-2	pH	6.52	pH	H			6.52	J	unknown
WG149178	FW-EBO	10/31/2016	5	L66540-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149178	FW-EBO	10/31/2016	5	L66540-2	Copper, Dissolved, ICP-MS	6.52	ug/L	H	0.2	2	6.52	J	unknown
WG149178	FW-EBO	10/31/2016	5	L66540-2	Lead, Dissolved, ICP-MS	0.56	ug/L	H	0.1	0.5	0.56	J	unknown
WG149178	FW-EBO	10/31/2016	5	L66540-2	Zinc, Dissolved, ICP-MS	4.86	ug/L	H	0.5	2.5	4.86	J	unknown
WG148709	FW-WBI	10/31/2016	5	L66540-3	Orthophosphate Phosphorus	0.0155	mg/L	H	0.0005	0.002	0.0155	J	unknown
WG148889	FW-WBI	10/31/2016	5	L66540-3	pH	6.6	pH	H			6.6	J	unknown
WG149168	FW-WBI	10/31/2016	5	L66540-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-WBI	10/31/2016	5	L66540-3	Copper, Dissolved, ICP-MS	1.8	ug/L	<RDL,H	0.2	2	1.8	J	unknown
WG149168	FW-WBI	10/31/2016	5	L66540-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG149168	FW-WBI	10/31/2016	5	L66540-3	Zinc, Dissolved, ICP-MS	16.6	ug/L	H	0.5	2.5	16.6	J	unknown
WG148709	FW-WBO	10/31/2016	5	L66540-4	Orthophosphate Phosphorus	2.22	mg/L	H	0.05	0.2	2.22	J	unknown
WG148889	FW-WBO	10/31/2016	5	L66540-4	pH	6.43	pH	H			6.43	J	unknown
WG149178	FW-WBO	10/31/2016	5	L66540-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149178	FW-WBO	10/31/2016	5	L66540-4	Copper, Dissolved, ICP-MS	7.63	ug/L	H	0.2	2	7.63	J	unknown
WG149178	FW-WBO	10/31/2016	5	L66540-4	Lead, Dissolved, ICP-MS	0.897	ug/L	H	0.1	0.5	0.897	J	unknown
WG149178	FW-WBO	10/31/2016	5	L66540-4	Zinc, Dissolved, ICP-MS	10.6	ug/L	H	0.5	2.5	10.6	J	unknown
WG148709	FW-WPCI	10/31/2016	5	L66540-5	Orthophosphate Phosphorus	0.0104	mg/L	H	0.0005	0.002	0.0104	J	unknown
WG148889	FW-WPCI	10/31/2016	5	L66540-5	pH	6.76	pH	H			6.76	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG149168	FW-WPCI	10/31/2016	5	L66540-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-WPCI	10/31/2016	5	L66540-5	Copper, Dissolved, ICP-MS	3.37	ug/L	H	0.2	2	3.37	J	unknown
WG149168	FW-WPCI	10/31/2016	5	L66540-5	Lead, Dissolved, ICP-MS	0.23	ug/L	<RDL,H	0.1	0.5	0.23	J	unknown
WG149168	FW-WPCI	10/31/2016	5	L66540-5	Zinc, Dissolved, ICP-MS	29.8	ug/L	H	0.5	2.5	29.8	J	unknown
WG148779	FW-WPCI	10/31/2016	5	L66540-5	Chrysene	0.017	ug/L	<RDL,JL	0.0094	0.0472	0.017	J	high
WG148709	FW-WPCEPO	10/31/2016	5	L66540-6	Orthophosphate Phosphorus	0.0254	mg/L	H	0.0005	0.002	0.0254	J	unknown
WG148889	FW-WPCEPO	10/31/2016	5	L66540-6	pH	6.53	pH	H			6.53	J	unknown
WG149168	FW-WPCEPO	10/31/2016	5	L66540-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-WPCEPO	10/31/2016	5	L66540-6	Copper, Dissolved, ICP-MS	3.45	ug/L	H	0.2	2	3.45	J	unknown
WG149168	FW-WPCEPO	10/31/2016	5	L66540-6	Lead, Dissolved, ICP-MS	0.19	ug/L	<RDL,H	0.1	0.5	0.19	J	unknown
WG149168	FW-WPCEPO	10/31/2016	5	L66540-6	Zinc, Dissolved, ICP-MS	31.3	ug/L	H	0.5	2.5	31.3	J	unknown
WG148709	FW-NFWHC	11/1/2016	5	L66540-7	Orthophosphate Phosphorus	0.0168	mg/L	H	0.0005	0.002	0.0168	J	unknown
WG148889	FW-NFWHC	11/1/2016	5	L66540-7	pH	7.06	pH	H			7.06	J	unknown
WG149168	FW-NFWHC	11/1/2016	5	L66540-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-NFWHC	11/1/2016	5	L66540-7	Copper, Dissolved, ICP-MS	2.77	ug/L	H	0.2	2	2.77	J	unknown
WG149168	FW-NFWHC	11/1/2016	5	L66540-7	Lead, Dissolved, ICP-MS	0.24	ug/L	<RDL,H	0.1	0.5	0.24	J	unknown
WG149168	FW-NFWHC	11/1/2016	5	L66540-7	Zinc, Dissolved, ICP-MS	16.6	ug/L	H	0.5	2.5	16.6	J	unknown
WG148709	FW-EBI	10/31/2016	5	L66540-8	Orthophosphate Phosphorus	0.0149	mg/L	H	0.0005	0.002	0.0149	J	unknown
WG148889	FW-EBI	10/31/2016	5	L66540-8	pH	6.7	pH	H			6.7	J	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-8	Copper, Dissolved, ICP-MS	1.5	ug/L	<RDL,H	0.2	2	1.5	J	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG149168	FW-EBI	10/31/2016	5	L66540-8	Zinc, Dissolved, ICP-MS	16.3	ug/L	H	0.5	2.5	16.3	J	unknown
WG148766	FW-EBI	11/1/2016	5	L66540-9	Fecal Coliform	140	CFU/100ml	SH,TA			140	J	unknown
WG149575	FW-EBI	12/19/2016	6	L66811-1	Orthophosphate Phosphorus	0.0116	mg/L	H	0.005	0.01	0.0116	J	unknown
WG149561	FW-EBI	12/19/2016	6	L66811-1	pH	7.14	pH	H			7.14	J	unknown
WG149594	FW-EBI	12/19/2016	6	L66811-1	Turbidity	5.39	NTU	H	0.2	0.5	5.39	J	unknown
WG149717	FW-EBI	12/19/2016	6	L66811-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-EBI	12/19/2016	6	L66811-1	Copper, Dissolved, ICP-MS	1.8	ug/L	<RDL,H	0.2	2	1.8	J	unknown
WG149717	FW-EBI	12/19/2016	6	L66811-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG149717	FW-EBI	12/19/2016	6	L66811-1	Zinc, Dissolved, ICP-MS	27.2	ug/L	H	0.5	2.5	27.2	J	unknown
WG149573	FW-EBI	12/19/2016	6	L66811-1	Benzo(g,h,i)perylene	0.0505	ug/L	B	0.0094	0.0472	0.0505	U	
WG149573	FW-EBI	12/19/2016	6	L66811-1	Dibenzo(a,h)anthracene	0.0501	ug/L	B	0.0094	0.0472	0.0501	U	
WG149573	FW-EBI	12/19/2016	6	L66811-1	Indeno(1,2,3-Cd)Pyrene	0.0507	ug/L	B	0.0094	0.0472	0.0507	U	
WG149575	FW-EBO	12/19/2016	6	L66811-2	Orthophosphate Phosphorus	0.626	mg/L	H	0.025	0.05	0.626	J	unknown
WG149561	FW-EBO	12/19/2016	6	L66811-2	pH	6.99	pH	H			6.99	J	unknown
WG149594	FW-EBO	12/19/2016	6	L66811-2	Turbidity	2.2	NTU	H	0.2	0.5	2.2	J	unknown
WG149717	FW-EBO	12/19/2016	6	L66811-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-EBO	12/19/2016	6	L66811-2	Copper, Dissolved, ICP-MS	2.04	ug/L	H	0.2	2	2.04	J	unknown
WG149717	FW-EBO	12/19/2016	6	L66811-2	Lead, Dissolved, ICP-MS	0.13	ug/L	<RDL,H	0.1	0.5	0.13	J	unknown
WG149717	FW-EBO	12/19/2016	6	L66811-2	Zinc, Dissolved, ICP-MS	3.07	ug/L	H	0.5	2.5	3.07	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG149573	FW-EBO	12/19/2016	6	L66811-2	Benzo(g,h,i)perylene	0.033	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-EBO	12/19/2016	6	L66811-2	Dibenzo(a,h)anthracene	0.032	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-EBO	12/19/2016	6	L66811-2	Indeno(1,2,3-Cd)Pyrene	0.032	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149575	FW-WBI	12/19/2016	6	L66811-3	Orthophosphate Phosphorus	0.0113	mg/L	H	0.005	0.01	0.0113	J	unknown
WG149561	FW-WBI	12/19/2016	6	L66811-3	pH	7.13	pH	H			7.13	J	unknown
WG149594	FW-WBI	12/19/2016	6	L66811-3	Turbidity	5.5	NTU	H	0.2	0.5	5.5	J	unknown
WG149717	FW-WBI	12/19/2016	6	L66811-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-WBI	12/19/2016	6	L66811-3	Copper, Dissolved, ICP-MS	1.6	ug/L	<RDL,H	0.2	2	1.6	J	unknown
WG149717	FW-WBI	12/19/2016	6	L66811-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG149717	FW-WBI	12/19/2016	6	L66811-3	Zinc, Dissolved, ICP-MS	27.1	ug/L	H	0.5	2.5	27.1	J	unknown
WG149573	FW-WBI	12/19/2016	6	L66811-3	Benzo(g,h,i)perylene	0.034	ug/L	<RDL,B	0.011	0.0541	0.0541	U	
WG149573	FW-WBI	12/19/2016	6	L66811-3	Dibenzo(a,h)anthracene	0.024	ug/L	<RDL,B	0.011	0.0541	0.0541	U	
WG149573	FW-WBI	12/19/2016	6	L66811-3	Indeno(1,2,3-Cd)Pyrene	0.033	ug/L	<RDL,B	0.011	0.0541	0.0541	U	
WG149582	FW-WBO	12/19/2016	6	L66811-4	Orthophosphate Phosphorus	2.52	mg/L	H	0.25	0.5	2.52	J	unknown
WG149561	FW-WBO	12/19/2016	6	L66811-4	pH	6.74	pH	H			6.74	J	unknown
WG149594	FW-WBO	12/19/2016	6	L66811-4	Turbidity	4.72	NTU	H	0.2	0.5	4.72	J	unknown
WG149717	FW-WBO	12/19/2016	6	L66811-4	Cadmium, Dissolved, ICP-MS	0.054	ug/L	<RDL,H	0.05	0.25	0.054	J	unknown
WG149717	FW-WBO	12/19/2016	6	L66811-4	Copper, Dissolved, ICP-MS	2.84	ug/L	H	0.2	2	2.84	J	unknown
WG149717	FW-WBO	12/19/2016	6	L66811-4	Lead, Dissolved, ICP-MS	0.62	ug/L	H	0.1	0.5	0.62	J	unknown
WG149717	FW-WBO	12/19/2016	6	L66811-4	Zinc, Dissolved, ICP-MS	7.78	ug/L	H	0.5	2.5	7.78	J	unknown
WG149573	FW-WBO	12/19/2016	6	L66811-4	Benzo(g,h,i)perylene	0.017	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-WBO	12/19/2016	6	L66811-4	Dibenzo(a,h)anthracene	0.018	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-WBO	12/19/2016	6	L66811-4	Indeno(1,2,3-Cd)Pyrene	0.018	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149575	FW-WPCI	12/19/2016	6	L66811-5	Orthophosphate Phosphorus	0.0125	mg/L	H	0.005	0.01	0.0125	J	unknown
WG149561	FW-WPCI	12/19/2016	6	L66811-5	pH	7.21	pH	H			7.21	J	unknown
WG149594	FW-WPCI	12/19/2016	6	L66811-5	Turbidity	35.1	NTU	H	0.2	0.5	35.1	J	unknown
WG149717	FW-WPCI	12/19/2016	6	L66811-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-WPCI	12/19/2016	6	L66811-5	Copper, Dissolved, ICP-MS	3.3	ug/L	H	0.2	2	3.3	J	unknown
WG149717	FW-WPCI	12/19/2016	6	L66811-5	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG149717	FW-WPCI	12/19/2016	6	L66811-5	Zinc, Dissolved, ICP-MS	47	ug/L	H	0.5	2.5	47	J	unknown
WG149573	FW-WPCI	12/19/2016	6	L66811-5	Benzo(g,h,i)perylene	0.0759	ug/L	B	0.0094	0.0472	0.0759	U	
WG149573	FW-WPCI	12/19/2016	6	L66811-5	Dibenzo(a,h)anthracene	0.024	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-WPCI	12/19/2016	6	L66811-5	Indeno(1,2,3-Cd)Pyrene	0.035	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149575	FW-WPCEPO	12/19/2016	6	L66811-6	Orthophosphate Phosphorus	0.0207	mg/L	H	0.005	0.01	0.0207	J	unknown
WG149561	FW-WPCEPO	12/19/2016	6	L66811-6	pH	7.12	pH	H			7.12	J	unknown
WG149594	FW-WPCEPO	12/19/2016	6	L66811-6	Turbidity	15.1	NTU	H	0.2	0.5	15.1	J	unknown
WG149717	FW-WPCEPO	12/19/2016	6	L66811-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-WPCEPO	12/19/2016	6	L66811-6	Copper, Dissolved, ICP-MS	2.85	ug/L	H	0.2	2	2.85	J	unknown
WG149717	FW-WPCEPO	12/19/2016	6	L66811-6	Lead, Dissolved, ICP-MS	0.17	ug/L	<RDL,H	0.1	0.5	0.17	J	unknown
WG149717	FW-WPCEPO	12/19/2016	6	L66811-6	Zinc, Dissolved, ICP-MS	54	ug/L	H	0.5	2.5	54	J	unknown
WG149573	FW-WPCEPO	12/19/2016	6	L66811-6	Benzo(g,h,i)perylene	0.026	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG149573	FW-WPCEPO	12/19/2016	6	L66811-6	Dibenzo(a,h)anthracene	0.014	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-WPCEPO	12/19/2016	6	L66811-6	Indeno(1,2,3-Cd)Pyrene	0.018	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149575	FW-NFWHC	12/19/2016	6	L66811-7	Orthophosphate Phosphorus	0.0144	mg/L	H	0.005	0.01	0.0144	J	unknown
WG149561	FW-NFWHC	12/19/2016	6	L66811-7	pH	7.64	pH	H			7.64	J	unknown
WG149594	FW-NFWHC	12/19/2016	6	L66811-7	Turbidity	10	NTU	H	0.2	0.5	10	J	unknown
WG149717	FW-NFWHC	12/19/2016	6	L66811-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG149717	FW-NFWHC	12/19/2016	6	L66811-7	Copper, Dissolved, ICP-MS	1.7	ug/L	<RDL,H	0.2	2	1.7	J	unknown
WG149717	FW-NFWHC	12/19/2016	6	L66811-7	Lead, Dissolved, ICP-MS	0.17	ug/L	<RDL,H	0.1	0.5	0.17	J	unknown
WG149717	FW-NFWHC	12/19/2016	6	L66811-7	Zinc, Dissolved, ICP-MS	22.9	ug/L	H	0.5	2.5	22.9	J	unknown
WG149573	FW-NFWHC	12/19/2016	6	L66811-7	Benzo(g,h,i)perylene	0.016	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-NFWHC	12/19/2016	6	L66811-7	Dibenzo(a,h)anthracene	0.011	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149573	FW-NFWHC	12/19/2016	6	L66811-7	Indeno(1,2,3-Cd)Pyrene	0.013	ug/L	<RDL,B	0.0094	0.0472	0.0472	U	
WG149575	FFBLANK	12/20/2016	6	L66811-8	Orthophosphate Phosphorus		mg/L	<MDL	0.005	0.01	0.005	UJ	unknown
WG149912	FW-EBI	1/17/2017	7	L66937-1	Orthophosphate Phosphorus	0.0128	mg/L	H	0.0005	0.002	0.0128	J	unknown
WG149906	FW-EBI	1/17/2017	7	L66937-1	pH	7.33	pH	H			7.33	J	unknown
WG150217	FW-EBI	1/17/2017	7	L66937-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150217	FW-EBI	1/17/2017	7	L66937-1	Copper, Dissolved, ICP-MS	1.7	ug/L	<RDL,H	0.2	2	1.7	J	unknown
WG150217	FW-EBI	1/17/2017	7	L66937-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150217	FW-EBI	1/17/2017	7	L66937-1	Zinc, Dissolved, ICP-MS	21.1	ug/L	H	0.5	2.5	21.1	J	unknown
WG149912	FFBLANK	1/18/2017	7	L66937-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG149912	FW-EBO	1/17/2017	7	L66937-2	Orthophosphate Phosphorus	0.284	mg/L	H	0.01	0.04	0.284	J	unknown
WG149906	FW-EBO	1/17/2017	7	L66937-2	pH	6.82	pH	H			6.82	J	unknown
WG150217	FW-EBO	1/17/2017	7	L66937-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150217	FW-EBO	1/17/2017	7	L66937-2	Copper, Dissolved, ICP-MS	2.35	ug/L	H	0.2	2	2.35	J	unknown
WG150217	FW-EBO	1/17/2017	7	L66937-2	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150217	FW-EBO	1/17/2017	7	L66937-2	Zinc, Dissolved, ICP-MS	2.2	ug/L	<RDL,H	0.5	2.5	2.2	J	unknown
WG149912	FW-WBI	1/17/2017	7	L66937-3	Orthophosphate Phosphorus	0.0127	mg/L	H	0.0005	0.002	0.0127	J	unknown
WG149906	FW-WBI	1/17/2017	7	L66937-3	pH	7	pH	H			7	J	unknown
WG150217	FW-WBI	1/17/2017	7	L66937-3	Cadmium, Dissolved, ICP-MS	0.07	ug/L	<RDL,H	0.05	0.25	0.07	J	unknown
WG150217	FW-WBI	1/17/2017	7	L66937-3	Copper, Dissolved, ICP-MS	1.7	ug/L	<RDL,H	0.2	2	1.7	J	unknown
WG150217	FW-WBI	1/17/2017	7	L66937-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150217	FW-WBI	1/17/2017	7	L66937-3	Zinc, Dissolved, ICP-MS	21.7	ug/L	H	0.5	2.5	21.7	J	unknown
WG149912	FW-WBO	1/17/2017	7	L66937-4	Orthophosphate Phosphorus	1.08	mg/L	H	0.1	0.4	1.08	J	unknown
WG149906	FW-WBO	1/17/2017	7	L66937-4	pH	6.57	pH	H			6.57	J	unknown
WG150217	FW-WBO	1/17/2017	7	L66937-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150217	FW-WBO	1/17/2017	7	L66937-4	Copper, Dissolved, ICP-MS	2.83	ug/L	H	0.2	2	2.83	J	unknown
WG150217	FW-WBO	1/17/2017	7	L66937-4	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG150217	FW-WBO	1/17/2017	7	L66937-4	Zinc, Dissolved, ICP-MS	4.96	ug/L	H	0.5	2.5	4.96	J	unknown
WG149912	FW-WPCI	1/17/2017	7	L66937-5	Orthophosphate Phosphorus	0.0106	mg/L	H	0.0005	0.002	0.0106	J	unknown
WG149906	FW-WPCI	1/17/2017	7	L66937-5	pH	6.94	pH	H			6.94	J	unknown
WG150217	FW-WPCI	1/17/2017	7	L66937-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150217	FW-WPCI	1/17/2017	7	L66937-5	Copper, Dissolved, ICP-MS	2.96	ug/L	H	0.2	2	2.96	J	unknown
WG150217	FW-WPCI	1/17/2017	7	L66937-5	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG150217	FW-WPCI	1/17/2017	7	L66937-5	Zinc, Dissolved, ICP-MS	31.2	ug/L	H	0.5	2.5	31.2	J	unknown
WG149912	FW-WPCEPO	1/17/2017	7	L66937-6	Orthophosphate Phosphorus	0.0187	mg/L	H	0.0005	0.002	0.0187	J	unknown
WG149906	FW-WPCEPO	1/17/2017	7	L66937-6	pH	6.9	pH	H			6.9	J	unknown
WG150217	FW-WPCEPO	1/17/2017	7	L66937-6	Cadmium, Dissolved, ICP-MS	0.057	ug/L	<RDL,H	0.05	0.25	0.057	J	unknown
WG150217	FW-WPCEPO	1/17/2017	7	L66937-6	Copper, Dissolved, ICP-MS	2.96	ug/L	H	0.2	2	2.96	J	unknown
WG150217	FW-WPCEPO	1/17/2017	7	L66937-6	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG150217	FW-WPCEPO	1/17/2017	7	L66937-6	Zinc, Dissolved, ICP-MS	40.6	ug/L	H	0.5	2.5	40.6	J	unknown
WG149912	FW-NFWHC	1/17/2017	7	L66937-7	Orthophosphate Phosphorus	0.0178	mg/L	H	0.0005	0.002	0.0178	J	unknown
WG149906	FW-NFWHC	1/17/2017	7	L66937-7	pH	7.26	pH	H			7.26	J	unknown
WG150217	FW-NFWHC	1/17/2017	7	L66937-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150217	FW-NFWHC	1/17/2017	7	L66937-7	Copper, Dissolved, ICP-MS	2.29	ug/L	H	0.2	2	2.29	J	unknown
WG150217	FW-NFWHC	1/17/2017	7	L66937-7	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG150217	FW-NFWHC	1/17/2017	7	L66937-7	Zinc, Dissolved, ICP-MS	15.7	ug/L	H	0.5	2.5	15.7	J	unknown
WG149912	FW-EBI	1/17/2017	7	L66937-8	Orthophosphate Phosphorus	0.013	mg/L	H	0.0005	0.002	0.013	J	unknown
WG149906	FW-EBI	1/17/2017	7	L66937-8	pH	7.01	pH	H			7.01	J	unknown
WG150208	FW-EBI	2/8/2017	8	L67069-1	Orthophosphate Phosphorus	0.00758	mg/L	H	0.0005	0.002	0.00758	J	unknown
WG150178	FW-EBI	2/8/2017	8	L67069-1	pH	6.96	pH	H			6.96	J	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-1	Copper, Dissolved, ICP-MS	0.94	ug/L	<RDL,H	0.2	2	0.94	J	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-1	Zinc, Dissolved, ICP-MS	17	ug/L	H	0.5	2.5	17	J	unknown
WG150141	FW-WBI	2/9/2017	8	L67069-11	Fecal Coliform	120	CFU/100ml	C			120	J	unknown
WG150208	FFBLANK	2/9/2017	8	L67069-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150208	FW-EBO	2/8/2017	8	L67069-2	Orthophosphate Phosphorus	0.342	mg/L	H	0.0025	0.01	0.342	J	unknown
WG150178	FW-EBO	2/8/2017	8	L67069-2	pH	7.1	pH	H			7.1	J	unknown
WG150558	FW-EBO	2/8/2017	8	L67069-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-EBO	2/8/2017	8	L67069-2	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG150558	FW-EBO	2/8/2017	8	L67069-2	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-EBO	2/8/2017	8	L67069-2	Zinc, Dissolved, ICP-MS	2.57	ug/L	H	0.5	2.5	2.57	J	unknown
WG150208	FW-WBI	2/8/2017	8	L67069-3	Orthophosphate Phosphorus	0.0083	mg/L	H	0.0005	0.002	0.0083	J	unknown
WG150178	FW-WBI	2/8/2017	8	L67069-3	pH	6.97	pH	H			6.97	J	unknown
WG150558	FW-WBI	2/8/2017	8	L67069-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-WBI	2/8/2017	8	L67069-3	Copper, Dissolved, ICP-MS	0.99	ug/L	<RDL,H	0.2	2	0.99	J	unknown
WG150558	FW-WBI	2/8/2017	8	L67069-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-WBI	2/8/2017	8	L67069-3	Zinc, Dissolved, ICP-MS	19	ug/L	H	0.5	2.5	19	J	unknown
WG150208	FW-WBO	2/8/2017	8	L67069-4	Orthophosphate Phosphorus	0.93	mg/L	H	0.01	0.04	0.93	J	unknown
WG150178	FW-WBO	2/8/2017	8	L67069-4	pH	6.49	pH	H			6.49	J	unknown
WG150558	FW-WBO	2/8/2017	8	L67069-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-WBO	2/8/2017	8	L67069-4	Copper, Dissolved, ICP-MS	2.08	ug/L	H	0.2	2	2.08	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150558	FW-WBO	2/8/2017	8	L67069-4	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG150558	FW-WBO	2/8/2017	8	L67069-4	Zinc, Dissolved, ICP-MS	5.39	ug/L	H	0.5	2.5	5.39	J	unknown
WG150208	FW-WPCI	2/8/2017	8	L67069-5	Orthophosphate Phosphorus	0.00388	mg/L	H	0.0005	0.002	0.00388	J	unknown
WG150178	FW-WPCI	2/8/2017	8	L67069-5	pH	6.96	pH	H			6.96	J	unknown
WG150558	FW-WPCI	2/8/2017	8	L67069-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-WPCI	2/8/2017	8	L67069-5	Copper, Dissolved, ICP-MS	2.05	ug/L	H	0.2	2	2.05	J	unknown
WG150558	FW-WPCI	2/8/2017	8	L67069-5	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-WPCI	2/8/2017	8	L67069-5	Zinc, Dissolved, ICP-MS	30.4	ug/L	H	0.5	2.5	30.4	J	unknown
WG150208	FW-WPCEPO	2/8/2017	8	L67069-6	Orthophosphate Phosphorus	0.023	mg/L	H	0.0005	0.002	0.023	J	unknown
WG150178	FW-WPCEPO	2/8/2017	8	L67069-6	pH	6.97	pH	H			6.97	J	unknown
WG150558	FW-WPCEPO	2/8/2017	8	L67069-6	Cadmium, Dissolved, ICP-MS	0.064	ug/L	<RDL,H	0.05	0.25	0.064	J	unknown
WG150558	FW-WPCEPO	2/8/2017	8	L67069-6	Copper, Dissolved, ICP-MS	2.62	ug/L	H	0.2	2	2.62	J	unknown
WG150558	FW-WPCEPO	2/8/2017	8	L67069-6	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-WPCEPO	2/8/2017	8	L67069-6	Zinc, Dissolved, ICP-MS	46.4	ug/L	H	0.5	2.5	46.4	J	unknown
WG150208	FW-NFWHC	2/8/2017	8	L67069-7	Orthophosphate Phosphorus	0.0117	mg/L	H	0.001	0.004	0.0117	J	unknown
WG150178	FW-NFWHC	2/8/2017	8	L67069-7	pH	7.39	pH	H			7.39	J	unknown
WG150558	FW-NFWHC	2/8/2017	8	L67069-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-NFWHC	2/8/2017	8	L67069-7	Copper, Dissolved, ICP-MS	5.52	ug/L	H	0.2	2	5.52	J	unknown
WG150558	FW-NFWHC	2/8/2017	8	L67069-7	Lead, Dissolved, ICP-MS	0.27	ug/L	<RDL,H	0.1	0.5	0.27	J	unknown
WG150558	FW-NFWHC	2/8/2017	8	L67069-7	Zinc, Dissolved, ICP-MS	25.3	ug/L	H	0.5	2.5	25.3	J	unknown
WG150208	FW-EBI	2/8/2017	8	L67069-8	Orthophosphate Phosphorus	0.00741	mg/L	H	0.0005	0.002	0.00741	J	unknown
WG150178	FW-EBI	2/8/2017	8	L67069-8	pH	7	pH	H			7	J	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-8	Copper, Dissolved, ICP-MS	0.99	ug/L	<RDL,H	0.2	2	0.99	J	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150558	FW-EBI	2/8/2017	8	L67069-8	Zinc, Dissolved, ICP-MS	17.9	ug/L	H	0.5	2.5	17.9	J	unknown
WG150471	FW-EBI	2/15/2017	9	L67141-1	Orthophosphate Phosphorus	0.00767	mg/L	H	0.0005	0.002	0.00767	J	unknown
WG150301	FW-EBI	2/15/2017	9	L67141-1	pH	7.14	pH	H			7.14	J	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-1	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-1	Zinc, Dissolved, ICP-MS	13	ug/L	H	0.5	2.5	13	J	unknown
WG150471	FFBLANK	2/16/2017	9	L67141-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150471	FW-WBO	2/16/2017	9	L67141-17	Orthophosphate Phosphorus	1.31	mg/L	H	0.005	0.02	1.31	J	unknown
WG150301	FW-WBO	2/16/2017	9	L67141-17	pH	6.72	pH	H			6.72	J	unknown
WG150618	FW-WBO	2/16/2017	9	L67141-17	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150618	FW-WBO	2/16/2017	9	L67141-17	Copper, Dissolved, ICP-MS	4.83	ug/L	H	0.2	2	4.83	J	unknown
WG150618	FW-WBO	2/16/2017	9	L67141-17	Lead, Dissolved, ICP-MS	0.32	ug/L	<RDL,H	0.1	0.5	0.32	J	unknown
WG150618	FW-WBO	2/16/2017	9	L67141-17	Zinc, Dissolved, ICP-MS	5.04	ug/L	H	0.5	2.5	5.04	J	unknown
WG150471	FW-EBO	2/15/2017	9	L67141-2	Orthophosphate Phosphorus	0.452	mg/L	H	0.005	0.02	0.452	J	unknown
WG150301	FW-EBO	2/15/2017	9	L67141-2	pH	6.87	pH	H			6.87	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150726	FW-EBO	2/15/2017	9	L67141-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-EBO	2/15/2017	9	L67141-2	Copper, Dissolved, ICP-MS	2.86	ug/L	H	0.2	2	2.86	J	unknown
WG150726	FW-EBO	2/15/2017	9	L67141-2	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG150726	FW-EBO	2/15/2017	9	L67141-2	Zinc, Dissolved, ICP-MS	2.5	ug/L	H	0.5	2.5	2.5	J	unknown
WG150471	FW-WBI	2/15/2017	9	L67141-3	Orthophosphate Phosphorus	0.00963	mg/L	H	0.0005	0.002	0.00963	J	unknown
WG150301	FW-WBI	2/15/2017	9	L67141-3	pH	6.92	pH	H			6.92	J	unknown
WG150726	FW-WBI	2/15/2017	9	L67141-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-WBI	2/15/2017	9	L67141-3	Copper, Dissolved, ICP-MS	1.8	ug/L	<RDL,H	0.2	2	1.8	J	unknown
WG150726	FW-WBI	2/15/2017	9	L67141-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150726	FW-WBI	2/15/2017	9	L67141-3	Zinc, Dissolved, ICP-MS	12.4	ug/L	H	0.5	2.5	12.4	J	unknown
WG150471	FW-WBO	2/15/2017	9	L67141-4	Orthophosphate Phosphorus	1.32	mg/L	H	0.005	0.02	1.32	J	unknown
WG150301	FW-WBO	2/15/2017	9	L67141-4	pH	6.65	pH	H			6.65	J	unknown
WG150618	FW-WBO	2/15/2017	9	L67141-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150618	FW-WBO	2/15/2017	9	L67141-4	Copper, Dissolved, ICP-MS	5.07	ug/L	H	0.2	2	5.07	J	unknown
WG150618	FW-WBO	2/15/2017	9	L67141-4	Lead, Dissolved, ICP-MS	0.35	ug/L	<RDL,H	0.1	0.5	0.35	J	unknown
WG150618	FW-WBO	2/15/2017	9	L67141-4	Zinc, Dissolved, ICP-MS	5.88	ug/L	H	0.5	2.5	5.88	J	unknown
WG150471	FW-WPCI	2/15/2017	9	L67141-5	Orthophosphate Phosphorus	0.00396	mg/L	H	0.0005	0.002	0.00396	J	unknown
WG150301	FW-WPCI	2/15/2017	9	L67141-5	pH	7.01	pH	H			7.01	J	unknown
WG150726	FW-WPCI	2/15/2017	9	L67141-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-WPCI	2/15/2017	9	L67141-5	Copper, Dissolved, ICP-MS	2.47	ug/L	H	0.2	2	2.47	J	unknown
WG150726	FW-WPCI	2/15/2017	9	L67141-5	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150726	FW-WPCI	2/15/2017	9	L67141-5	Zinc, Dissolved, ICP-MS	21	ug/L	H	0.5	2.5	21	J	unknown
WG150471	FW-WPCEPO	2/15/2017	9	L67141-6	Orthophosphate Phosphorus	0.0222	mg/L	H	0.0005	0.002	0.0222	J	unknown
WG150301	FW-WPCEPO	2/15/2017	9	L67141-6	pH	6.92	pH	H			6.92	J	unknown
WG150726	FW-WPCEPO	2/15/2017	9	L67141-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-WPCEPO	2/15/2017	9	L67141-6	Copper, Dissolved, ICP-MS	3.07	ug/L	H	0.2	2	3.07	J	unknown
WG150726	FW-WPCEPO	2/15/2017	9	L67141-6	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG150726	FW-WPCEPO	2/15/2017	9	L67141-6	Zinc, Dissolved, ICP-MS	29.1	ug/L	H	0.5	2.5	29.1	J	unknown
WG150471	FW-NFWHC	2/15/2017	9	L67141-7	Orthophosphate Phosphorus	0.0263	mg/L	H	0.005	0.02	0.0263	J	unknown
WG150301	FW-NFWHC	2/15/2017	9	L67141-7	pH	7.24	pH	H			7.24	J	unknown
WG150726	FW-NFWHC	2/15/2017	9	L67141-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-NFWHC	2/15/2017	9	L67141-7	Copper, Dissolved, ICP-MS	2.39	ug/L	H	0.2	2	2.39	J	unknown
WG150726	FW-NFWHC	2/15/2017	9	L67141-7	Lead, Dissolved, ICP-MS	0.22	ug/L	<RDL,H	0.1	0.5	0.22	J	unknown
WG150726	FW-NFWHC	2/15/2017	9	L67141-7	Zinc, Dissolved, ICP-MS	13.9	ug/L	H	0.5	2.5	13.9	J	unknown
WG150471	FW-EBI	2/15/2017	9	L67141-8	Orthophosphate Phosphorus	0.00788	mg/L	H	0.0005	0.002	0.00788	J	unknown
WG150301	FW-EBI	2/15/2017	9	L67141-8	pH	6.95	pH	H			6.95	J	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-8	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG150726	FW-EBI	2/15/2017	9	L67141-8	Zinc, Dissolved, ICP-MS	12.9	ug/L	H	0.5	2.5	12.9	J	unknown
WG150613	FW-EBI	3/7/2017	10	L67231-1	Orthophosphate Phosphorus	0.00823	mg/L	H	0.0005	0.002	0.00823	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150606	FW-EBI	3/7/2017	10	L67231-1	pH	6.98	pH	H			6.98	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-1	Copper, Dissolved, ICP-MS	2.22	ug/L	H	0.2	2	2.22	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-1	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-1	Zinc, Dissolved, ICP-MS	18.8	ug/L	H	0.5	2.5	18.8	J	unknown
WG150613	FFBLANK	3/8/2017	10	L67231-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150613	FW-EBO	3/7/2017	10	L67231-2	Orthophosphate Phosphorus	0.579	mg/L	H	0.0025	0.01	0.579	J	unknown
WG150606	FW-EBO	3/7/2017	10	L67231-2	pH	6.8	pH	H			6.8	J	unknown
WG151118	FW-EBO	3/7/2017	10	L67231-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/7/2017	10	L67231-2	Copper, Dissolved, ICP-MS	3.84	ug/L	H	0.2	2	3.84	J	unknown
WG151118	FW-EBO	3/7/2017	10	L67231-2	Lead, Dissolved, ICP-MS	0.29	ug/L	<RDL,H	0.1	0.5	0.29	J	unknown
WG151118	FW-EBO	3/7/2017	10	L67231-2	Zinc, Dissolved, ICP-MS	3.41	ug/L	H	0.5	2.5	3.41	J	unknown
WG150613	FW-WBI	3/7/2017	10	L67231-3	Orthophosphate Phosphorus	0.00828	mg/L	H	0.0005	0.002	0.00828	J	unknown
WG150606	FW-WBI	3/7/2017	10	L67231-3	pH	6.93	pH	H			6.93	J	unknown
WG151071	FW-WBI	3/7/2017	10	L67231-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WBI	3/7/2017	10	L67231-3	Copper, Dissolved, ICP-MS	2.17	ug/L	H	0.2	2	2.17	J	unknown
WG151071	FW-WBI	3/7/2017	10	L67231-3	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG151071	FW-WBI	3/7/2017	10	L67231-3	Zinc, Dissolved, ICP-MS	18.4	ug/L	H	0.5	2.5	18.4	J	unknown
WG150613	FW-WBO	3/7/2017	10	L67231-4	Orthophosphate Phosphorus	2.21	mg/L	H	0.013	0.05	2.21	J	unknown
WG150606	FW-WBO	3/7/2017	10	L67231-4	pH	6.75	pH	H			6.75	J	unknown
WG150618	FW-WBO	3/7/2017	10	L67231-4	Cadmium, Dissolved, ICP-MS	0.052	ug/L	<RDL,H	0.05	0.25	0.052	J	unknown
WG150618	FW-WBO	3/7/2017	10	L67231-4	Copper, Dissolved, ICP-MS	6.18	ug/L	H	0.2	2	6.18	J	unknown
WG150618	FW-WBO	3/7/2017	10	L67231-4	Lead, Dissolved, ICP-MS	1.14	ug/L	H	0.1	0.5	1.14	J	unknown
WG150618	FW-WBO	3/7/2017	10	L67231-4	Zinc, Dissolved, ICP-MS	8.26	ug/L	H	0.5	2.5	8.26	J	unknown
WG150613	FW-WPCI	3/7/2017	10	L67231-5	Orthophosphate Phosphorus	0.00581	mg/L	H	0.0005	0.002	0.00581	J	unknown
WG150606	FW-WPCI	3/7/2017	10	L67231-5	pH	7.12	pH	H			7.12	J	unknown
WG151071	FW-WPCI	3/7/2017	10	L67231-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCI	3/7/2017	10	L67231-5	Copper, Dissolved, ICP-MS	3.1	ug/L	H	0.2	2	3.1	J	unknown
WG151071	FW-WPCI	3/7/2017	10	L67231-5	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG151071	FW-WPCI	3/7/2017	10	L67231-5	Zinc, Dissolved, ICP-MS	21.3	ug/L	H	0.5	2.5	21.3	J	unknown
WG150613	FW-WPCEPO	3/7/2017	10	L67231-6	Orthophosphate Phosphorus	0.0198	mg/L	H	0.0005	0.002	0.0198	J	unknown
WG150606	FW-WPCEPO	3/7/2017	10	L67231-6	pH	7.07	pH	H			7.07	J	unknown
WG151071	FW-WPCEPO	3/7/2017	10	L67231-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCEPO	3/7/2017	10	L67231-6	Copper, Dissolved, ICP-MS	3.36	ug/L	H	0.2	2	3.36	J	unknown
WG151071	FW-WPCEPO	3/7/2017	10	L67231-6	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG151071	FW-WPCEPO	3/7/2017	10	L67231-6	Zinc, Dissolved, ICP-MS	29.4	ug/L	H	0.5	2.5	29.4	J	unknown
WG150613	FW-NFWHC	3/7/2017	10	L67231-7	Orthophosphate Phosphorus	0.0154	mg/L	H	0.0005	0.002	0.0154	J	unknown
WG150606	FW-NFWHC	3/7/2017	10	L67231-7	pH	7.49	pH	H			7.49	J	unknown
WG151071	FW-NFWHC	3/7/2017	10	L67231-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-NFWHC	3/7/2017	10	L67231-7	Copper, Dissolved, ICP-MS	2.45	ug/L	H	0.2	2	2.45	J	unknown
WG151071	FW-NFWHC	3/7/2017	10	L67231-7	Lead, Dissolved, ICP-MS	0.24	ug/L	<RDL,H	0.1	0.5	0.24	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151071	FW-NFWHC	3/7/2017	10	L67231-7	Zinc, Dissolved, ICP-MS	15.4	ug/L	H	0.5	2.5	15.4	J	unknown
WG150613	FW-EBI	3/7/2017	10	L67231-8	Orthophosphate Phosphorus	0.00863	mg/L	H	0.0005	0.002	0.00863	J	unknown
WG150606	FW-EBI	3/7/2017	10	L67231-8	pH	6.98	pH	H			6.98	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-8	Copper, Dissolved, ICP-MS	2.13	ug/L	H	0.2	2	2.13	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-8	Lead, Dissolved, ICP-MS	0.1	ug/L	<RDL,H	0.1	0.5	0.1	J	unknown
WG151071	FW-EBI	3/7/2017	10	L67231-8	Zinc, Dissolved, ICP-MS	18.2	ug/L	H	0.5	2.5	18.2	J	unknown
WG150821	FW-EBI	3/9/2017	11	L67283-1	Orthophosphate Phosphorus	0.00903	mg/L	H	0.0005	0.002	0.00903	J	unknown
WG150639	FW-EBI	3/9/2017	11	L67283-1	pH	6.92	pH	H			6.92	J	unknown
WG151071	FW-EBI	3/9/2017	11	L67283-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-EBI	3/9/2017	11	L67283-1	Copper, Dissolved, ICP-MS	2.3	ug/L	H	0.2	2	2.3	J	unknown
WG151071	FW-EBI	3/9/2017	11	L67283-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-EBI	3/9/2017	11	L67283-1	Zinc, Dissolved, ICP-MS	18.9	ug/L	H	0.5	2.5	18.9	J	unknown
WG150821	FFBLANK	3/10/2017	11	L67283-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150821	FW-EBO	3/9/2017	11	L67283-2	Orthophosphate Phosphorus	0.574	mg/L	H	0.0025	0.01	0.574	J	unknown
WG150639	FW-EBO	3/9/2017	11	L67283-2	pH	6.81	pH	H			6.81	J	unknown
WG151118	FW-EBO	3/9/2017	11	L67283-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/9/2017	11	L67283-2	Copper, Dissolved, ICP-MS	3.71	ug/L	H	0.2	2	3.71	J	unknown
WG151118	FW-EBO	3/9/2017	11	L67283-2	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG151118	FW-EBO	3/9/2017	11	L67283-2	Zinc, Dissolved, ICP-MS	3.29	ug/L	H	0.5	2.5	3.29	J	unknown
WG151028	FW-WBI	3/9/2017	11	L67283-3	Dissolved Organic Carbon	2.13	mg/L	J	0.5	1	2.13	J	unknown
WG150821	FW-WBI	3/9/2017	11	L67283-3	Orthophosphate Phosphorus	0.0082	mg/L	H	0.0005	0.002	0.0082	J	unknown
WG150639	FW-WBI	3/9/2017	11	L67283-3	pH	6.94	pH	H			6.94	J	unknown
WG150957	FW-WBI	3/9/2017	11	L67283-3	Total Organic Carbon	1.24	mg/L	J	0.5	1	1.24	J	unknown
WG151071	FW-WBI	3/9/2017	11	L67283-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WBI	3/9/2017	11	L67283-3	Copper, Dissolved, ICP-MS	2.28	ug/L	H	0.2	2	2.28	J	unknown
WG151071	FW-WBI	3/9/2017	11	L67283-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-WBI	3/9/2017	11	L67283-3	Zinc, Dissolved, ICP-MS	18.7	ug/L	H	0.5	2.5	18.7	J	unknown
WG150821	FW-WBO	3/9/2017	11	L67283-4	Orthophosphate Phosphorus	1.73	mg/L	H	0.01	0.04	1.73	J	unknown
WG150639	FW-WBO	3/9/2017	11	L67283-4	pH	6.74	pH	H			6.74	J	unknown
WG151118	FW-WBO	3/9/2017	11	L67283-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-WBO	3/9/2017	11	L67283-4	Copper, Dissolved, ICP-MS	6.4	ug/L	H	0.2	2	6.4	J	unknown
WG151118	FW-WBO	3/9/2017	11	L67283-4	Lead, Dissolved, ICP-MS	0.37	ug/L	<RDL,H	0.1	0.5	0.37	J	unknown
WG151118	FW-WBO	3/9/2017	11	L67283-4	Zinc, Dissolved, ICP-MS	7.18	ug/L	H	0.5	2.5	7.18	J	unknown
WG150821	FW-WPCI	3/9/2017	11	L67283-5	Orthophosphate Phosphorus	0.00381	mg/L	H	0.0005	0.002	0.00381	J	unknown
WG150639	FW-WPCI	3/9/2017	11	L67283-5	pH	7.09	pH	H			7.09	J	unknown
WG151071	FW-WPCI	3/9/2017	11	L67283-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCI	3/9/2017	11	L67283-5	Copper, Dissolved, ICP-MS	2.6	ug/L	H	0.2	2	2.6	J	unknown
WG151071	FW-WPCI	3/9/2017	11	L67283-5	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG151071	FW-WPCI	3/9/2017	11	L67283-5	Zinc, Dissolved, ICP-MS	23.5	ug/L	H	0.5	2.5	23.5	J	unknown
WG150821	FW-WPCEPO	3/9/2017	11	L67283-6	Orthophosphate Phosphorus	0.0205	mg/L	H	0.0005	0.002	0.0205	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150639	FW-WPCEPO	3/9/2017	11	L67283-6	pH	6.99	pH	H			6.99	J	unknown
WG151071	FW-WPCEPO	3/9/2017	11	L67283-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCEPO	3/9/2017	11	L67283-6	Copper, Dissolved, ICP-MS	3.14	ug/L	H	0.2	2	3.14	J	unknown
WG151071	FW-WPCEPO	3/9/2017	11	L67283-6	Lead, Dissolved, ICP-MS	0.16	ug/L	<RDL,H	0.1	0.5	0.16	J	unknown
WG151071	FW-WPCEPO	3/9/2017	11	L67283-6	Zinc, Dissolved, ICP-MS	30.7	ug/L	H	0.5	2.5	30.7	J	unknown
WG150821	FW-NFWHC	3/9/2017	11	L67283-7	Orthophosphate Phosphorus	0.0164	mg/L	H	0.0005	0.002	0.0164	J	unknown
WG150639	FW-NFWHC	3/9/2017	11	L67283-7	pH	7.41	pH	H			7.41	J	unknown
WG151071	FW-NFWHC	3/9/2017	11	L67283-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-NFWHC	3/9/2017	11	L67283-7	Copper, Dissolved, ICP-MS	2.41	ug/L	H	0.2	2	2.41	J	unknown
WG151071	FW-NFWHC	3/9/2017	11	L67283-7	Lead, Dissolved, ICP-MS	0.2	ug/L	<RDL,H	0.1	0.5	0.2	J	unknown
WG151071	FW-NFWHC	3/9/2017	11	L67283-7	Zinc, Dissolved, ICP-MS	15.8	ug/L	H	0.5	2.5	15.8	J	unknown
WG151071	FW-EBI	3/13/2017	12	L67313-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-EBI	3/13/2017	12	L67313-1	Copper, Dissolved, ICP-MS	3.61	ug/L	H	0.2	2	3.61	J	unknown
WG151071	FW-EBI	3/13/2017	12	L67313-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-EBI	3/13/2017	12	L67313-1	Zinc, Dissolved, ICP-MS	19.8	ug/L	H	0.5	2.5	19.8	J	unknown
WG150821	FFBLANK	3/14/2017	12	L67313-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150821	FW-EBO	3/13/2017	12	L67313-2	Orthophosphate Phosphorus	0.566	mg/L	H	0.0025	0.01	0.566	J	unknown
WG150765	FW-EBO	3/13/2017	12	L67313-2	pH	7.06	pH	H			7.06	J	unknown
WG151118	FW-EBO	3/13/2017	12	L67313-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/13/2017	12	L67313-2	Copper, Dissolved, ICP-MS	4.25	ug/L	H	0.2	2	4.25	J	unknown
WG151118	FW-EBO	3/13/2017	12	L67313-2	Lead, Dissolved, ICP-MS	0.36	ug/L	<RDL,H	0.1	0.5	0.36	J	unknown
WG151118	FW-EBO	3/13/2017	12	L67313-2	Zinc, Dissolved, ICP-MS	3.6	ug/L	H	0.5	2.5	3.6	J	unknown
WG150821	FW-WBI	3/13/2017	12	L67313-3	Orthophosphate Phosphorus	0.00761	mg/L	H	0.0005	0.002	0.00761	J	unknown
WG150765	FW-WBI	3/13/2017	12	L67313-3	pH	6.97	pH	H			6.97	J	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-3	Copper, Dissolved, ICP-MS	3.99	ug/L	H	0.2	2	3.99	J	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-3	Zinc, Dissolved, ICP-MS	19.3	ug/L	H	0.5	2.5	19.3	J	unknown
WG150821	FW-WBO	3/13/2017	12	L67313-4	Orthophosphate Phosphorus	1.72	mg/L	H	0.01	0.04	1.72	J	unknown
WG150765	FW-WBO	3/13/2017	12	L67313-4	pH	6.89	pH	H			6.89	J	unknown
WG151118	FW-WBO	3/13/2017	12	L67313-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-WBO	3/13/2017	12	L67313-4	Copper, Dissolved, ICP-MS	5.74	ug/L	H	0.2	2	5.74	J	unknown
WG151118	FW-WBO	3/13/2017	12	L67313-4	Lead, Dissolved, ICP-MS	0.672	ug/L	H	0.1	0.5	0.672	J	unknown
WG151118	FW-WBO	3/13/2017	12	L67313-4	Zinc, Dissolved, ICP-MS	7.38	ug/L	H	0.5	2.5	7.38	J	unknown
WG150821	FW-WPCI	3/13/2017	12	L67313-5	Orthophosphate Phosphorus	0.00807	mg/L	H	0.0005	0.002	0.00807	J	unknown
WG150765	FW-WPCI	3/13/2017	12	L67313-5	pH	7.14	pH	H			7.14	J	unknown
WG151071	FW-WPCI	3/13/2017	12	L67313-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCI	3/13/2017	12	L67313-5	Copper, Dissolved, ICP-MS	3.48	ug/L	H	0.2	2	3.48	J	unknown
WG151071	FW-WPCI	3/13/2017	12	L67313-5	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG151071	FW-WPCI	3/13/2017	12	L67313-5	Zinc, Dissolved, ICP-MS	25.5	ug/L	H	0.5	2.5	25.5	J	unknown
WG150821	FW-WPCEPO	3/13/2017	12	L67313-6	Orthophosphate Phosphorus	0.0299	mg/L	H	0.0005	0.002	0.0299	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG150765	FW-WPCEPO	3/13/2017	12	L67313-6	pH	7.11	pH	H			7.11	J	unknown
WG151071	FW-WPCEPO	3/13/2017	12	L67313-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCEPO	3/13/2017	12	L67313-6	Copper, Dissolved, ICP-MS	3.32	ug/L	H	0.2	2	3.32	J	unknown
WG151071	FW-WPCEPO	3/13/2017	12	L67313-6	Lead, Dissolved, ICP-MS	0.22	ug/L	<RDL,H	0.1	0.5	0.22	J	unknown
WG151071	FW-WPCEPO	3/13/2017	12	L67313-6	Zinc, Dissolved, ICP-MS	29.8	ug/L	H	0.5	2.5	29.8	J	unknown
WG150821	FW-NFWHC	3/13/2017	12	L67313-7	Orthophosphate Phosphorus	0.0188	mg/L	H	0.0005	0.002	0.0188	J	unknown
WG150765	FW-NFWHC	3/13/2017	12	L67313-7	pH	7.52	pH	H			7.52	J	unknown
WG151071	FW-NFWHC	3/13/2017	12	L67313-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-NFWHC	3/13/2017	12	L67313-7	Copper, Dissolved, ICP-MS	2.46	ug/L	H	0.2	2	2.46	J	unknown
WG151071	FW-NFWHC	3/13/2017	12	L67313-7	Lead, Dissolved, ICP-MS	0.25	ug/L	<RDL,H	0.1	0.5	0.25	J	unknown
WG151071	FW-NFWHC	3/13/2017	12	L67313-7	Zinc, Dissolved, ICP-MS	15.2	ug/L	H	0.5	2.5	15.2	J	unknown
WG150821	FW-WBI	3/13/2017	12	L67313-8	Orthophosphate Phosphorus	0.00823	mg/L	H	0.0005	0.002	0.00823	J	unknown
WG150765	FW-WBI	3/13/2017	12	L67313-8	pH	7	pH	H			7	J	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-8	Copper, Dissolved, ICP-MS	4.01	ug/L	H	0.2	2	4.01	J	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-WBI	3/13/2017	12	L67313-8	Zinc, Dissolved, ICP-MS	18.9	ug/L	H	0.5	2.5	18.9	J	unknown
WG150859	FW-EBI	3/14/2017	13	L67335-1	Orthophosphate Phosphorus	0.00742	mg/L	H	0.0005	0.002	0.00742	J	unknown
WG150789	FW-EBI	3/14/2017	13	L67335-1	pH	7.03	pH	H			7.03	J	unknown
WG151071	FW-EBI	3/14/2017	13	L67335-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-EBI	3/14/2017	13	L67335-1	Copper, Dissolved, ICP-MS	4.27	ug/L	H	0.2	2	4.27	J	unknown
WG151071	FW-EBI	3/14/2017	13	L67335-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-EBI	3/14/2017	13	L67335-1	Zinc, Dissolved, ICP-MS	18.9	ug/L	H	0.5	2.5	18.9	J	unknown
WG150859	FFBLANK	3/16/2017	13	L67335-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150859	FW-EBO	3/14/2017	13	L67335-2	Orthophosphate Phosphorus	0.514	mg/L	H	0.0025	0.01	0.514	J	unknown
WG150789	FW-EBO	3/14/2017	13	L67335-2	pH	7.03	pH	H			7.03	J	unknown
WG151118	FW-EBO	3/14/2017	13	L67335-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/14/2017	13	L67335-2	Copper, Dissolved, ICP-MS	3.89	ug/L	H	0.2	2	3.89	J	unknown
WG151118	FW-EBO	3/14/2017	13	L67335-2	Lead, Dissolved, ICP-MS	0.2	ug/L	<RDL,H	0.1	0.5	0.2	J	unknown
WG151118	FW-EBO	3/14/2017	13	L67335-2	Zinc, Dissolved, ICP-MS	3.1	ug/L	H	0.5	2.5	3.1	J	unknown
WG150859	FW-WBI	3/14/2017	13	L67335-3	Orthophosphate Phosphorus	0.00802	mg/L	H	0.0005	0.002	0.00802	J	unknown
WG150789	FW-WBI	3/14/2017	13	L67335-3	pH	7.04	pH	H			7.04	J	unknown
WG151071	FW-WBI	3/14/2017	13	L67335-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WBI	3/14/2017	13	L67335-3	Copper, Dissolved, ICP-MS	4.23	ug/L	H	0.2	2	4.23	J	unknown
WG151071	FW-WBI	3/14/2017	13	L67335-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151071	FW-WBI	3/14/2017	13	L67335-3	Zinc, Dissolved, ICP-MS	18.5	ug/L	H	0.5	2.5	18.5	J	unknown
WG150859	FW-WBO	3/14/2017	13	L67335-4	Orthophosphate Phosphorus	1.53	mg/L	H	0.01	0.04	1.53	J	unknown
WG150789	FW-WBO	3/14/2017	13	L67335-4	pH	7.01	pH	H			7.01	J	unknown
WG151118	FW-WBO	3/14/2017	13	L67335-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-WBO	3/14/2017	13	L67335-4	Copper, Dissolved, ICP-MS	5.49	ug/L	H	0.2	2	5.49	J	unknown
WG151118	FW-WBO	3/14/2017	13	L67335-4	Lead, Dissolved, ICP-MS	0.47	ug/L	<RDL,H	0.1	0.5	0.47	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151118	FW-WBO	3/14/2017	13	L67335-4	Zinc, Dissolved, ICP-MS	6.91	ug/L	H	0.5	2.5	6.91	J	unknown
WG150859	FW-WPCI	3/14/2017	13	L67335-5	Orthophosphate Phosphorus	0.00481	mg/L	H	0.0005	0.002	0.00481	J	unknown
WG150789	FW-WPCI	3/14/2017	13	L67335-5	pH	7.11	pH	H			7.11	J	unknown
WG151071	FW-WPCI	3/14/2017	13	L67335-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151071	FW-WPCI	3/14/2017	13	L67335-5	Copper, Dissolved, ICP-MS	3.08	ug/L	H	0.2	2	3.08	J	unknown
WG151071	FW-WPCI	3/14/2017	13	L67335-5	Lead, Dissolved, ICP-MS	0.37	ug/L	<RDL,H	0.1	0.5	0.37	J	unknown
WG151071	FW-WPCI	3/14/2017	13	L67335-5	Zinc, Dissolved, ICP-MS	26.4	ug/L	H	0.5	2.5	26.4	J	unknown
WG150859	FW-WPCEPO	3/14/2017	13	L67335-6	Orthophosphate Phosphorus	0.0219	mg/L	H	0.0005	0.002	0.0219	J	unknown
WG150789	FW-WPCEPO	3/14/2017	13	L67335-6	pH	7.12	pH	H			7.12	J	unknown
WG151091	FW-WPCEPO	3/14/2017	13	L67335-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WPCEPO	3/14/2017	13	L67335-6	Copper, Dissolved, ICP-MS	2.8	ug/L	H	0.2	2	2.8	J	unknown
WG151091	FW-WPCEPO	3/14/2017	13	L67335-6	Lead, Dissolved, ICP-MS	0.16	ug/L	<RDL,H	0.1	0.5	0.16	J	unknown
WG151091	FW-WPCEPO	3/14/2017	13	L67335-6	Zinc, Dissolved, ICP-MS	29.2	ug/L	H	0.5	2.5	29.2	J	unknown
WG150859	FW-NFWHC	3/14/2017	13	L67335-7	Orthophosphate Phosphorus	0.0188	mg/L	H	0.0005	0.002	0.0188	J	unknown
WG150789	FW-NFWHC	3/14/2017	13	L67335-7	pH	7.49	pH	H			7.49	J	unknown
WG151091	FW-NFWHC	3/14/2017	13	L67335-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-NFWHC	3/14/2017	13	L67335-7	Copper, Dissolved, ICP-MS	2.49	ug/L	H	0.2	2	2.49	J	unknown
WG151091	FW-NFWHC	3/14/2017	13	L67335-7	Lead, Dissolved, ICP-MS	0.24	ug/L	<RDL,H	0.1	0.5	0.24	J	unknown
WG151091	FW-NFWHC	3/14/2017	13	L67335-7	Zinc, Dissolved, ICP-MS	14.9	ug/L	H	0.5	2.5	14.9	J	unknown
WG150859	FW-WBI	3/14/2017	13	L67335-8	Orthophosphate Phosphorus	0.00752	mg/L	H	0.0005	0.002	0.00752	J	unknown
WG150789	FW-WBI	3/14/2017	13	L67335-8	pH	6.95	pH	H			6.95	J	unknown
WG151091	FW-WBI	3/14/2017	13	L67335-8	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WBI	3/14/2017	13	L67335-8	Copper, Dissolved, ICP-MS	3.93	ug/L	H	0.2	2	3.93	J	unknown
WG151091	FW-WBI	3/14/2017	13	L67335-8	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151091	FW-WBI	3/14/2017	13	L67335-8	Zinc, Dissolved, ICP-MS	17	ug/L	H	0.5	2.5	17	J	unknown
WG150997	FW-EBI	3/26/2017	14	L67398-1	Orthophosphate Phosphorus	0.00785	mg/L	H	0.0005	0.002	0.00785	J	unknown
WG150969	FW-EBI	3/26/2017	14	L67398-1	pH	7.15	pH	H			7.15	J	unknown
WG151091	FW-EBI	3/26/2017	14	L67398-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-EBI	3/26/2017	14	L67398-1	Copper, Dissolved, ICP-MS	3.47	ug/L	H	0.2	2	3.47	J	unknown
WG151091	FW-EBI	3/26/2017	14	L67398-1	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG151091	FW-EBI	3/26/2017	14	L67398-1	Zinc, Dissolved, ICP-MS	21.5	ug/L	H	0.5	2.5	21.5	J	unknown
WG150997	FFBLANK	3/27/2017	14	L67398-16	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG150997	FW-EBO	3/26/2017	14	L67398-2	Orthophosphate Phosphorus	0.743	mg/L	H	0.0025	0.01	0.743	J	unknown
WG150969	FW-EBO	3/26/2017	14	L67398-2	pH	6.72	pH	H			6.72	J	unknown
WG151118	FW-EBO	3/26/2017	14	L67398-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/26/2017	14	L67398-2	Copper, Dissolved, ICP-MS	5.13	ug/L	H	0.2	2	5.13	J	unknown
WG151118	FW-EBO	3/26/2017	14	L67398-2	Lead, Dissolved, ICP-MS	0.43	ug/L	<RDL,H	0.1	0.5	0.43	J	unknown
WG151118	FW-EBO	3/26/2017	14	L67398-2	Zinc, Dissolved, ICP-MS	4.76	ug/L	H	0.5	2.5	4.76	J	unknown
WG150997	FW-WBI	3/26/2017	14	L67398-3	Orthophosphate Phosphorus	0.00909	mg/L	H	0.0005	0.002	0.00909	J	unknown
WG150969	FW-WBI	3/26/2017	14	L67398-3	pH	7	pH	H			7	J	unknown
WG151091	FW-WBI	3/26/2017	14	L67398-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151091	FW-WBI	3/26/2017	14	L67398-3	Copper, Dissolved, ICP-MS	3.67	ug/L	H	0.2	2	3.67	J	unknown
WG151091	FW-WBI	3/26/2017	14	L67398-3	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG151091	FW-WBI	3/26/2017	14	L67398-3	Zinc, Dissolved, ICP-MS	22.1	ug/L	H	0.5	2.5	22.1	J	unknown
WG150997	FW-WBO	3/26/2017	14	L67398-4	Orthophosphate Phosphorus	2.02	mg/L	H	0.01	0.04	2.02	J	unknown
WG150969	FW-WBO	3/26/2017	14	L67398-4	pH	6.71	pH	H			6.71	J	unknown
WG151118	FW-WBO	3/26/2017	14	L67398-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-WBO	3/26/2017	14	L67398-4	Copper, Dissolved, ICP-MS	6.09	ug/L	H	0.2	2	6.09	J	unknown
WG151118	FW-WBO	3/26/2017	14	L67398-4	Lead, Dissolved, ICP-MS	1.01	ug/L	H	0.1	0.5	1.01	J	unknown
WG151118	FW-WBO	3/26/2017	14	L67398-4	Zinc, Dissolved, ICP-MS	8.26	ug/L	H	0.5	2.5	8.26	J	unknown
WG150997	FW-WPCI	3/26/2017	14	L67398-5	Orthophosphate Phosphorus	0.00553	mg/L	H	0.0005	0.002	0.00553	J	unknown
WG150969	FW-WPCI	3/26/2017	14	L67398-5	pH	7.07	pH	H			7.07	J	unknown
WG151091	FW-WPCI	3/26/2017	14	L67398-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WPCI	3/26/2017	14	L67398-5	Copper, Dissolved, ICP-MS	3.8	ug/L	H	0.2	2	3.8	J	unknown
WG151091	FW-WPCI	3/26/2017	14	L67398-5	Lead, Dissolved, ICP-MS	0.16	ug/L	<RDL,H	0.1	0.5	0.16	J	unknown
WG151091	FW-WPCI	3/26/2017	14	L67398-5	Zinc, Dissolved, ICP-MS	31.9	ug/L	H	0.5	2.5	31.9	J	unknown
WG150997	FW-WPCEPO	3/26/2017	14	L67398-6	Orthophosphate Phosphorus	0.0205	mg/L	H	0.0005	0.002	0.0205	J	unknown
WG150969	FW-WPCEPO	3/26/2017	14	L67398-6	pH	7.18	pH	H			7.18	J	unknown
WG151091	FW-WPCEPO	3/26/2017	14	L67398-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WPCEPO	3/26/2017	14	L67398-6	Copper, Dissolved, ICP-MS	3.24	ug/L	H	0.2	2	3.24	J	unknown
WG151091	FW-WPCEPO	3/26/2017	14	L67398-6	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG151091	FW-WPCEPO	3/26/2017	14	L67398-6	Zinc, Dissolved, ICP-MS	28.2	ug/L	H	0.5	2.5	28.2	J	unknown
WG150997	FW-NFWHC	3/26/2017	14	L67398-7	Orthophosphate Phosphorus	0.014	mg/L	H	0.0005	0.002	0.014	J	unknown
WG150969	FW-NFWHC	3/26/2017	14	L67398-7	pH	7.61	pH	H			7.61	J	unknown
WG151091	FW-NFWHC	3/26/2017	14	L67398-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-NFWHC	3/26/2017	14	L67398-7	Copper, Dissolved, ICP-MS	1.9	ug/L	<RDL,H	0.2	2	1.9	J	unknown
WG151091	FW-NFWHC	3/26/2017	14	L67398-7	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG151091	FW-NFWHC	3/26/2017	14	L67398-7	Zinc, Dissolved, ICP-MS	12.5	ug/L	H	0.5	2.5	12.5	J	unknown
WG150997	FW-EBI	3/29/2017	15	L67443-1	Orthophosphate Phosphorus	0.00696	mg/L	H	0.0005	0.002	0.00696	J	unknown
WG151030	FW-EBI	3/29/2017	15	L67443-1	pH	6.95	pH	H			6.95	J	unknown
WG151091	FW-EBI	3/29/2017	15	L67443-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-EBI	3/29/2017	15	L67443-1	Copper, Dissolved, ICP-MS	2.35	ug/L	H	0.2	2	2.35	J	unknown
WG151091	FW-EBI	3/29/2017	15	L67443-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151091	FW-EBI	3/29/2017	15	L67443-1	Zinc, Dissolved, ICP-MS	18.8	ug/L	H	0.5	2.5	18.8	J	unknown
WG151046	FW-EBI	3/29/2017	15	L67443-1	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FW-EBO	3/29/2017	15	L67443-2	Orthophosphate Phosphorus	0.658	mg/L	H	0.0025	0.01	0.658	J	unknown
WG151030	FW-EBO	3/29/2017	15	L67443-2	pH	6.84	pH	H			6.84	J	unknown
WG151118	FW-EBO	3/29/2017	15	L67443-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-EBO	3/29/2017	15	L67443-2	Copper, Dissolved, ICP-MS	4.1	ug/L	H	0.2	2	4.1	J	unknown
WG151118	FW-EBO	3/29/2017	15	L67443-2	Lead, Dissolved, ICP-MS	0.27	ug/L	<RDL,H	0.1	0.5	0.27	J	unknown
WG151118	FW-EBO	3/29/2017	15	L67443-2	Zinc, Dissolved, ICP-MS	3.88	ug/L	H	0.5	2.5	3.88	J	unknown
WG151046	FW-EBO	3/29/2017	15	L67443-2	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151556	FW-WBI	3/29/2017	15	L67443-3	Dissolved Organic Carbon	1.73	mg/L	TA	0.5	1	1.73	J	unknown
WG150997	FW-WBI	3/29/2017	15	L67443-3	Orthophosphate Phosphorus	0.00663	mg/L	H	0.0005	0.002	0.00663	J	unknown
WG151030	FW-WBI	3/29/2017	15	L67443-3	pH	7	pH	H			7	J	unknown
WG151433	FW-WBI	3/29/2017	15	L67443-3	Total Organic Carbon	1.29	mg/L	TA	0.5	1	1.29	J	unknown
WG151091	FW-WBI	3/29/2017	15	L67443-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WBI	3/29/2017	15	L67443-3	Copper, Dissolved, ICP-MS	2.41	ug/L	H	0.2	2	2.41	J	unknown
WG151091	FW-WBI	3/29/2017	15	L67443-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151091	FW-WBI	3/29/2017	15	L67443-3	Zinc, Dissolved, ICP-MS	19	ug/L	H	0.5	2.5	19	J	unknown
WG151046	FW-WBI	3/29/2017	15	L67443-3	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FW-WBO	3/29/2017	15	L67443-4	Orthophosphate Phosphorus	1.72	mg/L	H	0.01	0.04	1.72	J	unknown
WG151030	FW-WBO	3/29/2017	15	L67443-4	pH	6.69	pH	H			6.69	J	unknown
WG151118	FW-WBO	3/29/2017	15	L67443-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151118	FW-WBO	3/29/2017	15	L67443-4	Copper, Dissolved, ICP-MS	5.05	ug/L	H	0.2	2	5.05	J	unknown
WG151118	FW-WBO	3/29/2017	15	L67443-4	Lead, Dissolved, ICP-MS	0.654	ug/L	H	0.1	0.5	0.654	J	unknown
WG151118	FW-WBO	3/29/2017	15	L67443-4	Zinc, Dissolved, ICP-MS	7.75	ug/L	H	0.5	2.5	7.75	J	unknown
WG151046	FW-WBO	3/29/2017	15	L67443-4	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FW-WPCI	3/29/2017	15	L67443-5	Orthophosphate Phosphorus	0.00286	mg/L	H	0.0005	0.002	0.00286	J	unknown
WG151030	FW-WPCI	3/29/2017	15	L67443-5	pH	7.05	pH	H			7.05	J	unknown
WG151091	FW-WPCI	3/29/2017	15	L67443-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WPCI	3/29/2017	15	L67443-5	Copper, Dissolved, ICP-MS	2.37	ug/L	H	0.2	2	2.37	J	unknown
WG151091	FW-WPCI	3/29/2017	15	L67443-5	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151091	FW-WPCI	3/29/2017	15	L67443-5	Zinc, Dissolved, ICP-MS	25.8	ug/L	H	0.5	2.5	25.8	J	unknown
WG151046	FW-WPCI	3/29/2017	15	L67443-5	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FW-WPCEPO	3/29/2017	15	L67443-6	Orthophosphate Phosphorus	0.0295	mg/L	H	0.0005	0.002	0.0295	J	unknown
WG151030	FW-WPCEPO	3/29/2017	15	L67443-6	pH	7.18	pH	H			7.18	J	unknown
WG151091	FW-WPCEPO	3/29/2017	15	L67443-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-WPCEPO	3/29/2017	15	L67443-6	Copper, Dissolved, ICP-MS	2.93	ug/L	H	0.2	2	2.93	J	unknown
WG151091	FW-WPCEPO	3/29/2017	15	L67443-6	Lead, Dissolved, ICP-MS	0.18	ug/L	<RDL,H	0.1	0.5	0.18	J	unknown
WG151091	FW-WPCEPO	3/29/2017	15	L67443-6	Zinc, Dissolved, ICP-MS	32	ug/L	H	0.5	2.5	32	J	unknown
WG151046	FW-WPCEPO	3/29/2017	15	L67443-6	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FW-NFWHC	3/29/2017	15	L67443-7	Orthophosphate Phosphorus	0.0191	mg/L	H	0.0005	0.002	0.0191	J	unknown
WG151030	FW-NFWHC	3/29/2017	15	L67443-7	pH	7.65	pH	H			7.65	J	unknown
WG151091	FW-NFWHC	3/29/2017	15	L67443-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151091	FW-NFWHC	3/29/2017	15	L67443-7	Copper, Dissolved, ICP-MS	2.32	ug/L	H	0.2	2	2.32	J	unknown
WG151091	FW-NFWHC	3/29/2017	15	L67443-7	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG151091	FW-NFWHC	3/29/2017	15	L67443-7	Zinc, Dissolved, ICP-MS	14.6	ug/L	H	0.5	2.5	14.6	J	unknown
WG151046	FW-NFWHC	3/29/2017	15	L67443-7	Acenaphthylene		ug/L	<MDL,JG	0.0047	0.0236	0.0047	UJ	low
WG150997	FFBLANK	3/30/2017	15	L67443-8	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG151139	FW-EBI	4/5/2017	16	L67499-1	Orthophosphate Phosphorus	0.0109	mg/L	H	0.0005	0.002	0.0109	J	unknown
WG151168	FW-EBI	4/5/2017	16	L67499-1	pH	7.02	pH	H			7.02	J	unknown
WG151663	FW-EBI	4/5/2017	16	L67499-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151663	FW-EBI	4/5/2017	16	L67499-1	Copper, Dissolved, ICP-MS	2.99	ug/L	H	0.2	2	2.99	J	unknown
WG151663	FW-EBI	4/5/2017	16	L67499-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151663	FW-EBI	4/5/2017	16	L67499-1	Zinc, Dissolved, ICP-MS	24.3	ug/L	H	0.5	2.5	24.3	J	unknown
WG151139	FW-EBO	4/5/2017	16	L67499-2	Orthophosphate Phosphorus	0.74	mg/L	H	0.01	0.04	0.74	J	unknown
WG151168	FW-EBO	4/5/2017	16	L67499-2	pH	6.77	pH	H			6.77	J	unknown
WG151685	FW-EBO	4/5/2017	16	L67499-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151685	FW-EBO	4/5/2017	16	L67499-2	Copper, Dissolved, ICP-MS	4.38	ug/L	H	0.2	2	4.38	J	unknown
WG151685	FW-EBO	4/5/2017	16	L67499-2	Lead, Dissolved, ICP-MS	0.29	ug/L	<RDL,H	0.1	0.5	0.29	J	unknown
WG151685	FW-EBO	4/5/2017	16	L67499-2	Zinc, Dissolved, ICP-MS	3.74	ug/L	H	0.5	2.5	3.74	J	unknown
WG151139	FW-WBI	4/5/2017	16	L67499-3	Orthophosphate Phosphorus	0.0124	mg/L	H	0.0005	0.002	0.0124	J	unknown
WG151168	FW-WBI	4/5/2017	16	L67499-3	pH	7.02	pH	H			7.02	J	unknown
WG151663	FW-WBI	4/5/2017	16	L67499-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151663	FW-WBI	4/5/2017	16	L67499-3	Copper, Dissolved, ICP-MS	2.64	ug/L	H	0.2	2	2.64	J	unknown
WG151663	FW-WBI	4/5/2017	16	L67499-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG151663	FW-WBI	4/5/2017	16	L67499-3	Zinc, Dissolved, ICP-MS	24.4	ug/L	H	0.5	2.5	24.4	J	unknown
WG151139	FW-WBO	4/5/2017	16	L67499-4	Orthophosphate Phosphorus	2.01	mg/L	H	0.02	0.08	2.01	J	unknown
WG151168	FW-WBO	4/5/2017	16	L67499-4	pH	6.91	pH	H			6.91	J	unknown
WG151685	FW-WBO	4/5/2017	16	L67499-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151685	FW-WBO	4/5/2017	16	L67499-4	Copper, Dissolved, ICP-MS	5.39	ug/L	H	0.2	2	5.39	J	unknown
WG151685	FW-WBO	4/5/2017	16	L67499-4	Lead, Dissolved, ICP-MS	0.723	ug/L	H	0.1	0.5	0.723	J	unknown
WG151685	FW-WBO	4/5/2017	16	L67499-4	Zinc, Dissolved, ICP-MS	7.11	ug/L	H	0.5	2.5	7.11	J	unknown
WG151139	FW-WPCI	4/5/2017	16	L67499-5	Orthophosphate Phosphorus	0.00524	mg/L	H	0.0005	0.002	0.00524	J	unknown
WG151168	FW-WPCI	4/5/2017	16	L67499-5	pH	7.11	pH	H			7.11	J	unknown
WG151663	FW-WPCI	4/5/2017	16	L67499-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151663	FW-WPCI	4/5/2017	16	L67499-5	Copper, Dissolved, ICP-MS	4.38	ug/L	H	0.2	2	4.38	J	unknown
WG151663	FW-WPCI	4/5/2017	16	L67499-5	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG151663	FW-WPCI	4/5/2017	16	L67499-5	Zinc, Dissolved, ICP-MS	28.2	ug/L	H	0.5	2.5	28.2	J	unknown
WG151139	FW-WPCEPO	4/5/2017	16	L67499-6	Orthophosphate Phosphorus	0.0207	mg/L	H	0.0005	0.002	0.0207	J	unknown
WG151168	FW-WPCEPO	4/5/2017	16	L67499-6	pH	7.35	pH	H			7.35	J	unknown
WG151663	FW-WPCEPO	4/5/2017	16	L67499-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151663	FW-WPCEPO	4/5/2017	16	L67499-6	Copper, Dissolved, ICP-MS	3.37	ug/L	H	0.2	2	3.37	J	unknown
WG151663	FW-WPCEPO	4/5/2017	16	L67499-6	Lead, Dissolved, ICP-MS	0.13	ug/L	<RDL,H	0.1	0.5	0.13	J	unknown
WG151663	FW-WPCEPO	4/5/2017	16	L67499-6	Zinc, Dissolved, ICP-MS	30.9	ug/L	H	0.5	2.5	30.9	J	unknown
WG151139	FW-NFWHC	4/5/2017	16	L67499-7	Orthophosphate Phosphorus	0.0148	mg/L	H	0.0005	0.002	0.0148	J	unknown
WG151168	FW-NFWHC	4/5/2017	16	L67499-7	pH	7.71	pH	H			7.71	J	unknown
WG151663	FW-NFWHC	4/5/2017	16	L67499-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151663	FW-NFWHC	4/5/2017	16	L67499-7	Copper, Dissolved, ICP-MS	2.14	ug/L	H	0.2	2	2.14	J	unknown
WG151663	FW-NFWHC	4/5/2017	16	L67499-7	Lead, Dissolved, ICP-MS	0.16	ug/L	<RDL,H	0.1	0.5	0.16	J	unknown
WG151663	FW-NFWHC	4/5/2017	16	L67499-7	Zinc, Dissolved, ICP-MS	14.3	ug/L	H	0.5	2.5	14.3	J	unknown
WG151139	FFBLANK	4/6/2017	16	L67499-8	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG151474	FW-EBI	4/19/2017	17	L67594-1	Orthophosphate Phosphorus	0.0102	mg/L	H	0.0005	0.002	0.0102	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151426	FW-EBI	4/19/2017	17	L67594-1	pH	6.95	pH	H			6.95	J	unknown
WG152026	FW-EBI	4/19/2017	17	L67594-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-EBI	4/19/2017	17	L67594-1	Copper, Dissolved, ICP-MS	3.33	ug/L	H	0.2	2	3.33	J	unknown
WG152026	FW-EBI	4/19/2017	17	L67594-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG152026	FW-EBI	4/19/2017	17	L67594-1	Zinc, Dissolved, ICP-MS	24.6	ug/L	H	0.5	2.5	24.6	J	unknown
WG151474	FW-EBO	4/19/2017	17	L67594-2	Orthophosphate Phosphorus	0.741	mg/L	H	0.005	0.02	0.741	J	unknown
WG151426	FW-EBO	4/19/2017	17	L67594-2	pH	6.84	pH	H			6.84	J	unknown
WG151685	FW-EBO	4/19/2017	17	L67594-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151685	FW-EBO	4/19/2017	17	L67594-2	Copper, Dissolved, ICP-MS	3.64	ug/L	H	0.2	2	3.64	J	unknown
WG151685	FW-EBO	4/19/2017	17	L67594-2	Lead, Dissolved, ICP-MS	0.21	ug/L	<RDL,H	0.1	0.5	0.21	J	unknown
WG151685	FW-EBO	4/19/2017	17	L67594-2	Zinc, Dissolved, ICP-MS	3.84	ug/L	H	0.5	2.5	3.84	J	unknown
WG151474	FW-WBI	4/19/2017	17	L67594-3	Orthophosphate Phosphorus	0.0101	mg/L	H	0.0005	0.002	0.0101	J	unknown
WG151426	FW-WBI	4/19/2017	17	L67594-3	pH	6.95	pH	H			6.95	J	unknown
WG152026	FW-WBI	4/19/2017	17	L67594-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WBI	4/19/2017	17	L67594-3	Copper, Dissolved, ICP-MS	3.4	ug/L	H	0.2	2	3.4	J	unknown
WG152026	FW-WBI	4/19/2017	17	L67594-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG152026	FW-WBI	4/19/2017	17	L67594-3	Zinc, Dissolved, ICP-MS	25.4	ug/L	H	0.5	2.5	25.4	J	unknown
WG151474	FW-WBO	4/19/2017	17	L67594-4	Orthophosphate Phosphorus	2.1	mg/L	H	0.01	0.04	2.1	J	unknown
WG151426	FW-WBO	4/19/2017	17	L67594-4	pH	6.76	pH	H			6.76	J	unknown
WG151685	FW-WBO	4/19/2017	17	L67594-4	Cadmium, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.05	0.25	0.15	J	unknown
WG151685	FW-WBO	4/19/2017	17	L67594-4	Copper, Dissolved, ICP-MS	5.22	ug/L	H	0.2	2	5.22	J	unknown
WG151685	FW-WBO	4/19/2017	17	L67594-4	Lead, Dissolved, ICP-MS	0.695	ug/L	H	0.1	0.5	0.695	J	unknown
WG151685	FW-WBO	4/19/2017	17	L67594-4	Zinc, Dissolved, ICP-MS	8.57	ug/L	H	0.5	2.5	8.57	J	unknown
WG151474	FW-WPCI	4/19/2017	17	L67594-5	Orthophosphate Phosphorus	0.00455	mg/L	H	0.0005	0.002	0.00455	J	unknown
WG151426	FW-WPCI	4/19/2017	17	L67594-5	pH	7.04	pH	H			7.04	J	unknown
WG152026	FW-WPCI	4/19/2017	17	L67594-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WPCI	4/19/2017	17	L67594-5	Copper, Dissolved, ICP-MS	3.6	ug/L	H	0.2	2	3.6	J	unknown
WG152026	FW-WPCI	4/19/2017	17	L67594-5	Lead, Dissolved, ICP-MS	0.12	ug/L	<RDL,H	0.1	0.5	0.12	J	unknown
WG152026	FW-WPCI	4/19/2017	17	L67594-5	Zinc, Dissolved, ICP-MS	27.6	ug/L	H	0.5	2.5	27.6	J	unknown
WG151474	FW-WPCEPO	4/19/2017	17	L67594-6	Orthophosphate Phosphorus	0.0343	mg/L	H	0.0005	0.002	0.0343	J	unknown
WG151426	FW-WPCEPO	4/19/2017	17	L67594-6	pH	7.25	pH	H			7.25	J	unknown
WG152026	FW-WPCEPO	4/19/2017	17	L67594-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WPCEPO	4/19/2017	17	L67594-6	Copper, Dissolved, ICP-MS	3.32	ug/L	H	0.2	2	3.32	J	unknown
WG152026	FW-WPCEPO	4/19/2017	17	L67594-6	Lead, Dissolved, ICP-MS	0.18	ug/L	<RDL,H	0.1	0.5	0.18	J	unknown
WG152026	FW-WPCEPO	4/19/2017	17	L67594-6	Zinc, Dissolved, ICP-MS	32.4	ug/L	H	0.5	2.5	32.4	J	unknown
WG151474	FW-NFWHC	4/19/2017	17	L67594-7	Orthophosphate Phosphorus	0.0187	mg/L	H	0.0005	0.002	0.0187	J	unknown
WG151426	FW-NFWHC	4/19/2017	17	L67594-7	pH	7.67	pH	H			7.67	J	unknown
WG152026	FW-NFWHC	4/19/2017	17	L67594-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-NFWHC	4/19/2017	17	L67594-7	Copper, Dissolved, ICP-MS	2.63	ug/L	H	0.2	2	2.63	J	unknown
WG152026	FW-NFWHC	4/19/2017	17	L67594-7	Lead, Dissolved, ICP-MS	0.18	ug/L	<RDL,H	0.1	0.5	0.18	J	unknown
WG152026	FW-NFWHC	4/19/2017	17	L67594-7	Zinc, Dissolved, ICP-MS	12.3	ug/L	H	0.5	2.5	12.3	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG151474	FFBLANK	4/20/2017	17	L67594-8	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG151474	FW-EBI	4/23/2017	18	L67617-1	Orthophosphate Phosphorus	0.0146	mg/L	H	0.0005	0.002	0.0146	J	unknown
WG151481	FW-EBI	4/23/2017	18	L67617-1	pH	7	pH	H			7	J	unknown
WG152026	FW-EBI	4/23/2017	18	L67617-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-EBI	4/23/2017	18	L67617-1	Copper, Dissolved, ICP-MS	3.78	ug/L	H	0.2	2	3.78	J	unknown
WG152026	FW-EBI	4/23/2017	18	L67617-1	Lead, Dissolved, ICP-MS	0.11	ug/L	<RDL,H	0.1	0.5	0.11	J	unknown
WG152026	FW-EBI	4/23/2017	18	L67617-1	Zinc, Dissolved, ICP-MS	25	ug/L	H	0.5	2.5	25	J	unknown
WG151474	FW-EBO	4/23/2017	18	L67617-2	Orthophosphate Phosphorus	0.8	mg/L	H	0.005	0.02	0.8	J	unknown
WG151481	FW-EBO	4/23/2017	18	L67617-2	pH	6.96	pH	H			6.96	J	unknown
WG151685	FW-EBO	4/23/2017	18	L67617-2	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151685	FW-EBO	4/23/2017	18	L67617-2	Copper, Dissolved, ICP-MS	3.77	ug/L	H	0.2	2	3.77	J	unknown
WG151685	FW-EBO	4/23/2017	18	L67617-2	Lead, Dissolved, ICP-MS	0.24	ug/L	<RDL,H	0.1	0.5	0.24	J	unknown
WG151685	FW-EBO	4/23/2017	18	L67617-2	Zinc, Dissolved, ICP-MS	3.57	ug/L	H	0.5	2.5	3.57	J	unknown
WG151474	FW-WBI	4/23/2017	18	L67617-3	Orthophosphate Phosphorus	0.0135	mg/L	H	0.0005	0.002	0.0135	J	unknown
WG151481	FW-WBI	4/23/2017	18	L67617-3	pH	6.99	pH	H			6.99	J	unknown
WG152026	FW-WBI	4/23/2017	18	L67617-3	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WBI	4/23/2017	18	L67617-3	Copper, Dissolved, ICP-MS	3.38	ug/L	H	0.2	2	3.38	J	unknown
WG152026	FW-WBI	4/23/2017	18	L67617-3	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG152026	FW-WBI	4/23/2017	18	L67617-3	Zinc, Dissolved, ICP-MS	24.4	ug/L	H	0.5	2.5	24.4	J	unknown
WG151474	FW-WBO	4/23/2017	18	L67617-4	Orthophosphate Phosphorus	2.14	mg/L	H	0.01	0.04	2.14	J	unknown
WG151481	FW-WBO	4/23/2017	18	L67617-4	pH	6.95	pH	H			6.95	J	unknown
WG151685	FW-WBO	4/23/2017	18	L67617-4	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG151685	FW-WBO	4/23/2017	18	L67617-4	Copper, Dissolved, ICP-MS	4.57	ug/L	H	0.2	2	4.57	J	unknown
WG151685	FW-WBO	4/23/2017	18	L67617-4	Lead, Dissolved, ICP-MS	0.642	ug/L	H	0.1	0.5	0.642	J	unknown
WG151685	FW-WBO	4/23/2017	18	L67617-4	Zinc, Dissolved, ICP-MS	7.47	ug/L	H	0.5	2.5	7.47	J	unknown
WG151474	FW-WPCI	4/23/2017	18	L67617-5	Orthophosphate Phosphorus	0.00314	mg/L	H	0.0005	0.002	0.00314	J	unknown
WG151481	FW-WPCI	4/23/2017	18	L67617-5	pH	7	pH	H			7	J	unknown
WG152026	FW-WPCI	4/23/2017	18	L67617-5	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WPCI	4/23/2017	18	L67617-5	Copper, Dissolved, ICP-MS	4.65	ug/L	H	0.2	2	4.65	J	unknown
WG152026	FW-WPCI	4/23/2017	18	L67617-5	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG152026	FW-WPCI	4/23/2017	18	L67617-5	Zinc, Dissolved, ICP-MS	27.9	ug/L	H	0.5	2.5	27.9	J	unknown
WG151474	FW-WPCEPO	4/23/2017	18	L67617-6	Orthophosphate Phosphorus	0.0172	mg/L	H	0.0005	0.002	0.0172	J	unknown
WG151481	FW-WPCEPO	4/23/2017	18	L67617-6	pH	7.22	pH	H			7.22	J	unknown
WG152026	FW-WPCEPO	4/23/2017	18	L67617-6	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-WPCEPO	4/23/2017	18	L67617-6	Copper, Dissolved, ICP-MS	3.3	ug/L	H	0.2	2	3.3	J	unknown
WG152026	FW-WPCEPO	4/23/2017	18	L67617-6	Lead, Dissolved, ICP-MS	0.15	ug/L	<RDL,H	0.1	0.5	0.15	J	unknown
WG152026	FW-WPCEPO	4/23/2017	18	L67617-6	Zinc, Dissolved, ICP-MS	29.2	ug/L	H	0.5	2.5	29.2	J	unknown
WG151474	FW-NFWHC	4/23/2017	18	L67617-7	Orthophosphate Phosphorus	0.0166	mg/L	H	0.0005	0.002	0.0166	J	unknown
WG151481	FW-NFWHC	4/23/2017	18	L67617-7	pH	7.7	pH	H			7.7	J	unknown
WG152026	FW-NFWHC	4/23/2017	18	L67617-7	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	FW-NFWHC	4/23/2017	18	L67617-7	Copper, Dissolved, ICP-MS	2.42	ug/L	H	0.2	2	2.42	J	unknown

Table A. Federal Way Stormwater Monitoring - SAM Effectiveness Study- Data Validation Flags and Bias Notation

Workgroup	Locator	Collect Date	Storm #	Sample ID	Parameter	NUMVALUE	Units	Lab Qual	MDL	RDL	DV Value	DV Qual	DV Bias
WG152026	FW-NFWHC	4/23/2017	18	L67617-7	Lead, Dissolved, ICP-MS	0.16	ug/L	<RDL,H	0.1	0.5	0.16	J	unknown
WG152026	FW-NFWHC	4/23/2017	18	L67617-7	Zinc, Dissolved, ICP-MS	12.5	ug/L	H	0.5	2.5	12.5	J	unknown
WG151448	FW-NFWHC	4/23/2017	18	L67617-7	Benzo(a)anthracene		ug/L	<QL	0.024	0.0472	0.024	UJ	low
WG151448	FW-NFWHC	4/23/2017	18	L67617-7	Chrysene		ug/L	<QL	0.024	0.0472	0.024	UJ	low
WG151448	FW-NFWHC	4/23/2017	18	L67617-7	Fluoranthene		ug/L	<QL	0.024	0.0472	0.024	UJ	low
WG151448	FW-NFWHC	4/23/2017	18	L67617-7	Pyrene		ug/L	<QL	0.024	0.0472	0.024	UJ	low
WG151474	FFBLANK	4/24/2017	18	L67617-8	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG151744	EQUIPBLANK	5/8/2017	Blank	L67724-1	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown
WG151995	EQUIPBLANK	5/8/2017	Blank	L67724-1	pH	6.08	pH	H			6.08	J	unknown
WG152026	EQUIPBLANK	5/8/2017	Blank	L67724-1	Cadmium, Dissolved, ICP-MS		ug/L	<MDL,H	0.05	0.25	0.05	UJ	unknown
WG152026	EQUIPBLANK	5/8/2017	Blank	L67724-1	Copper, Dissolved, ICP-MS		ug/L	<MDL,H	0.2	2	0.2	UJ	unknown
WG152026	EQUIPBLANK	5/8/2017	Blank	L67724-1	Lead, Dissolved, ICP-MS		ug/L	<MDL,H	0.1	0.5	0.1	UJ	unknown
WG152026	EQUIPBLANK	5/8/2017	Blank	L67724-1	Zinc, Dissolved, ICP-MS		ug/L	<MDL,H	0.5	2.5	0.5	UJ	unknown
WG151744	FFBLANK	5/8/2017	Blank	L67724-2	Orthophosphate Phosphorus		mg/L	<MDL	0.0005	0.002	0.0005	UJ	unknown

Appendix G3:
PCB Data Validation

LABORATORY DATA CONSULTANTS, INC.
2701 Loker Ave. West, Suite 220, Carlsbad, CA 92010 Bus: 760-827-1100 Fax: 760-827-1099

King County Environmental Laboratory
322 W. Ewing Street
Seattle WA 98119
ATTN: Mr. Fritz Grothkopp

September 9, 2016

SUBJECT: LDW Federal Way SW Monitoring, Data Validation

Dear Mr. Grothkopp,

Enclosed is the final validation report for the fraction listed below. This SDG was received on August 18, 2016. Attachment 1 is a summary of the samples that were reviewed for each analysis.

LDC Project #36926:

SDG #	**Fraction**
PR161851	Polychlorinated Biphenyls as Congeners

The data validation was performed under Level III guidelines. The analyses were validated using the following documents, as applicable to each method:

- Quality Assurance Project Plan: Effectiveness Monitoring of the South 3256th Street Retrofit and Expansion Project, Federal Way, WA, February 2016
- US Environmental Protection Agency Region 10 SOP for the Validation of Polychlorinated Biphenyl Data, Revision 1.0, December 8, 1995

Please feel free to contact us if you have any questions.

Sincerely,

Stella Cuenco

Stella Cuenco
Operations Manager/Senior Chemist

Level III EDD **LDC #36926 (King County - Seattle WA / LDW Federal Way SW Monitoring)** Project #421879-240

LDC	SDG#	DATE REC'D	(3) DATE DUE	PCB Cong. (1668C)																															
Matrix:	Water/Sediment			W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
A	PR161851	08/18/16	09/09/16	10	0																														
Total	T/SC			10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: LDW Federal Way SW Monitoring

LDC Report Date: September 7, 2016

Parameters: Polychlorinated Biphenyls as Congeners

Validation Level: Level III

Laboratory: Pacific Rim Laboratories, Inc.

Sample Delivery Group (SDG): PR161851

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
L65007-1	PR161851	Water	03/09/16
L65007-2	PR161852	Water	03/09/16
L65007-5	PR161853	Water	03/09/16
L65007-6	PR161854	Water	03/09/16
L65007-7	PR161855	Water	03/09/16
L65095-1	PR161856	Water	03/23/16
L65095-2	PR161857	Water	03/23/16
L65095-5	PR161858	Water	03/23/16
L65095-6	PR161859	Water	03/23/16
L65095-7	PR161860	Water	03/23/16
L65095-7DUP	PR161860DUP	Water	03/23/16

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA (February 2016) and US Environmental Protection Agency (EPA) Region 10 SOP for the Validation of Polychlorinated Biphenyl (PCB) Data (Revision 1.0, December 8, 1995). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Polychlorinated Biphenyls (PCBs) as Congeners by Environmental Protection Agency (EPA) Method 1668C

All sample results were subjected to Level III data validation, which comprises an evaluation of quality control (QC) summary results.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

J1 Blank Contamination: Indicates possible high bias and/or false positives.

J2 Calibration Range exceeded: Indicates possible low bias.

J3 Holding times not met: Indicates low bias for most analytes.

J4 Other QC parameters outside control limits: bias not readily determined.

J5 Other QC parameters outside control limits. The reported results appear to be biased high. The actual value of target compound in the sample may be lower than the value reported by the laboratory.

J6 Other QC parameters outside control limits. The reported results appear to be biased low. The actual value of target compound in the sample may be higher than the value reported by the laboratory.

R Quality control indicates the data is not usable.

NJ Presumptive evidence of presence of the compound at an estimated quantity.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition and cooler temperatures upon receipt met validation criteria.

All technical holding time requirements were met.

II. HRGC/HRMS Instrument Performance Check

Instrument performance was checked at the required frequency.

The static resolving power was at least 10,000 (10% valley definition).

III. Initial Calibration and Initial Calibration Verification

A five point initial calibration was performed as required by the method.

The percent relative standard deviations (%RSD) were less than or equal to 20.0% for unlabeled compounds and less than or equal to 35.0% for labeled compounds.

The ion abundance ratios for all compounds were within validation criteria.

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration results were within the QC limits for unlabeled compounds and labeled compounds.

The ion abundance ratios for all compounds were within validation criteria.

V. Laboratory Blanks

Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks with the following exceptions:

Blank ID	Extraction Date	Compound	Concentration	Associated Samples
MBFS06291606	06/25/16	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls	69.8 pg/L 5.87 pg/L 6.3 pg/L 7 pg/L 69.8 pg/L 12.2 pg/L 7 pg/L	All samples in SDG PR161851

Sample concentrations were compared to concentrations detected in the laboratory blanks. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated laboratory blanks with the following exceptions:

Sample	Compound	Reported Concentration	Modified Final Concentration
L65007-1	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	102 pg/L 7.85 pg/L 10.3 pg/L 10.8 pg/L 102 pg/L 33.6 pg/L	102U pg/L 7.85U pg/L 10.3U pg/L 10.8U pg/L 102J pg/L 33.6J pg/L
L65007-2	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	6.51 pg/L 9.87 pg/L 7.86 pg/L 28.1 pg/L 18.2 pg/L	6.51U pg/L 9.87U pg/L 7.86U pg/L 28.1J pg/L 18.2J pg/L
L65007-5	PCB-011 PCB-031 Dichlorobiphenyls	56.4 pg/L 14.6 pg/L 56.4 pg/L	56.4U pg/L 14.6U pg/L 56.4J pg/L
L65007-6	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	33.1 pg/L 7.69 pg/L 14.5 pg/L 27.7 pg/L 33.1 pg/L 44.8 pg/L	33.1U pg/L 7.69U pg/L 14.5U pg/L 27.7U pg/L 33.1J pg/L 44.8J pg/L
L65007-7	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls	8.14 pg/L 15 pg/L 19.3 pg/L 44.2 pg/L	8.14U pg/L 15U pg/L 19.3U pg/L 44.2J pg/L
L65095-1	PCB-011 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls	45.2 pg/L 8.58 pg/L 6.48 pg/L 53.8 pg/L 24.6 pg/L 33.5 pg/L	45.2U pg/L 8.58U pg/L 6.48U pg/L 53.8J pg/L 24.6J pg/L 33.5J pg/L
L65095-2	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls	26.7 pg/L 5.89 pg/L 7.72 pg/L 6.42 pg/L 26.7 pg/L 20.9 pg/L 30.2 pg/L	26.7U pg/L 5.89U pg/L 7.72U pg/L 6.42U pg/L 26.7J pg/L 20.9J pg/L 30.2J pg/L
L65095-5	PCB-011 PCB-031 Dichlorobiphenyls	72.8 pg/L 25.4 pg/L 72.8 pg/L	72.8U pg/L 25.4U pg/L 72.8J pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L65095-6	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	29.9 pg/L 5.84 pg/L 9.09 pg/L 9.78 pg/L 29.9 pg/L 25.6 pg/L	29.9U pg/L 5.84U pg/L 9.09U pg/L 9.78U pg/L 29.9J pg/L 25.6J pg/L
L65095-7	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	3.74 pg/L 6.79 pg/L 7.42 pg/L 21.2 pg/L 20.5 pg/L	3.74U pg/L 6.79U pg/L 7.42U pg/L 21.2J pg/L 20.5J pg/L
L65095-7DUP	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	5.02 pg/L 5.72 pg/L 7.64 pg/L 15 pg/L 25.2 pg/L	5.02U pg/L 5.72U pg/L 7.64U pg/L 15J pg/L 25.2J pg/L

Laboratory blank results flagged "NJ" by the laboratory as estimated maximum possible concentration (EMPC) and reported below the quantitation limit (QL) are considered not detected.

VI. Field Blanks

No field blanks were identified in this SDG.

VII. Matrix Spike/Matrix Spike Duplicates/Duplicate Sample Analysis

The laboratory has indicated that there were no matrix spike (MS) and matrix spike duplicate (MSD) analyses specified for the samples in this SDG, and therefore matrix spike and matrix spike duplicate analyses were not performed for this SDG.

Duplicate (DUP) sample analysis was performed on an associated project sample. Results were within QC limits.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

IX. Field Duplicates

No field duplicates were identified in this SDG.

X. Internal Standards

All internal standard recoveries (%R) were within QC limits.

XI. Compound Quantitation

All compound quantitations were within validation criteria with the following exceptions:

Sample	Compound	Flag	A or P
All samples in SDG PR161851	All compounds flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC).	U	A

Raw data were not reviewed for Level III validation.

XII. Target Compound Identification

Raw data were not reviewed for Level III validation.

XIII. System Performance

Raw data were not reviewed for Level III validation.

XIV. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to results reported by the laboratory as EMPCs, data were qualified as not detected in eleven samples.

Due to laboratory blank contamination, data were qualified as not detected or estimated in eleven samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

LDW Federal Way SW Monitoring
Polychlorinated Biphenyls as Congeners - Data Qualification Summary - SDG PR161851

Sample	Compound	Flag	A or P	Reason
L65007-1 L65007-2 L65007-5 L65007-6 L65007-7 L65095-1 L65095-2 L65095-5 L65095-6 L65095-7 L65095-7DUP	All compounds flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC).	U	A	Compound quantitation (EMPC)

LDW Federal Way SW Monitoring
Polychlorinated Biphenyls as Congeners - Laboratory Blank Data Qualification Summary - SDG PR161851

Sample	Compound	Modified Final Concentration	A or P
L65007-1	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	102U pg/L 7.85U pg/L 10.3U pg/L 10.8U pg/L 102J pg/L 33.6J pg/L	A
L65007-2	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	6.51U pg/L 9.87U pg/L 7.86U pg/L 28.1J pg/L 18.2J pg/L	A
L65007-5	PCB-011 PCB-031 Dichlorobiphenyls	56.4U pg/L 14.6U pg/L 56.4J pg/L	A
L65007-6	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	33.1U pg/L 7.69U pg/L 14.5U pg/L 27.7U pg/L 33.1J pg/L 44.8J pg/L	A
L65007-7	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls	8.14U pg/L 15U pg/L 19.3U pg/L 44.2J pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L65095-1	PCB-011 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls	45.2U pg/L 8.58U pg/L 6.48U pg/L 53.8J pg/L 24.6J pg/L 33.5J pg/L	A
L65095-2	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls	26.7U pg/L 5.89U pg/L 7.72U pg/L 6.42U pg/L 26.7J pg/L 20.9J pg/L 30.2J pg/L	A
L65095-5	PCB-011 PCB-031 Dichlorobiphenyls	72.8U pg/L 25.4U pg/L 72.8J pg/L	A
L65095-6	PCB-011 PCB-031 PCB-028 PCB-052/069 Dichlorobiphenyls Trichlorobiphenyls	29.9U pg/L 5.84U pg/L 9.09U pg/L 9.78U pg/L 29.9J pg/L 25.6J pg/L	A
L65095-7	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	3.74U pg/L 6.79U pg/L 7.42U pg/L 21.2J pg/L 20.5J pg/L	A
L65095-7DUP	PCB-031 PCB-028 PCB-052/069 Trichlorobiphenyls Tetrachlorobiphenyls	5.02U pg/L 5.72U pg/L 7.64U pg/L 15J pg/L 25.2J pg/L	A

LDC #: 36926A31
SDG #: PR161851
Laboratory: Pacific Rim Laboratories, Inc.

VALIDATION COMPLETENESS WORKSHEET
Level III

Date: 8/25/16
Page: 1 of 1
Reviewer: V
2nd Reviewer: A

METHOD: HRGC/HRMS Polychlorinated Biphenyl Congeners (EPA Method 1668C)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	HRGC/HRMS Instrument performance check	A	
III.	Initial calibration/~~ICV~~	A	RSD ≤ 20/35%
IV.	Continuing calibration	A	QC limits
V.	Laboratory Blanks	SW ~~A~~	
VI.	Field blanks	N	
VII.	Matrix spike/Matrix spike duplicates /DUP	N / A	
VIII.	Laboratory control samples	A	LCS
IX.	Field duplicates	N	
X.	Internal standards	A	
XI.	Compound quantitation RL/LOQ/LODs	SW	N or NJ flag - EMPC
XII.	Target compound identification	N	
XIII.	System performance	N	
XIV.	Overall assessment of data	A	

Note:
A = Acceptable
N = Not provided/applicable
SW = See worksheet
ND = No compounds detected
R = Rinsate
FB = Field blank
D = Duplicate
TB = Trip blank
EB = Equipment blank
SB=Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	L65007-1	PR161851	Water	03/09/16
2	L65007-2	PR161852	Water	03/09/16
3	L65007-5	PR161853	Water	03/09/16
4	L65007-6	PR161854	Water	03/09/16
5	L65007-7	PR161855	Water	03/09/16
6	L65095-1	PR161856	Water	03/23/16
7	L65095-2	PR161857	Water	03/23/16
8	L65095-5	PR161858	Water	03/23/16
9	L65095-6	PR161859	Water	03/23/16
10	L65095-7	PR161860	Water	03/23/16
11	L65095-7DUP	PR161860DUP	Water	03/23/16
12				
13				
14				
15				

LDC #: 36926A31

VALIDATION FINDINGS WORKSHEET
Blanks

Page: 1 of 1
Reviewer: [illegible]
2nd Reviewer: [illegible]

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)

Blank extraction date: 6/25/16 **Blank analysis date:** 6/29/16
Conc. units: pg/L **Associated samples:** All Qualify U

Compound	Blank ID	Sample Identification												
	MBFS06291606	5x	1	2	3	4	5	6	7	8	9	10	11	
PCB-011	69.8	349	102		56.4	33.1		45.2	26.7	72.8	29.9			
PCB-031	5.87	29.35	7.85	6.51	14.6	7.69	8.14		5.89	25.4	5.84	3.74	5.02	
PCB-028	6.3	31.5	10.3	9.87		14.5	15	8.58	7.72		9.09	6.79	5.72	
PCB-052/069	7	35	10.8	7.86		27.7	19.3	6.48	6.42		9.78	7.42	7.64	
Dichlorobiphenyls	69.8	349	102J		56.4J	33.1J		53.8J	26.7J	72.8J	29.9J			
Trichlorobiphenyls	12.2	61	33.6J	28.1J		44.8J	44.2J	24.6J	20.9J		25.6J	21.2J	15J	
Tetrachlorobiphenyls	7	35		18.2J				33.5J	30.2J			20.5J	25.2J	

Laboratory blank results flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC) are considered not detected.

All contaminants within five times the blank concentration were qualified as not detected, "U".

LDC #: 36926

EDD POPULATION COMPLETENESS WORKSHEET

Date: 9/9/16
Page: 1 of 1
2nd Reviewer: JR

The LDC job number listed above was entered by JR.

	EDD Process		Comments/Action
I.	EDD Completeness	-	
Ia.	- All methods present?	y	
Ib.	- All samples present/match report?	y	
Ic.	- All reported analytes present?	y	
Id.	-10% or 100% verification of EDD?	y	
II.	EDD Preparation/Entry	-	
IIa.	- Carryover U/J?	—	
IIb.	- Reason Codes used? If so, note which codes	y	LDC
IIc.	-Additional Information (QC Level, Validator, Date, Validated Y/N, etc.)	—	
III.	Reasonableness Checks	-	
IIIa.	- Do all qualified ND results have ND qualifier (i.e. UJ)?	y	
IIIb.	- Do all qualified detect results have detect qualifier (i.e. J)?	y	
IIIc.	- If reason codes used, do all qualified results have reason code field populated?	y	
IIId.	-Does the detect flag require changing for blank qualifiers? If so, are all U results marked ND?	—	
IIIe.	- Do blank concentrations in report match EDD, where data was qualified due to blank?	y	
IIIf.	- Were any results rejected for overall assessment? If so, were results changed to nonreportable?	—	
IIIg.	- Is the readme complete? If applicable, were edits or discrepancies listed in the readme?	y	

Notes:

09/09/16

The zip file provided contains two files:

File	Format	Description	
1) Readme_FederalWay_090916.docx	MS Word 2007	A "Readme" file (this document).	
	MS Excel 2007	SDG	LDC#
2) EDD Federal Way SW Monitoring 421879-240 - PR161851-1860.xlsx		PR161851	36926A

No discrepancies were observed between the hardcopy data packages and the electronic data deliverables during EDD population of validation qualifiers. A 100% verification of the EDD was not performed.

Please contact Stella Cuenco at (760) 827-1100 if you have any questions regarding this electronic data submittal.

LABORATORY DATA CONSULTANTS, INC.
2701 Loker Ave. West, Suite 220, Carlsbad, CA 92010 Bus: 760-827-1100 Fax: 760-827-1099

King County Environmental Laboratory
322 W. Ewing Street
Seattle WA 98119
ATTN: Mr. Fritz Grothkopp

September 21, 2017

SUBJECT: LDW Federal Way SW Monitoring, Data Validation

Dear Mr. Grothkopp,

Enclosed is the final validation report for the fraction listed below. This SDG was received on August 23, 2017. Attachment 1 is a summary of the samples that were reviewed for analysis.

LDC Project #39333:

SDG #	Fraction
PR164584	Polychlorinated Biphenyls as Congeners

The data validation was performed under Level III guidelines. The analyses were validated using the following documents, as applicable to each method:

- Quality Assurance Project Plan: Effectiveness Monitoring of the South 3256[th] Street Retrofit and Expansion Project, Federal Way, WA, February 2016

- US Environmental Protection Agency Region 10 SOP for the Validation of Polychlorinated Biphenyl Data, Revision 1.0, December 8, 1995

Please feel free to contact us if you have any questions.

Sincerely,

Stella Cuenco
Operations Manager/Senior Chemist

683 pages-SF

Attachment 1

Level III EDD

LDC #39333 (King County - Seattle WA / LDW Federal Way SW Monitoring)

Project #421879-240

LDC	SDG#	DATE REC'D	(3) DATE DUE	PCB Cong. (1668C)																															
Matrix: Water/Sediment				W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
A	PR164584	08/23/17	09/14/17	21	0																														
Total	T/SC			21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21

Shaded cells indicate Level IV validation (all other cells are Level II validation). These sample counts do not include MS/MSD, and DUPs

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: LDW Federal Way SW Monitoring

LDC Report Date: September 11, 2017

Parameters: Polychlorinated Biphenyls as Congeners

Validation Level: Level III

Laboratory: Pacific Rim Laboratories, Inc.

Sample Delivery Group (SDG): PR164584

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
L66540-1	PR164577	Water	10/31/16
L66540-2	PR164578	Water	10/31/16
L66540-3	PR164579	Water	10/31/16
L66540-4	PR164580	Water	10/31/16
L66540-5	PR164581	Water	10/31/16
L66540-6	PR164582	Water	10/31/16
L66540-7	PR164583	Water	11/01/16
L66453-1	PR164584	Water	10/20/16
L66453-2	PR164585	Water	10/20/16
L66453-3	PR164586	Water	10/20/16
L66453-4	PR164587	Water	10/20/16
L66453-5	PR164588	Water	10/19/16
L66453-6	PR164589	Water	10/19/16
L66453-7	PR164590	Water	10/19/16
L66385-1	PR164591	Water	10/26/16
L66385-2	PR164592	Water	10/26/16
L66385-3	PR164593	Water	10/26/16
L66385-4	PR164594	Water	10/26/16
L66385-5	PR164595	Water	10/26/16
L66385-6	PR164596	Water	10/26/16
L66385-7	PR164597	Water	10/26/16
L66453-5DUP	PR164588DUP	Water	10/19/16
L66385-1DUP	PR164591DUP	Water	10/26/16

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA (February 2016) and US Environmental Protection Agency (EPA) Region 10 SOP for the Validation of Polychlorinated Biphenyl (PCB) Data (Revision 1.0, December 8, 1995). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Polychlorinated Biphenyls (PCBs) as Congeners by Environmental Protection Agency (EPA) Method 1668C

All sample results were subjected to Level III data validation, which comprises an evaluation of quality control (QC) summary results.

The following are definitions of the data qualifiers:

U Indicates the compound or analyte was analyzed for but not detected at or above the stated limit.

J Indicates an estimated value.

- J1 Blank Contamination: Indicates possible high bias and/or false positives.
- J2 Calibration Range exceeded: Indicates possible low bias.
- J3 Holding times not met: Indicates low bias for most analytes.
- J4 Other QC parameters outside control limits: bias not readily determined.
- J5 Other QC parameters outside control limits. The reported results appear to be biased high. The actual value of target compound in the sample may be lower than the value reported by the laboratory.
- J6 Other QC parameters outside control limits. The reported results appear to be biased low. The actual value of target compound in the sample may be higher than the value reported by the laboratory.

R Quality control indicates the data is not usable.

NJ Presumptive evidence of presence of the compound at an estimated quantity.

UJ Indicates the compound or analyte was analyzed for but not detected. The sample detection limit is an estimated value.

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

The chain-of-custodies were reviewed for documentation of temperatures. Although the cooler temperatures for all samples were reported at 9.5°C upon receipt by the laboratory, no data was qualified based on these cooler temperatures since the compounds are not expected to degrade significantly during shipping or storage.

All technical holding time requirements were met.

II. HRGC/HRMS Instrument Performance Check

Instrument performance was checked at the required frequency.

The static resolving power was at least 10,000 (10% valley definition).

III. Initial Calibration

A five point initial calibration was performed as required by the method.

The percent relative standard deviations (%RSD) were less than or equal to 20.0% for unlabeled compounds and less than or equal to 35.0% for labeled compounds.

The ion abundance ratios for all compounds were within validation criteria.

IV. Continuing Calibration

Continuing calibration was performed at the required frequencies.

All of the continuing calibration results were within the QC limits for unlabeled compounds and labeled compounds.

The ion abundance ratios for all compounds were within validation criteria.

V. Laboratory Blanks

Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks with the following exceptions:

Blank ID	Extraction Date	Compound	Concentration	Associated Samples
PC170001B	01/04/17	PCB-003	1.58 pg/L	L66540-1
		PCB-005/008	7.07 pg/L	
		PCB-011	46 pg/L	
		PCB-018	8.67 pg/L	
		PCB-017	3.9 pg/L	
		PCB-031	7.71 pg/L	
		PCB-028	8.18 pg/L	
		PCB-020/033	3.39 pg/L	
		PCB-022	2.6 pg/L	
		PCB-052/069	10.3 pg/L	
		PCB-159	1.4 pg/L	
		PCB-194	18.4 pg/L	
		Monochlorobiphenyls	1.6 pg/L	
		Dichlorobiphenyls	53.1 pg/L	
		Trichlorobiphenyls	34.5 pg/L	
		Tetrachlorobiphenyls	10.3 pg/L	
		Hexachlorobiphenyls	1.4 pg/L	
		Octachlorobiphenyls	18.4 pg/L	
PC170006B	01/06/17	PCB-011	56.9 pg/L	L66540-2
		PCB-018	11.7 pg/L	L66540-3
		PCB-031	10.9 pg/L	L66540-4
		PCB-028	8.06 pg/L	L66540-5
		PCB-052/069	8.57 pg/L	L66540-6
		PCB-064	2.33 pg/L	L66540-7
		PCB-097	6.24 pg/L	L66453-1
		PCB-118	3.51 pg/L	L66453-2
		PCB-180	31 pg/L	L66453-3
		PCB-209	6.96 pg/L	L66453-4
		Dichlorobiphenyls	56.9 pg/L	L66453-5
		Trichlorobiphenyls	30.7 pg/L	L66453-6
		Tetrachlorobiphenyls	10.9 pg/L	L66453-7
		Pentachlorobiphenyls	9.8 pg/L	L66453-5DUP
		Heptachlorobiphenyls	31 pg/L	
		Decachlorobiphenyl	7 pg/L	

Blank ID	Extraction Date	Compound	Concentration	Associated Samples
PC170012B	01/10/17	PCB-005/008	6.1 pg/L	L66385-1
		PCB-011	34.5 pg/L	L66385-2
		PCB-018	9.87 pg/L	L66385-3
		PCB-031	5.29 pg/L	L66385-4
		PCB-028	5.07 pg/L	L66385-5
		PCB-020/033	3.25 pg/L	L66385-6
		PCB-022	2.54 pg/L	L66385-7
		PCB-052/069	6.17 pg/L	L66385-1DUP
		PCB-047/048	4.15 pg/L	
		PCB-044	5.01 pg/L	
		PCB-070	4.8 pg/L	
		PCB-093/098/095	7.45 pg/L	
		PCB-101	7.77 pg/L	
		PCB-118	2.08 pg/L	
		PCB-139/149	6.34 pg/L	
		PCB-153	2.99 pg/L	
		PCB-138	5.69 pg/L	
		PCB-156	1.98 pg/L	
		PCB-182/187	6.36 pg/L	
		PCB-180	37 pg/L	
		PCB-201	1.84 pg/L	
		PCB-199	8.78 pg/L	
		PCB-203	7.14 pg/L	
		PCB-194	6.56 pg/L	
		PCB-205	2.27 pg/L	
		PCB-209	6.97 pg/L	
		Dichlorobiphenyls	40.6 pg/L	
		Trichlorobiphenyls	26 pg/L	
		Tetrachlorobiphenyls	20.1 pg/L	
		Pentachlorobiphenyls	17.3 pg/L	
		Hexachlorobiphenyls	17 pg/L	
		Heptachlorobiphenyls	43.4 pg/L	
		Octachlorobiphenyls	26.6 pg/L	

Sample concentrations were compared to concentrations detected in the laboratory blanks. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated laboratory blanks with the following exceptions:

Sample	Compound	Reported Concentration	Modified Final Concentration
L66540-1	PCB-011	51.6 pg/L	51.6U pg/L
	PCB-018	7.68 pg/L	7.68U pg/L
	PCB-031	7.45 pg/L	7.45U pg/L
	PCB-028	9.59 pg/L	9.59U pg/L
	PCB-020/033	3.58 pg/L	3.58U pg/L
	PCB-052/069	12.5 pg/L	12.5U pg/L
	PCB-194	16.5 pg/L	16.5U pg/L
	Dichlorobiphenyls	51.6 pg/L	51.6U pg/L
	Trichlorobiphenyls	28.3 pg/L	28.3J pg/L
	Tetrachlorobiphenyls	12.5 pg/L	12.5U pg/L
	Octachlorobiphenyls	54.9 pg/L	54.9J pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66540-2	PCB-011	58.5 pg/L	58.5U pg/L
	PCB-018	16.8 pg/L	16.8U pg/L
	PCB-031	10.9 pg/L	10.9U pg/L
	PCB-028	12.6 pg/L	12.6U pg/L
	PCB-052/069	10.8 pg/L	10.8U pg/L
	PCB-180	48 pg/L	48U pg/L
	PCB-209	7.43 pg/L	7.43U pg/L
	Dichlorobiphenyls	58.5 pg/L	58.5U pg/L
	Trichlorobiphenyls	56.2 pg/L	56.2J pg/L
	Tetrachlorobiphenyls	25.3 pg/L	25.3J pg/L
	Heptachlorobiphenyls	62.3 pg/L	62.3J pg/L
	Decachlorobiphenyl	7.4 pg/L	7.4U pg/L
L66540-3	PCB-011	45.7 pg/L	45.7U pg/L
	PCB-018	12.3 pg/L	12.3U pg/L
	PCB-031	6.2 pg/L	6.2U pg/L
	PCB-028	8.9 pg/L	8.9U pg/L
	PCB-052/069	5.39 pg/L	5.39U pg/L
	PCB-064	1.86 pg/L	1.86U pg/L
	PCB-118	15.6 pg/L	15.6U pg/L
	PCB-180	106 pg/L	106U pg/L
	PCB-209	8.53 pg/L	8.53U pg/L
	Dichlorobiphenyls	45.7 pg/L	45.7U pg/L
	Trichlorobiphenyls	47.1 pg/L	47.1J pg/L
	Tetrachlorobiphenyls	36.5 pg/L	36.5J pg/L
	Decachlorobiphenyl	8.5 pg/L	8.5U pg/L
L66540-4	PCB-011	54.9 pg/L	54.9U pg/L
	PCB-018	15.7 pg/L	15.7U pg/L
	PCB-031	7.43 pg/L	7.43U pg/L
	PCB-028	8.46 pg/L	8.46U pg/L
	PCB-052/069	12.8 pg/L	12.8U pg/L
	PCB-064	3.42 pg/L	3.42U pg/L
	PCB-097	11.6 pg/L	11.6U pg/L
	PCB-118	16.6 pg/L	16.6U pg/L
	PCB-180	18.5 pg/L	18.5U pg/L
	PCB-209	9.32 pg/L	9.32U pg/L
	Dichlorobiphenyls	63.2 pg/L	63.2J pg/L
	Trichlorobiphenyls	60 pg/L	60J pg/L
	Tetrachlorobiphenyls	54.5 pg/L	54.5J pg/L
	Heptachlorobiphenyls	58.7 pg/L	58.7J pg/L
	Decachlorobiphenyl	9.3 pg/L	9.3U pg/L
L66540-5	PCB-011	98.9 pg/L	98.9U pg/L
	PCB-018	14.7 pg/L	14.7U pg/L
	PCB-031	12.5 pg/L	12.5U pg/L
	PCB-028	24 pg/L	24U pg/L
	PCB-052/069	30.2 pg/L	30.2U pg/L
	PCB-064	15.8 pg/L	15.8U pg/L
	PCB-180	61.8 pg/L	61.8U pg/L
	Dichlorobiphenyls	108 pg/L	108J pg/L
	Trichlorobiphenyls	106 pg/L	106J pg/L
	Heptachlorobiphenyls	144 pg/L	144J pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66540-6	PCB-011	85.7 pg/L	85.7U pg/L
	PCB-018	23.6 pg/L	23.6U pg/L
	PCB-031	7.87 pg/L	7.87U pg/L
	PCB-028	6.62 pg/L	6.62U pg/L
	PCB-052/069	15.5 pg/L	15.5U pg/L
	PCB-064	6.98 pg/L	6.98U pg/L
	PCB-118	11.4 pg/L	11.4U pg/L
	PCB-180	47.3 pg/L	47.3U pg/L
	PCB-209	4.66 pg/L	4.66U pg/L
	Dichlorobiphenyls	107 pg/L	107J pg/L
	Trichlorobiphenyls	38.1 pg/L	38.1J pg/L
	Heptachlorobiphenyls	86.6 pg/L	86.6J pg/L
	Decachlorobiphenyl	4.7 pg/L	4.7U pg/L
L66540-7	PCB-011	77.4 pg/L	77.4U pg/L
	PCB-018	14.1 pg/L	14.1U pg/L
	PCB-028	6.54 pg/L	6.54U pg/L
	PCB-052/069	19.1 pg/L	19.1U pg/L
	PCB-064	5.95 pg/L	5.95U pg/L
	PCB-180	87.2 pg/L	87.2U pg/L
	Dichlorobiphenyls	77.4 pg/L	77.4U pg/L
	Trichlorobiphenyls	20.6 pg/L	20.6J pg/L
	Heptachlorobiphenyls	136 pg/L	136J pg/L
L66453-1	PCB-011	52.3 pg/L	52.3U pg/L
	PCB-018	14.6 pg/L	14.6U pg/L
	PCB-031	4.84 pg/L	4.84U pg/L
	PCB-052/069	14.7 pg/L	14.7U pg/L
	PCB-064	12.4 pg/L	12.4U pg/L
	PCB-180	64.6 pg/L	64.6U pg/L
	Dichlorobiphenyls	52.3 pg/L	52.3U pg/L
	Trichlorobiphenyls	19.4 pg/L	19.4J pg/L
	Heptachlorobiphenyls	87.4 pg/L	87.4J pg/L
L66453-2	PCB-011	54.8 pg/L	54.8U pg/L
	PCB-018	26.8 pg/L	26.8U pg/L
	PCB-052/069	19.5 pg/L	19.5U pg/L
	PCB-118	13.5 pg/L	13.5U pg/L
	PCB-180	144 pg/L	144U pg/L
	PCB-209	14.7 pg/L	14.7U pg/L
	Dichlorobiphenyls	54.8 pg/L	54.8U pg/L
	Trichlorobiphenyls	26.8 pg/L	26.8J pg/L
	Decachlorobiphenyl	14.7 pg/L	14.7U pg/L
L66453-3	PCB-011	53 pg/L	53U pg/L
	PCB-018	20 pg/L	20U pg/L
	PCB-031	4.12 pg/L	4.12U pg/L
	PCB-052/069	11.5 pg/L	11.5U pg/L
	PCB-064	6.19 pg/L	6.19U pg/L
	PCB-097	9.86 pg/L	9.86U pg/L
	PCB-118	13.4 pg/L	13.4U pg/L
	PCB-180	56.4 pg/L	56.4U pg/L
	PCB-209	4.78 pg/L	4.78U pg/L
	Dichlorobiphenyls	53 pg/L	53U pg/L
	Trichlorobiphenyls	24.1 pg/L	24.1J pg/L
	Heptachlorobiphenyls	123 pg/L	123J pg/L
	Decachlorobiphenyl	4.8 pg/L	4.8U pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66453-4	PCB-011	47.4 pg/L	47.4U pg/L
	PCB-018	30.6 pg/L	30.6U pg/L
	PCB-031	5.82 pg/L	5.82U pg/L
	PCB-028	6.17 pg/L	6.17U pg/L
	PCB-052/069	23 pg/L	23U pg/L
	PCB-064	7.66 pg/L	7.66U pg/L
	PCB-097	16.7 pg/L	16.7U pg/L
	PCB-180	85.1 pg/L	85.1U pg/L
	PCB-209	10.2 pg/L	10.2U pg/L
	Dichlorobiphenyls	47.4 pg/L	47.4U pg/L
	Trichlorobiphenyls	54.9 pg/L	54.9J pg/L
	Heptachlorobiphenyls	147 pg/L	147J pg/L
	Decachlorobiphenyl	10.2 pg/L	10.2U pg/L
L66453-5	PCB-011	69.8 pg/L	69.8U pg/L
	PCB-031	8.14 pg/L	8.14U pg/L
	PCB-028	16.9 pg/L	16.9U pg/L
	PCB-097	14.9 pg/L	14.9U pg/L
	PCB-180	87 pg/L	87U pg/L
	PCB-209	8.91 pg/L	8.91U pg/L
	Dichlorobiphenyls	69.8 pg/L	69.8U pg/L
	Trichlorobiphenyls	44.8 pg/L	44.8J pg/L
	Decachlorobiphenyl	8.9 pg/L	8.9U pg/L
L66453-6	PCB-011	66.6 pg/L	66.6U pg/L
	PCB-018	12.6 pg/L	12.6U pg/L
	PCB-031	6.14 pg/L	6.14U pg/L
	PCB-028	12.4 pg/L	12.4U pg/L
	PCB-052/069	28.9 pg/L	28.9U pg/L
	PCB-064	11.2 pg/L	11.2U pg/L
	PCB-097	13.6 pg/L	13.6U pg/L
	PCB-180	85.8 pg/L	85.8U pg/L
	PCB-209	13.6 pg/L	13.6U pg/L
	Dichlorobiphenyls	66.6 pg/L	66.6U pg/L
	Trichlorobiphenyls	34.6 pg/L	34.6J pg/L
	Decachlorobiphenyl	13.6 pg/L	13.6U pg/L
L66453-7	PCB-011	56.3 pg/L	56.3U pg/L
	PCB-018	10.8 pg/L	10.8U pg/L
	PCB-031	8.12 pg/L	8.12U pg/L
	PCB-028	10.6 pg/L	10.6U pg/L
	PCB-052/069	18.3 pg/L	18.3U pg/L
	PCB-097	20.5 pg/L	20.5U pg/L
	PCB-209	9.63 pg/L	9.63U pg/L
	Dichlorobiphenyls	63.8 pg/L	63.8J pg/L
	Trichlorobiphenyls	42.6 pg/L	42.6J pg/L
	Decachlorobiphenyl	9.6 pg/L	9.6U pg/L
L66453-5DUP	PCB-011	46.4 pg/L	46.4U pg/L
	PCB-018	20.8 pg/L	20.8U pg/L
	PCB-031	6.62 pg/L	6.62U pg/L
	PCB-097	19.9 pg/L	19.9U pg/L
	PCB-180	136 pg/L	136U pg/L
	PCB-209	9.42 pg/L	9.42U pg/L
	Dichlorobiphenyls	46.4 pg/L	46.4U pg/L
	Trichlorobiphenyls	30.6 pg/L	30.6J pg/L
	Decachlorobiphenyl	9.4 pg/L	9.4U pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66385-1	PCB-011	44 pg/L	44U pg/L
	PCB-018	13.2 pg/L	13.2U pg/L
	PCB-031	4.94 pg/L	4.94U pg/L
	PCB-028	4.39 pg/L	4.39U pg/L
	PCB-052/069	8.71 pg/L	8.71U pg/L
	PCB-047/048	4.76 pg/L	4.76U pg/L
	PCB-070	12.6 pg/L	12.6U pg/L
	PCB-093/098/095	20.3 pg/L	20.3U pg/L
	PCB-118	9.73 pg/L	9.73U pg/L
	PCB-182/187	11.3 pg/L	11.3U pg/L
	PCB-180	100 pg/L	100U pg/L
	PCB-199	11.4 pg/L	11.4U pg/L
	PCB-203	14.3 pg/L	14.3U pg/L
	PCB-194	16.2 pg/L	16.2U pg/L
	PCB-209	10.8 pg/L	10.8U pg/L
	Dichlorobiphenyls	44 pg/L	44U pg/L
	Trichlorobiphenyls	22.5 pg/L	22.5J pg/L
	Tetrachlorobiphenyls	38.9 pg/L	38.9J pg/L
	Pentachlorobiphenyls	83.4 pg/L	83.4J pg/L
	Heptachlorobiphenyls	177 pg/L	177J pg/L
	Octachlorobiphenyls	41.9 pg/L	41.9J pg/L
	Decachlorobiphenyl	10.8 pg/L	10.8U pg/L
L66385-1DUP	PCB-011	49.5 pg/L	49.5U pg/L
	PCB-018	15.4 pg/L	15.4U pg/L
	PCB-031	3.56 pg/L	3.56U pg/L
	PCB-028	7.2 pg/L	7.2U pg/L
	PCB-052/069	10 pg/L	10U pg/L
	PCB-047/048	4.53 pg/L	4.53U pg/L
	PCB-070	10.3 pg/L	10.3U pg/L
	PCB-093/098/095	23 pg/L	23U pg/L
	PCB-101	24.2 pg/L	24.2U pg/L
	PCB-156	7.25 pg/L	7.25U pg/L
	PCB-182/187	17 pg/L	17U pg/L
	PCB-180	67.4 pg/L	67.4U pg/L
	PCB-203	9.88 pg/L	9.88U pg/L
	PCB-194	10 pg/L	10U pg/L
	PCB-205	6.64 pg/L	6.64U pg/L
	PCB-209	12.6 pg/L	12.6U pg/L
	Dichlorobiphenyls	49.5 pg/L	49.5U pg/L
	Trichlorobiphenyls	26.2 pg/L	26.2J pg/L
	Tetrachlorobiphenyls	34.1 pg/L	34.1J pg/L
	Heptachlorobiphenyls	132 pg/L	132J pg/L
	Octachlorobiphenyls	12.6 pg/L	26.5J pg/L
	Decachlorobiphenyl	12.6 pg/L	12.6U pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66385-2	PCB-011	36.3 pg/L	36.3U pg/L
	PCB-018	17.8 pg/L	17.8U pg/L
	PCB-031	8.13 pg/L	8.13U pg/L
	PCB-028	8.5 pg/L	8.5U pg/L
	PCB-020/033	3.76 pg/L	3.76U pg/L
	PCB-022	2.32 pg/L	2.32U pg/L
	PCB-052/069	10.5 pg/L	10.5U pg/L
	PCB-047/048	3.49 pg/L	3.49U pg/L
	PCB-070	12.1 pg/L	12.1U pg/L
	PCB-093/098/095	25.3 pg/L	25.3U pg/L
	PCB-101	25.6 pg/L	25.6U pg/L
	PCB-139/149	14.5 pg/L	14.5U pg/L
	PCB-138	22.8 pg/L	22.8U pg/L
	PCB-156	4.66 pg/L	4.66U pg/L
	PCB-182/187	15.3 pg/L	15.3U pg/L
	PCB-180	90.6 pg/L	90.6U pg/L
	PCB-199	11.5 pg/L	11.5U pg/L
	PCB-203	23.6 pg/L	23.6U pg/L
	PCB-194	11.8 pg/L	11.8U pg/L
	PCB-209	9.51 pg/L	9.51U pg/L
	Dichlorobiphenyls	36.3 pg/L	36.3U pg/L
	Trichlorobiphenyls	40.5 pg/L	40.5J pg/L
	Tetrachlorobiphenyls	36.4 pg/L	36.4J pg/L
	Heptachlorobiphenyls	154 pg/L	154J pg/L
	Octachlorobiphenyls	51.6 pg/L	51.6J pg/L
	Decachlorobiphenyl	9.5 pg/L	9.5U pg/L
L66385-3	PCB-005/008	5.61 pg/L	5.61U pg/L
	PCB-011	47 pg/L	47U pg/L
	PCB-018	10.5 pg/L	10.5U pg/L
	PCB-031	4.89 pg/L	4.89U pg/L
	PCB-028	7.5 pg/L	7.5U pg/L
	PCB-020/033	2.83 pg/L	2.83U pg/L
	PCB-052/069	9.13 pg/L	9.13U pg/L
	PCB-047/048	4.23 pg/L	4.23U pg/L
	PCB-044	11.6 pg/L	11.6U pg/L
	PCB-070	10.7 pg/L	10.7U pg/L
	PCB-093/098/095	22.9 pg/L	22.9U pg/L
	PCB-101	24 pg/L	24U pg/L
	PCB-139/149	23.9 pg/L	23.9U pg/L
	PCB-156	6.22 pg/L	6.22U pg/L
	PCB-182/187	14.4 pg/L	14.4U pg/L
	PCB-180	75.1 pg/L	75.1U pg/L
	PCB-199	11.4 pg/L	11.4U pg/L
	PCB-203	14.6 pg/L	14.6U pg/L
	PCB-194	11.3 pg/L	11.3U pg/L
	PCB-205	5.99 pg/L	5.99U pg/L
	PCB-209	7.31 pg/L	7.31U pg/L
	Dichlorobiphenyls	52.6 pg/L	52.6J pg/L
	Trichlorobiphenyls	38.4 pg/L	38.4J pg/L
	Tetrachlorobiphenyls	53.9 pg/L	53.9J pg/L
	Heptachlorobiphenyls	151 pg/L	151J pg/L
	Octachlorobiphenyls	47.8 pg/L	47.8J pg/L
	Decachlorobiphenyl	7.3 pg/L	7.3U pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66385-4	PCB-011	47 pg/L	47U pg/L
	PCB-018	12.5 pg/L	12.5U pg/L
	PCB-031	11.9 pg/L	11.9U pg/L
	PCB-028	12.9 pg/L	12.9U pg/L
	PCB-052/069	20.3 pg/L	20.3U pg/L
	PCB-047/048	9.02 pg/L	9.02U pg/L
	PCB-044	24.4 pg/L	24.4U pg/L
	PCB-093/098/095	26.9 pg/L	26.9U pg/L
	PCB-101	37.6 pg/L	37.6U pg/L
	PCB-138	21 pg/L	21U pg/L
	PCB-156	9.89 pg/L	9.89U pg/L
	PCB-182/187	18.3 pg/L	18.3U pg/L
	PCB-180	79 pg/L	79U pg/L
	PCB-199	18.2 pg/L	18.2U pg/L
	PCB-203	13.5 pg/L	13.5U pg/L
	PCB-194	12.4 pg/L	12.4U pg/L
	PCB-205	5.85 pg/L	5.85U pg/L
	PCB-209	9.95 pg/L	9.95U pg/L
	Dichlorobiphenyls	47 pg/L	47U pg/L
	Trichlorobiphenyls	37.3 pg/L	37.3J pg/L
	Tetrachlorobiphenyls	98.7 pg/L	98.7J pg/L
	Hexachlorobiphenyls	68 pg/L	68J pg/L
	Heptachlorobiphenyls	155 pg/L	155J pg/L
	Octachlorobiphenyls	57.1 pg/L	57.1J pg/L
	Decachlorobiphenyl	10 pg/L	10U pg/L
L66385-5	PCB-005/008	16.4 pg/L	16.4U pg/L
	PCB-011	104 pg/L	104U pg/L
	PCB-018	25.5 pg/L	25.5U pg/L
	PCB-031	25 pg/L	25U pg/L
	PCB-020/033	11.2 pg/L	11.2U pg/L
	PCB-199	34.7 pg/L	34.7U pg/L
	PCB-194	15.3 pg/L	15.3U pg/L
	PCB-209	11.9 pg/L	11.9U pg/L
	Dichlorobiphenyls	140 pg/L	140J pg/L
	Octachlorobiphenyls	103 pg/L	103J pg/L
	Decachlorobiphenyl	11.9 pg/L	11.9U pg/L
L66385-6	PCB-011	47.1 pg/L	47.1U pg/L
	PCB-018	13.4 pg/L	13.4U pg/L
	PCB-031	10.7 pg/L	10.7U pg/L
	PCB-028	12.7 pg/L	12.7U pg/L
	PCB-020/033	7.37 pg/L	7.37U pg/L
	PCB-052/069	17.1 pg/L	17.1U pg/L
	PCB-047/048	6.52 pg/L	6.52U pg/L
	PCB-044	16.5 pg/L	16.5U pg/L
	PCB-156	6.82 pg/L	6.82U pg/L
	PCB-180	109 pg/L	109U pg/L
	PCB-199	18.5 pg/L	18.5U pg/L
	PCB-203	19.8 pg/L	19.8U pg/L
	PCB-194	10.9 pg/L	10.9U pg/L
	PCB-205	6.23 pg/L	6.23U pg/L
	PCB-209	7.74 pg/L	7.74U pg/L
	Dichlorobiphenyls	47.1 pg/L	47.1U pg/L
	Trichlorobiphenyls	58.1 pg/L	58.1J pg/L
	Heptachlorobiphenyls	214 pg/L	214J pg/L
	Octachlorobiphenyls	61.3 pg/L	61.3J pg/L
	Decachlorobiphenyl	7.7 pg/L	7.7U pg/L

Sample	Compound	Reported Concentration	Modified Final Concentration
L66385-7	PCB-005/008	9.85 pg/L	9.85U pg/L
	PCB-011	58 pg/L	58U pg/L
	PCB-018	24.7 pg/L	24.7U pg/L
	PCB-031	4.84 pg/L	4.84U pg/L
	PCB-028	8.02 pg/L	8.02U pg/L
	PCB-022	3.27 pg/L	3.27U pg/L
	PCB-052/069	14.5 pg/L	14.5U pg/L
	PCB-047/048	4.77 pg/L	4.77U pg/L
	PCB-044	10.9 pg/L	10.9U pg/L
	PCB-070	8.98 pg/L	8.98U pg/L
	PCB-199	31.4 pg/L	31.4U pg/L
	PCB-203	34.9 pg/L	34.9U pg/L
	PCB-194	14.6 pg/L	14.6U pg/L
	PCB-205	8.49 pg/L	8.49U pg/L
	PCB-209	11.5 pg/L	11.5U pg/L
	Dichlorobiphenyls	67.9 pg/L	67.9J pg/L
	Trichlorobiphenyls	45 pg/L	45J pg/L
	Tetrachlorobiphenyls	48.5 pg/L	48.5J pg/L
	Octachlorobiphenyls	108 pg/L	108J pg/L
	Decachlorobiphenyl	11.5 pg/L	11.5U pg/L

Laboratory blank results flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC) are considered not detected.

VI. Field Blanks

No field blanks were identified in this SDG.

VII. Matrix Spike/Matrix Spike Duplicates/Duplicate Sample Analysis

The laboratory has indicated that there were no matrix spike (MS) and matrix spike duplicate (MSD) analyses specified for the samples in this SDG, and therefore matrix spike and matrix spike duplicate analyses were not performed for this SDG.

Duplicate (DUP) sample analysis was performed on an associated project sample. Results were within QC limits.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

IX. Field Duplicates

No field duplicates were identified in this SDG.

X. Internal Standards

All internal standard recoveries (%R) were within QC limits.

XI. Compound Quantitation

All compound quantitations were within validation criteria with the following exceptions:

Sample	Compound	Flag	A or P
All samples in SDG PR164584	All compounds flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC).	U	A

Raw data were not reviewed for Level III validation.

XII. Target Compound Identification

Raw data were not reviewed for Level III validation.

XIII. System Performance

Raw data were not reviewed for Level III validation.

XIV. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to results reported by the laboratory as EMPCs, data were qualified as not detected in twenty-three samples.

Due to laboratory blank contamination, data were qualified as not detected or estimated in twenty-three samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

LDW Federal Way SW Monitoring
Polychlorinated Biphenyls as Congeners - Data Qualification Summary - SDG PR164584

Sample	Compound	Flag	A or P	Reason
L66540-1 L66540-2 L66540-3 L66540-4 L66540-5 L66540-6 L66540-7 L66453-1 L66453-2 L66453-3 L66453-4 L66453-5 L66453-6 L66453-7 L66385-1 L66385-2 L66385-3 L66385-4 L66385-5 L66385-6 L66385-7 L66453-5DUP L66385-1DUP	All compounds flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC).	U	A	Compound quantitation (EMPC)

LDW Federal Way SW Monitoring
Polychlorinated Biphenyls as Congeners - Laboratory Blank Data Qualification Summary - SDG PR164584

Sample	Compound	Modified Final Concentration	A or P
L66540-1	PCB-011 PCB-018 PCB-031 PCB-028 PCB-020/033 PCB-052/069 PCB-194 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls Octachlorobiphenyls	51.6U pg/L 7.68U pg/L 7.45U pg/L 9.59U pg/L 3.58U pg/L 12.5U pg/L 16.5U pg/L 51.6U pg/L 28.3J pg/L 12.5U pg/L 54.9J pg/L	A
L66540-2	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls Heptachlorobiphenyls Decachlorobiphenyl	58.5U pg/L 16.8U pg/L 10.9U pg/L 12.6U pg/L 10.8U pg/L 48U pg/L 7.43U pg/L 58.5U pg/L 56.2J pg/L 25.3J pg/L 62.3J pg/L 7.4U pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L66540-3	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-118 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls Decachlorobiphenyl	45.7U pg/L 12.3U pg/L 6.2U pg/L 8.9U pg/L 5.39U pg/L 1.86U pg/L 15.6U pg/L 106U pg/L 8.53U pg/L 45.7U pg/L 47.1J pg/L 36.5J pg/L 8.5U pg/L	A
L66540-4	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-097 PCB-118 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls Heptachlorobiphenyls Decachlorobiphenyl	54.9U pg/L 15.7U pg/L 7.43U pg/L 8.46U pg/L 12.8U pg/L 3.42U pg/L 11.6U pg/L 16.6U pg/L 18.5U pg/L 9.32U pg/L 63.2J pg/L 60J pg/L 54.5J pg/L 58.7J pg/L 9.3U pg/L	A
L66540-5	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-180 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls	98.9U pg/L 14.7U pg/L 12.5U pg/L 24U pg/L 30.2U pg/L 15.8U pg/L 61.8U pg/L 108J pg/L 106J pg/L 144J pg/L	A
L66540-6	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-118 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls Decachlorobiphenyl	85.7U pg/L 23.6U pg/L 7.87U pg/L 6.62U pg/L 15.5U pg/L 6.98U pg/L 11.4U pg/L 47.3U pg/L 4.66U pg/L 107J pg/L 38.1J pg/L 86.6J pg/L 4.7U pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L66540-7	PCB-011 PCB-018 PCB-028 PCB-052/069 PCB-064 PCB-180 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls	77.4U pg/L 14.1U pg/L 6.54U pg/L 19.1U pg/L 5.95U pg/L 87.2U pg/L 77.4U pg/L 20.6J pg/L 136J pg/L	A
L66453-1	PCB-011 PCB-018 PCB-031 PCB-052/069 PCB-064 PCB-180 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls	52.3U pg/L 14.6U pg/L 4.84U pg/L 14.7U pg/L 12.4U pg/L 64.6U pg/L 52.3U pg/L 19.4J pg/L 87.4J pg/L	A
L66453-2	PCB-011 PCB-018 PCB-052/069 PCB-118 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Decachlorobiphenyl	54.8U pg/L 26.8U pg/L 19.5U pg/L 13.5U pg/L 144U pg/L 14.7U pg/L 54.8U pg/L 26.8J pg/L 14.7U pg/L	A
L66453-3	PCB-011 PCB-018 PCB-031 PCB-052/069 PCB-064 PCB-097 PCB-118 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls Decachlorobiphenyl	53U pg/L 20U pg/L 4.12U pg/L 11.5U pg/L 6.19U pg/L 9.86U pg/L 13.4U pg/L 56.4U pg/L 4.78U pg/L 53U pg/L 24.1J pg/L 123J pg/L 4.8U pg/L	A
L66453-4	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-097 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls Decachlorobiphenyl	47.4U pg/L 30.6U pg/L 5.82U pg/L 6.17U pg/L 23U pg/L 7.66U pg/L 16.7U pg/L 85.1U pg/L 10.2U pg/L 47.4U pg/L 54.9J pg/L 147J pg/L 10.2U pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L66453-5	PCB-011 PCB-031 PCB-028 PCB-097 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Decachlorobiphenyl	69.8U pg/L 8.14U pg/L 16.9U pg/L 14.9U pg/L 87U pg/L 8.91U pg/L 69.8U pg/L 44.8J pg/L 8.9U pg/L	A
L66453-6	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-064 PCB-097 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Decachlorobiphenyl	66.6U pg/L 12.6U pg/L 6.14U pg/L 12.4U pg/L 28.9U pg/L 11.2U pg/L 13.6U pg/L 85.8U pg/L 13.6U pg/L 66.6U pg/L 34.6J pg/L 13.6U pg/L	A
L66453-7	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-097 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Decachlorobiphenyl	56.3U pg/L 10.8U pg/L 8.12U pg/L 10.6U pg/L 18.3U pg/L 20.5U pg/L 9.63U pg/L 63.8J pg/L 42.6J pg/L 9.6U pg/L	A
L66453-5DUP	PCB-011 PCB-018 PCB-031 PCB-097 PCB-180 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Decachlorobiphenyl	46.4U pg/L 20.8U pg/L 6.62U pg/L 19.9U pg/L 136U pg/L 9.42U pg/L 46.4U pg/L 30.6J pg/L 9.4U pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L66385-1	PCB-011	44U pg/L	A
	PCB-018	13.2U pg/L	
	PCB-031	4.94U pg/L	
	PCB-028	4.39U pg/L	
	PCB-052/069	8.71U pg/L	
	PCB-047/048	4.76U pg/L	
	PCB-070	12.6U pg/L	
	PCB-093/098/095	20.3U pg/L	
	PCB-118	9.73U pg/L	
	PCB-182/187	11.3U pg/L	
	PCB-180	100U pg/L	
	PCB-199	11.4U pg/L	
	PCB-203	14.3U pg/L	
	PCB-194	16.2U pg/L	
	PCB-209	10.8U pg/L	
	Dichlorobiphenyls	44U pg/L	
	Trichlorobiphenyls	22.5J pg/L	
	Tetrachlorobiphenyls	38.9J pg/L	
	Pentachlorobiphenyls	83.4J pg/L	
	Heptachlorobiphenyls	177J pg/L	
	Octachlorobiphenyls	41.9J pg/L	
	Decachlorobiphenyl	10.8U pg/L	
L66385-1DUP	PCB-011	49.5U pg/L	A
	PCB-018	15.4U pg/L	
	PCB-031	3.56U pg/L	
	PCB-028	7.2U pg/L	
	PCB-052/069	10U pg/L	
	PCB-047/048	4.53U pg/L	
	PCB-070	10.3U pg/L	
	PCB-093/098/095	23U pg/L	
	PCB-101	24.2U pg/L	
	PCB-156	7.25U pg/L	
	PCB-182/187	17U pg/L	
	PCB-180	67.4U pg/L	
	PCB-203	9.88U pg/L	
	PCB-194	10U pg/L	
	PCB-205	6.64U pg/L	
	PCB-209	12.6U pg/L	
	Dichlorobiphenyls	49.5U pg/L	
	Trichlorobiphenyls	26.2J pg/L	
	Tetrachlorobiphenyls	34.1J pg/L	
	Heptachlorobiphenyls	132J pg/L	
	Octachlorobiphenyls	26.5J pg/L	
	Decachlorobiphenyl	12.6U pg/L	

Sample	Compound	Modified Final Concentration	A or P
L66385-2	PCB-011	36.3U pg/L	A
	PCB-018	17.8U pg/L	
	PCB-031	8.13U pg/L	
	PCB-028	8.5U pg/L	
	PCB-020/033	3.76U pg/L	
	PCB-022	2.32U pg/L	
	PCB-052/069	10.5U pg/L	
	PCB-047/048	3.49U pg/L	
	PCB-070	12.1U pg/L	
	PCB-093/098/095	25.3U pg/L	
	PCB-101	25.6U pg/L	
	PCB-139/149	14.5U pg/L	
	PCB-138	22.8U pg/L	
	PCB-156	4.66U pg/L	
	PCB-182/187	15.3U pg/L	
	PCB-180	90.6U pg/L	
	PCB-199	11.5U pg/L	
	PCB-203	23.6U pg/L	
	PCB-194	11.8U pg/L	
	PCB-209	9.51U pg/L	
	Dichlorobiphenyls	36.3U pg/L	
	Trichlorobiphenyls	40.5J pg/L	
	Tetrachlorobiphenyls	36.4J pg/L	
	Heptachlorobiphenyls	154J pg/L	
	Octachlorobiphenyls	51.6J pg/L	
	Decachlorobiphenyl	9.5U pg/L	
L66385-3	PCB-005/008	5.61U pg/L	A
	PCB-011	47U pg/L	
	PCB-018	10.5U pg/L	
	PCB-031	4.89U pg/L	
	PCB-028	7.5U pg/L	
	PCB-020/033	2.83U pg/L	
	PCB-052/069	9.13U pg/L	
	PCB-047/048	4.23U pg/L	
	PCB-044	11.6U pg/L	
	PCB-070	10.7U pg/L	
	PCB-093/098/095	22.9U pg/L	
	PCB-101	24U pg/L	
	PCB-139/149	23.9U pg/L	
	PCB-156	6.22U pg/L	
	PCB-182/187	14.4U pg/L	
	PCB-180	75.1U pg/L	
	PCB-199	11.4U pg/L	
	PCB-203	14.6U pg/L	
	PCB-194	11.3U pg/L	
	PCB-205	5.99U pg/L	
	PCB-209	7.31U pg/L	
	Dichlorobiphenyls	52.6J pg/L	
	Trichlorobiphenyls	38.4J pg/L	
	Tetrachlorobiphenyls	53.9J pg/L	
	Heptachlorobiphenyls	151J pg/L	
	Octachlorobiphenyls	47.8J pg/L	
	Decachlorobiphenyl	7.3U pg/L	

Sample	Compound	Modified Final Concentration	A or P
L66385-4	PCB-011 PCB-018 PCB-031 PCB-028 PCB-052/069 PCB-047/048 PCB-044 PCB-093/098/095 PCB-101 PCB-138 PCB-156 PCB-182/187 PCB-180 PCB-199 PCB-203 PCB-194 PCB-205 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Tetrachlorobiphenyls Hexachlorobiphenyls Heptachlorobiphenyls Octachlorobiphenyls Decachlorobiphenyl	47U pg/L 12.5U pg/L 11.9U pg/L 12.9U pg/L 20.3U pg/L 9.02U pg/L 24.4U pg/L 26.9U pg/L 37.6U pg/L 21U pg/L 9.89U pg/L 18.3U pg/L 79U pg/L 18.2U pg/L 13.5U pg/L 12.4U pg/L 5.85U pg/L 9.95U pg/L 47U pg/L 37.3J pg/L 98.7J pg/L 68J pg/L 155J pg/L 57.1J pg/L 10U pg/L	A
L66385-5	PCB-005/008 PCB-011 PCB-018 PCB-031 PCB-020/033 PCB-199 PCB-194 PCB-209 Dichlorobiphenyls Octachlorobiphenyls Decachlorobiphenyl	16.4U pg/L 104U pg/L 25.5U pg/L 25U pg/L 11.2U pg/L 34.7U pg/L 15.3U pg/L 11.9U pg/L 140J pg/L 103J pg/L 11.9U pg/L	A
L66385-6	PCB-011 PCB-018 PCB-031 PCB-028 PCB-020/033 PCB-052/069 PCB-047/048 PCB-044 PCB-156 PCB-180 PCB-199 PCB-203 PCB-194 PCB-205 PCB-209 Dichlorobiphenyls Trichlorobiphenyls Heptachlorobiphenyls Octachlorobiphenyls Decachlorobiphenyl	47.1U pg/L 13.4U pg/L 10.7U pg/L 12.7U pg/L 7.37U pg/L 17.1U pg/L 6.52U pg/L 16.5U pg/L 6.82U pg/L 109U pg/L 18.5U pg/L 19.8U pg/L 10.9U pg/L 6.23U pg/L 7.74U pg/L 47.1U pg/L 58.1J pg/L 214J pg/L 61.3J pg/L 7.7U pg/L	A

Sample	Compound	Modified Final Concentration	A or P
L66385-7	PCB-005/008	9.85U pg/L	A
	PCB-011	58U pg/L	
	PCB-018	24.7U pg/L	
	PCB-031	4.84U pg/L	
	PCB-028	8.02U pg/L	
	PCB-022	3.27U pg/L	
	PCB-052/069	14.5U pg/L	
	PCB-047/048	4.77U pg/L	
	PCB-044	10.9U pg/L	
	PCB-070	8.98U pg/L	
	PCB-199	31.4U pg/L	
	PCB-203	34.9U pg/L	
	PCB-194	14.6U pg/L	
	PCB-205	8.49U pg/L	
	PCB-209	11.5U pg/L	
	Dichlorobiphenyls	67.9J pg/L	
	Trichlorobiphenyls	45J pg/L	
	Tetrachlorobiphenyls	48.5J pg/L	
	Octachlorobiphenyls	108J pg/L	
	Decachlorobiphenyl	11.5U pg/L	

LDC #: 39333A31

SDG #: PR164584

Laboratory: Pacific Rim Laboratories, Inc.

VALIDATION COMPLETENESS WORKSHEET

Level III

Date: 08/31/17

Reviewer: JVG

2nd Reviewer: ~

METHOD: HRGC/HRMS Polychlorinated Biphenyl Congeners (EPA Method 1668C)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A / A	cooler temp = 9.5°C (Text)
II.	HRGC/HRMS Instrument performance check	A	JVG
III.	Initial calibration/I~~CV~~	A / N	ICAL ≤ 20% UL/35% L ~~ICV ≤ 20% UL/35% L~~
IV.	Continuing calibration	A	CCV ≤ QC limits
V.	Laboratory Blanks	SW	
VI.	Field blanks	N	
VII.	Matrix spike/Matrix spike duplicates / LD	N / A	LD = 12/22, 15/23
VIII.	Laboratory control samples	A	LCS
IX.	Field duplicates	N	
X.	Internal standards	A	
XI.	Compound quantitation RL/LOQ/LODs	SW	
XII.	Target compound identification	N	
XIII.	System performance	N	
XIV.	Overall assessment of data	A	

Note:

A = Acceptable	ND = No compounds detected	D = Duplicate	SB=Source blank
N = Not provided/applicable	R = Rinsate	TB = Trip blank	OTHER:
SW = See worksheet	FB = Field blank	EB = Equipment blank	

		Client ID	Lab ID	Matrix	Date
1	1	L66540-1	PR164577	Water	10/31/16
2	2	L66540-2	PR164578	Water	10/31/16
3	2	L66540-3	PR164579	Water	10/31/16
4	2	L66540-4	PR164580	Water	10/31/16
5	2	L66540-5	PR164581	Water	10/31/16
6	2	L66540-6	PR164582	Water	10/31/16
7	2	L66540-7	PR164583	Water	11/01/16
8	2	L66453-1	PR164584	Water	10/20/16
9	2	L66453-2	PR164585	Water	10/20/16
10	2	L66453-3	PR164586	Water	10/20/16
11	2	L66453-4	PR164587	Water	10/20/16
12	2	L66453-5	PR164588	Water	10/19/16
13	2	L66453-6	PR164589	Water	10/19/16
14	2	L66453-7	PR164590	Water	10/19/16
15	3	L66385-1	PR164591	Water	10/26/16

LDC #: 39333A31

SDG #: PR164584

Laboratory: Pacific Rim Laboratories, Inc.

VALIDATION COMPLETENESS WORKSHEET

Level III

Date: 08/31/17

Reviewer: JVG

2nd Reviewer: ______

METHOD: HRGC/HRMS Polychlorinated Biphenyl Congeners (EPA Method 1668C)

	Client ID	Lab ID	Matrix	Date
16 3	L66385-2	PR164592	Water	10/26/16
17 3	L66385-3	PR164593	Water	10/26/16
18 3	L66385-4	PR164594	Water	10/26/16
19 3	L66385-5	PR164595	Water	10/26/16
20 3	L66385-6	PR164596	Water	10/26/16
21 3	L66385-7	PR164597	Water	10/26/16
22 2	L66453-5DUP	PR164588DUP	Water	10/19/16
23 3	L66385-1DUP	PR164591DUP	Water	10/26/16
24				
25				
26				
27				
28				

Notes:

1	PC170001B						
2	PC170006B						
3	PC170012B						

VALIDATION FINDINGS WORKSHEET
Blanks

Reviewer: JVG
2nd Reviewer: 7

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)
Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".
Y N N/A Were all samples associated with a method blank?
Y N N/A Was a method blank performed for each matrix and whenever a sample extraction was performed?
Y N N/A Was the method blank contaminated? If yes, please see qualification below.
Blank extraction date: 01/04/17 **Blank analysis date:** 3/09/17
Conc. units: pg/L **Associated samples:** 1 qual U except totals (either U or J)

Compound	Blank ID	Sample Identification								
(PRL023)	PC170001B	5x		1						
PCB-003	1.58	7.90								
PCB-005/008	7.07	35.35								
PCB-011	46	230.00		51.6						
PCB-018	8.67	43.35		7.68						
PCB-017	3.9	19.50								
PCB-031	7.71	38.55		7.45						
PCB-028	8.18	40.90		9.59						
PCB-020/033	3.39	16.95		3.58						
PCB-022	2.6	13.00								
PCB-052/069	10.3	51.50		12.5						
PCB-159	1.4	7.00								
PCB-194	18.4	92.00		16.5						
totals Monochlorobiphenyls	1.6	8.00								
Dichlorobiphenyls	53.1	265.50		51.6 /U						
Trichlorobiphenyls	34.5	172.50		28.3 /J						
Tetrachlorobiphenyls	10.3	51.50		12.5/U						
Hexachlorobiphenyls	1.4	7.00								
Octachlorobiphenyls	18.4	92.00		54.9 /J						

All results qualified by the lab as N or NJ were qualified as not detected, "U".

BLDC #: 39333A31

VALIDATION FINDINGS WORKSHEET
Blanks

Page: 2 of 5
Reviewer: JVG
2nd Reviewer: A

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Were all samples associated with a method blank?

Y N N/A Was a method blank performed for each matrix and whenever a sample extraction was performed?

Y N N/A Was the method blank contaminated? If yes, please see qualification below.

Blank extraction date: 01/06/17 **Blank analysis date:** 3/09/17

Conc. units: pg/L **Associated samples:** 2-14, 22

qual U except totals (either U or J)

Compound	Blank ID	Sample Identification								
(PRL024)	PC170006B	5x	2	3	4	5	6	7	8	9
PCB-011	56.9	284.50	58.5	45.7	54.9	98.9	85.7	77.4	52.3	54.8
PCB-018	11.7	58.50	16.8	12.3	15.7	14.7	23.6	14.1	14.6	26.8
PCB-031	10.9	54.50	10.9	6.2	7.43	12.5	7.87		4.84	~~3.4~~ JVG
PCB-028	8.06	40.30	12.6	8.9	8.46	24	6.62	6.54		
PCB-052/069	8.57	42.85	16.8	5.39	12.8	30.2	15.5	19.1	14.7	19.5
PCB-064	2.33	11.65		1.86	3.42	15.8	6.98	5.95	12.4	
PCB-097	6.24	31.20			11.6					
PCB-118	3.51	17.55		15.6	16.6	~~36.6~~ JVG	11.4			13.5
PCB-180	31	155.00	48	106	18.5	61.8	47.3	87.2	64.6	144
PCB-20~~8~~9	6.96	34.80	7.43	8.53	9.32	~~6.24~~ JVG	4.66			14.7
Dichlorobiphenyls	56.9	284.50	58.5/U	45.7/U	63.2/J	108/J	107/J	77.4/U	52.3/U	54.8/U
Trichlorobiphenyls	30.7	153.50	56.2/J	47.1/J	60	106/	38.1/J	20.6/J	19.4/J	26.8/J
Tetrachlorobiphenyls	10.9	54.50	25.3/J	36.5/	54.5					
Pentachlorobiphenyls	9.8	49.00								
Heptachlorobiphenyls	31	155.00	62.3/J		58.7	144/J	86.6/J	136/J	87.4/J	
Decachlorobiphenyls	7	35.00	7.4/U	8.5/U	9.3/U		4.7/U			14.7/~~J~~ U

totals)

All results qualified by the lab as N or NJ were qualified as not detected, "U".

BLDC #: 39333A31

VALIDATION FINDINGS WORKSHEET

Blanks

Reviewer: JVG
2nd Reviewer: [illegible]

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Were all samples associated with a method blank?

Y N N/A Was a method blank performed for each matrix and whenever a sample extraction was performed?

Y N N/A Was the method blank contaminated? If yes, please see qualification below.

Blank extraction date: 01/06/17 **Blank analysis date:** 3/09/17

Conc. units: pg/L **Associated samples:** 2-14, 22

qual U except totals (either U or J)

Compound	Blank ID	Sample Identification								
(PRL024)	PC170006B	5x	10	11	12	13	14	22		
PCB-011	56.9	284.50	53	47.4	69.8	66.6	56.3	46.4		
PCB-018	11.7	58.50	20	30.6	~~4~~ JVG	12.6	10.8	20.8		
PCB-031	10.9	54.50	4.12	5.82	8.14	6.~~62~~ 14	8.12	6.62		
PCB-028	8.06	40.30		6.17	16.9	12.4	10.6			
PCB-052/069	8.57	42.85	11.5	23	~~8~~	28.9	18.3			
→ PCB-064	2.33	11.65	6.19	7.66		11.2				
PCB-097	6.24	31.20	9.86	16.7	14.9	13.6	20.5	19.9		
PCB-118	3.51	17.55	13.4				JVG ~~38.7~~			
PCB-180	31	155.00	56.4	~~18.~~ 85.1	87	85.8		136		
PCB-20~~8~~9	6.96	34.80	4.78	10.2	8.91	13.6	9.63	9.42		
Totals) Dichlorobiphenyls	56.9	284.50	53/U	47.4/U	69.8/U	66.6/U	63.8/J	46.4/U		
Trichlorobiphenyls	30.7	153.50	24.1/J	54.9/J	44.8/J	34.6/J	42.6/J	30.6/J		
Tetrachlorobiphenyls	10.9	54.50								
Pentachlorobiphenyls	9.8	49.00								
Heptachlorobiphenyls	31	155.00	123/J	147/J						
Decachlorobiphenyls	7	35.00	4.8/U	10.2/U	8.9/U	13.6/U	9.6/J	9.4/U		

All results qualified by the lab as N or NJ were qualified as not detected, "U".

LDC #: 39333A31

VALIDATION FINDINGS WORKSHEET
Blanks

Reviewer: JVG
2nd Reviewer: R

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Were all samples associated with a method blank?
Y N N/A Was a method blank performed for each matrix and whenever a sample extraction was performed?
Y N N/A Was the method blank contaminated? If yes, please see qualification below.

Blank extraction date: 01/10/17 **Blank analysis date:** 3/17/17

Conc. units: pg/L **Associated samples:** 15-21, 23

Qual U except totals (either U or J)

Compound	Blank ID	Sample Identification								
(PRL025)	PC170012B	5x	15	23	16	17	18	19	20	21
PCB-005/008	6.1	30.5				5.61		16.4		9.85
PCB-011	34.5	172.5	44	49.5	36.3	47	47	104	47.1	58
PCB-018	9.87	49.35	13.2	15.4	17.8	10.5	12.5	25.5	13.4	24.7
PCB-031	5.29	26.45	4.94	3.56	8.13	4.89	11.9	25	10.7	4.84
PCB-028	5.07	25.35	4.39	7.2	8.5	7.5	12.9		12.7	8.02
PCB-020/033	3.25	16.25			3.76	2.83		11.2	7.37	
PCB-022	2.54	12.7			2.32					3.27
PCB-052/069	6.17	30.85	8.71	10	10.5	9.13	20.3		17.1	14.5
PCB-047/048	4.15	20.75	4.76	4.53	3.49	4.23	9.02		6.52	4.77
PCB-044	5.01	25.05				~~4.23~~ 11.6	24.4		16.5	10.9
PCB-070	4.8	24	12.6	16.3	12.1	10.7				8.98
PCB-093/098/095	7.45	37.25	20.3	23	25.3	22.9	26.9			
PCB-101	7.77	38.85		24.2	25.6	24	37.6			
PCB-118	2.08	10.4	9.73							
PCB-139/149	6.34	31.7			14.5	23.9				
PCB-153	2.99	14.95								
PCB-138	5.69	28.45			22.8		21			
PCB-156	1.98	9.9		7.25	4.66	6.22	9.89		6.82	
PCB-182/187	6.36	31.8	11.3	17	15.3	14.4	18.3			
PCB-180	37	185	100	67.4	90.6	75.1	79		109	

All results qualified by the lab as N or NJ were qualified as not detected, "U".

VALIDATION FINDINGS WORKSHEET
Blanks

Reviewer: JVG
2nd Reviewer: [illegible]

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668C)
Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".
Y N N/A Were all samples associated with a method blank?
Y N N/A Was a method blank performed for each matrix and whenever a sample extraction was performed?
Y N N/A Was the method blank contaminated? If yes, please see qualification below.

Blank extraction date: 01/10/17 **Blank analysis date:** 3/17/17
Conc. units: pg/L **Associated samples:** 15-21, 23

Totals?

Compound	Blank ID	Sample Identification								
(PRL025)	PC170012B	5x	15	23 ~~16~~	~~17~~ 16	17 ~~18~~	18	19	20	21
PCB-201	1.84	9.2								
PCB-199	8.78	43.9	11.4		11.5	11.4	18.2	34.7	18.5	31.4
PCB-203	7.14	35.7	14.3	9.88	~~26.~~ 23.6	14.6	13.5		19.8	34.9
PCB-194	6.56	32.8	16.2	10	11.8	11.3	12.4	15.3	10.9	14.6
PCB-205	2.27	11.35		6.64		5.99	5.85		6.23	8.99
PCB-209	6.97	34.85	10.8	12.6	9.51	7.31	9.95	11.9	7.74	11.5
Dichlorobiphenyls	40.6	203.00	44/U	49.5/U	36.3/U	52.6/J	47/U	140/J	47.1/U	67.9/J
Trichlorobiphenyls	26	130.00	22.5/J	26.2/J	90.5/J	38.4/	37.3/J		58.1/J	45/
Tetrachlorobiphenyls	20.1	100.50	38.9/	34.1/	36.4/	53.9/	98.7/J			48.5/
Pentachlorobiphenyls	17.3	86.50	83.4/							
Hexachlorobiphenyls	17	85.00					68/J			
Heptachlorobiphenyls	43.4	217.00	177/J	132/J	154/J	151/J	155/		219/J	
Octachlorobiphenyls	26.6	133.00	41.9/J	~~12.6/U~~ 26.5/J	51.6/	47.8/J	57.1/	103/J	61.3/	108/J
Decachlorobiphenyls	6.97 *	34.85	10.8/U	12.6/U	9.51/U	7.31/U	~~9.95~~U 10	11.9/U	7.74/U	11.5/U

* Value from PCB-209

All results qualified by lab as N or NJ were qualified as not detected, "U".

LDC #: 39333A31

VALIDATION FINDINGS WORKSHEET
Compound Quantitation and RLs

Reviewer: JYG
2nd Reviewer: PR

METHOD: HRGC/HRMS PCB Congeners (EPA Method 1668)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Were the correct internal standard (IS), quantitation ions and relative response factors (RRF) used to quantitate the compound?
Y N N/A Compound quantitation and CRQLs were adjusted to reflect all sample dilutions and dry weight factors (if necessary).

#	Date	Sample ID	Compound	Finding	Qualifications
		All		All compounds flagged "N" or "NJ" by the laboratory as estimated maximum possible concentration (EMPC).	U/A

Comments: See sample calculation verification worksheet for recalculations

LDC #: 39333

EDD POPULATION COMPLETENESS WORKSHEET

Date: 9/20
Page: 1 of 1
2nd Reviewer: OG

The LDC job number listed above was entered by JE.

	EDD Process		Comments/Action
I.	EDD Completeness	-	
Ia.	- All methods present?	Y	
Ib.	- All samples present/match report?	Y	
Ic.	- All reported analytes present?	Y	
Id.	- 10% or 100% verification of EDD?	Y	
II.	EDD Preparation/Entry	-	
IIa.	- Carryover U/J?	—	
IIb.	- Reason Codes used? If so, note which codes.	Y	LDC
IIc.	- Additional Information (QC Level, Validator, Validated Y/N, etc.)	N	
III.	Reasonableness Checks	-	
IIIa.	- Do all qualified ND results have ND qualifier (e.g. UJ)?	Y	
IIIb.	- Do all qualified detect results have detect qualifier (e.g. J)?	Y	
IIIc.	- If reason codes are used, do all qualified results have reason code field populated, and vice versa?	Y	
IIId.	-Does the detect flag require changing for blank qualifier? If so, are all U results marked ND?	+	
IIIe.	- Do blank concentrations in report match EDD where data was qualified due to blank contamination?	Y	
IIIf.	- Were multiple results reported due to dilutions/reanalysis? If so, were results qualified appropriately?	+	
IIIg.	-Are there any discrepancies between the data packet and the EDD?	Y	

Notes: *see discrepancy sheet Sample PR164588D PCB-174 Lab qual N changed to NJ

Appendix G4:
DATA QUALITY SUMMARY FOR CONTINUOUS FLOW, TURBIDITY AND TEMPERATURE MONITORING

APPENDIX G4 – DATA QUALITY SUMMARY FOR CONTINUOUS FLOW, TURBIDITY AND TEMPERATURE MONITORING

This appendix summarizes the data quality assessment conducted for continuous flow, turbidity and temperature measurements. Daily average and maximum values for turbidity and temperature were evaluated for the period before and after the retrofit and expansion. The post-retrofit period includes, but is not limited to, data collected during the 18 sampled storm events (Appendix K).

Flow data included in the final report are limited to data collected during sampled storm events. This summary describes how the quality of flow data collected during the storm sampling interval (March 2016 – April 2017) was assured and assessed, and a description of uncertainties associated with the data. Continuous flow data collected before the sampling interval were also reviewed extensively to ensure meters were functioning correctly, but those data were not included in any data analyses and were not included in the report.

G4.1 Flow meter calibration and verification

Water levels measured by the flow meters were calibrated upon installation and verified directly in the field on a regular basis. Flow data were reviewed regularly and field conditions were checked when anomalies were apparent. Once installed and calibrated the flow meters did not require recalibration, but they did require special considerations.

The meter at the inlet to the wetland complex (WCI) was calibrated to a depth of 0.00 ft in air when it was installed and did not require any further adjustments. At one point a large rock became nestled in front of the velocity meter which resulted in anomalous velocity readings, but this was quickly resolved by removing the obstruction. Because WCI required confined space entry protocol, depth measurements were confirmed visually from above.

The meter at the creek site (NFWHC) fared similarly, only needing maintenance when rocks impeded velocity measurements. We were able to manually confirm the accuracy of the depth measurements at this site with a ruler.

The meter measuring the combined flow from the wetland complex and the east bioretention facility (WCEBO) was easier to access and depth measurements were checked and confirmed regularly.

The bubbler flow meters at the bioretention facility outlets (EBO and WBO) were installed in conjunction with Thel-mar volumetric weirs, which require a 0.00 depth calibration when the water is at the bottom of the notch of the weir. This required filling the stormwater pipes with water until the water level just reached the bottom of the weir's v-notch. To fill the pipes with water we borrowed a water tank truck from the City of Federal

Way and pumped water into the pipes, calibrating the flow meter to 0.00 right as the water crested the weir. During higher flows the flow meter could be checked manually with a ruler to confirm its accuracy. These flow meters did not need to be recalibrated after the initial calibration, but due to the growth of a biofilm they required regular cleaning. As the tube became clogged, the depth measurements would read erroneously high, but scrubbing the bubbler tube outlets as well as blowing forced air through the bubbler tube resolved this issue.

The meters at the bioretention inlets (WBI and EBI) also had bubbler flow meters, but these were calibrated to a depth of 0.00 ft in air and did not require any maintenance or recalibration once installed.

In addition, bucket tests were done to verify recorded flow rates at the three locations where flow data could be collected (Table 1). Bucket tests involved capturing flow in a calibrated bucket over a timed interval to estimate the flow rate. At least three bucket tests were done at each site on each date and average bucket flow rates (Table 1) were compared to flow rates recorded by the flow meter. The relative percent difference (RPD) between the two measurements was then calculated (Table 1). The high RPDs (>20% for at least one test at each location) for a number of comparisons suggested the data may be biased; therefore, all flow data were flagged as estimates (Table 1).

Table 1. Comparison of flow rates measured by flow meters and bucket tests at three locations.

Location	Date	Average flow (cfs) recorded by meter	Average flow (cfs) recorded with bucket test	RPD (%)	Bias
EBI	2/8/2017	0.0625	0.0364	52.78	Meter overestimating flow
EBI	2/15/2017	0.1929	0.1697	12.79	Meter overestimating flow
EBI	4/5/2017	0.1205	0.1113	7.92	Meter overestimating flow
EBO	3/16/2017	0.0170	0.0089	62.14	Meter overestimating flow
EBO	4/5/2017	0.0827	0.0726	13.01	Meter overestimating flow
EBO	4/20/2017	0.0380	0.0125	100.70	Meter overestimating flow
WBO	3/16/2017	0.0400	0.0491	-20.41	Meter underestimating flow
WBO	3/27/2017	0.0340	0.0076	127.00	Meter overestimating flow

It should be noted that bucket tests could only be performed when flows were relatively low, and therefore do not necessarily represent data quality during higher flow periods. In addition, the highest RPDs were observed during the lowest flows. Bucket testing was done during relatively low flow conditions to facilitate the ability to time and physically collect flow in the bucket. It was challenging to quickly get the bucket in and out of the confined catch basins during high flow conditions. However, field tests indicate flow meters may be more accurate when flow rates are higher. Although bucket testing could only be conducted at three locations, it is assumed the accuracy of the other flow meters is similar.

G4.2 Reconciling flow data

It was assumed that influent and effluent flow volumes at each facility (east and west bioretention facilities [EB and WB], and the wetland complex [WC]) would be comparable because most, if not all, of the flow was accounted for by monitoring the sample locations (QAPP 2016). For example, it was assumed flow into EB would be approximately equal to flow out of EB because there were no other known inputs and it was anticipated that infiltration would be minimal. Thus, an additional line of evidence that flow meters were accurately recording flow data was assumed to be confirmation that inflow and outflow volumes were similar during a storm, and the ratio of inflow to outflow was consistent across storms. However, results indicate that the average RPD between inflow and outflow volumes was 43% at both the EB and WB (Table 2). During some storms, flows into the facilities exceeded outflows, while the opposite was true for other storms (Table 2). Possible causes for the inconsistent flow pattern and high RPDs include: 1) periodic ground water inputs to the facilities, 2) periodic infiltration from the facilities to ground water, and/or 3) flow meters were inaccurate and variable.

Staff suspect that ground water inputs to the facilities and infiltration of flow to ground water may have affected flow volumes for two reasons. The first is that wetlands are ubiquitous in the area upstream and to the west of the S. 356th Street regional detention facility (RDF). Geologic tests prior to the retrofit and expansion indicated the water table near the RDF was high and as a result a deep pond initially planned for the site was altered (Fei Tang, personal communication). Complex sub-surface flows would therefore be expected in this area. Second, throughout the study, staff observed a small but steady discharge from each bioretention facility outlet, even after long dry periods and no measured inflow to the facilities. The continuous discharge suggests groundwater inflow likely contributed some input to the facilities, though it is unclear if and how this changed during storm events.

Based on the data collected for this study it is not possible to resolve the sources of error in the flow monitoring data. Results of the bucket testing suggest there were some errors in flow meter measurements, and field observations suggest complex groundwater flow paths were also likely affecting flow into and out of the facilities. Additional ground water monitoring data would be necessary to better discern the possible sources of error.

Table 2. Estimates of total volume, flowing into and out of EB and WB, during each storm event. Relative percent difference (RPD) between inlet and outlet flow was calculated when data were available for both locations.

Storm Number	East Bioretention Facility				West Bioretention Facility			
	Total Storm Volume In (cubic feet)	Total Storm Volume Out (cubic feet)	RPD (%)	Summary	Total Storm Volume In (cubic feet)	Total Storm Volume Out (cubic feet)	RPD (%)	Summary
1	10503	19133	58	Out > In	18587	ND	NA	NA
2	886	3948	127	Out > In	276	ND	NA	NA
3	ND	17624	NA	NA	16083	9593	51	In > Out
4	32254	25584	23	In > Out	17017	10154	51	In > Out
5	4236	11105	90	Out > In	2442	3332	31	Out > In
6	3587	6606	59	Out > In	2267	ND	NA	NA
7	ND	27124	NA	NA	21386	14100*	41	In > Out*
8	47779	ND	NA	NA	21404	17791*	18	In > Out*
9	62077	32689	62	In > Out	29678	ND	NA	NA
10	12197	8278	38	In > Out	6492	ND	NA	NA
11	19162	13010	38	In > Out	9017	5388	50	In > Out
12	ND	12065	NA	NA	8319	4347	63	In > Out
13	28602	18874	41	In > Out	12918	9097*	35	In > Out*
14	3465	3562	3	Out > In	2315	ND	NA	NA
15	14190	10380	31	In > Out	6398	ND	NA	NA
16	5238	5799	10	Out > In	4034	ND	NA	NA
17	7160	7896	10	Out > In	4242	6450	41	Out > In
18	4365	5047	14	Out > In	2834	4756	51	Out > In
Average			43				43	

* Facility overflowed; measured outflow volume is likely an underestimate of total outflow.

ND - no data or unreliable data.

NA - insufficient data to make comparison.

Due to the uncertainties outlined above, all flow data are flagged as estimates. Flow data were rejected when the meter malfunctioned or a blockage led to erroneous measurements. In addition, flow volume estimates from the WB outlet were rejected when water overflowed from the facility and not accounted for at WBO. Table 3 includes the summary of locations where flow volume data were acceptable and therefore used to calculate pollutant load estimates.

Table 3. Summary of flow volume estimates by location and storm event that were of acceptable quality and used for load calculations.

Storm Number	EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
1	✓	✓	✓	X	✓	✓	✓
2	✓	✓	X	X	✓	✓	✓
3	X	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓	✓	✓
6	✓	✓	✓	X	✓	✓	✓
7	X	✓	✓	X	✓	✓	✓
8	✓	X	✓	X	✓	✓	X
9	✓	✓	✓	X	X	✓	✓
10	✓	✓	✓	X	✓	✓	✓
11	✓	✓	✓	✓	✓	✓	✓
12	X	✓	✓	✓	✓	✓	✓
13	✓	✓	✓	X	✓	✓	✓
14	✓	✓	✓	X	✓	✓	✓
15	✓	✓	✓	X	X	✓	✓
16	✓	✓	✓	X	X	✓	✓
17	✓	✓	✓	✓	✓	✓	✓
18	✓	✓	✓	✓	✓	✓	✓

✓ - volume data used to calculate loads

X and shaded – volume data not available or not of sufficient quality to be used to calculate loads

G4.3 Turbidity and temperature monitoring

The YSI sondes used to continuously record turbidity and temperature at the inlet and main outlet of the S. 356th Street RDF were replaced monthly. When each sonde was deployed, the turbidity measurement was checked against two standards and calibrated and rechecked if needed. When each was retrieved, a turbidity end check was done and all end checks passed the accepted tolerance limit (±5% of reading or 4 NTU, whichever is greater, King County 2016). There was no evidence of systematic drift resulting in biased measurements. The temperature measurements were checked with a certified thermometer when each sonde was initially deployed and again at the end of the project. All measurements were within ±0.09°C, and therefore were within acceptable tolerance limits (±0.3°C, King County 2016).

References

King County. 2016. Quality Assurance Project Plan: Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

Appendix H:
Detailed Results

<u>Contents:</u>

APPENDIX H1 – DETAILED DATA SUMMARY: CONCENTRATION

This appendix presents a detailed summary of the data used to prepare the report including summary statistics (i.e., minimum, maximum, mean, and median) for concentration data (Table 1), as well as figures that provide a comparison of influent and effluent results for each parameter. Data included here were validated, as described in Appendix G2. Sampling locations include the inlet and outlets of the east and west bioretention facilities (EBI, EBO, WBI, WBO), the inlet to the wetland complex (WCI), the combined outlet of the wetland complex and the east bioretention facility (WCEBO), and the North Fork of West Hylebos Creek, downstream of the detention facility. Note: the location code for the North Fork West Hylebos Creek site has been shortened here from NFWHC to NWH.

Table 1. Summary of validated nutrient and bacteria data at each sampling location.

		EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
Total Phosphorus (mg/L)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	0.0212	0.369	0.0222	1.05	0.0382	0.0433	0.0364
	Max	0.0483	1.30	0.0444	3.83	0.0977	0.0767	0.107
	Mean	0.0319	0.711	0.0317	2.40	0.0630	0.0606	0.0562
	Median	0.0294	0.691	0.0329	2.48	0.0569	0.0596	0.0528
Total Nitrogen (mg/L)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	0.161	0.445	0.180	1.48	0.382	0.273	0.561
	Max	0.459	2.38	0.476	6.52	0.774	0.517	1.00
	Mean	0.304	1.21	0.299	3.26	0.569	0.423	0.664
	Median	0.296	1.15	0.255	2.89	0.567	0.434	0.616
Ortho-phosphate P (µg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.00429 J	0.284 J	0.00445 J	0.930 J	0.00286 J	0.0134 J	0.0117 J
	Max	0.0211 J	1.01 J	0.0207 J	3.13 J	0.0131 J	0.0343 J	0.0263 J
	Mean	0.0105 J	0.610 J	0.0108 J	1.97 J	0.00664 J	0.0234 J	0.0172 J
	Median	0.0102 J	0.603 J	0.00987 J	2.02 J	0.00508 J	0.0221 J	0.0167 J
Nitrate/nitrite N (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.0526	0.123	0.0539	0.0899	0.0909	0.0400	0.212
	Max	0.166	0.834	0.171	4.25	0.260	0.204	0.403
	Mean	0.0974	0.417	0.0995	1.20	0.154	0.133	0.293
	Median	0.0962	0.379	0.0879	0.851	0.152	0.147	0.294
Ammonia N (mg/L)	FOD	16/17	18/18	17/18	18/18	18/18	18/18	18/18
	Min	0.0020 U	0.0333	0.0020 U	0.147	0.0489	0.0112	0.0028 J
	Max	0.0928	0.22	0.0901	0.687	0.164	0.129	0.0778
	Mean	0.0444 J	0.0777 J	0.0423 J	0.322 J	0.0968	0.0450	0.0219 J
	Median	0.0387	0.0556	0.0388	0.254	0.0962	0.0351	0.0147
Fecal Coliform (CFU/100mL)	FOD	10/10	10/10	10/10	10/10	10/10	10/10	10/10
	Min	9	23	9	1	80	10 J	4
	Max	1,900 J	200 J	1,500 J	410 J	1,100	900 J	410 J
	Mean	348 J	57 J	305 J	66 J	519 J	198 J	101 J
	Median	102 J	45 J	100 J	7	515 J	94	53 J

P – phosphorus; N –nitrogen; CFU – colony forming unit;
FOD – frequency of detection; J – estimated value; U – non-detect

Table 2. Summary of validated data for conventional parameters at each sampling location.

		EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
TSS (mg/L)	FOD	17/17	18/18	18/18	17/18	18/18	18/18	18/18
	Min	1.22	0.84 J	1.68	0.74 J	9.79	2.80	3.33
	Max	14.5	6.24	14.2	14.8	61.2	22.4	27.3
	Mean	5.34	2.32 J	5.70	4.68 J	36.7	10.0	13.3
	Median	4.74	1.95	4.43	2.72	37.2	8.12	12.1
TOC (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	1.10	2.67	1.24 J	6.49	1.59	2.29	3.94
	Max	3.01	13.9	3.16	33.8	7.40	4.44	10.3
	Mean	1.74	6.62	1.86 J	16.3	4.75	3.25	6.15
	Median	1.62	5.95	1.65	14.2	5.04	3.23	5.85
DOC (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.71 J	1.18	0.86 J	6.41	1.14	1.66	3.59
	Max	2.81	13.5	3.10	28.1	4.05	4.45	8.69
	Mean	1.54 J	6.53	1.79 J	15.1	2.58	2.97	5.28
	Median	1.54	5.84	1.75 J	14.1	2.57	2.97	4.92
Turbidity (NTU)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	2.38	2.20 J	2.85	2.55	10.5	4.55	4.72
	Max	12.9	9.23	12.5	17.9	56.8	41.1	35.7
	Mean	6.47 J	4.75 J	6.63 J	6.08 J	29.4 J	16.0 J	14.9 J
	Median	6.12	4.40	5.90	4.69 J	27.9	12.5	14.0
Conductivity (µmhos/cm)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	19.1	37.7	19.5	71.7	27.2	37.5	87.1
	Max	223	246	211	376	140	267	272
	Mean	52.6	88.4	53.9	146	51.2	83.2	134
	Median	27.1	69.4	26.7	119	40.1	68.8	125
pH (pH units)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	6.50 J	6.45 J	6.48 J	6.37 J	6.58 J	6.53 J	7.06 J
	Max	7.33 J	7.10 J	7.13 J	7.16 J	7.21 J	7.35 J	7.71 J
	Mean	6.96 J	6.81 J	6.90 J	6.72 J	7.00 J	7.02 J	7.45 J
	Median	6.98 J	6.82 J	6.97 J	6.74 J	7.05 J	7.09 J	7.49 J
Hardness (mg $CaCO_3$/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	4.71	7.85	4.89	14.4	10.4	12.6	30.2
	Max	12.7	44.8	12.3	82.0	28.5	36.0	70.1
	Mean	7.34	19.2	7.51	38.7	14.9	20.5	47.9
	Median	7.44	18.0	7.74	33.9	14.5	19.9	46.5

TSS – total suspended solids; TOC – total organic carbon; DOC – dissolved organic carbon;
DO – dissolved oxygen; FOD – frequency of detection; J – estimated value

Table 3. Summary of validated metals data at each sampling location.

		EBI		EBO		WBI		WBO		WCI		WCEBO		NWH	
Total Cadmium (µg/L)	FOD	1/18		4/18		1/18		9/18		13/18		3/18		4/18	
	Min	0.050	U	0.050	U	0.050	U	0.050	U	0.050	U	0.050	U	0.050	U
	Max	0.072	J	0.12	J	0.11	J	0.19	J	0.10	J	0.093	J	0.072	J
	Mean	NC		0.056	J	NC		0.072	J	0.066	J	0.054	J	0.053	J
	Median	NC		0.050	U	NC		0.053	J	0.063	J	0.050	U	0.050	U
Total Copper (µg/L)	FOD	18/18		18/18		18/18		18/18		18/18		18/18		18/18	
	Min	1.9	J	1.8	J	2.03		2.60		5.77		3.76		2.45	
	Max	5.95		8.30		6.55		17.0		15.3		8.11		6.38	
	Mean	3.73	J	4.35	J	3.79		6.29		10.2		5.49		3.99	
	Median	3.54		4.07		3.52		5.67		10.6		5.21		3.86	
Total Lead (µg/L)	FOD	18/18		18/18		18/18		18/18		18/18		18/18		18/18	
	Min	0.21	J	0.20	J	0.25	J	0.30	J	1.27		0.44	J	0.557	
	Max	1.52		0.823		1.46		2.08		6.23		2.30		3.88	
	Mean	0.683	J	0.45	J	0.672	J	0.961	J	3.69		1.22	J	1.61	
	Median	0.624		0.43	J	0.607		0.858		3.58		1.29		1.52	
Total Zinc (µg/L)	FOD	18/18		18/18		18/18		18/18		18/18		18/18		18/18	
	Min	17.1		3.62		18.9		6.08		41.9		34.3		16.7	
	Max	38.4		6.34		35.1		16.2		97.3		67.7		44.8	
	Mean	26.8		4.89		26.7		9.26		65.4		44.3		26.9	
	Median	26.2		4.78		26.1		8.28		63.8		40.5		26.0	
Dissolved Cadmium (µg/L)	FOD	0/18		0/18		1/18		5/18		0/18		2/18		0/18	
	Min	NC		NC		0.050	U	0.050	U	NC		0.050	U	NC	
	Max	0.050	U	0.050	U	0.070	J	0.150	J	0.050	U	0.064	J	0.050	U
	Mean	NC		NC		NC		0.058	J	NC		NC		NC	
	Median	NC		NC		NC		0.050	U	NC		NC		NC	
Dissolved Copper (µg/L)	FOD	18/18		18/18		18/18		18/18		18/18		18/18		18/18	
	Min	0.94	J	1.6	J	0.99	J	2.08	J	2.05	J	2.62	J	1.7	J
	Max	4.27	J	7.09	J	4.80	J	14.1	J	5.36	J	5.94	J	5.52	J
	Mean	2.51	J	3.91	J	2.59	J	5.71	J	3.34	J	3.47	J	2.64	J
	Median	2.26	J	3.81	J	2.23	J	5.31	J	3.20	J	3.27	J	2.46	J
Dissolved Lead (µg/L)	FOD	3/18		16/18		2/18		18/18		14/18		17/18		18/18	
	Min	0.10	U	0.10	U	0.10	U	0.12	J	0.10	U	0.10	U	0.13	J
	Max	0.11	J	0.560	J	0.11	J	1.14	J	0.37	J	0.683	J	0.34	J
	Mean	0.10	J	0.25	J	NC		0.641	J	0.15	J	0.19	J	0.22	J
	Median	0.10	U	0.23	J	NC		0.663	J	0.12	J	0.16	J	0.21	J
Dissolved Zinc (µg/L)	FOD	18/18		18/18		18/18		18/18		18/18		18/18		18/18	
	Min	13.0	J	2.2	J	12.4	J	4.96	J	21.0	J	28.2	J	12.3	J
	Max	27.2	J	4.86	J	27.1	J	13.9	J	47.0	J	54.0	J	25.3	J
	Mean	19.9	J	3.46	J	20.1	J	7.79	J	28.0	J	33.2	J	15.4	J
	Median	18.9	J	3.51	J	19.0	J	7.43	J	27.0	J	30.8	J	14.8	J

FOD – frequency of detection; NC – not calculated due to low sample number; U – not-detect; J – estimated value

Table 4. Summary of validated organic contaminant data at each sampling location.

		EBI		EBO		WBI		WBO		WCI		WCEBO		NWH	
Total PAHs (µg/L)	FOD	11/17		5/18		11/17		4/18		18/18		13/18		12/18	
	Min	0.0078	J	0.0070	J	0.0094	U	0.0056	J	0.046	J	0.0094	U	0.0094	U
	Max	0.0967	J	0.0451	J	0.113	J	0.024	U	0.641	J	0.238	J	0.078	J
	Mean	0.0283	J	0.014	J	0.0299	J	0.012	J	0.303	J	0.054	J	0.022	J
	Median	0.0158	J	0.0094	U	0.0146	J	0.0094	U	0.287	J	0.030	J	0.018	J
Total PCBs (pg/L)	FOD	15/15		15/15		13/13		13/13		15/15		15/15		15/15	
	Min	203	J	7.89	J	199	J	1.73	J	27.0	J	70.4	J	224	J
	Max	6,200	J	1,230	J	2,440	J	665	J	3,910	J	1,890	J	3,220	J
	Mean	919	J	230	J	733	J	178	J	1,610	J	525	J	970	J
	Median	551	J	111	J	529	J	112	J	1,290	J	406	J	541	J

FOD – frequency of detection; U – not-detect; J – estimated value

Figures of Results by Facility and by Location

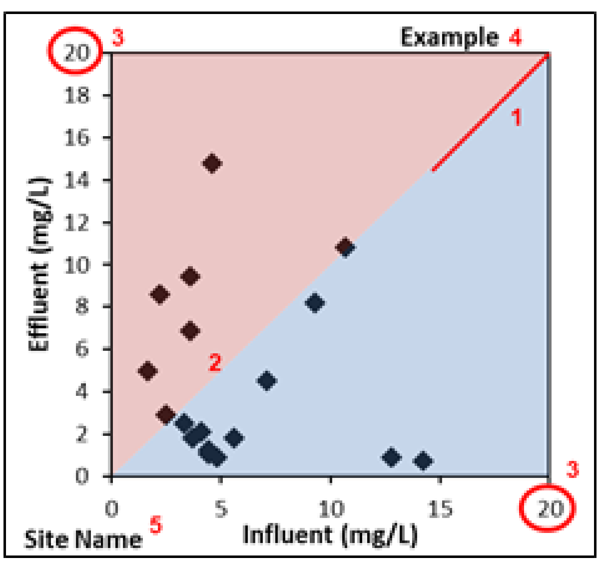
This section includes figures that summarize concentration results for each facility, including field measurements. Each page includes five figures that summarize results for a single parameter; box plots display the distribution of results for each site and four scatter plots compare influent and effluent concentrations. The example figures below provide explanations for the two figure types.

Scatter Plot Explanation:
These figures plot effluent versus influent concentrations for each sampling event at a given facility. Features of the plots are noted with red numbers and explained below.

1 – The middle line between the red and blue shading represents no change between influent and effluent concentrations, or a 1 to 1 ratio.
2 – Data points within the red shaded area represent samples with effluent concentrations that were higher than influent concentrations (> 1 to 1 ratio). Data points in the blue shaded area represent samplings with effluent concentrations that were lower than influent concentrations (< 1 to 1 ratio).
3 – Where possible, the x and y concentration scales and units are the same for each parameter across facilities to facilitate comparison. Exceptions are identified with red axis labels.
4 – Name of parameter
5 – Facility name:

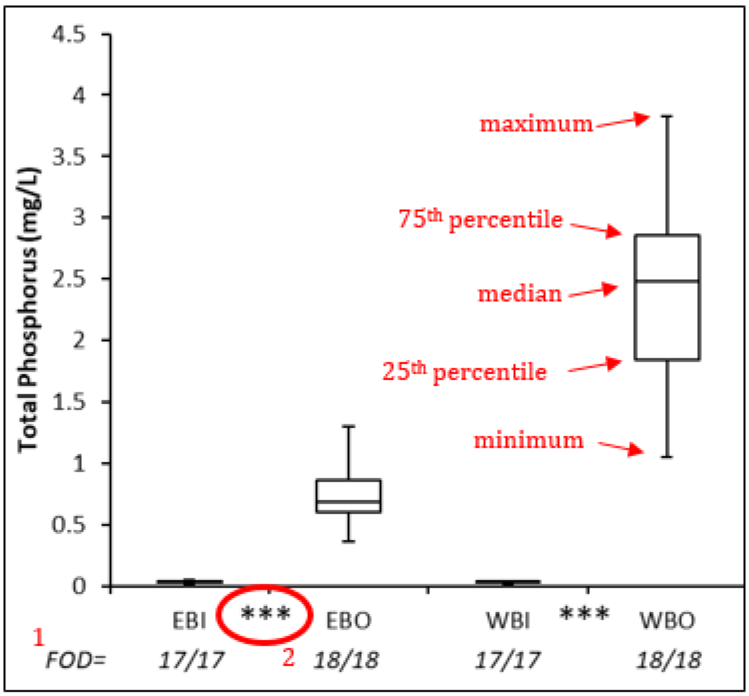
- East Bioretention (EB) = EBI vs. EBO
- West Bioretention (WB) = WBI vs. WBO
- Wetland Complex (WC*) = WCI vs. WCEBO
- Whole System* = WCI vs. NWH

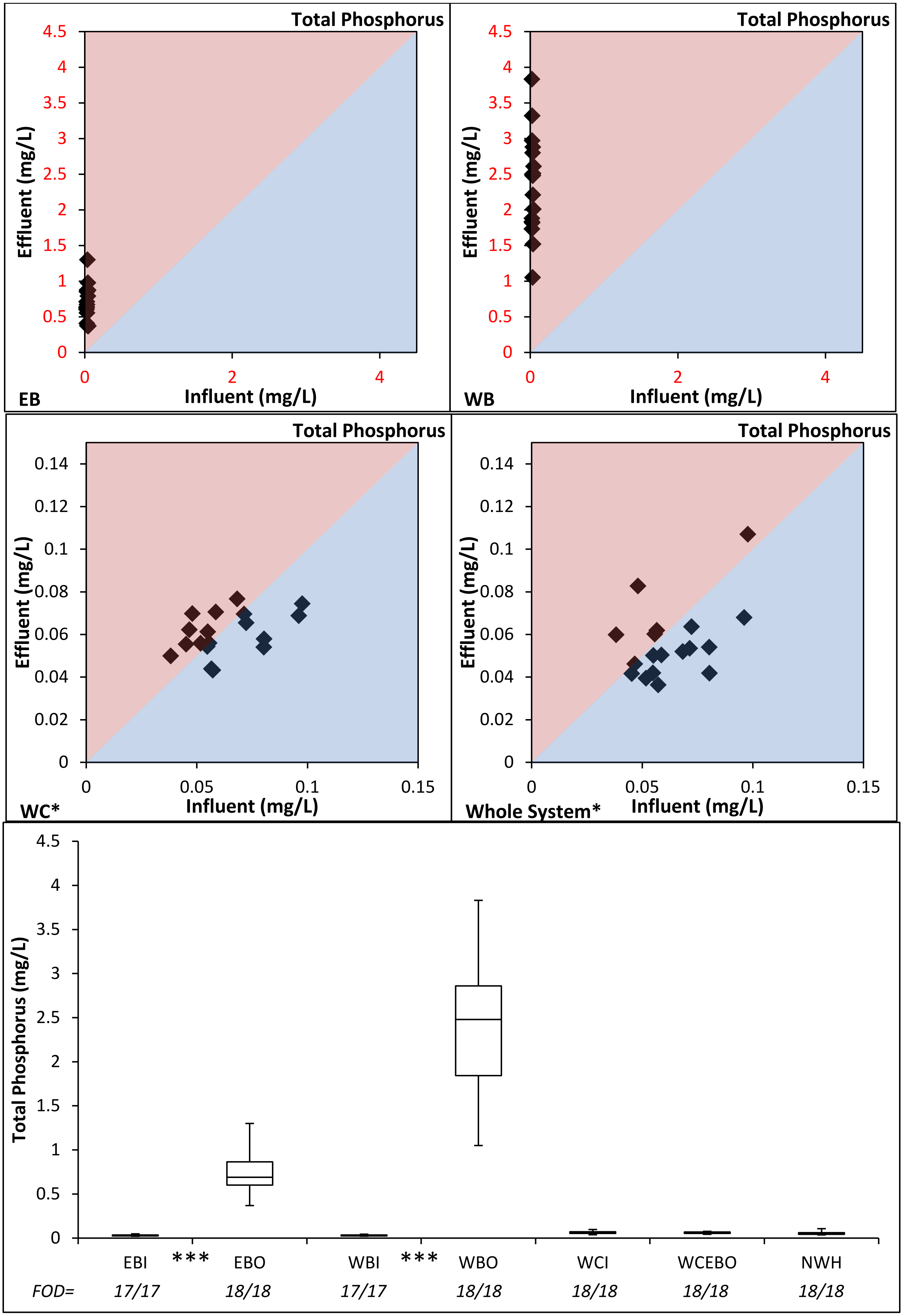
*These comparisons are not entirely representative of influent and effluent flows for these systems, but provide approximate estimates as described in Appendix A.
Note: Figures with several non-detect results include red lines indicating the method detection limit.

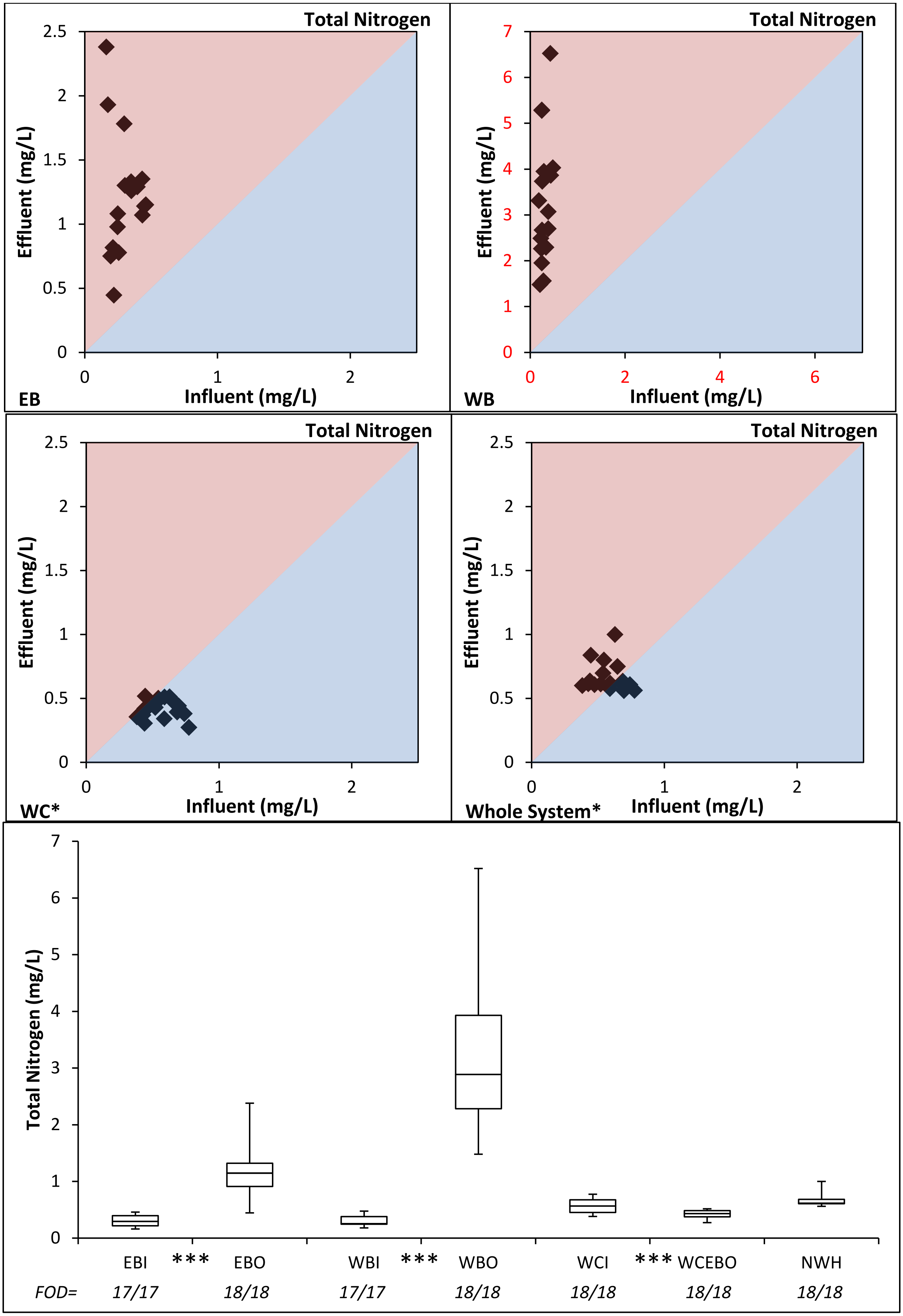


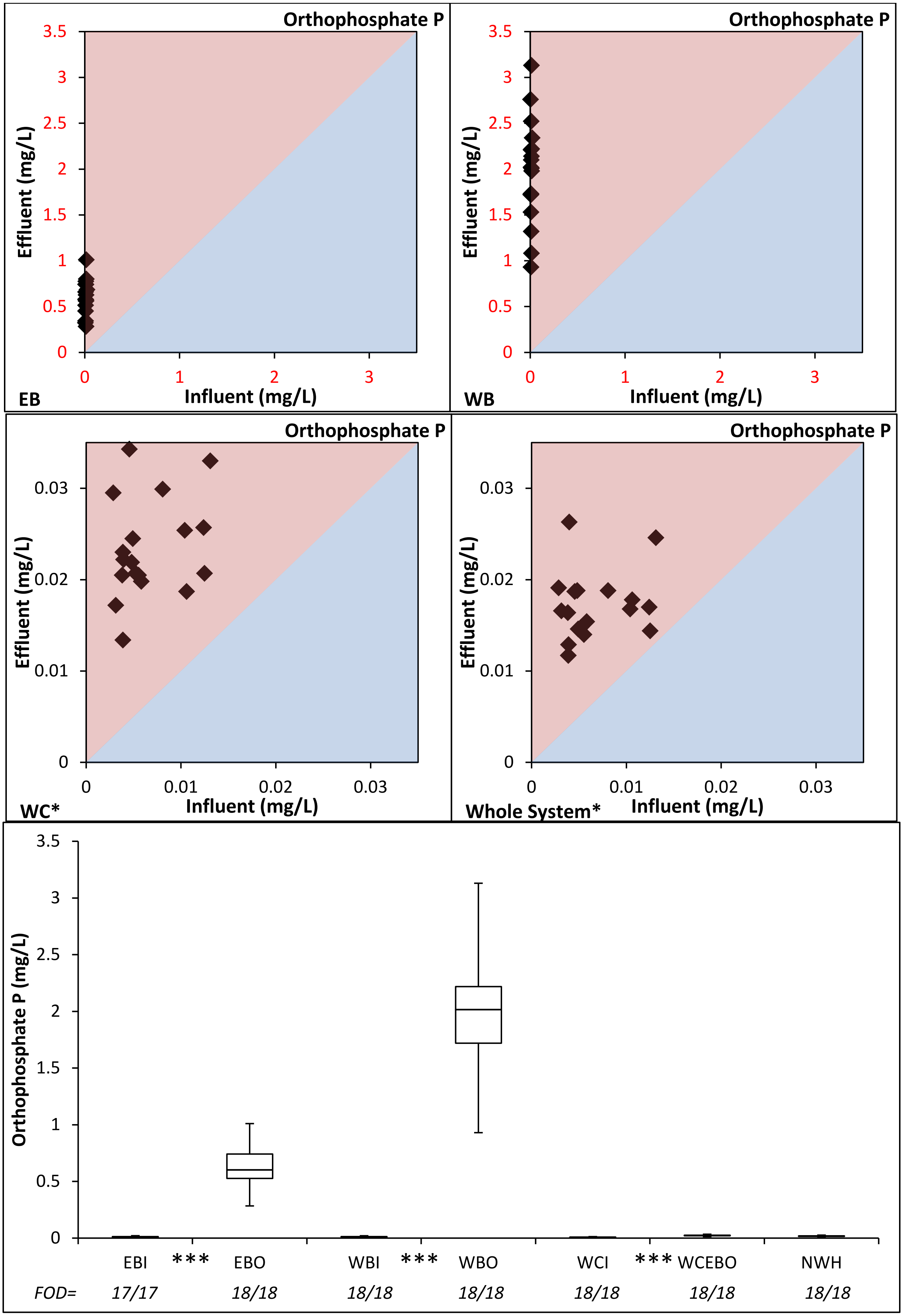
Box Plot Explanation:
Box plots illustrate the distribution of results for each site as indicated in the example figure below. Features of the plots are noted with red numbers and explained below.

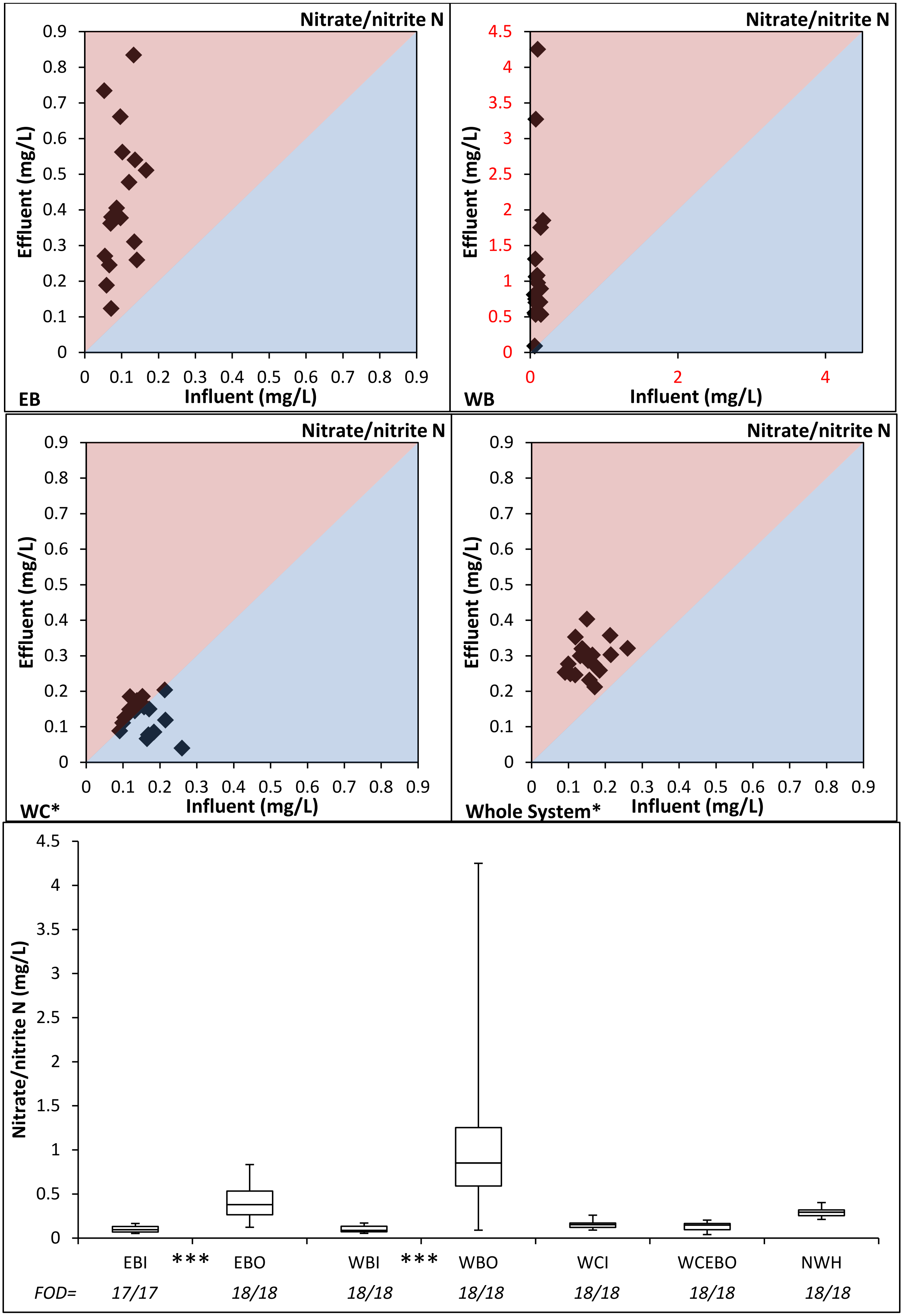
1 – Frequency of detection (FOD): non-detects are included at the method detection limit (MDL) value.
2 – The asterisks indicate statistically significant differences between influent and effluent concentrations (i.e., EBI vs. EBO, WBI vs. WBO, WCI vs. WCEBO): *** = p<0.001, ** = p<0.01, * = p<0.05. See Appendix E for statistical methods descriptions.

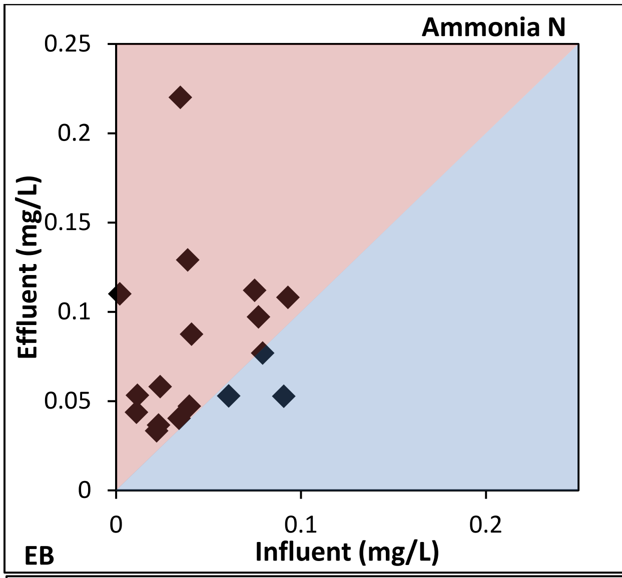


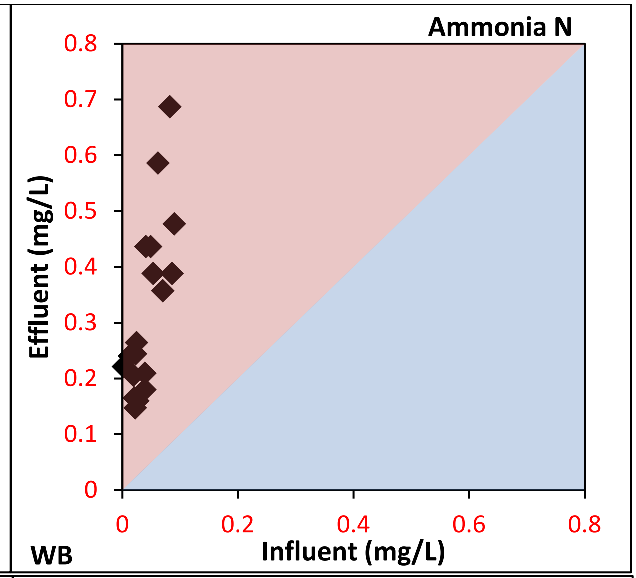

Total Phosphorus
Effluent (mg/L)
Influent (mg/L)
EB
Total Phosphorus
Effluent (mg/L)
Influent (mg/L)
WB
Total Phosphorus
Effluent (mg/L)
Influent (mg/L)
WC*
Total Phosphorus
Effluent (mg/L)
Influent (mg/L)
Whole System*
Total Phosphorus (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

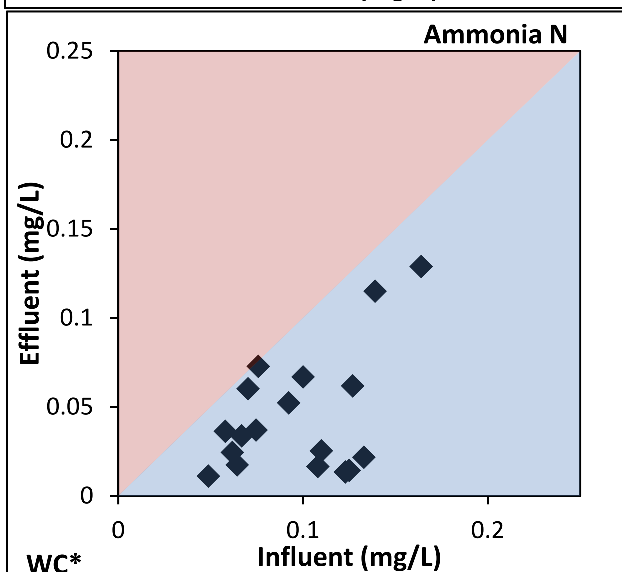

Total Nitrogen
Effluent (mg/L)
Influent (mg/L)
EB
Total Nitrogen
Effluent (mg/L)
Influent (mg/L)
WB
Total Nitrogen
Effluent (mg/L)
Influent (mg/L)
WC*
Total Nitrogen
Effluent (mg/L)
Influent (mg/L)
Whole System*
Total Nitrogen (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
***
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

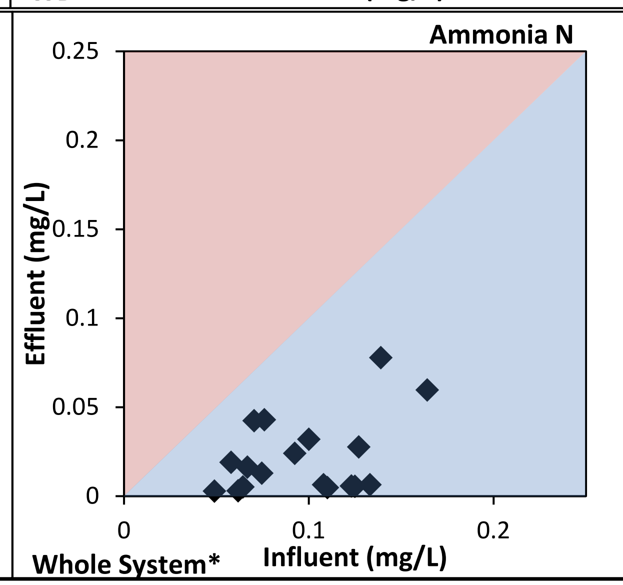

Orthophosphate P
Effluent (mg/L)
Influent (mg/L)
EB
Orthophosphate P
Effluent (mg/L)
Influent (mg/L)
WB
Orthophosphate P
Effluent (mg/L)
Influent (mg/L)
WC*
Orthophosphate P
Effluent (mg/L)
Influent (mg/L)
Whole System*
Orthophosphate P (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
***
WCEBO
NWH
FOD=
17/17
18/18
18/18
18/18
18/18
18/18
18/18

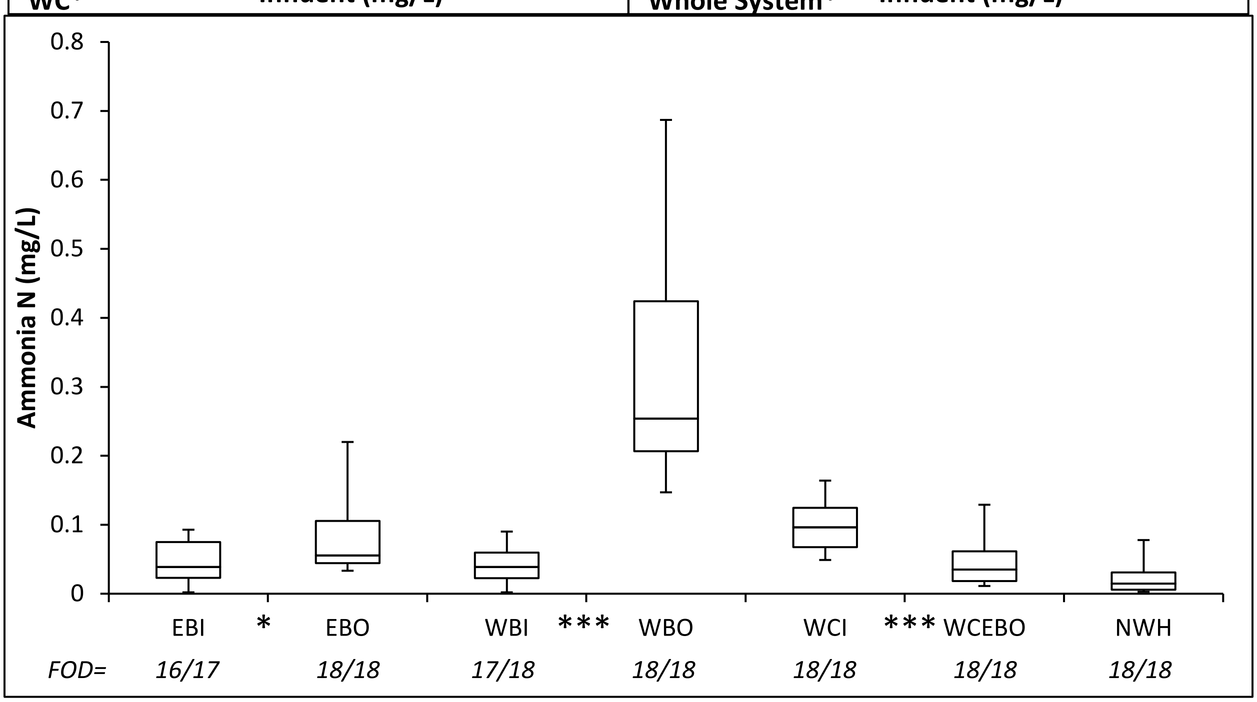

Nitrate/nitrite N
Effluent (mg/L)
Influent (mg/L)
EB
Nitrate/nitrite N
Effluent (mg/L)
Influent (mg/L)
WB
Nitrate/nitrite N
Effluent (mg/L)
Influent (mg/L)
WC*
Nitrate/nitrite N
Effluent (mg/L)
Influent (mg/L)
Whole System*
Nitrate/nitrite N (mg/L)
EBI *** EBO WBI *** WBO WCI WCEBO NWH
FOD= 17/17 18/18 18/18 18/18 18/18 18/18 18/18

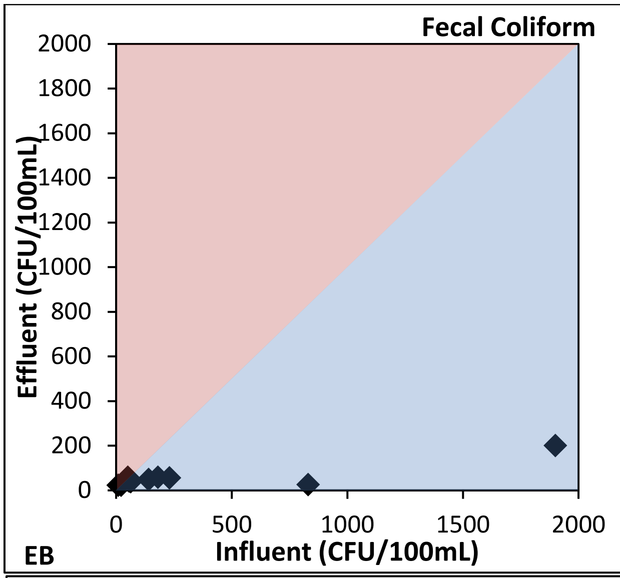

Ammonia N
Effluent (mg/L)
Influent (mg/L)
EB

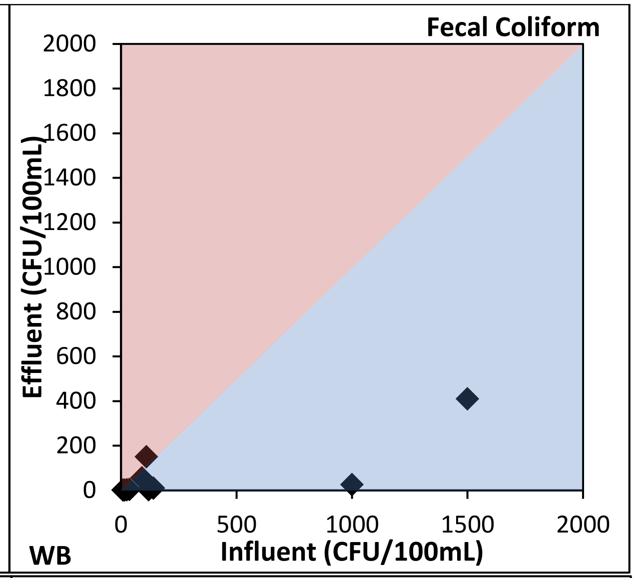

Ammonia N
Effluent (mg/L)
Influent (mg/L)
WB

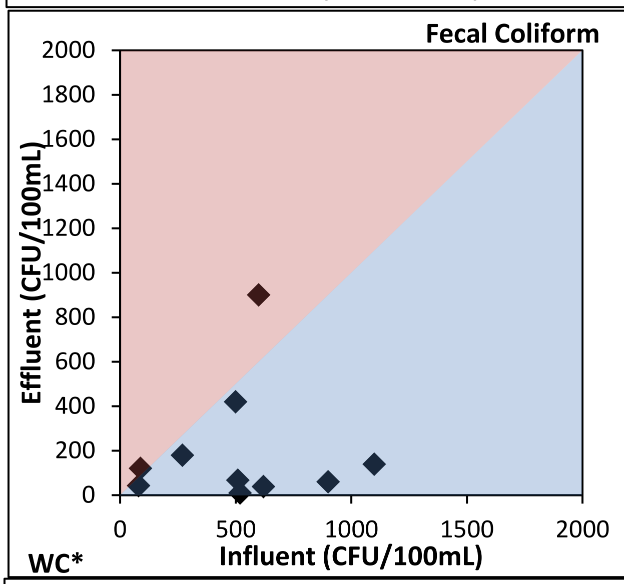

Ammonia N
Effluent (mg/L)
Influent (mg/L)
WC*

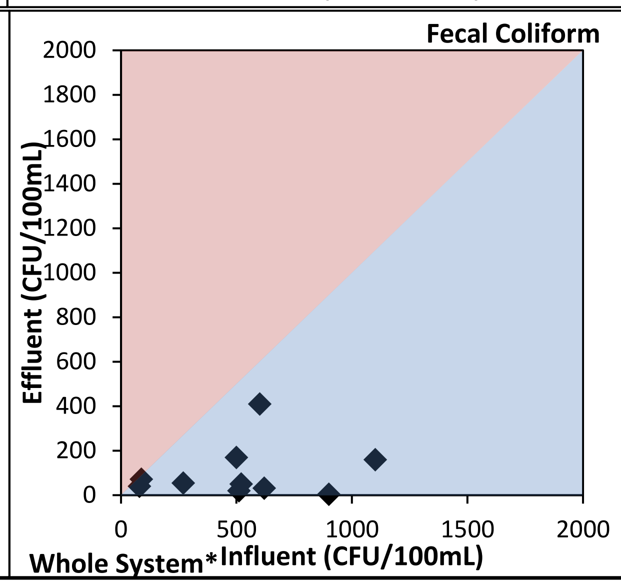

Ammonia N
Effluent (mg/L)
Influent (mg/L)
Whole System*

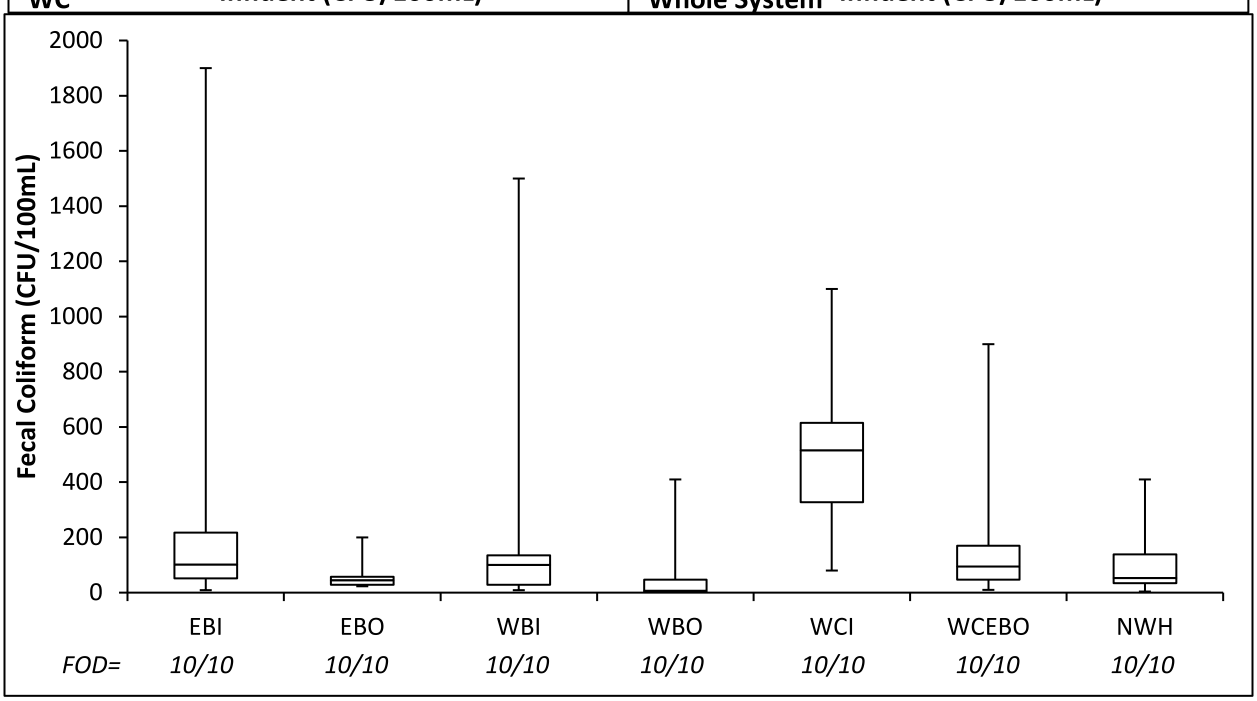

Ammonia N (mg/L)
EBI
*
EBO
WBI
***
WBO
WCI
***
WCEBO
NWH
FOD=
16/17
18/18
17/18
18/18
18/18
18/18
18/18

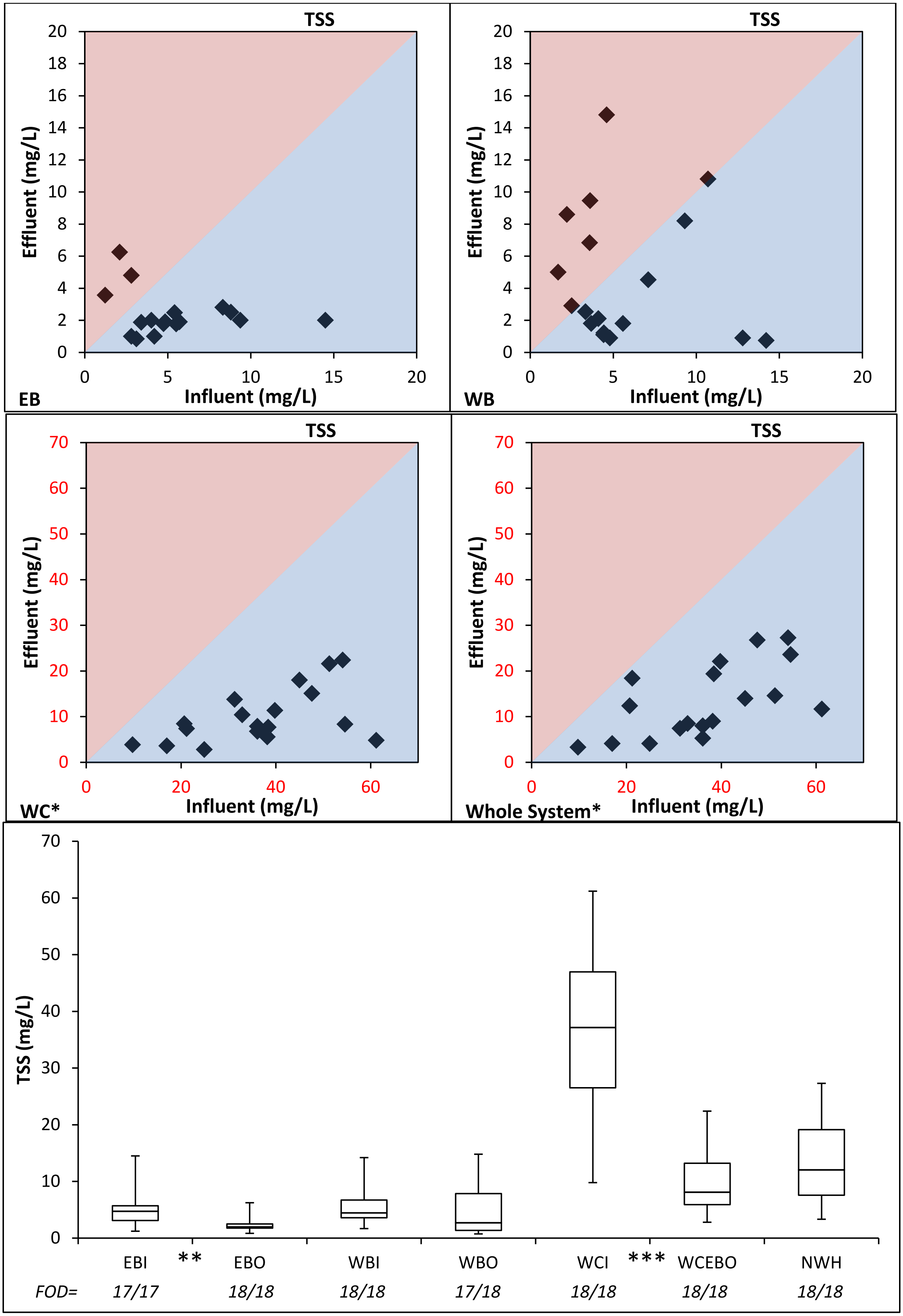

Fecal Coliform
Effluent (CFU/100mL)
Influent (CFU/100mL)
EB

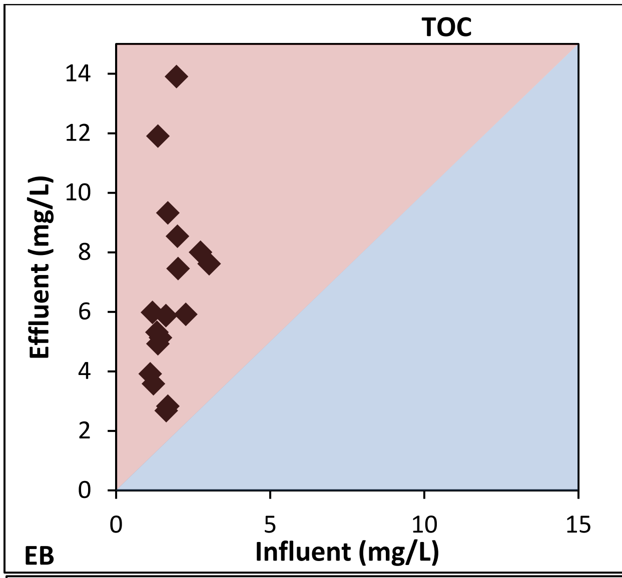

Fecal Coliform
Effluent (CFU/100mL)
Influent (CFU/100mL)
WB

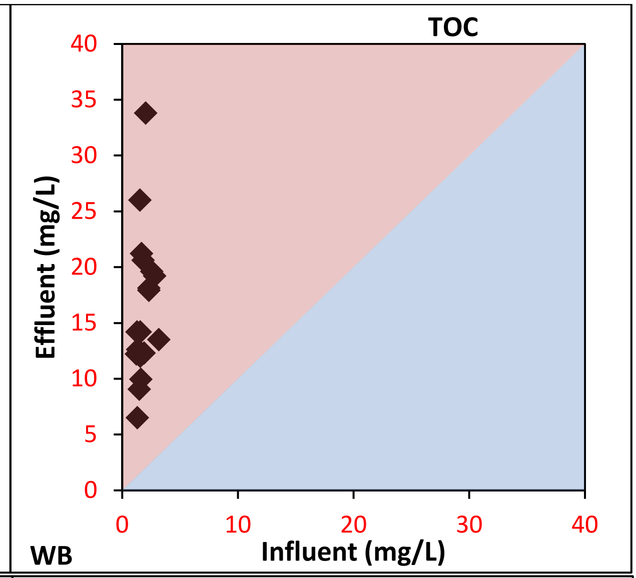

Fecal Coliform
Effluent (CFU/100mL)
Influent (CFU/100mL)
WC*

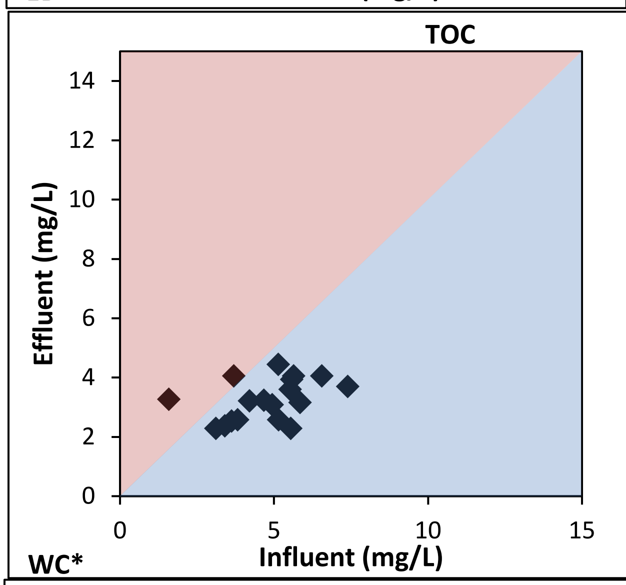

Fecal Coliform
Effluent (CFU/100mL)
Influent (CFU/100mL)
Whole System*

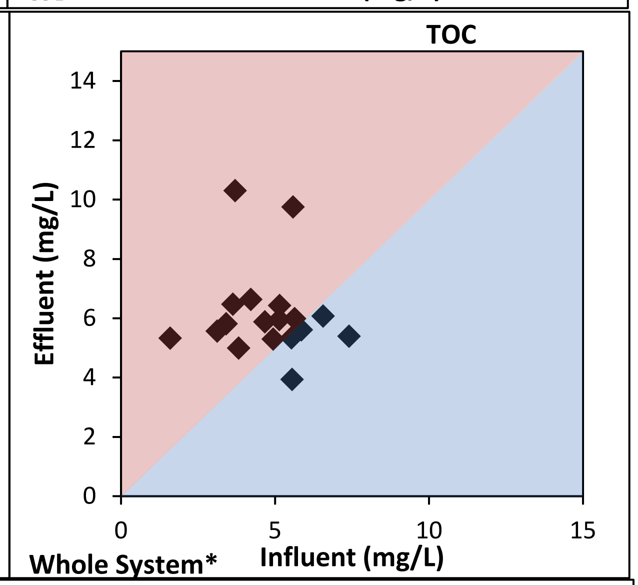

Fecal Coliform (CFU/100mL)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
10/10
10/10
10/10
10/10
10/10
10/10
10/10

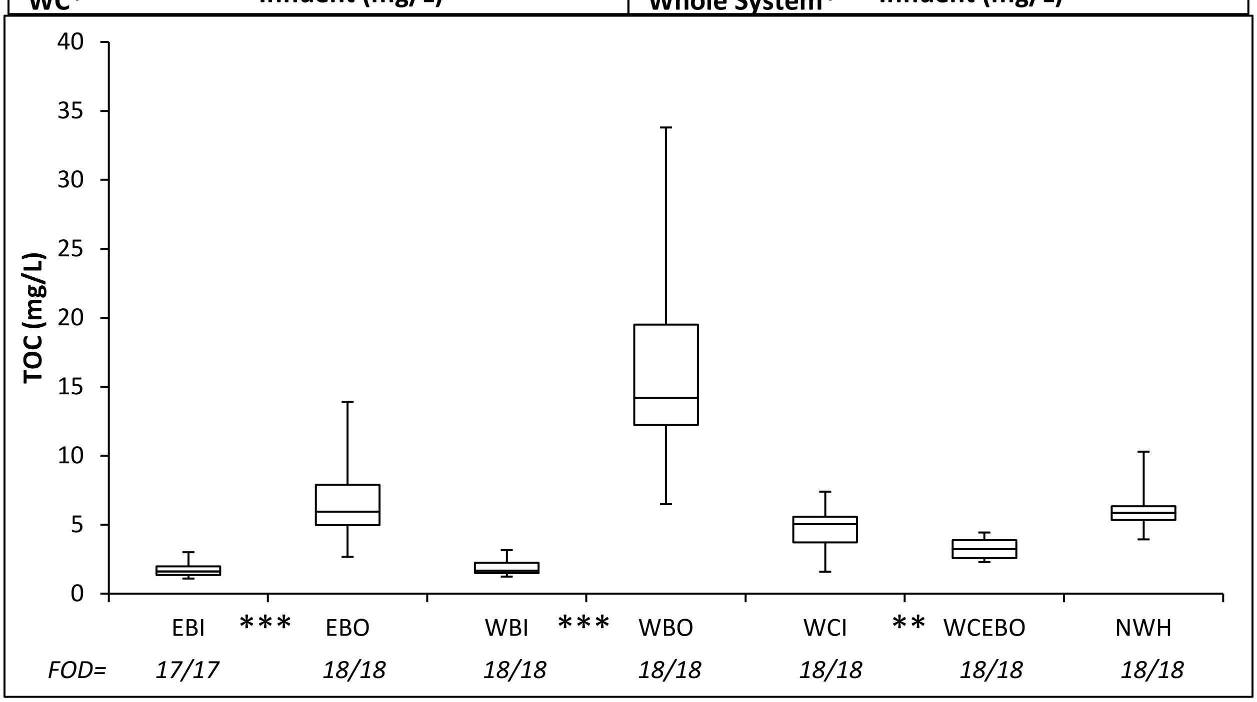

TSS
Effluent (mg/L)
Influent (mg/L)
EB
TSS
Effluent (mg/L)
Influent (mg/L)
WB
TSS
Effluent (mg/L)
Influent (mg/L)
WC*
TSS
Effluent (mg/L)
Influent (mg/L)
Whole System*
TSS (mg/L)
EBI
**
EBO
WBI
WBO
WCI
***
WCEBO
NWH
FOD=
17/17
18/18
18/18
17/18
18/18
18/18
18/18

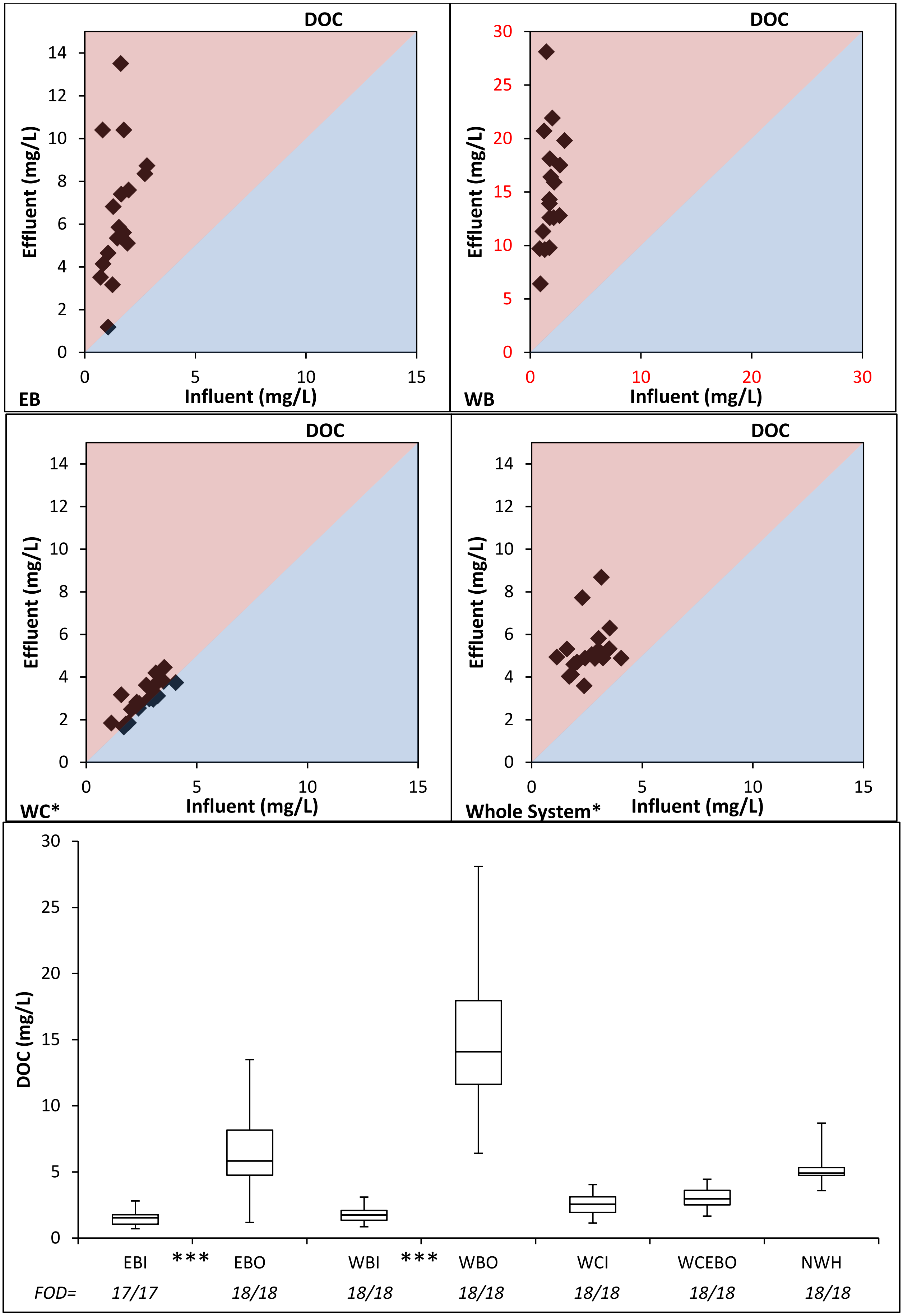

TOC
Effluent (mg/L)
Influent (mg/L)
EB

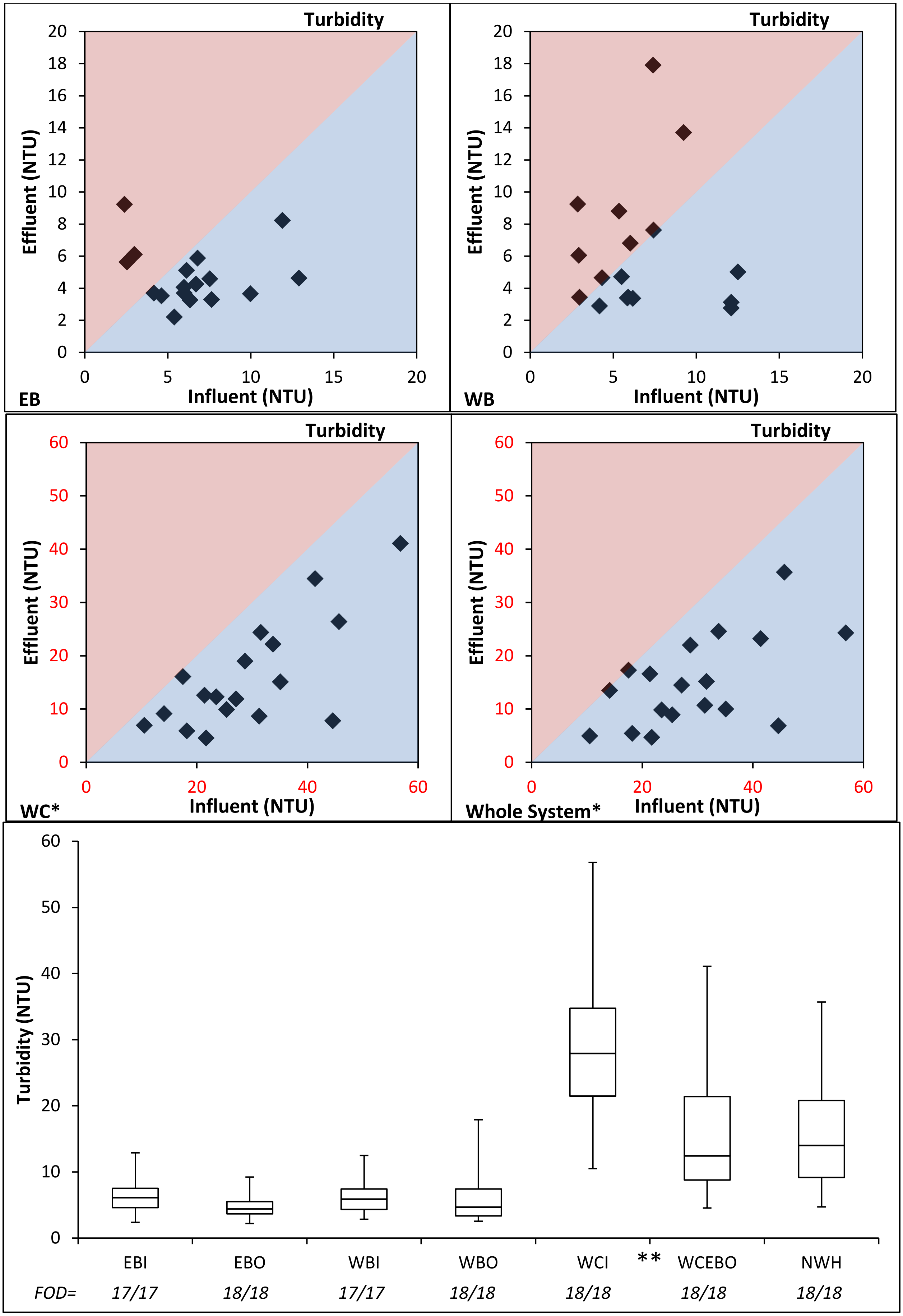

TOC
Effluent (mg/L)
Influent (mg/L)
WB

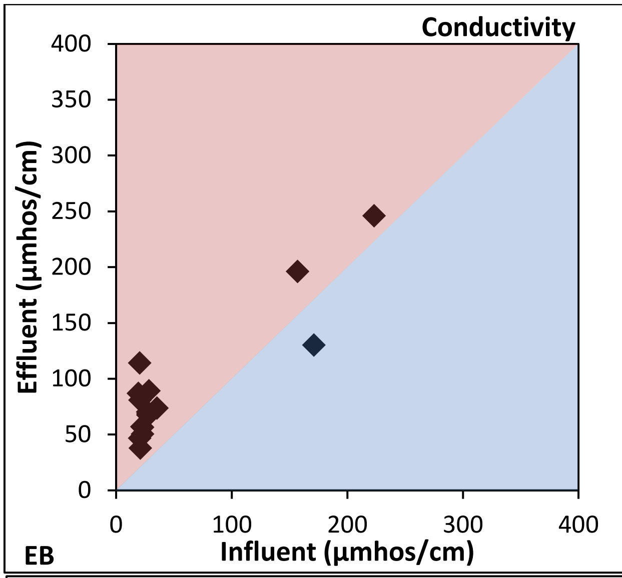

TOC
Effluent (mg/L)
Influent (mg/L)
WC*

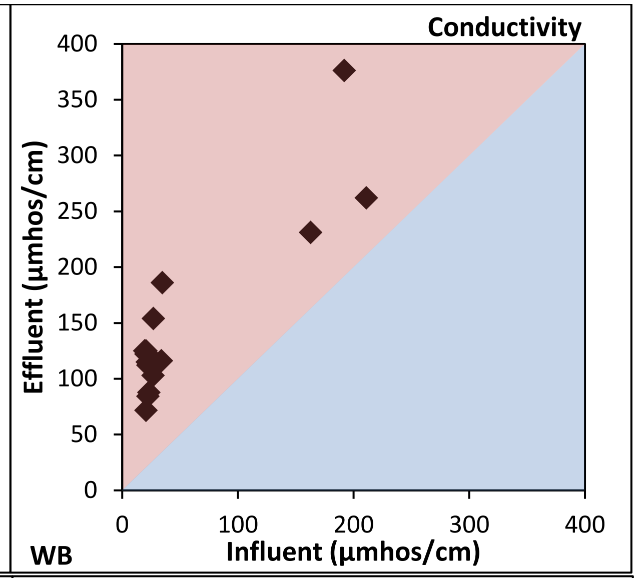

TOC
Effluent (mg/L)
Influent (mg/L)
Whole System*

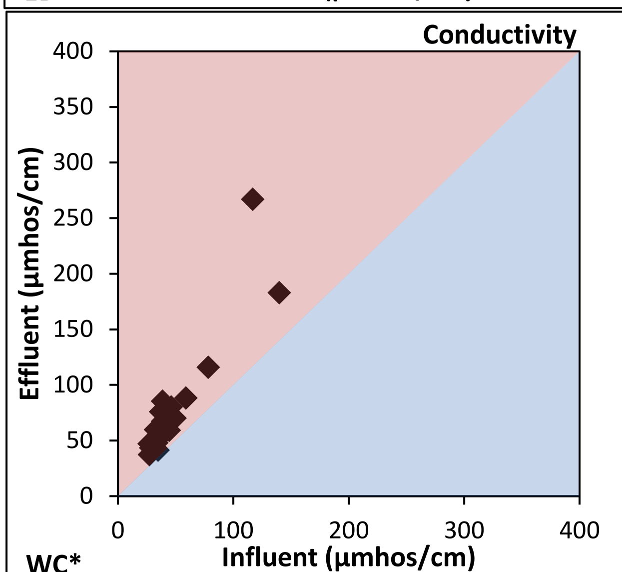

TOC (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
**
WCEBO
NWH
FOD=
17/17
18/18
18/18
18/18
18/18
18/18
18/18

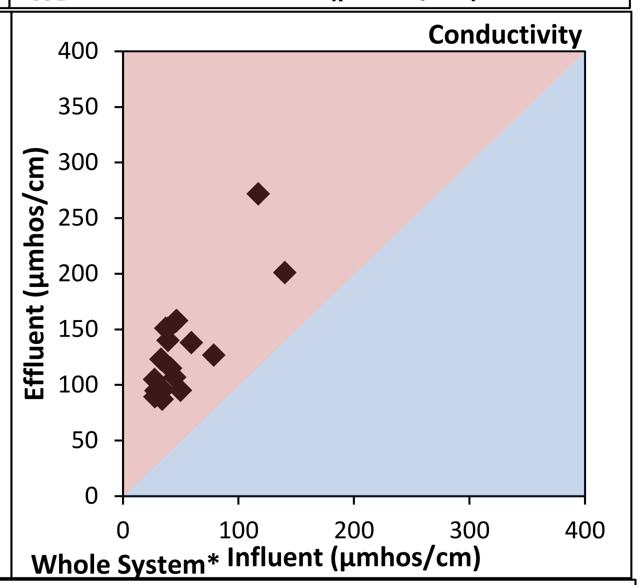

DOC
Effluent (mg/L)
Influent (mg/L)
EB
DOC
Effluent (mg/L)
Influent (mg/L)
WB
DOC
Effluent (mg/L)
Influent (mg/L)
WC*
DOC
Effluent (mg/L)
Influent (mg/L)
Whole System*
DOC (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
18/18
18/18
18/18
18/18
18/18

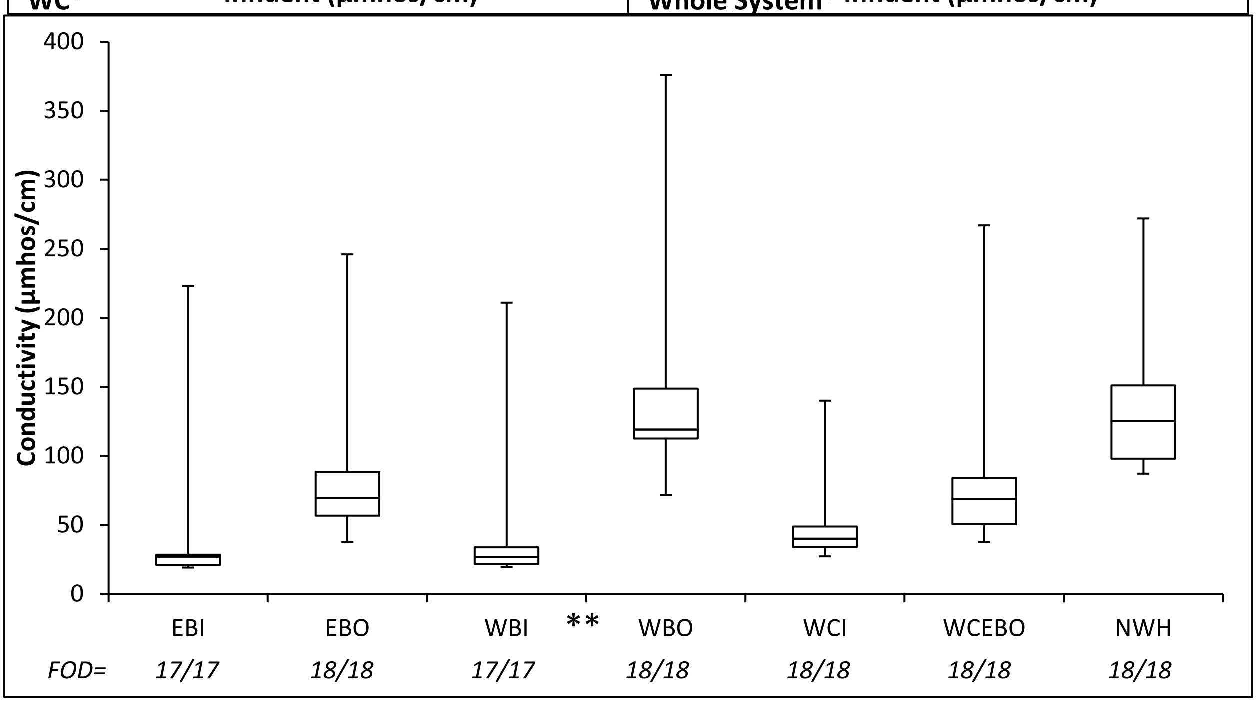

Turbidity
Effluent (NTU)
Influent (NTU)
EB
Turbidity
Effluent (NTU)
Influent (NTU)
WB
Turbidity
Effluent (NTU)
Influent (NTU)
WC*
Turbidity
Effluent (NTU)
Influent (NTU)
Whole System*
Turbidity (NTU)
EBI
EBO
WBI
WBO
WCI
**
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

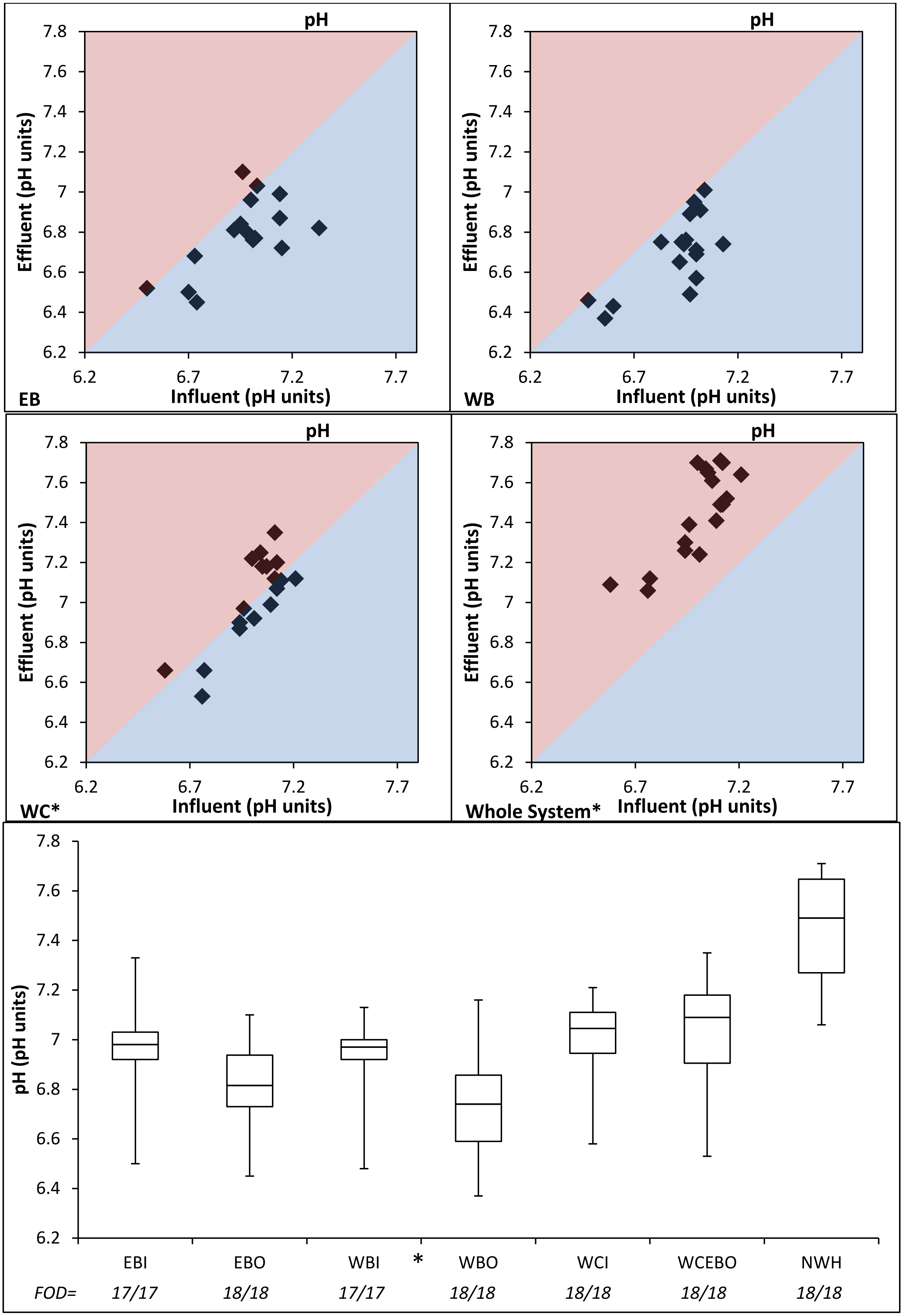

Conductivity
400
350
300
250
200
150
100
50
0
Effluent (µmhos/cm)
0
100
200
300
400
Influent (µmhos/cm)
EB

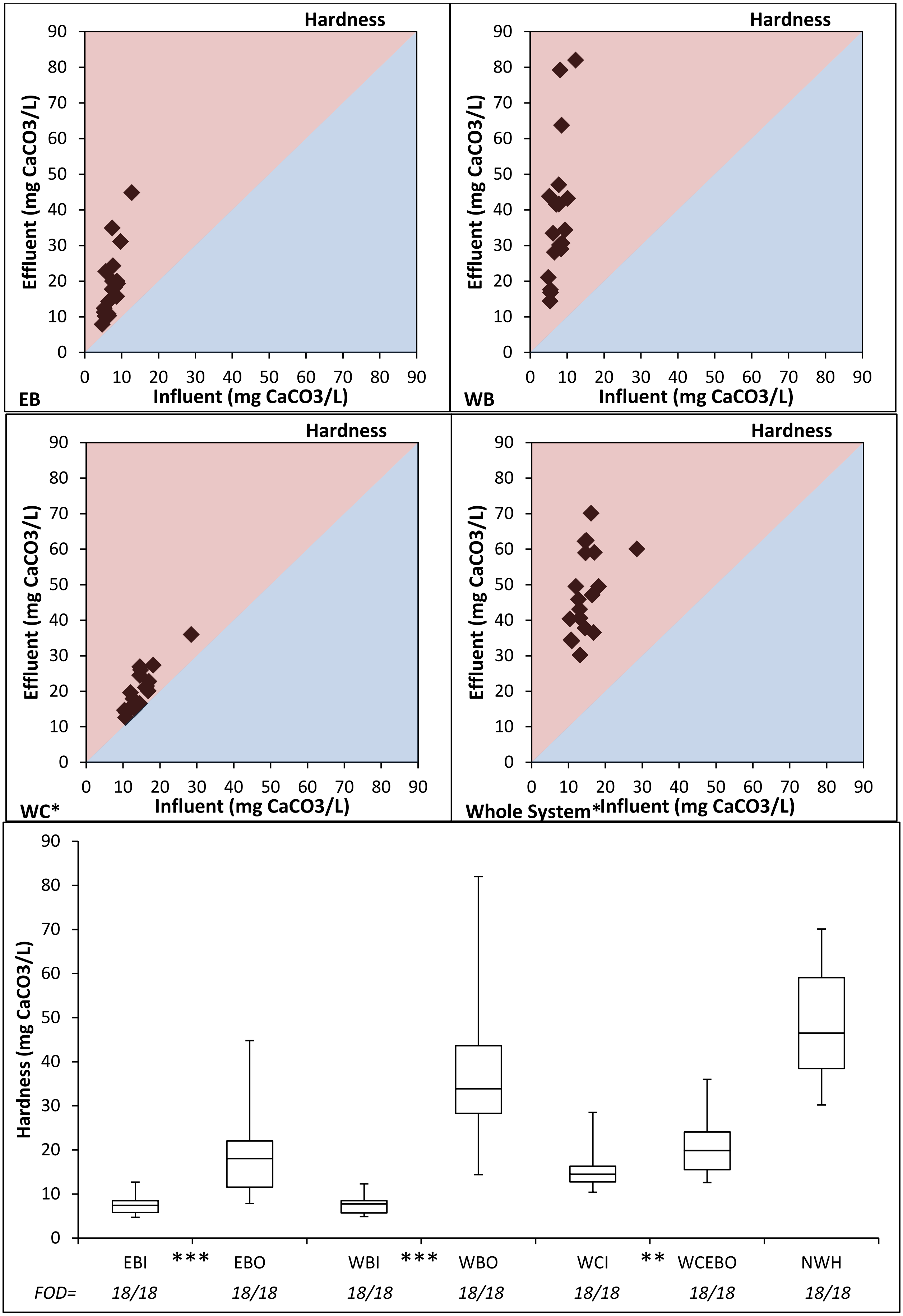

Conductivity
400
350
300
250
200
150
100
50
0
Effluent (µmhos/cm)
0
100
200
300
400
Influent (µmhos/cm)
WB

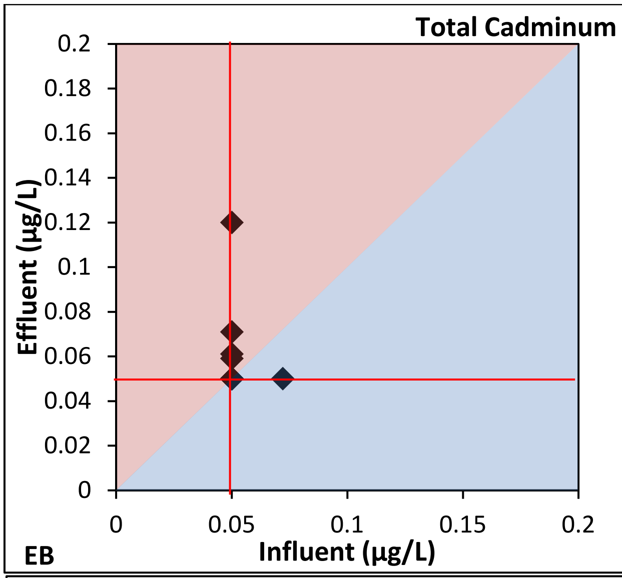

Conductivity
400
350
300
250
200
150
100
50
0
Effluent (µmhos/cm)
0
100
200
300
400
Influent (µmhos/cm)
WC*

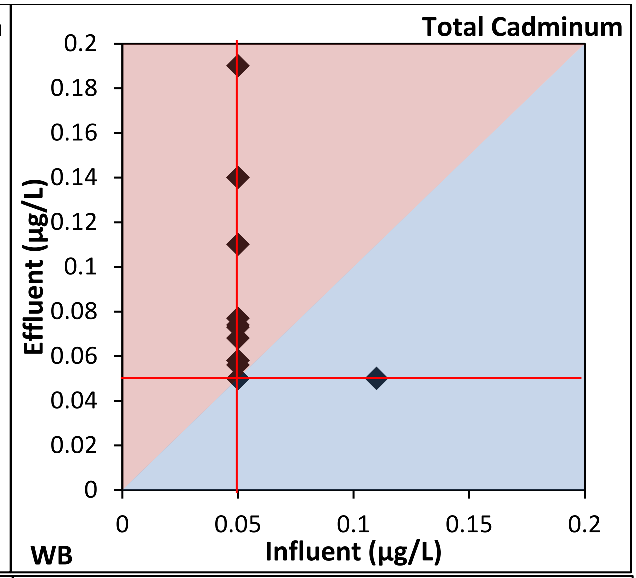

Conductivity
400
350
300
250
200
150
100
50
0
Effluent (µmhos/cm)
0
100
200
300
400
Influent (µmhos/cm)
Whole System*

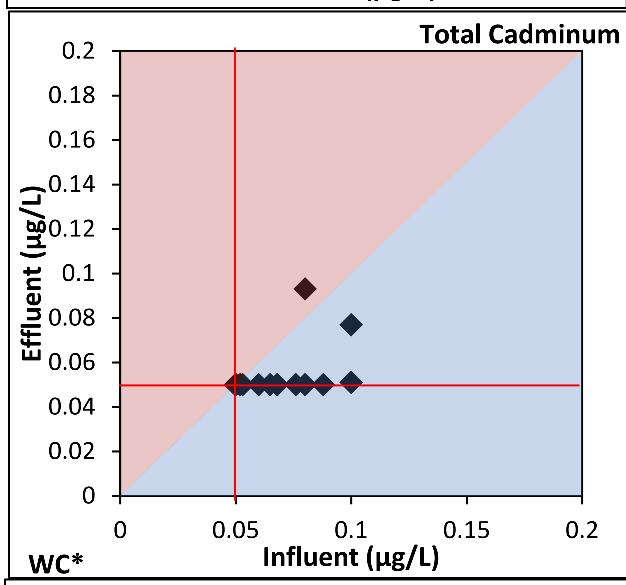

400
350
300
250
200
150
100
50
0
Conductivity (µmhos/cm)
EBI
EBO
WBI
**
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

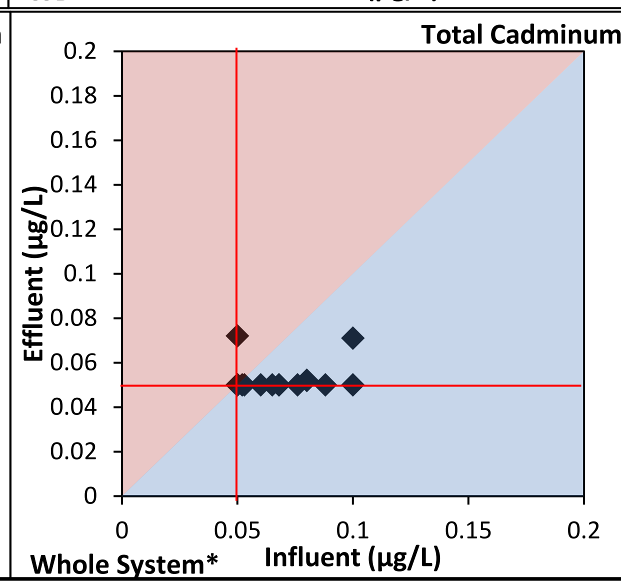

pH
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6.2
6.7
7.2
7.7
Effluent (pH units)
Influent (pH units)
EB
WB
WC*
Whole System*
pH (pH units)
EBI
EBO
WBI
*
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

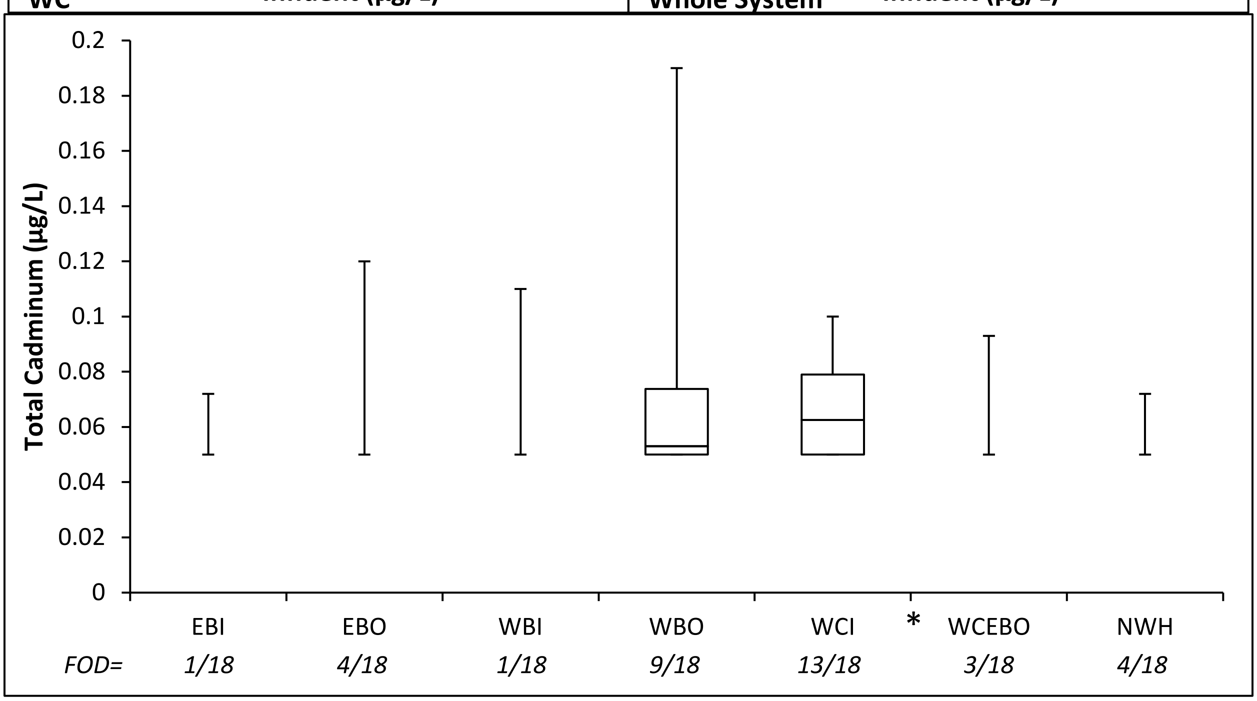

Hardness
Effluent (mg CaCO3/L)
Influent (mg CaCO3/L)
EB
Hardness
Effluent (mg CaCO3/L)
Influent (mg CaCO3/L)
WB
Hardness
Effluent (mg CaCO3/L)
Influent (mg CaCO3/L)
WC*
Hardness
Effluent (mg CaCO3/L)
Influent (mg CaCO3/L)
Whole System*
Hardness (mg CaCO3/L)
EBI *** EBO
WBI *** WBO
WCI ** WCEBO
NWH
FOD= 18/18 18/18 18/18 18/18 18/18 18/18 18/18

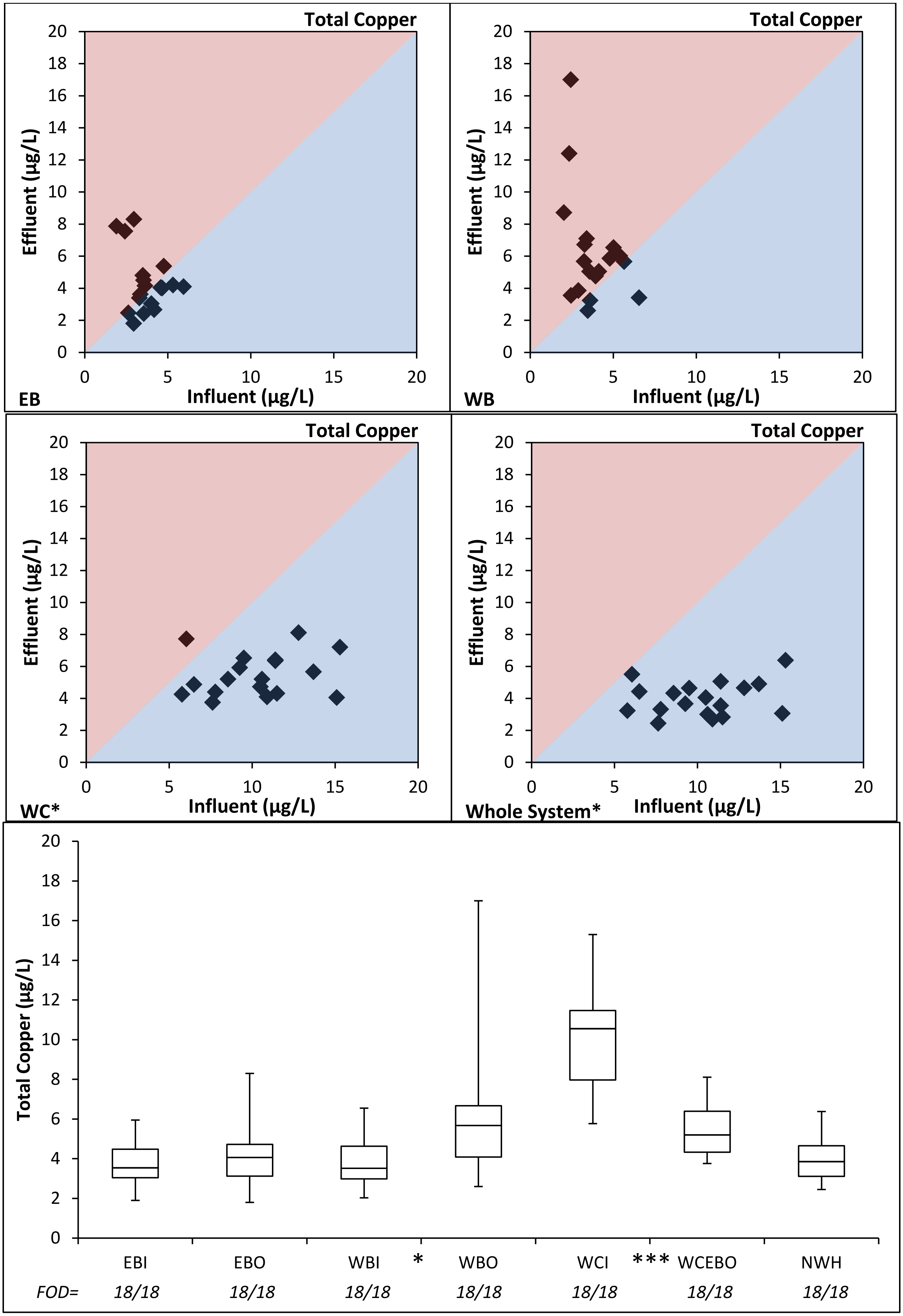

Total Cadminum
Effluent (µg/L)
Influent (µg/L)
EB
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.05
0.1
0.15
0.2

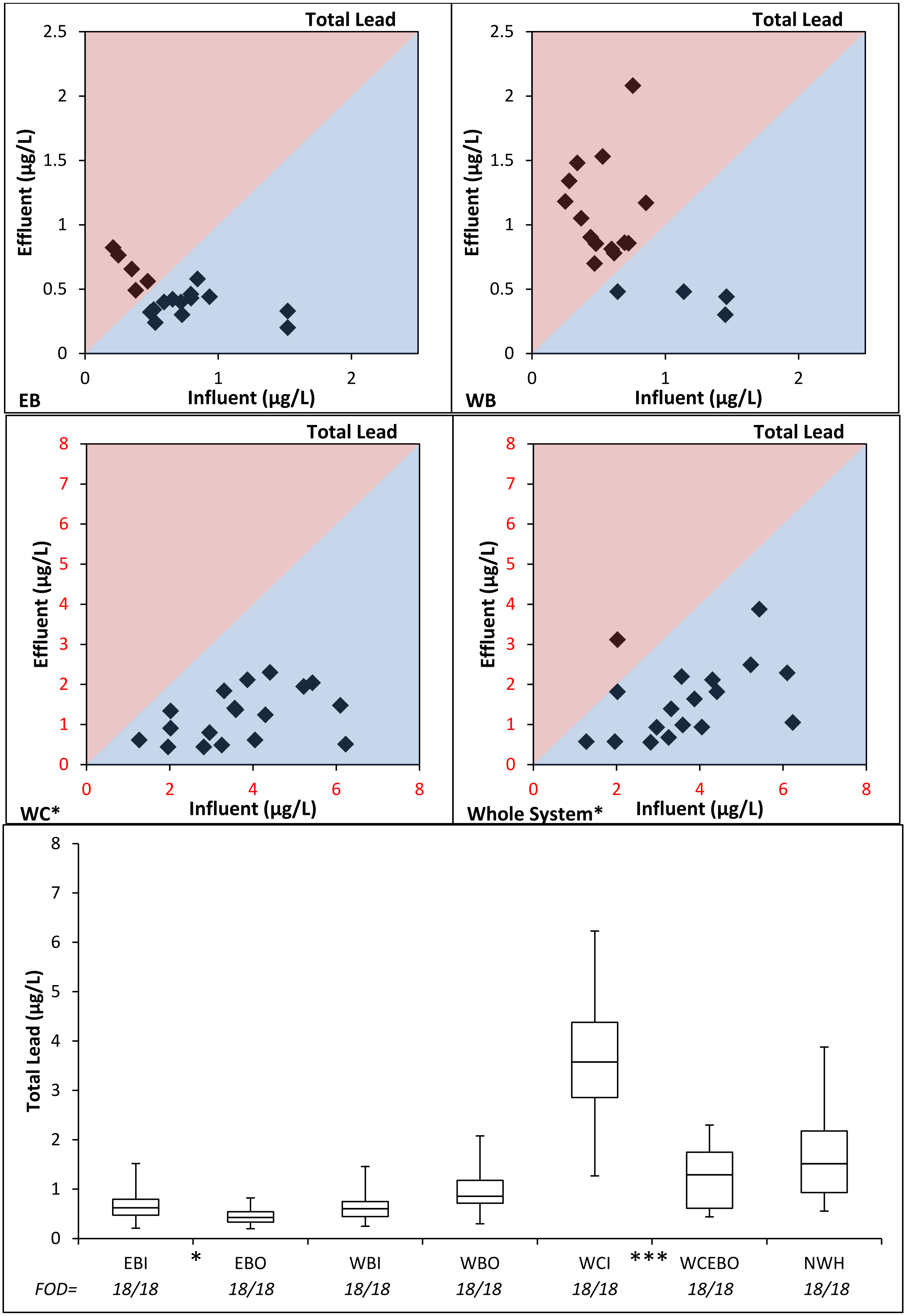

Total Cadminum
Effluent (µg/L)
Influent (µg/L)
WB
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.05
0.1
0.15
0.2

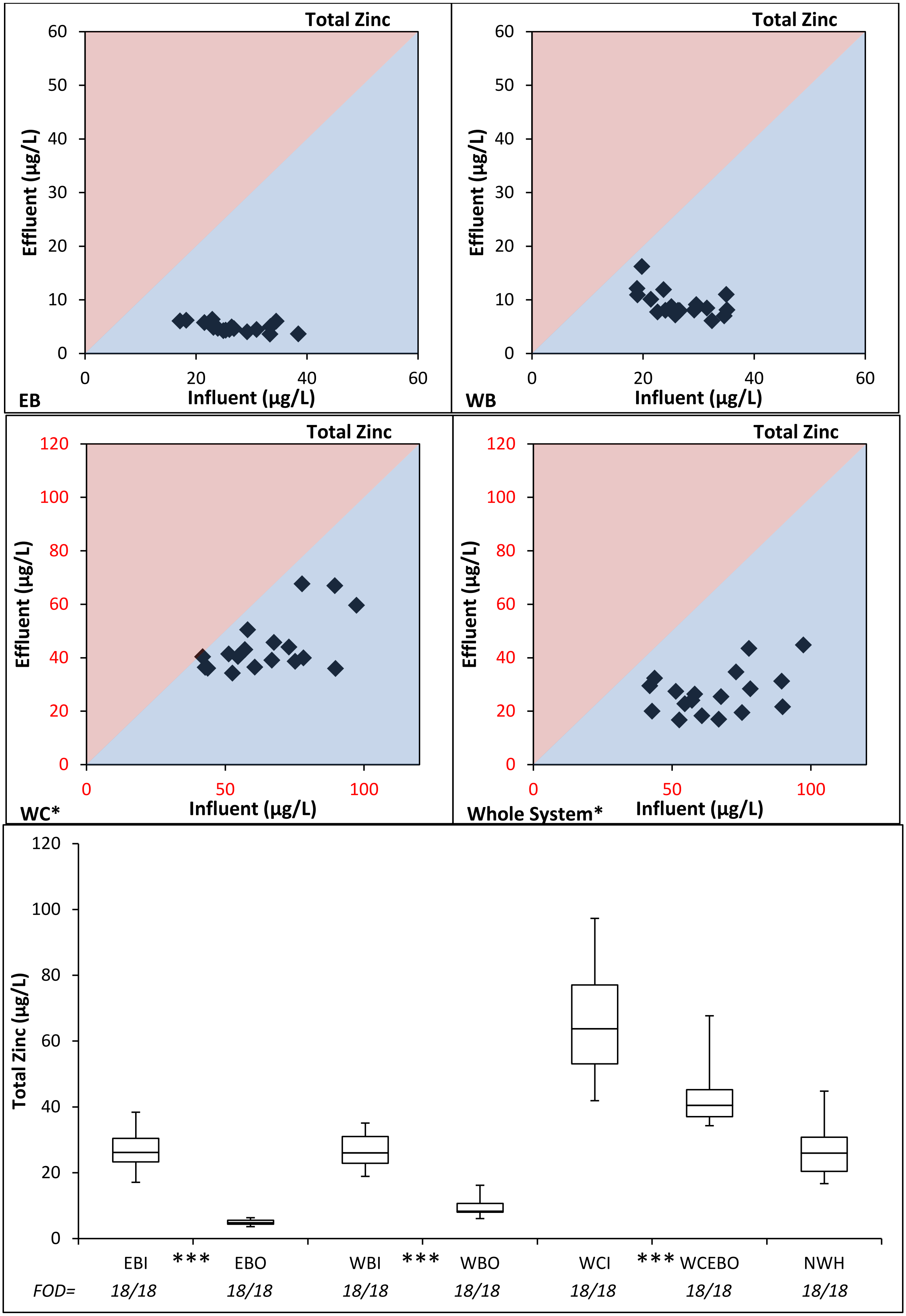

Total Cadminum
Effluent (µg/L)
Influent (µg/L)
WC*
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.05
0.1
0.15
0.2

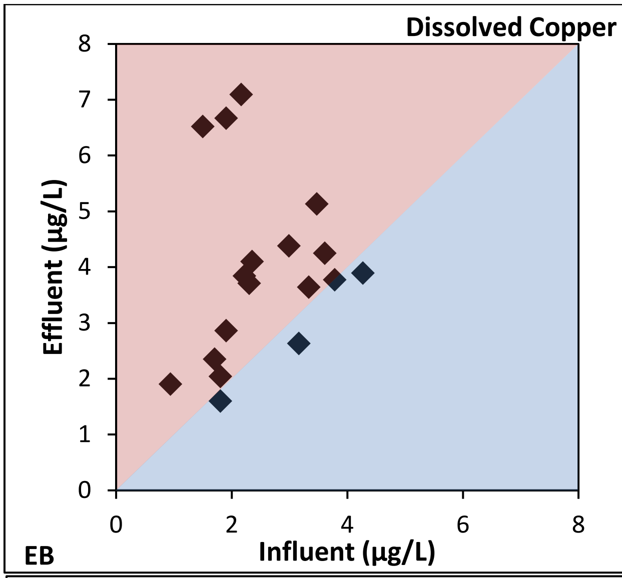

Total Cadminum
Effluent (µg/L)
Influent (µg/L)
Whole System*
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
0.05
0.1
0.15
0.2

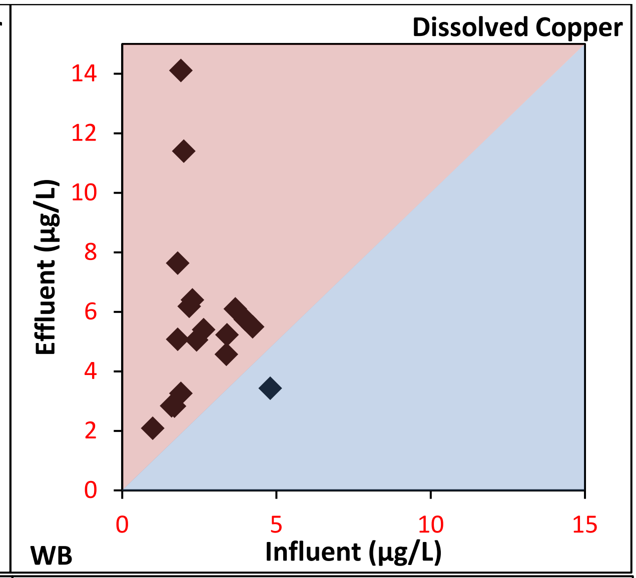

Total Cadminum (µg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
EBI
EBO
WBI
WBO
WCI
*
WCEBO
NWH
FOD=
1/18
4/18
1/18
9/18
13/18
3/18
4/18

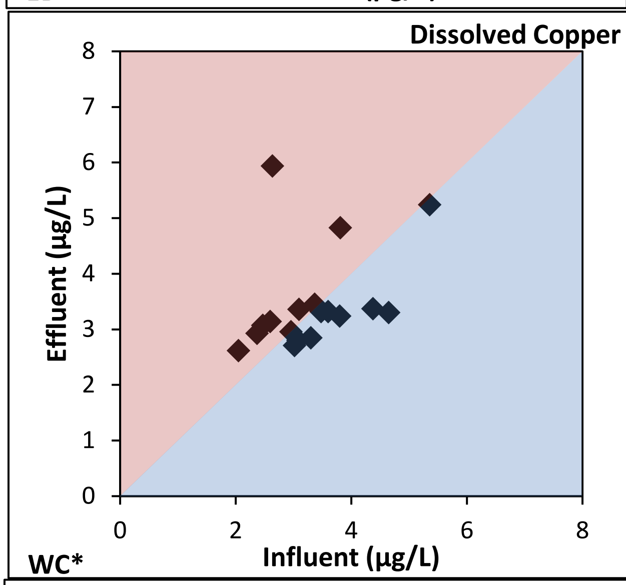

Total Copper
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Copper (µg/L)
EBI
EBO
WBI
*
WBO
WCI
***
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18

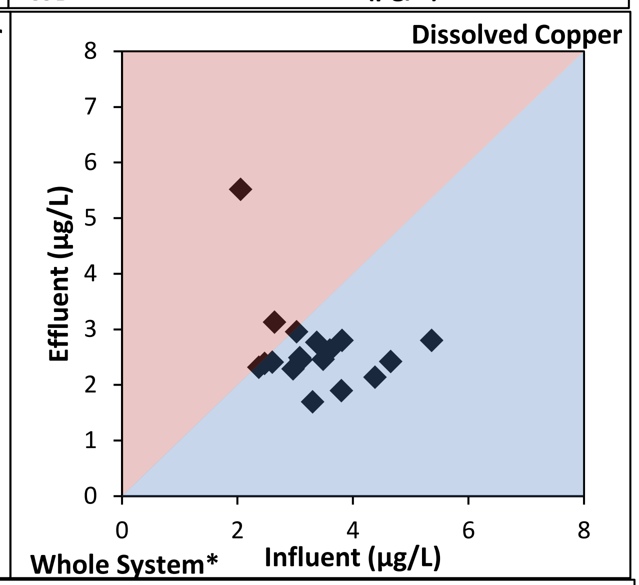

Total Lead
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Lead (µg/L)
EBI
*
EBO
WBI
WBO
WCI
***
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18

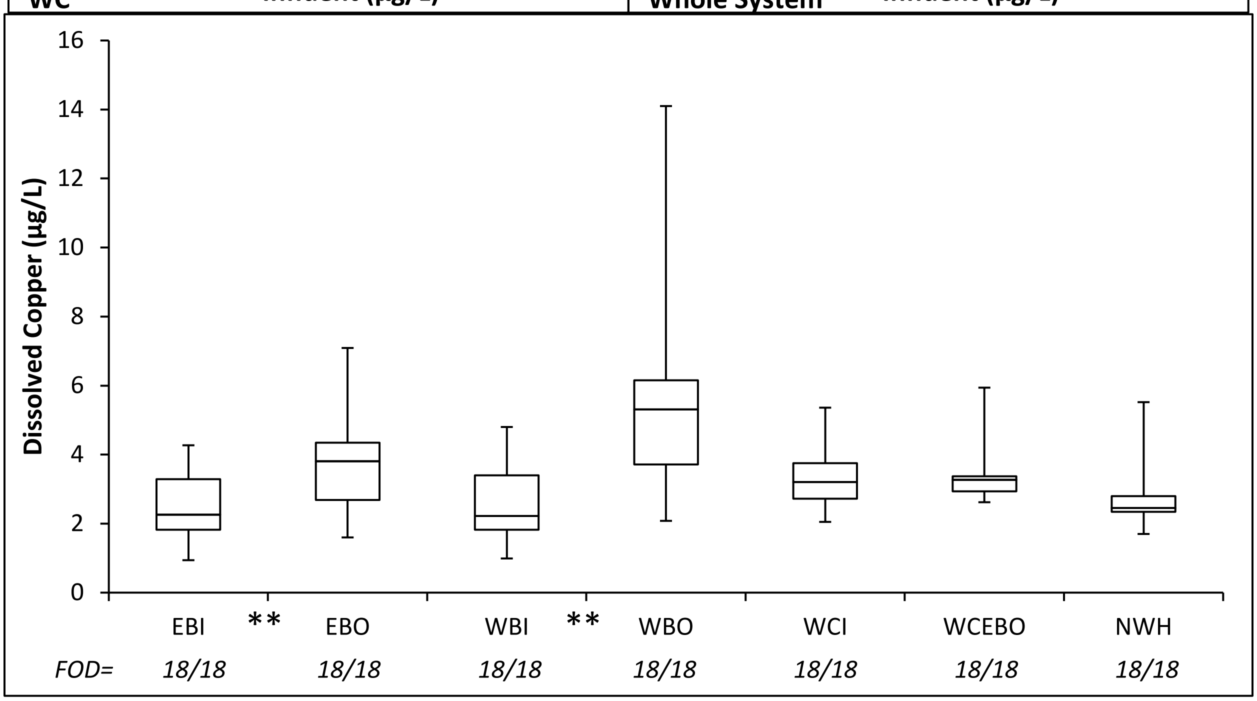

Total Zinc
Effluent (µg/L)
Influent (µg/L)
EB
Total Zinc
Effluent (µg/L)
Influent (µg/L)
WB
Total Zinc
Effluent (µg/L)
Influent (µg/L)
WC*
Total Zinc
Effluent (µg/L)
Influent (µg/L)
Whole System*
Total Zinc (µg/L)
EBI *** EBO WBI *** WBO WCI *** WCEBO NWH
FOD= 18/18 18/18 18/18 18/18 18/18 18/18 18/18

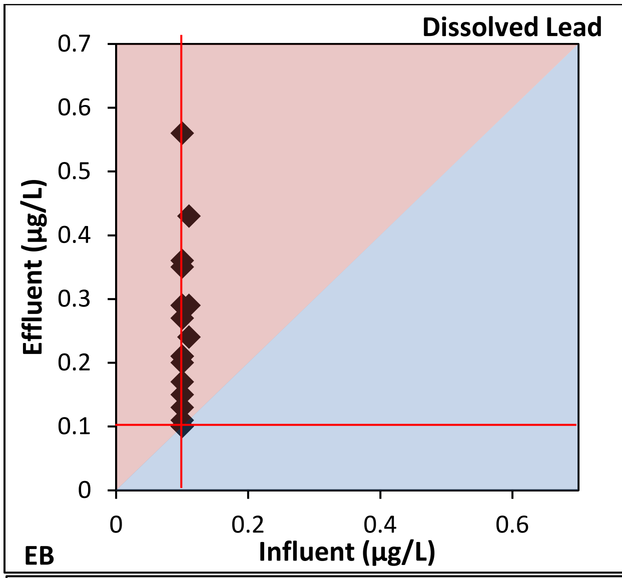

Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
EB

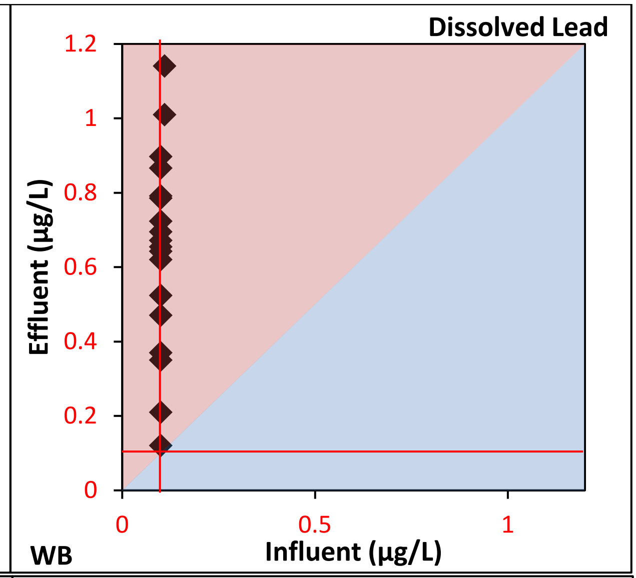

Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
WB

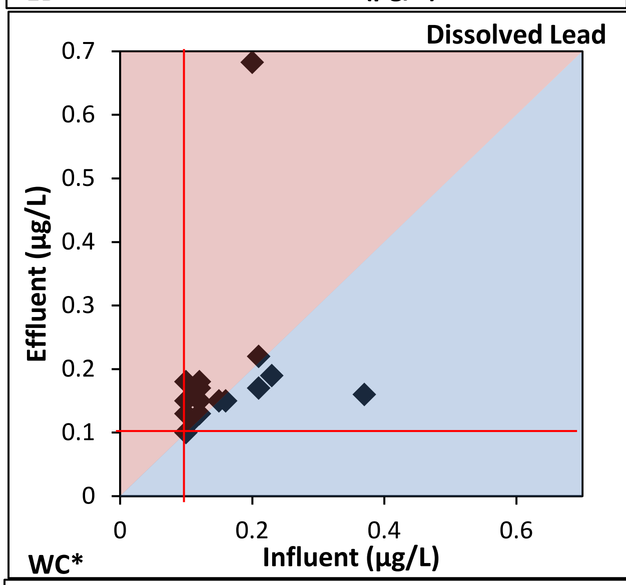

Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
WC*

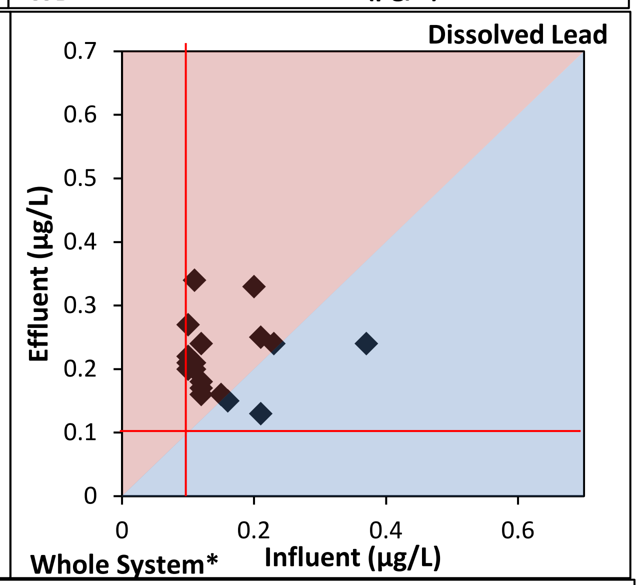

Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
Whole System*

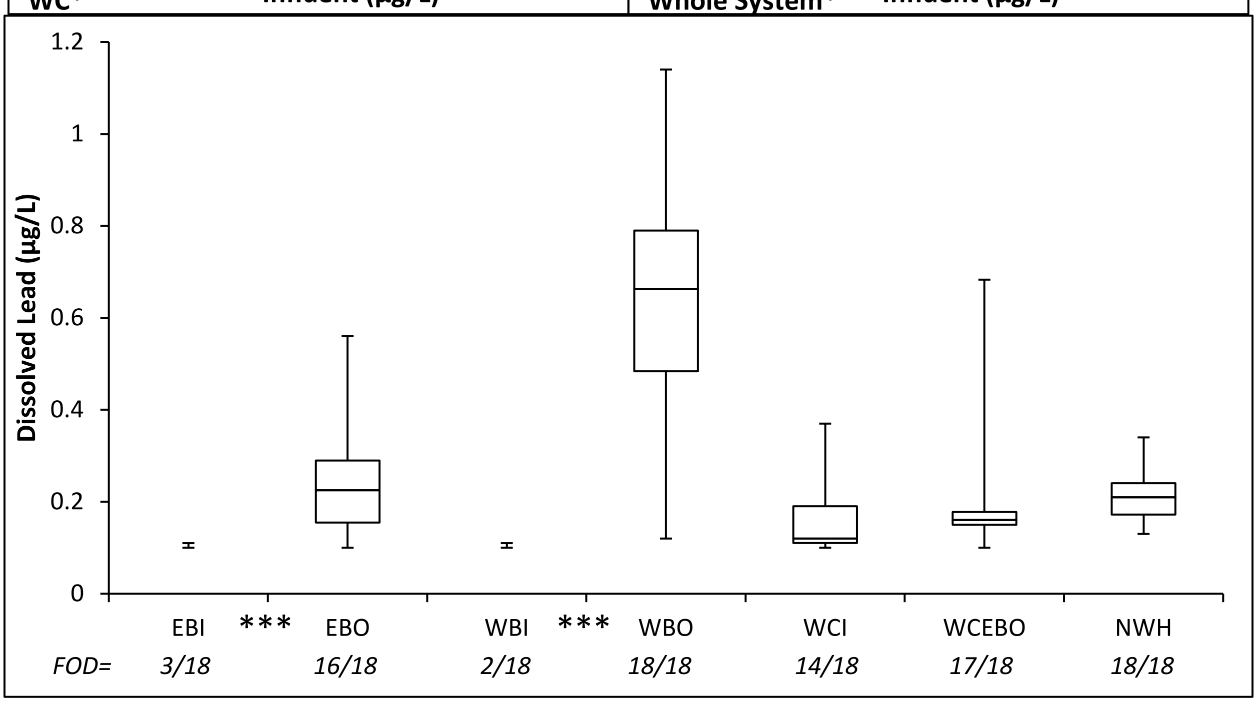

Dissolved Copper (µg/L)
EBI
**
EBO
WBI
**
WBO
WCI
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18

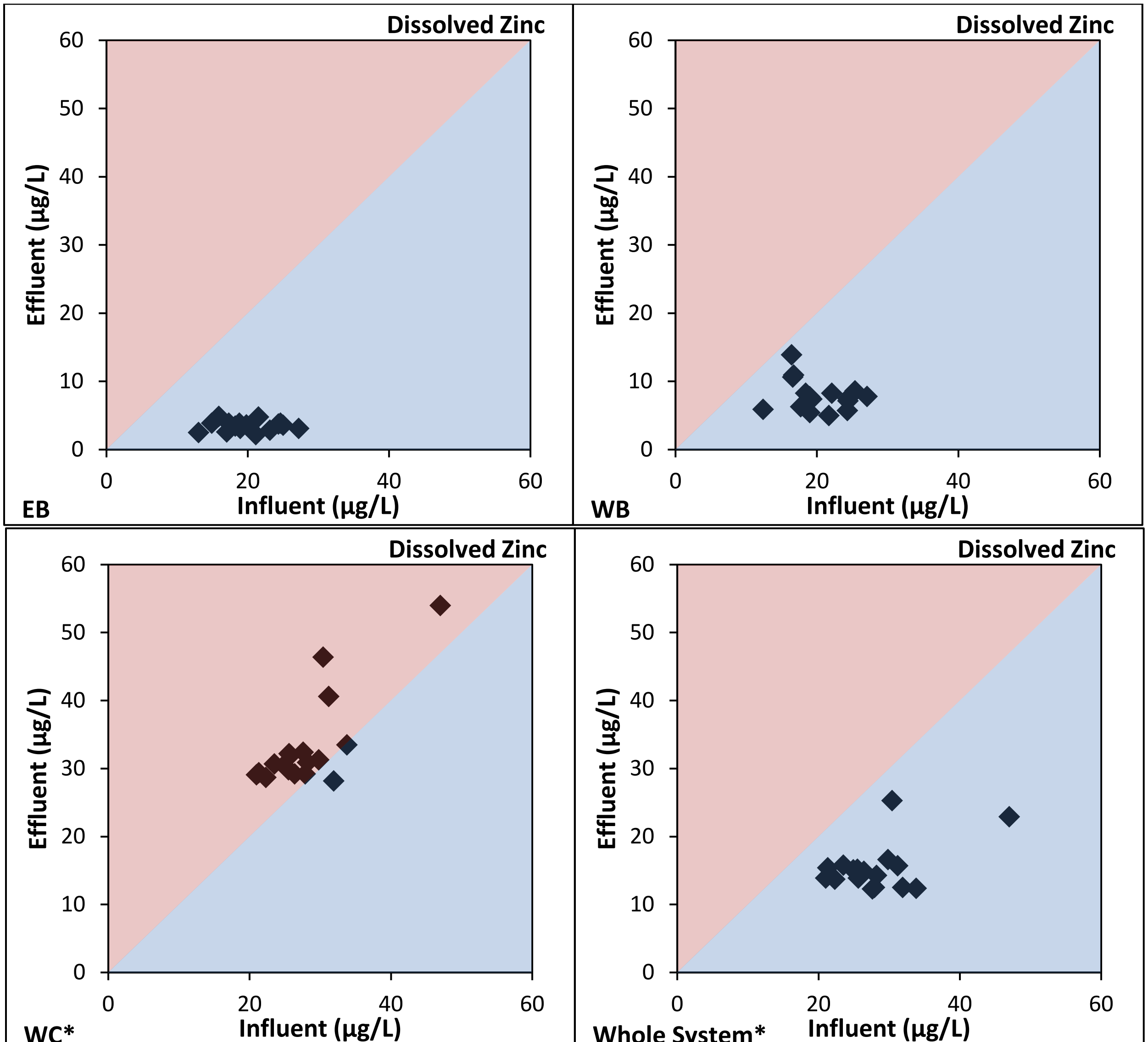

Dissolved Lead
Effluent (µg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
Influent (µg/L)
EB

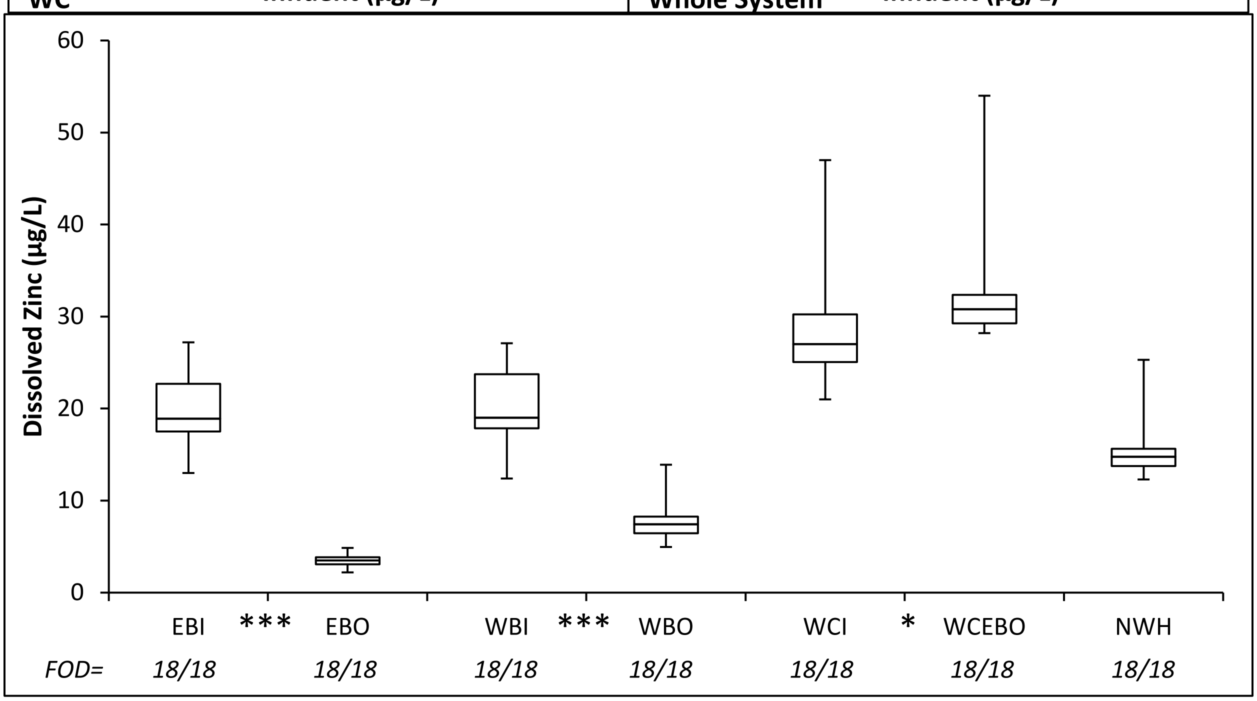

Dissolved Lead
Effluent (µg/L)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
Influent (µg/L)
WB

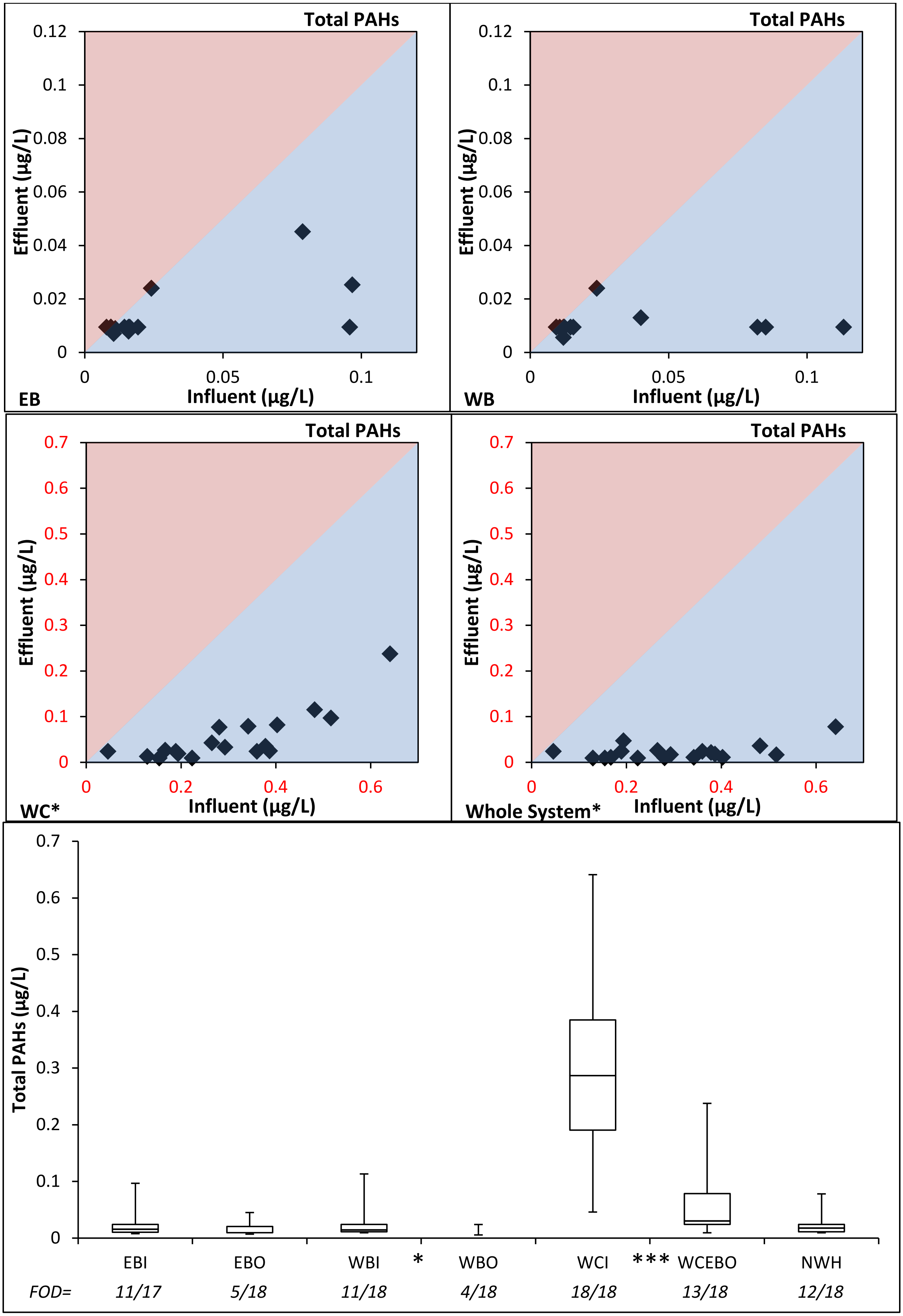

Dissolved Lead
Effluent (µg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
Influent (µg/L)
WC*


Dissolved Lead
Effluent (µg/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
Influent (µg/L)
Whole System*

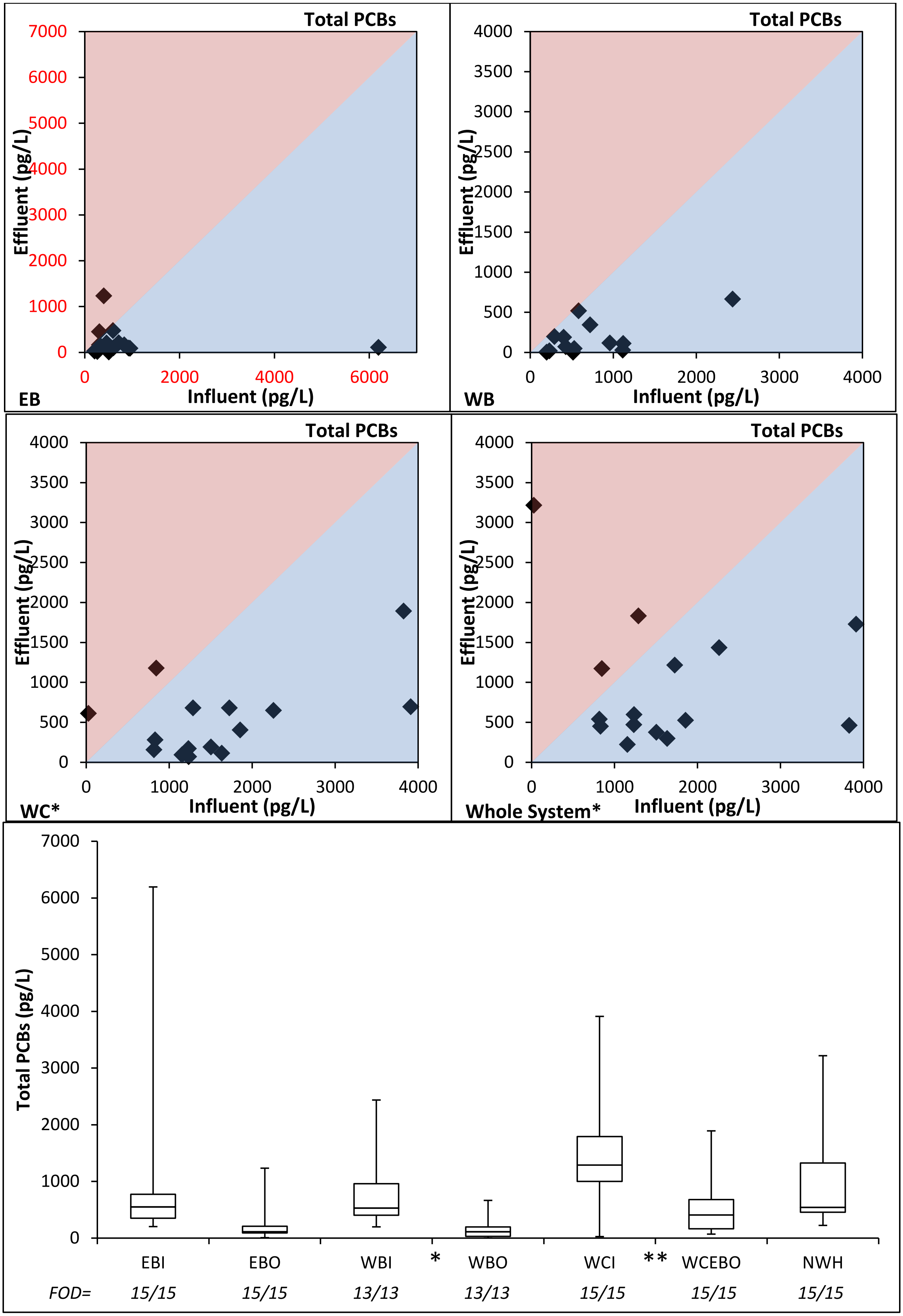

Dissolved Lead (µg/L)
1.2
1
0.8
0.6
0.4
0.2
0
EBI
***
EBO
WBI
***
WBO
WCI
WCEBO
NWH
FOD=
3/18
16/18
2/18
18/18
14/18
17/18
18/18


Dissolved Zinc
Effluent (µg/L)
Influent (µg/L)
0
10
20
30
40
50
60
0
20
40
60
EB
Dissolved Zinc
Effluent (µg/L)
Influent (µg/L)
WB
Dissolved Zinc
Effluent (µg/L)
Influent (µg/L)
WC*
Dissolved Zinc
Effluent (µg/L)
Influent (µg/L)
Whole System*


Dissolved Zinc (µg/L)
0
10
20
30
40
50
60
EBI
***
EBO
WBI
***
WBO
WCI
*
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18



Total PAHs
Effluent (µg/L)
Influent (µg/L)
0
0.02
0.04
0.06
0.08
0.1
0.12
0
0.05
0.1
EB
Total PAHs
Effluent (µg/L)
Influent (µg/L)
WB
Total PAHs
Effluent (µg/L)
Influent (µg/L)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.2
0.4
0.6
WC*
Total PAHs
Effluent (µg/L)
Influent (µg/L)
Whole System*
Total PAHs (µg/L)
EBI
EBO
WBI
*
WBO
WCI
***
WCEBO
NWH
FOD=
11/17
5/18
11/18
4/18
18/18
13/18
12/18


Total PCBs
Effluent (pg/L)
Influent (pg/L)
EB
Total PCBs
Effluent (pg/L)
Influent (pg/L)
WB
Total PCBs
Effluent (pg/L)
Influent (pg/L)
WC*
Total PCBs
Effluent (pg/L)
Influent (pg/L)
Whole System*
Total PCBs (pg/L)
EBI
EBO
WBI
*
WBO
WCI
**
WCEBO
NWH
FOD=
15/15
15/15
13/13
13/13
15/15
15/15
15/15

APPENDIX H2 – DETAILED DATA SUMMARY: LOADING ESTIMATES

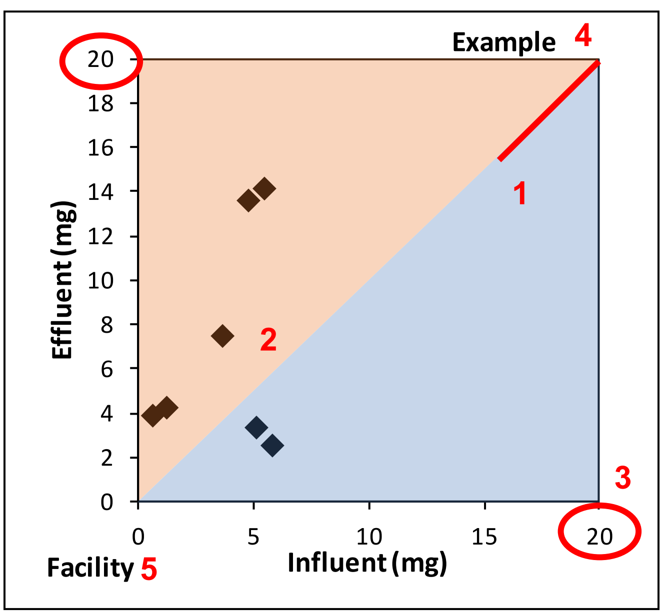
This section summarizes loadings estimates using figures similar to those summarizing concentration data in Section H1. However, there were only five storms where loadings could be reliably calculated for samples across all sites. The box plot display the distribution of loadings results for these five storms. The scatter plots compare influent and effluent loadings, including all sample pairs for which loadings could be reliably calculated at each facility. The format of these figure types are generally similar to those above with some notable exceptions underlined below.

Scatter Plot Explanation:
These figures plot effluent versus influent loadings for each sampling event with reliable loadings at a given facility. Features of the plots are noted with red numbers and explained below.

1 – The middle line between the red and blue shading represents no change between influent and effluent loadings, or a 1 to 1 ratio.
2 – Data points in the red shading illustrate sampling events where loadings were higher in the effluent than the influent (> 1 to 1 ratio). Data points in the blue shading illustrate sampling events where loadings were lower in the effluent than the influent (< 1 to 1 ratio).
3 – Where possible, the x and y scales and units are the same for each parameter across the facilities to facilitate comparison. Exceptions are identified with red axis labels.
4 – Name of parameter
5 – Facility name:

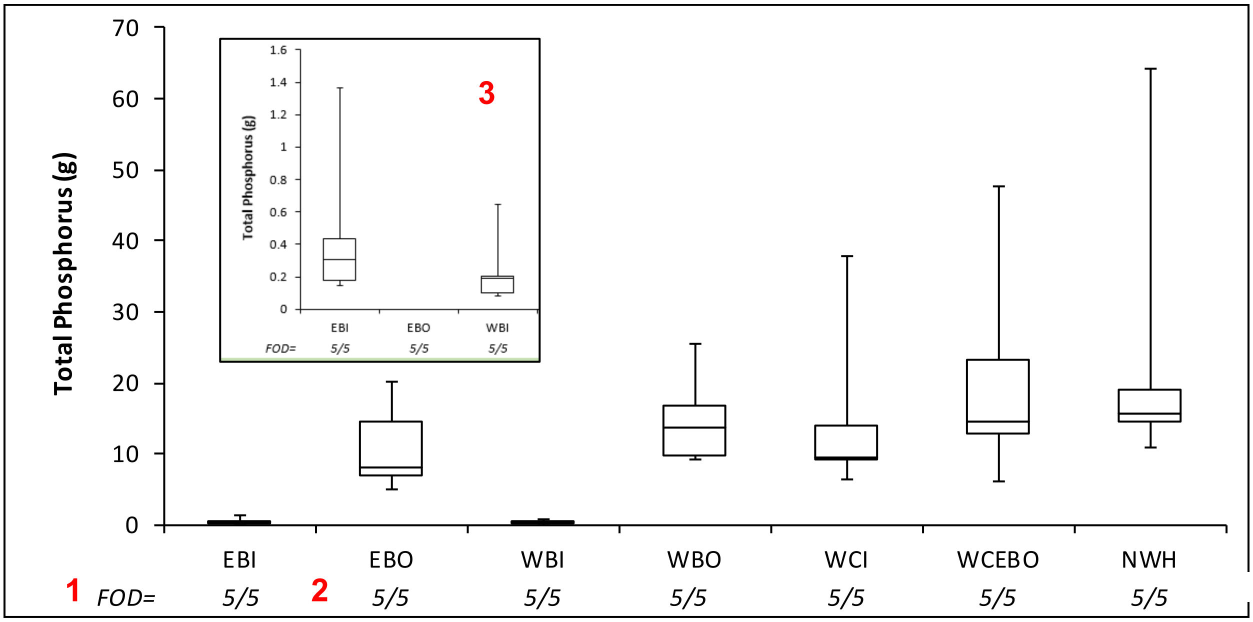
- East Bioretention (EB) = EBI vs. EBO
- West Bioretention (WB) = WBI vs. WBO
- Wetland Complex (WC) = WCI vs. WCEBO - EBO
- Whole System = WCI + EBI + WBI vs. WCEBO + WBO

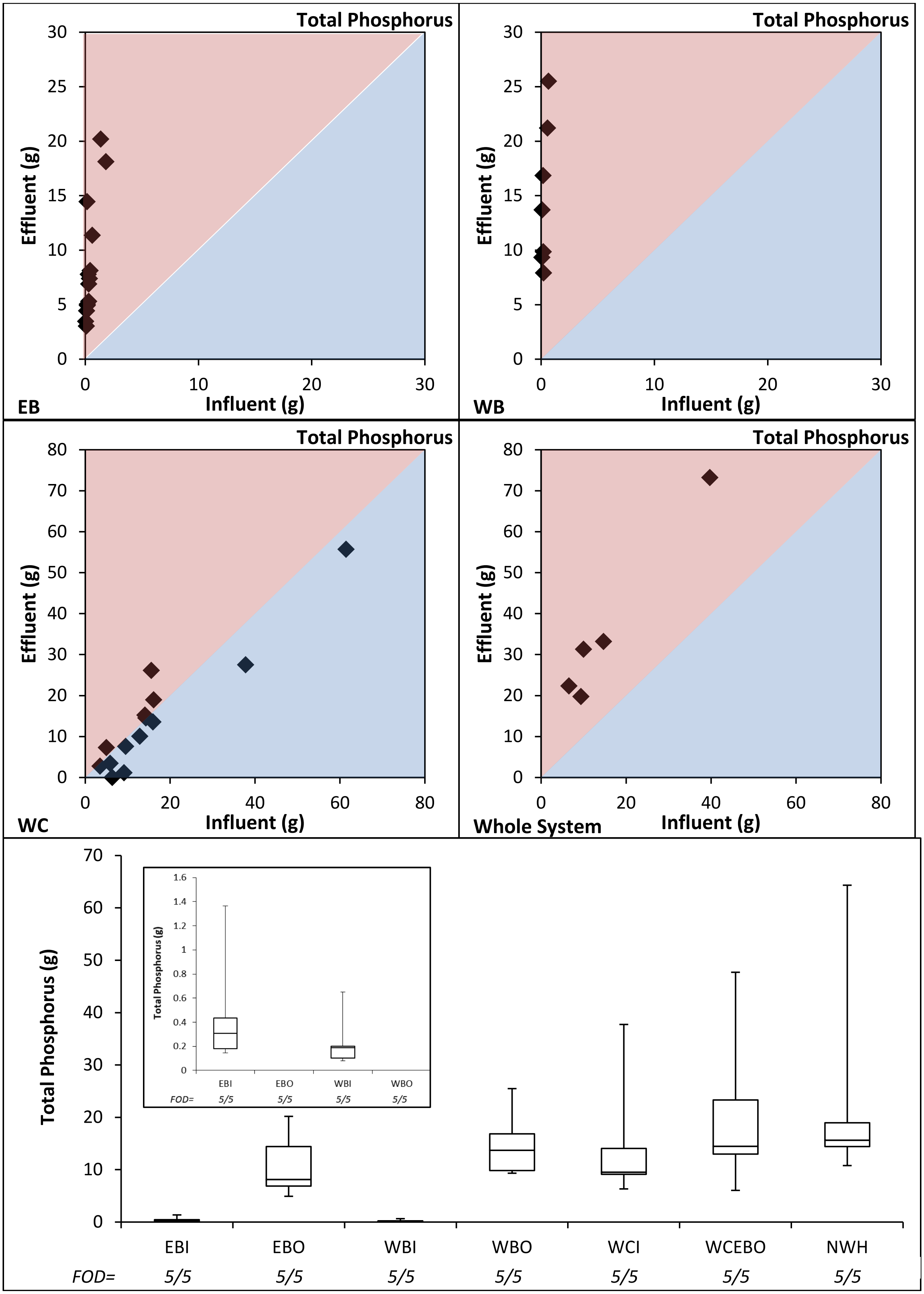
Note: Figures with several non-detect results include red lines indicating the method detection limit.



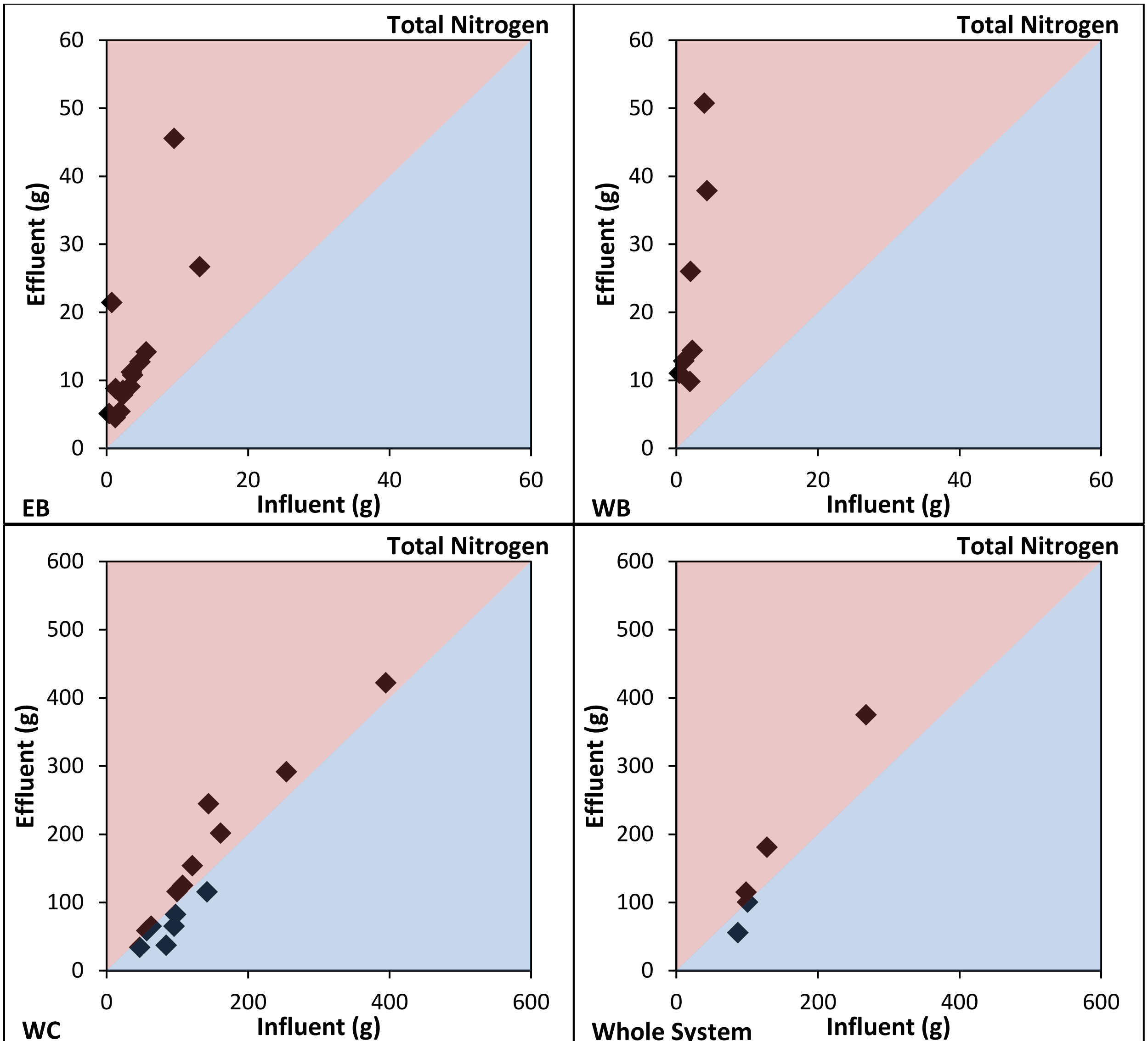
Box Plot Explanation:
These figures plot the distribution of results for each site as indicated in the example figure below. Although there are more results for some facilities than others (as seen with the scatter plots), the box plots include only the storms for which reliable loadings could be calculated across <u>all sites</u> (n=5).

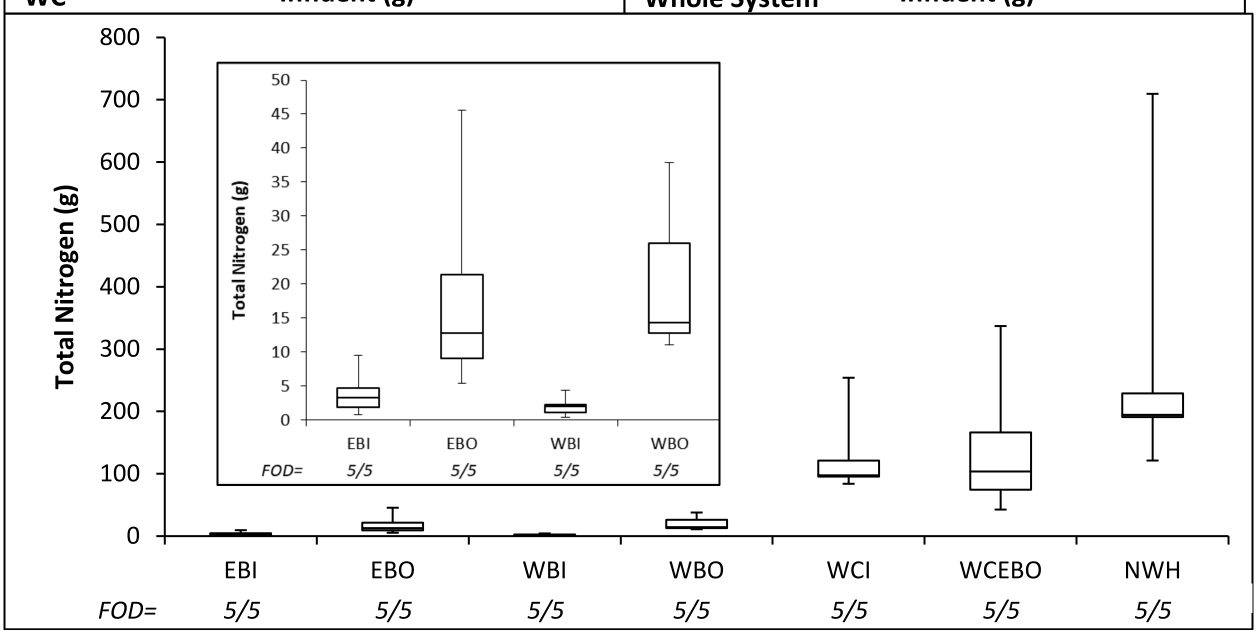
1 – Frequency of detection (FOD): non-detects are included at the method detection limit (MDL) value.
2 – Statistical differences were not calculated for loadings.
3 – Loadings often differed by orders of magnitude between the bioretention facilities and the wetland complex. Inset figures were included to illustrate the lower magnitude of loadings at the bioretention facilities.

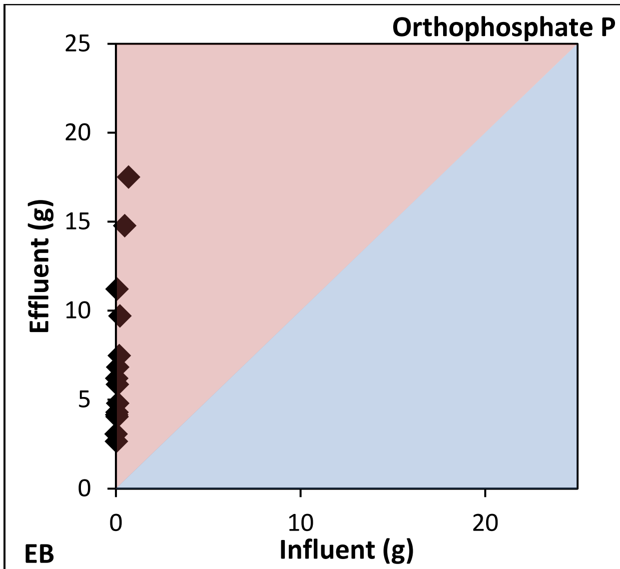


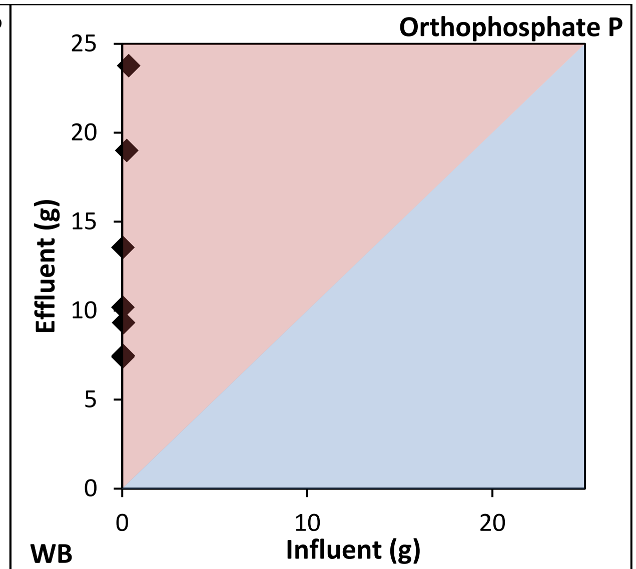


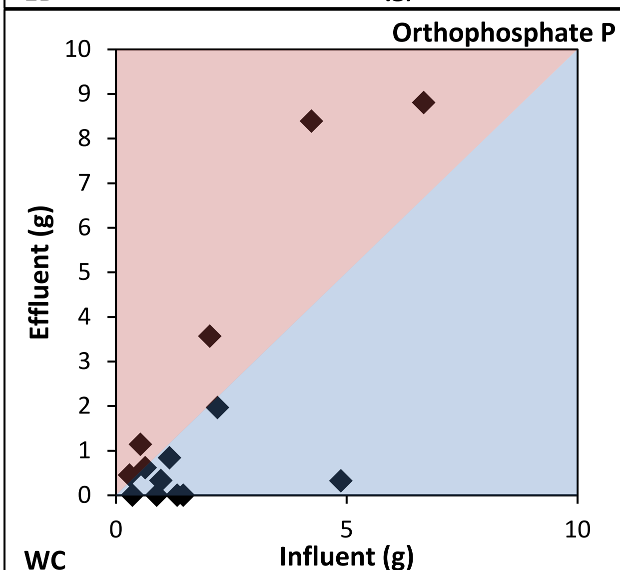
Total Phosphorus
Effluent (g)
Influent (g)
EB
Total Phosphorus
Effluent (g)
Influent (g)
WB
Total Phosphorus
Effluent (g)
Influent (g)
WC
Total Phosphorus
Effluent (g)
Influent (g)
Whole System
Total Phosphorus (g)
EBI
EBO
WBI
WBO
FOD= 5/5 5/5 5/5 5/5
Total Phosphorus (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD= 5/5 5/5 5/5 5/5 5/5 5/5 5/5

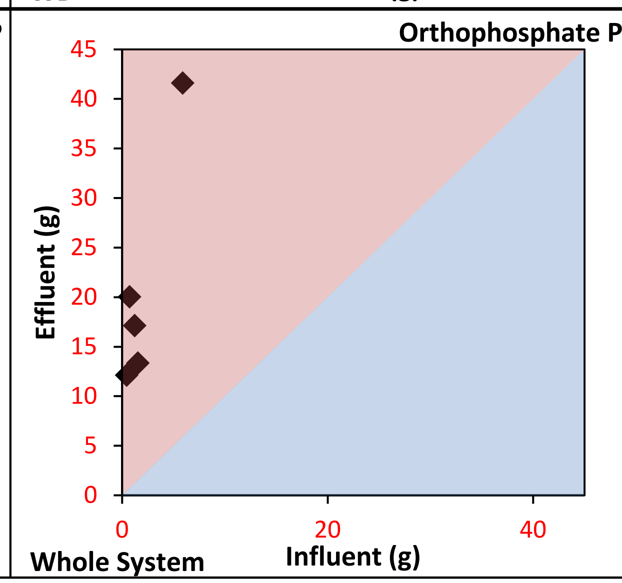

Total Nitrogen
Effluent (g)
Influent (g)
EB
WB
WC
Whole System

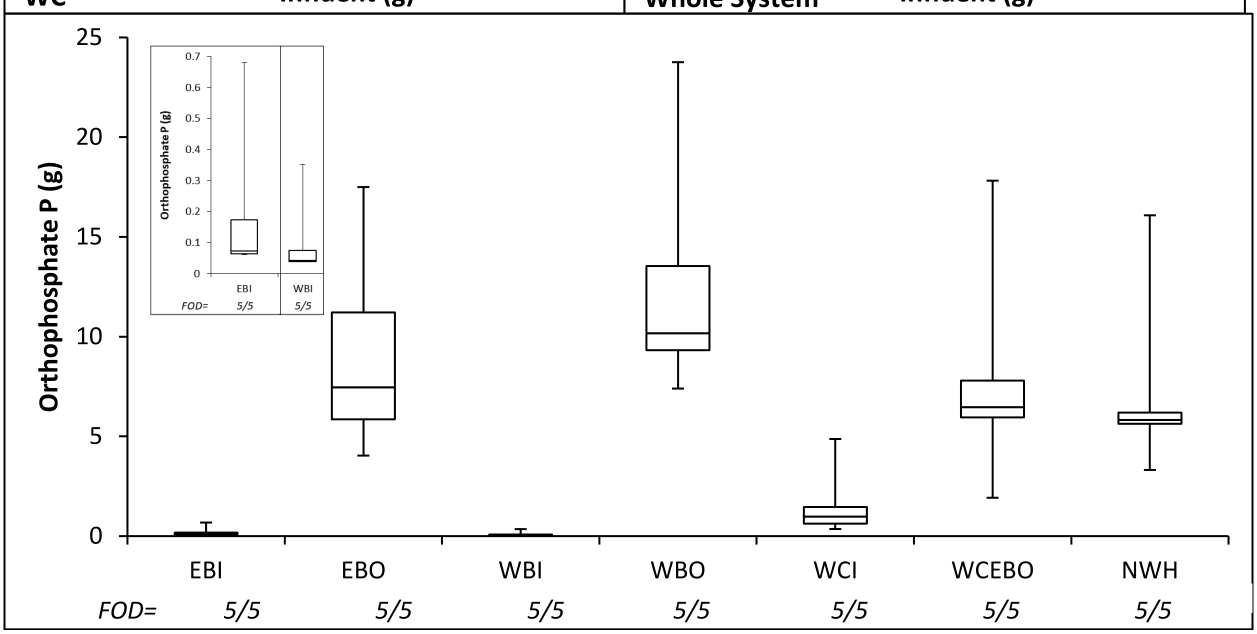

Total Nitrogen (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5

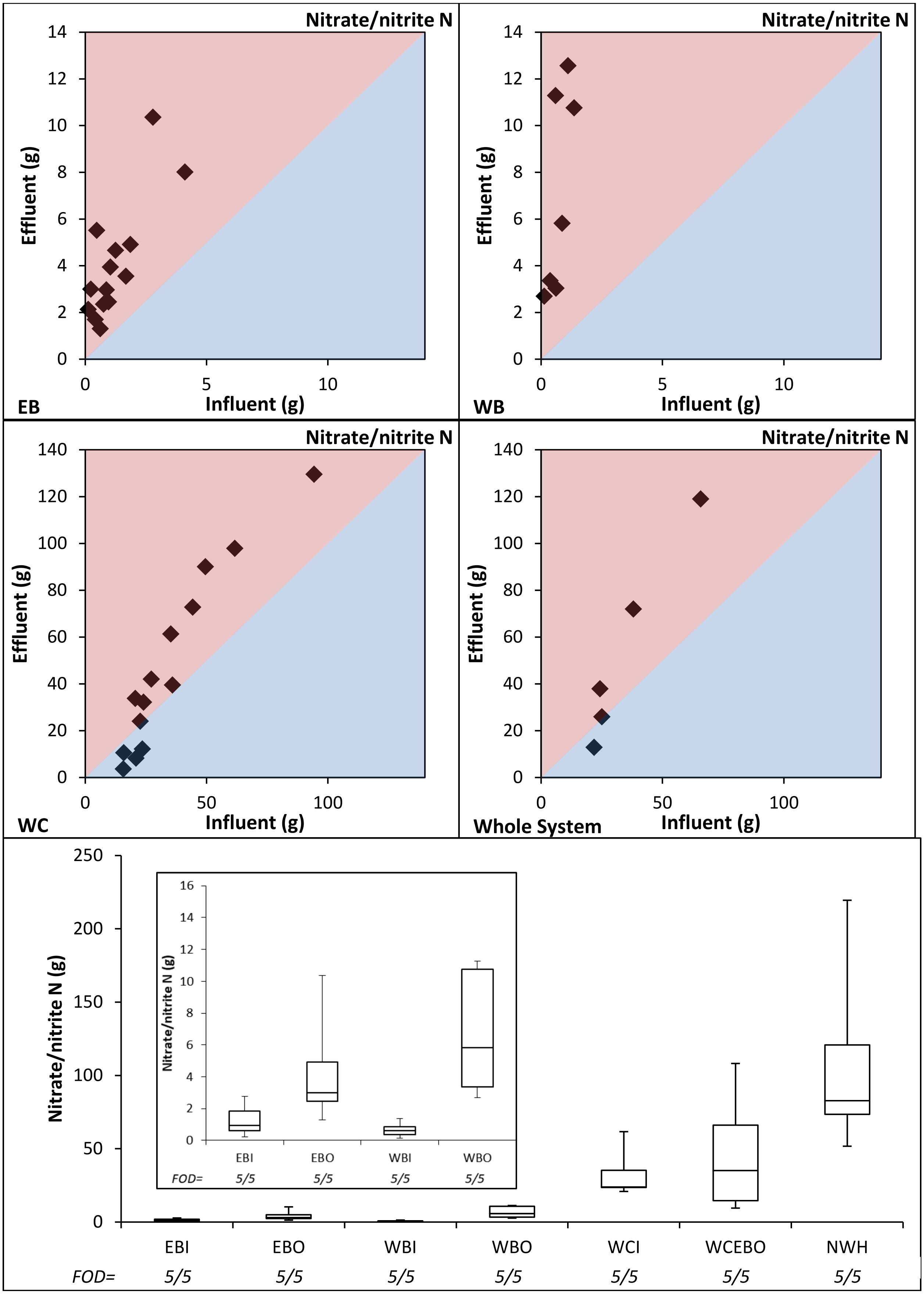

Orthophosphate P
Effluent (g)
Influent (g)
EB
0
5
10
15
20
25
0
10
20


Orthophosphate P
Effluent (g)
Influent (g)
WB
0
5
10
15
20
25
0
10
20

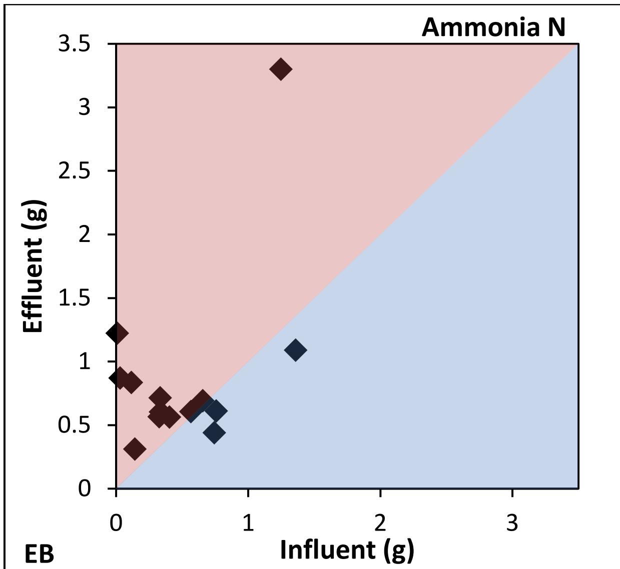

Orthophosphate P
Effluent (g)
Influent (g)
WC
0
1
2
3
4
5
6
7
8
9
10
0
5
10

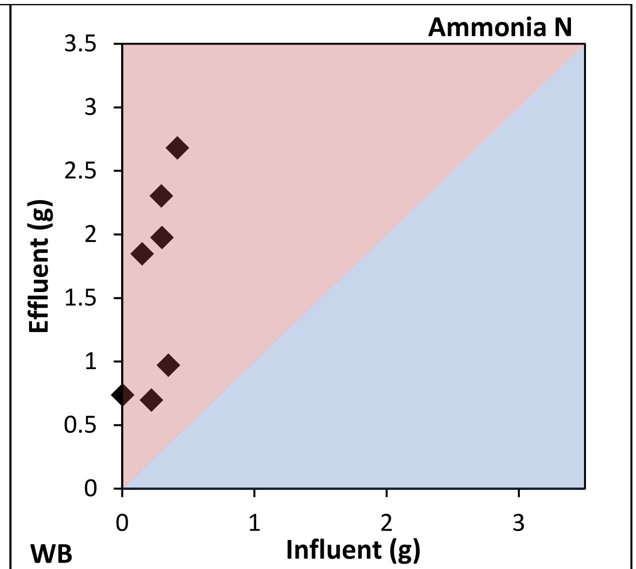

Orthophosphate P
Effluent (g)
Influent (g)
Whole System
0
5
10
15
20
25
30
35
40
45
0
20
40

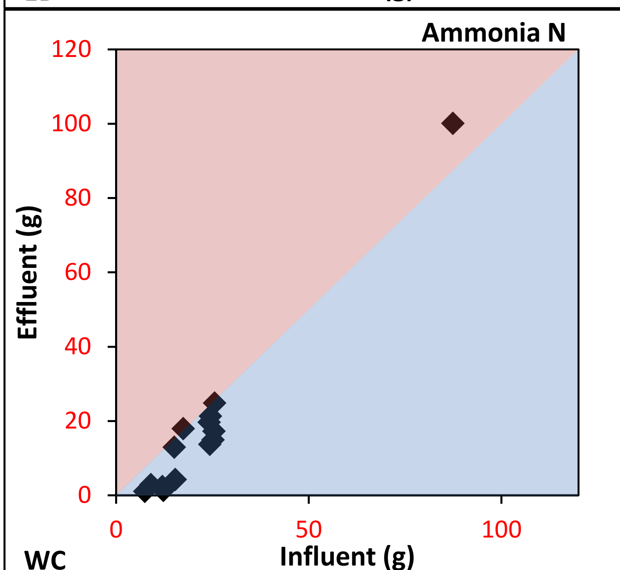

Orthophosphate P (g)
0
5
10
15
20
25
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5

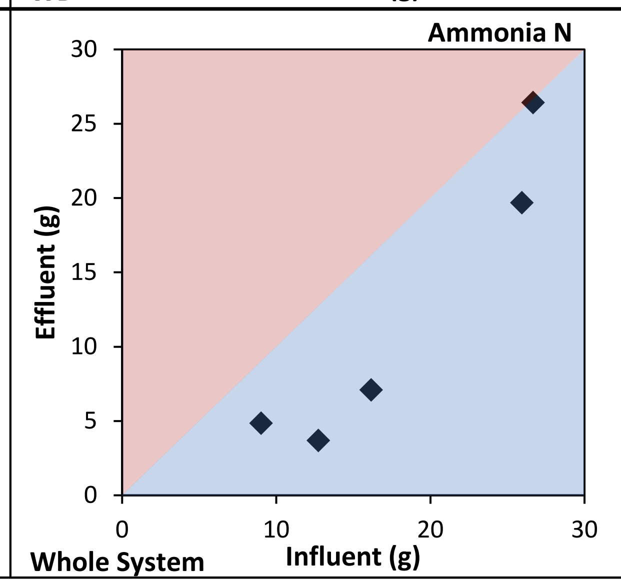


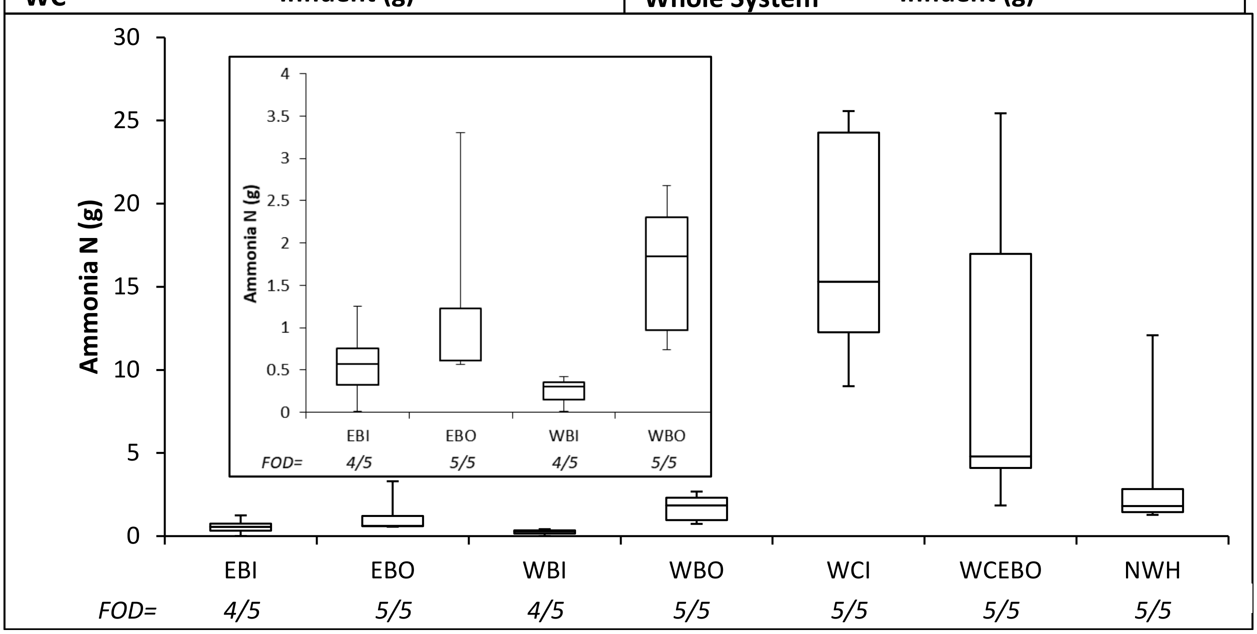
Nitrate/nitrite N
Effluent (g)
Influent (g)
EB
Nitrate/nitrite N
Effluent (g)
Influent (g)
WB
Nitrate/nitrite N
Effluent (g)
Influent (g)
WC
Nitrate/nitrite N
Effluent (g)
Influent (g)
Whole System
Nitrate/nitrite N (g)
EBI
EBO
WBI
WBO
FOD=
5/5
5/5
5/5
5/5
Nitrate/nitrite N (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5

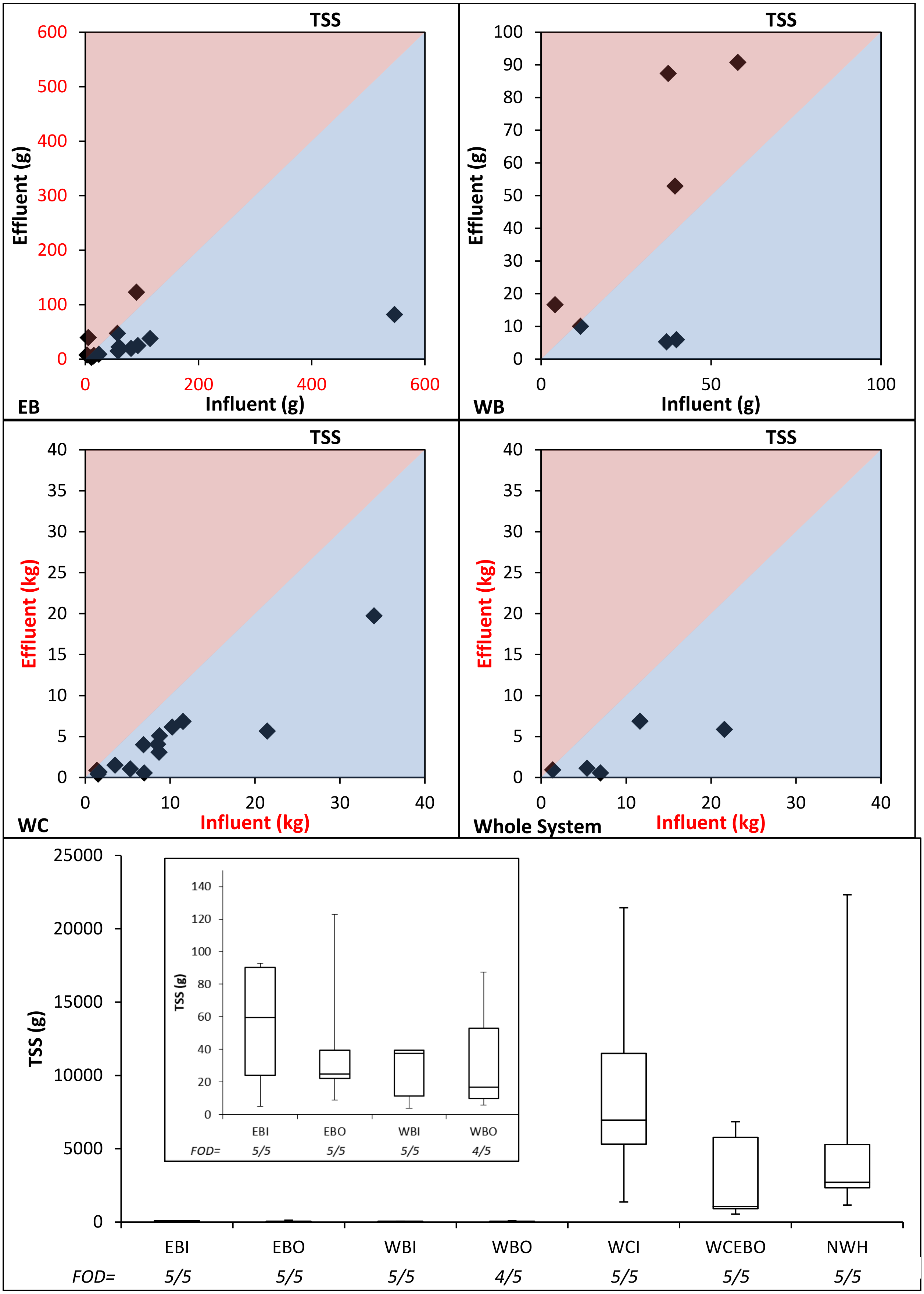

Ammonia N
Effluent (g)
Influent (g)
EB

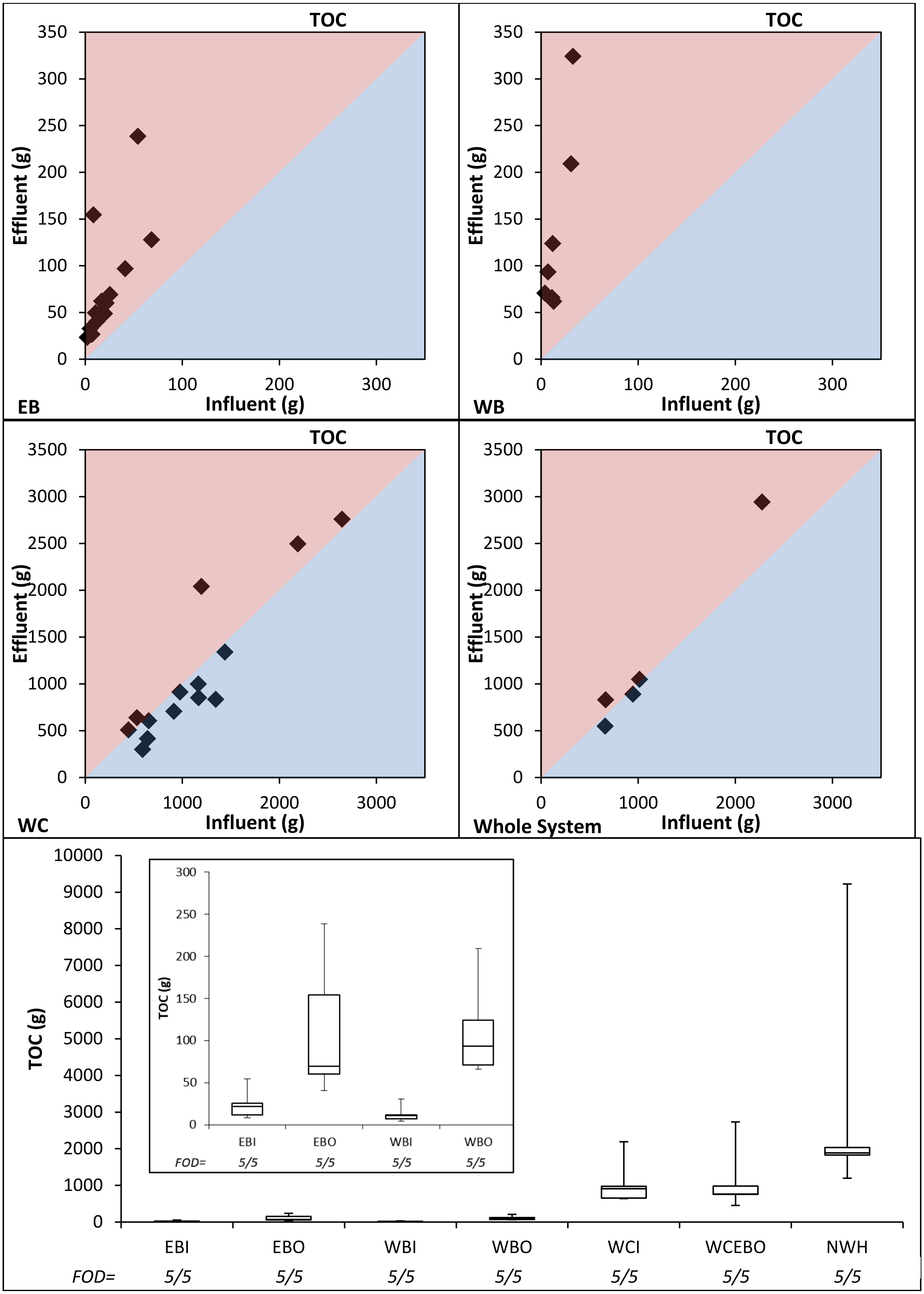

Ammonia N
Effluent (g)
Influent (g)
WB

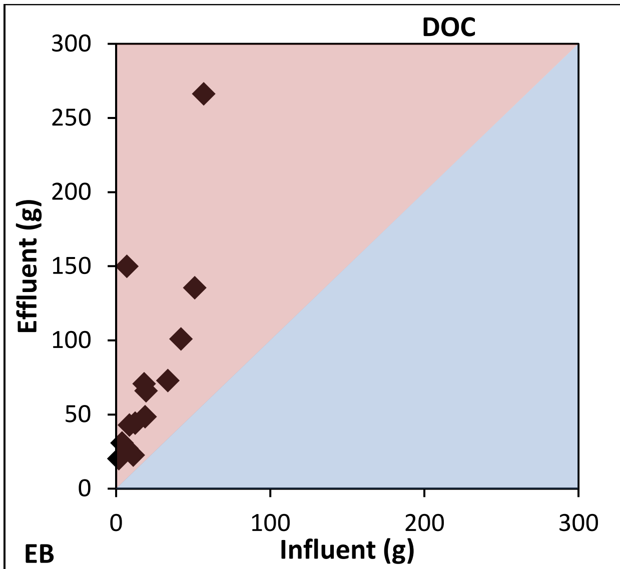

Ammonia N
Effluent (g)
Influent (g)
WC

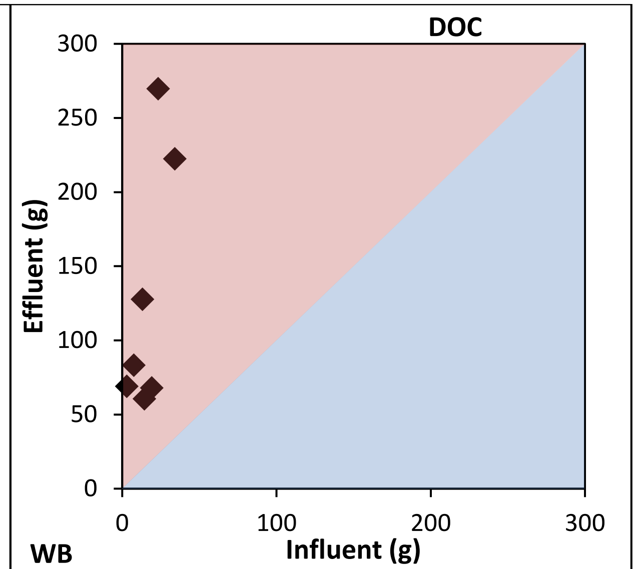

Ammonia N
Effluent (g)
Influent (g)
Whole System

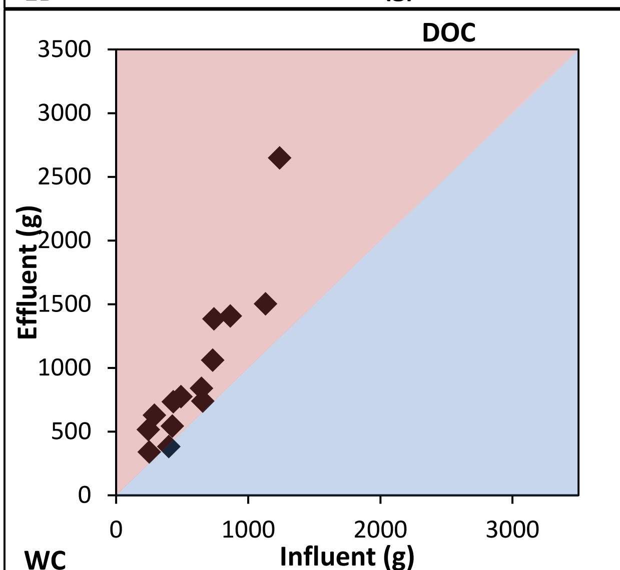

Ammonia N (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
4/5
5/5
4/5
5/5
5/5
5/5
5/5

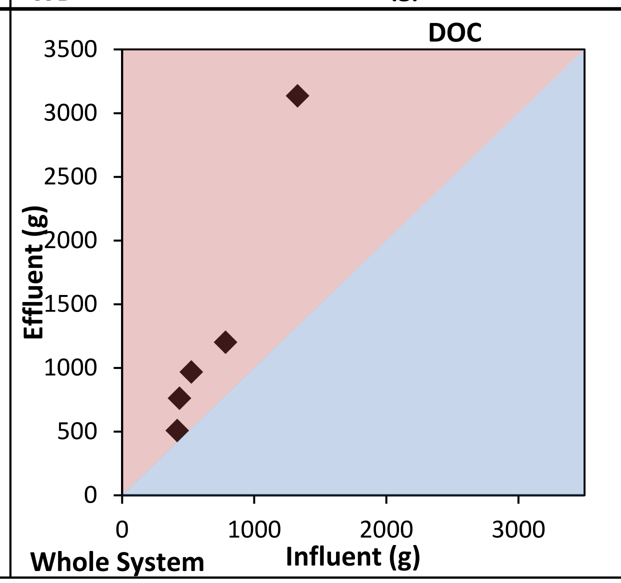

TSS
Effluent (g)
Influent (g)
EB
TSS
Effluent (g)
Influent (g)
WB
TSS
Effluent (kg)
Influent (kg)
WC
TSS
Effluent (kg)
Influent (kg)
Whole System
TSS (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
4/5
5/5
5/5
5/5

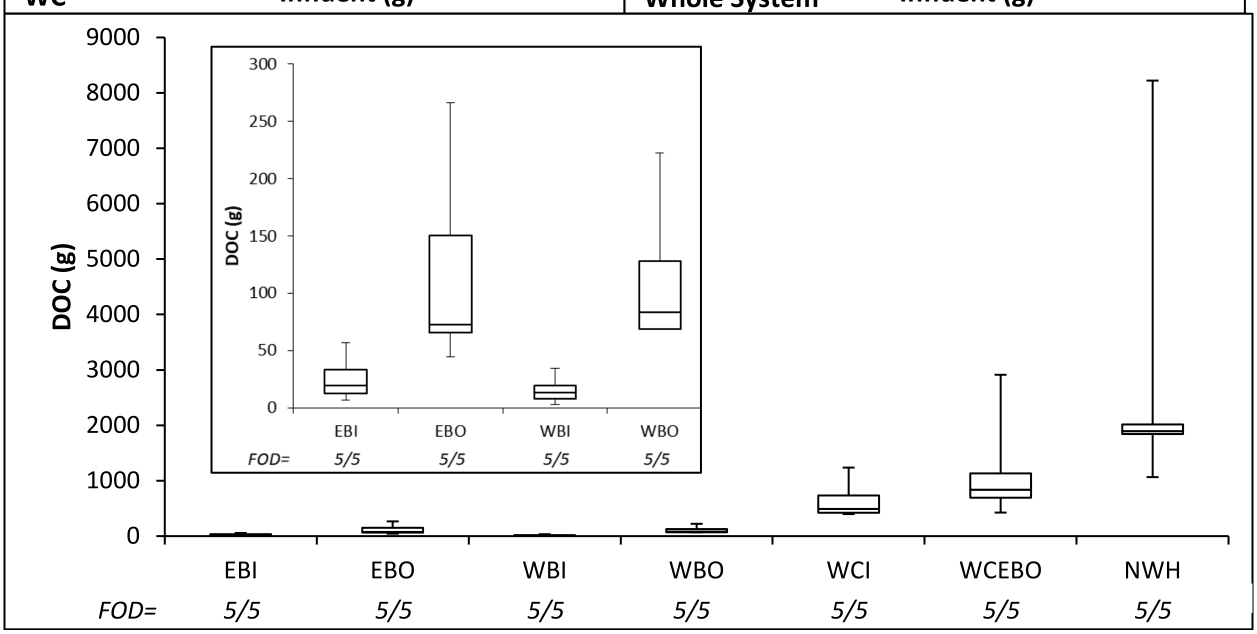

TOC
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
TOC (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

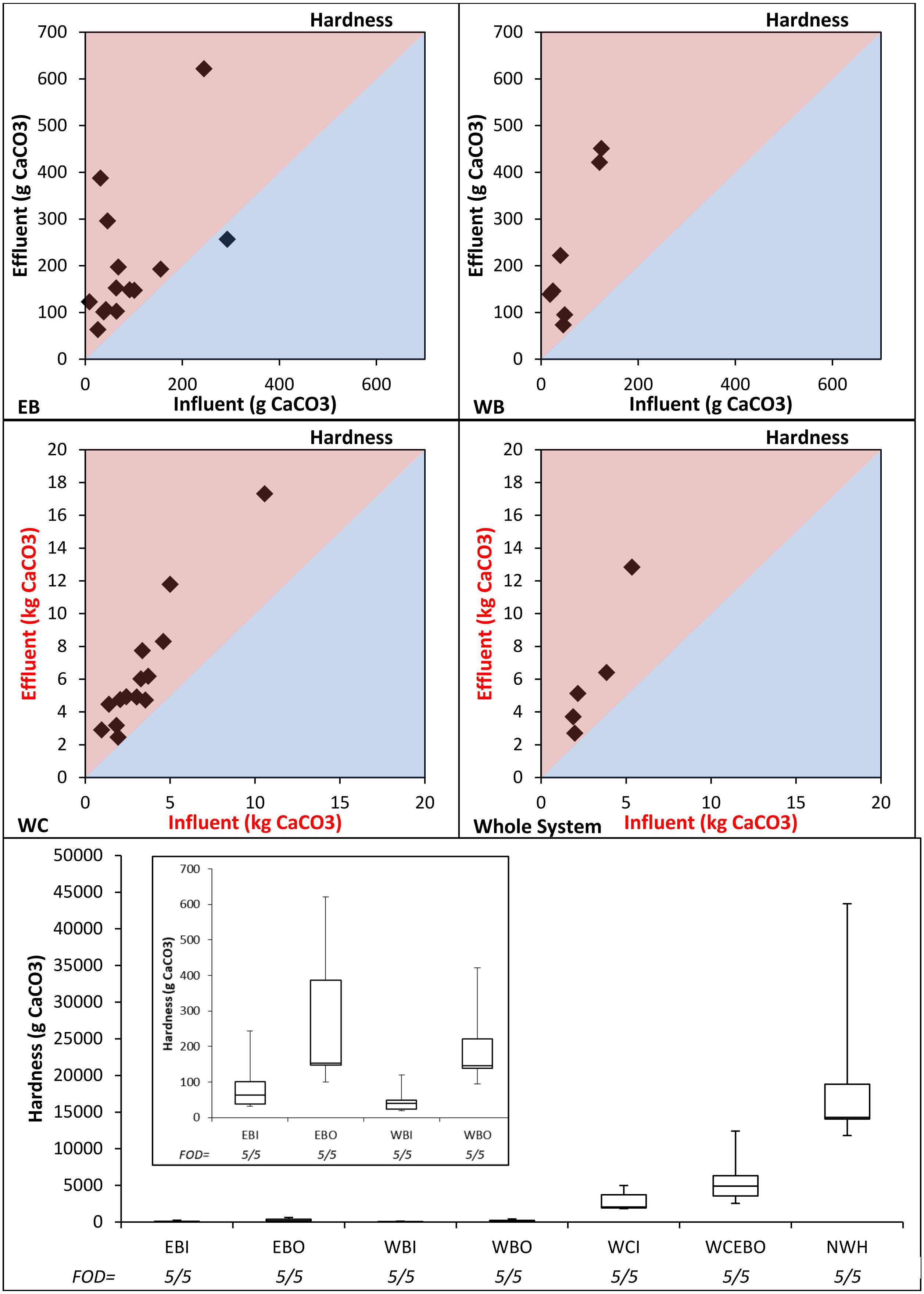

DOC
Effluent (g)
Influent (g)
300
250
200
150
100
50
0
0
100
200
300
EB

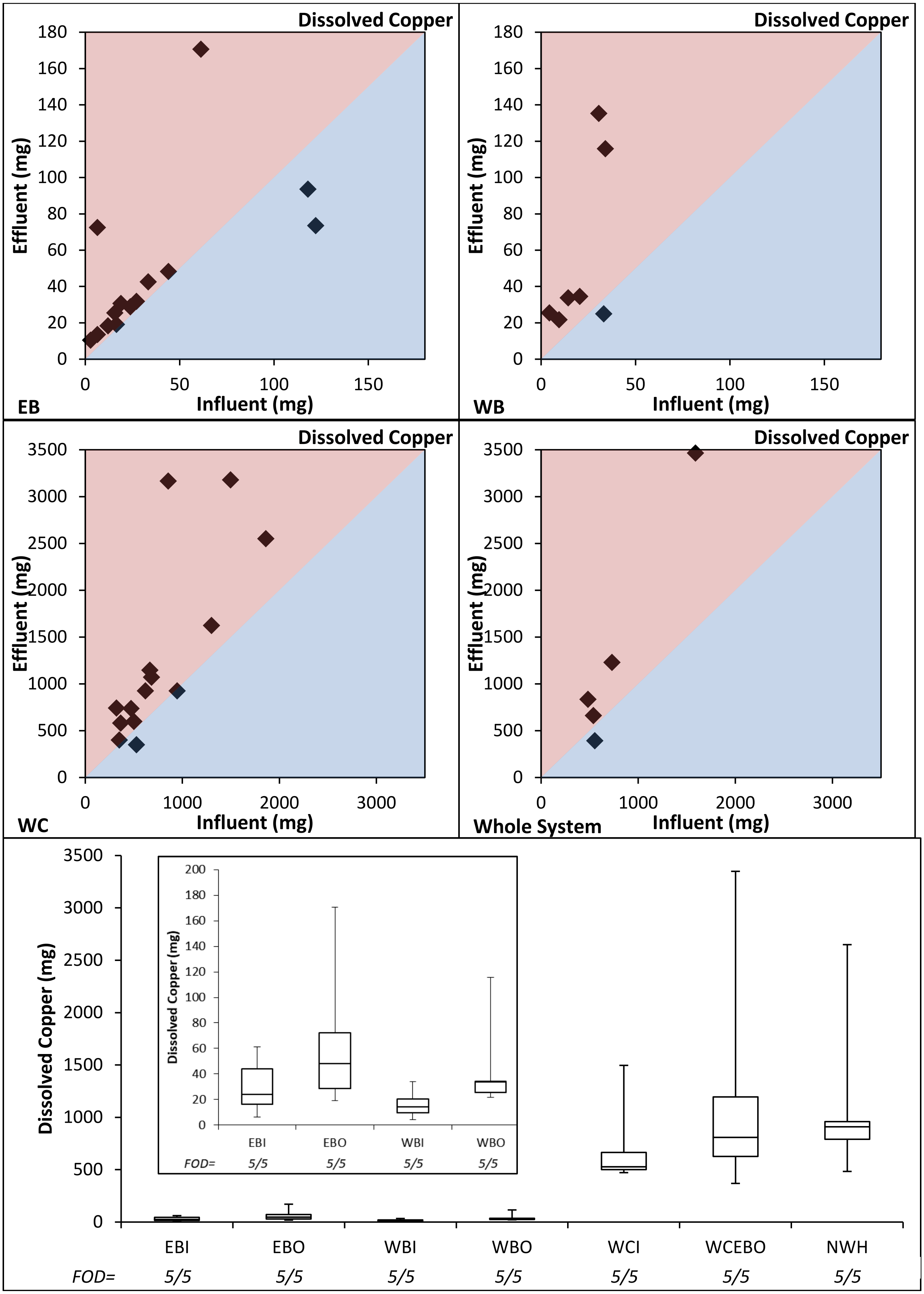

DOC
Effluent (g)
Influent (g)
300
250
200
150
100
50
0
0
100
200
300
WB

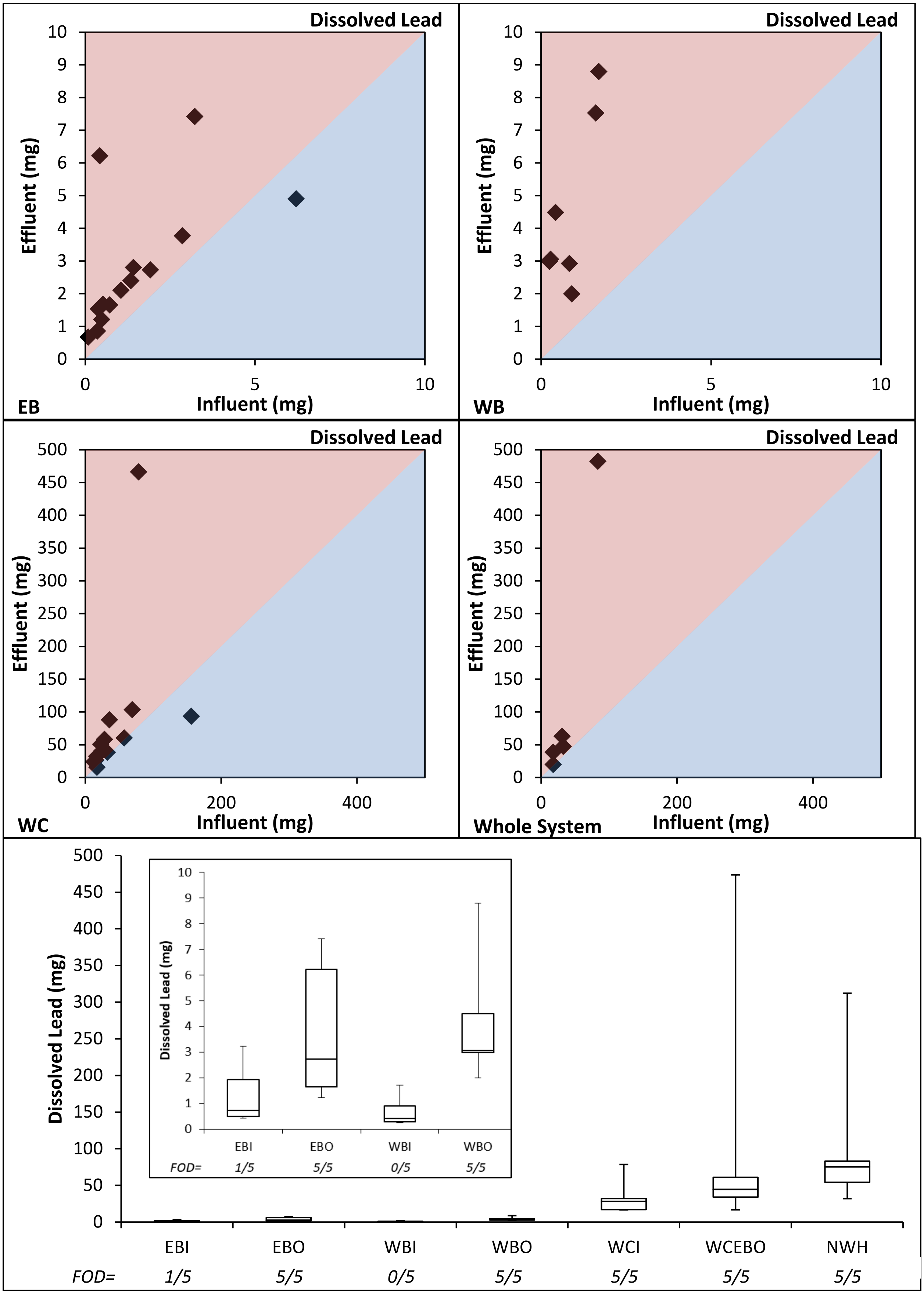

DOC
Effluent (g)
Influent (g)
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
WC


DOC
Effluent (g)
Influent (g)
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
Whole System

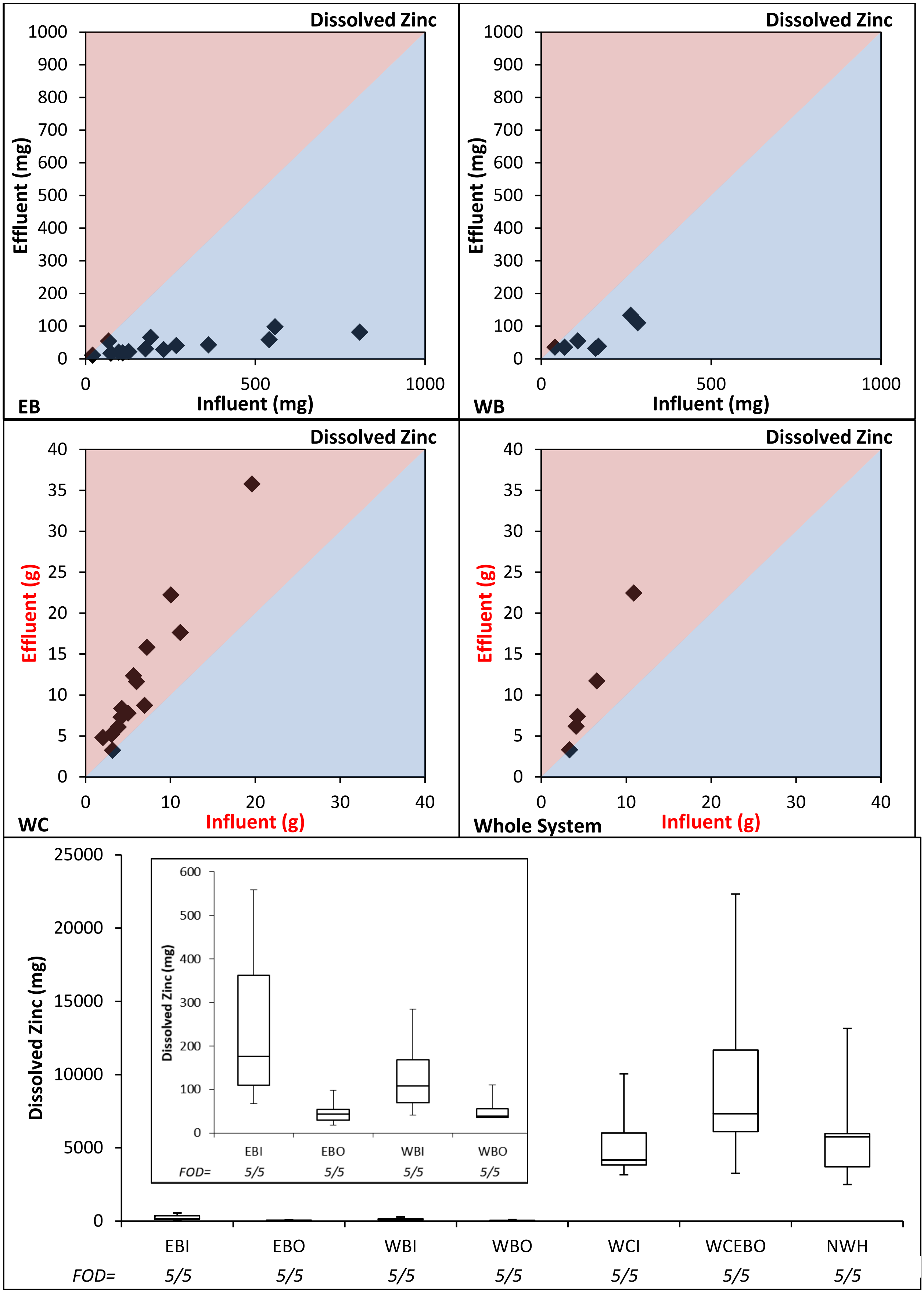

DOC (g)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5
DOC (g)
300
250
200
150
100
50
0
EBI
EBO
WBI
WBO
FOD=
5/5
5/5
5/5
5/5

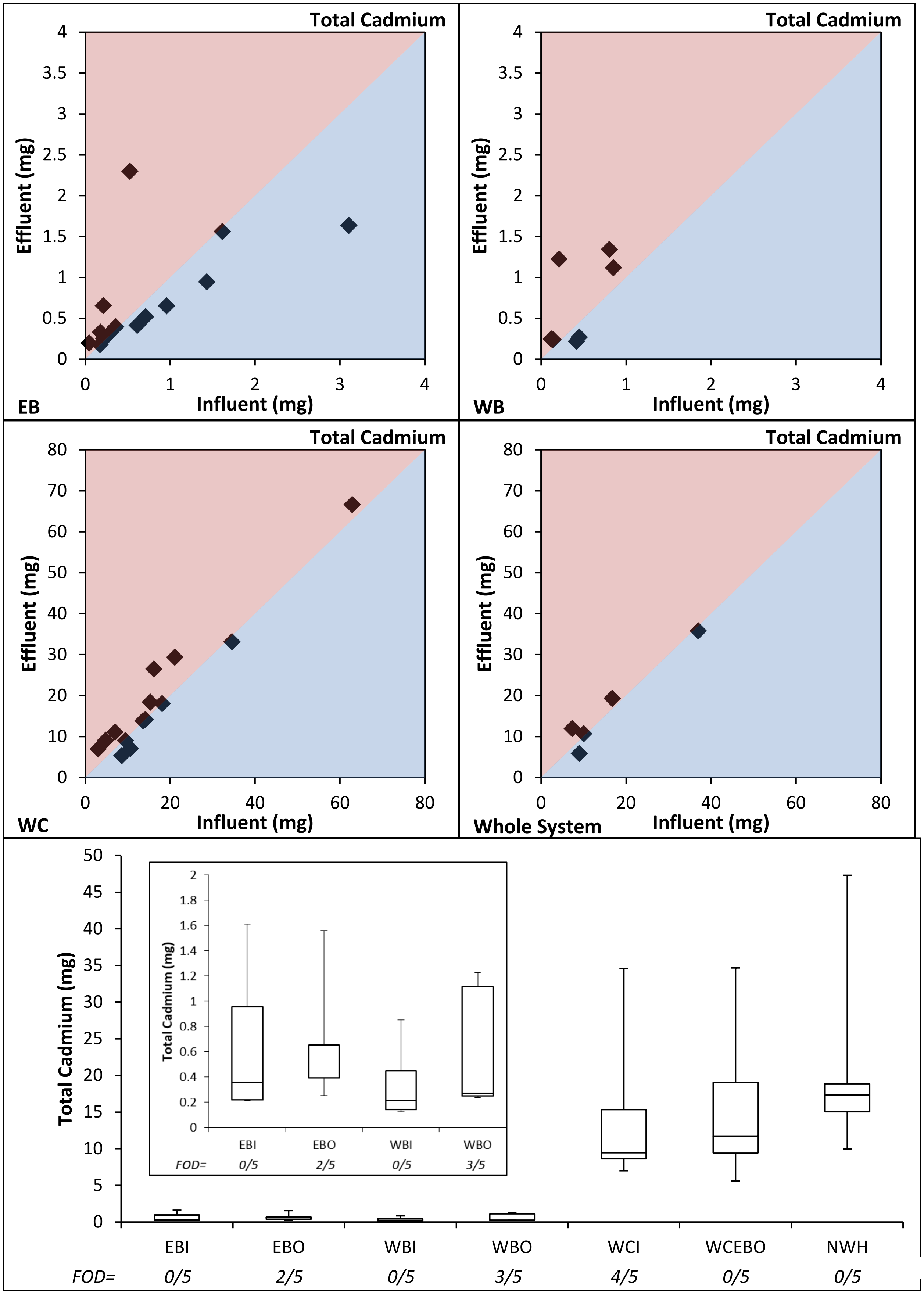

Hardness
Effluent (g CaCO3)
Influent (g CaCO3)
EB
Hardness
Effluent (g CaCO3)
Influent (g CaCO3)
WB
Hardness
Effluent (kg CaCO3)
Influent (kg CaCO3)
WC
Hardness
Effluent (kg CaCO3)
Influent (kg CaCO3)
Whole System
Hardness (g CaCO3)
EBI EBO WBI WBO WCI WCEBO NWH
FOD= 5/5 5/5 5/5 5/5 5/5 5/5 5/5
Hardness (g CaCO3)
EBI EBO WBI WBO
FOD= 5/5 5/5 5/5 5/5

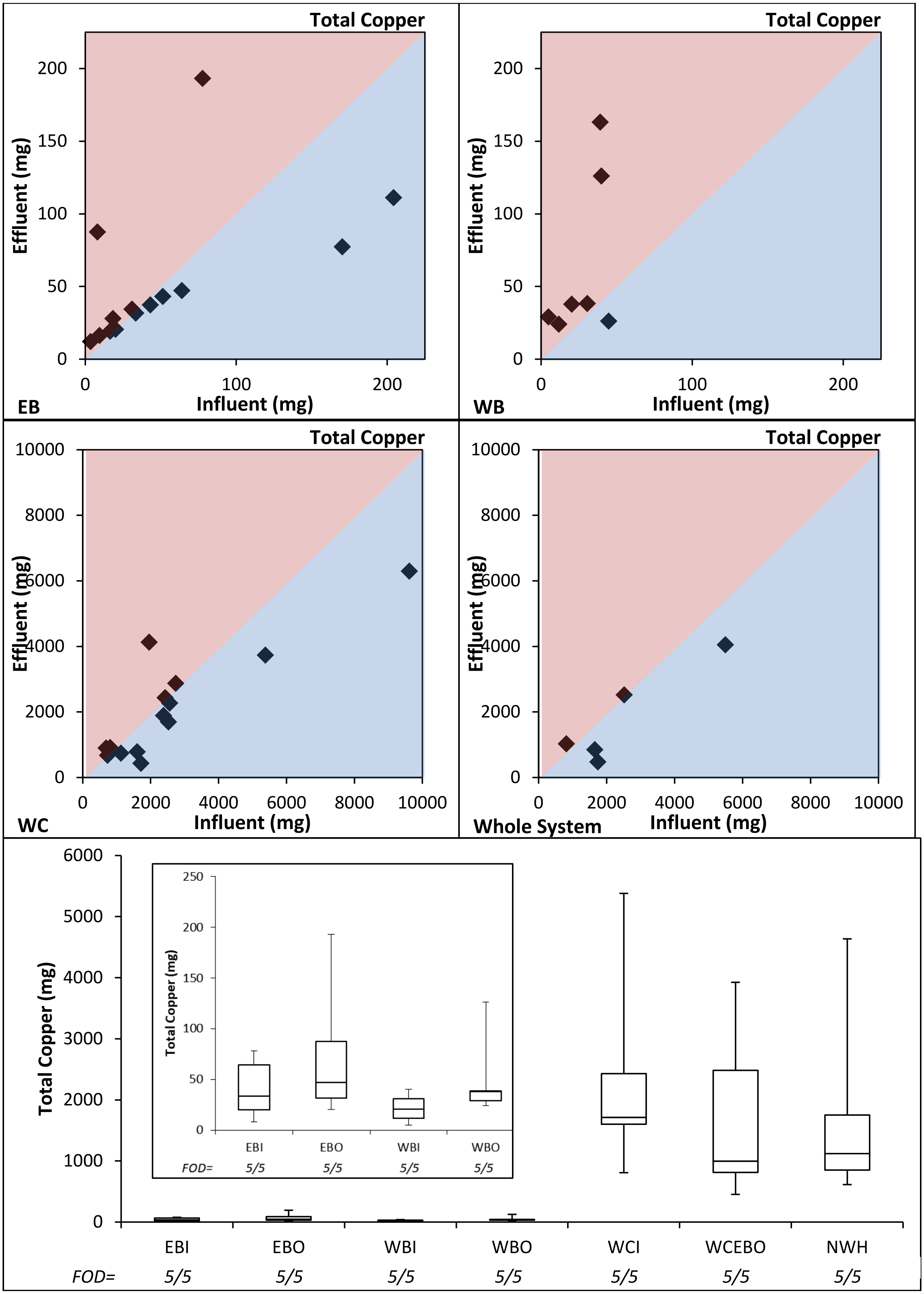

Dissolved Copper
Effluent (mg)
Influent (mg)
EB
Dissolved Copper
Effluent (mg)
Influent (mg)
WB
Dissolved Copper
Effluent (mg)
Influent (mg)
WC
Dissolved Copper
Effluent (mg)
Influent (mg)
Whole System
Dissolved Copper (mg)
EBI
EBO
WBI
WBO
FOD=
5/5
5/5
5/5
5/5
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5

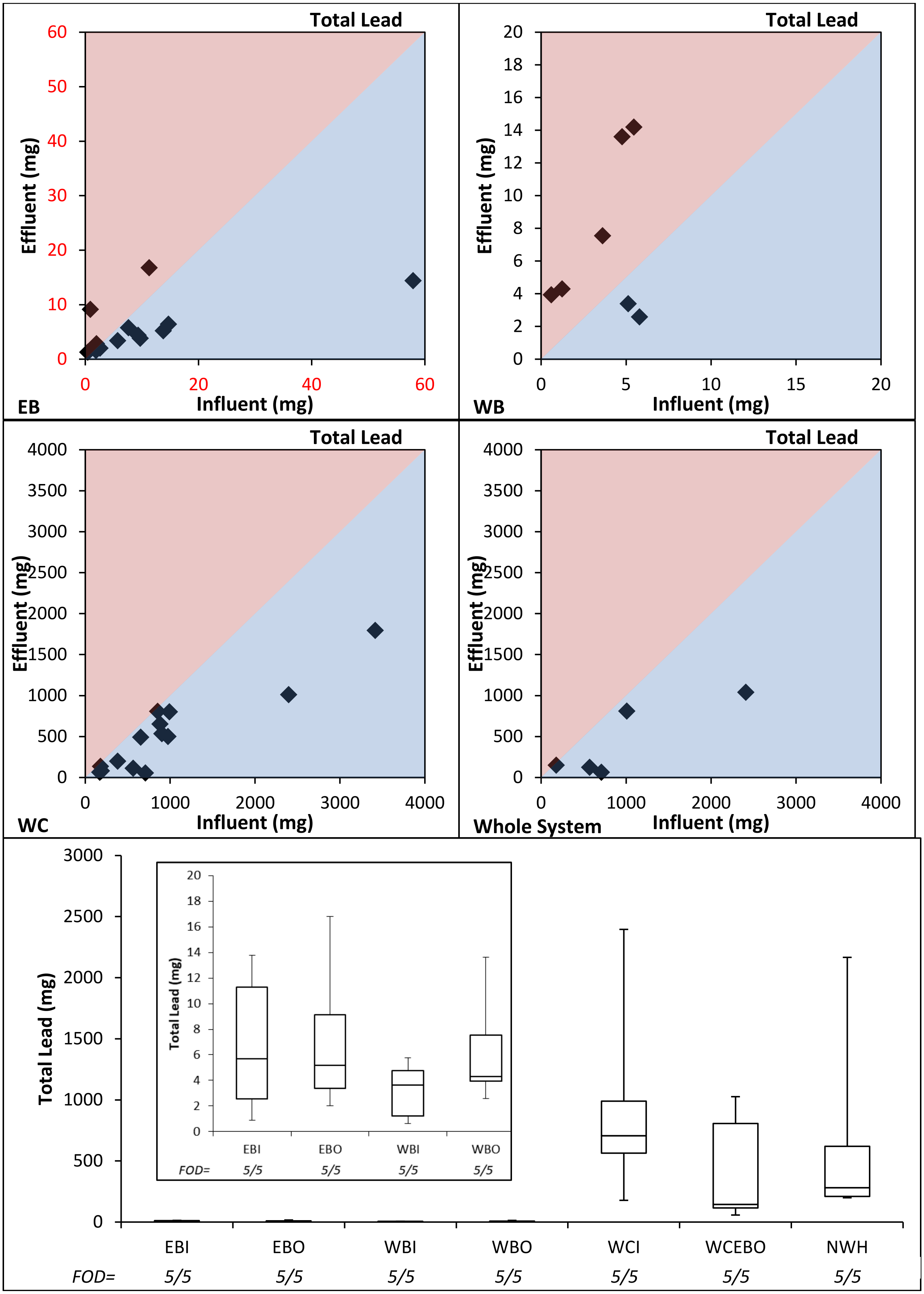


Dissolved Lead
Effluent (mg)
Influent (mg)
EB
Dissolved Lead
Effluent (mg)
Influent (mg)
WB
Dissolved Lead
Effluent (mg)
Influent (mg)
WC
Dissolved Lead
Effluent (mg)
Influent (mg)
Whole System
Dissolved Lead (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
1/5
5/5
0/5
5/5
5/5
5/5
5/5

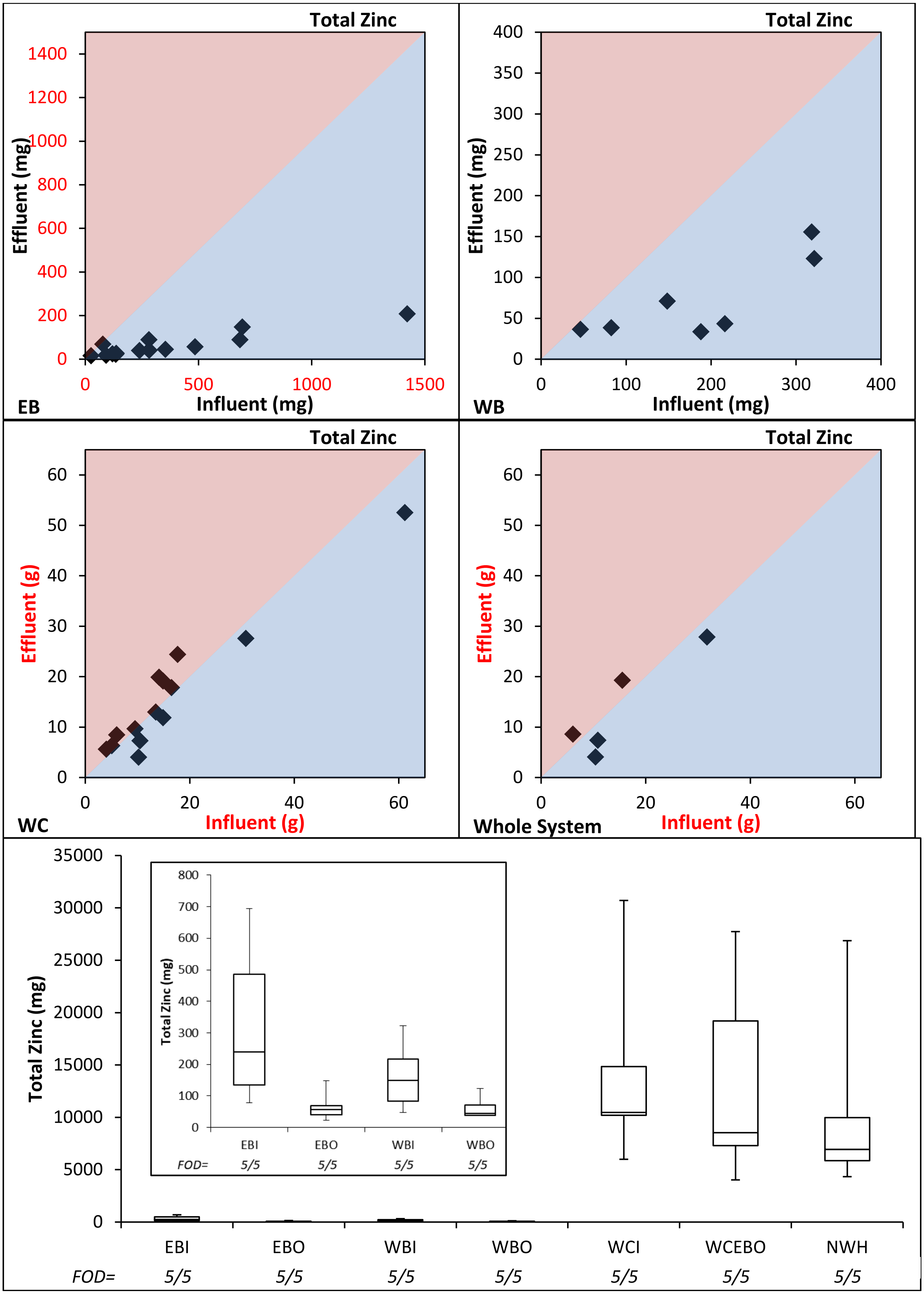

Dissolved Zinc
Effluent (mg)
Influent (mg)
EB
Dissolved Zinc
Effluent (mg)
Influent (mg)
WB
Dissolved Zinc
Effluent (g)
Influent (g)
WC
Dissolved Zinc
Effluent (g)
Influent (g)
Whole System
Dissolved Zinc (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5
Dissolved Zinc (mg)
EBI
EBO
WBI
WBO
FOD=
5/5
5/5
5/5
5/5

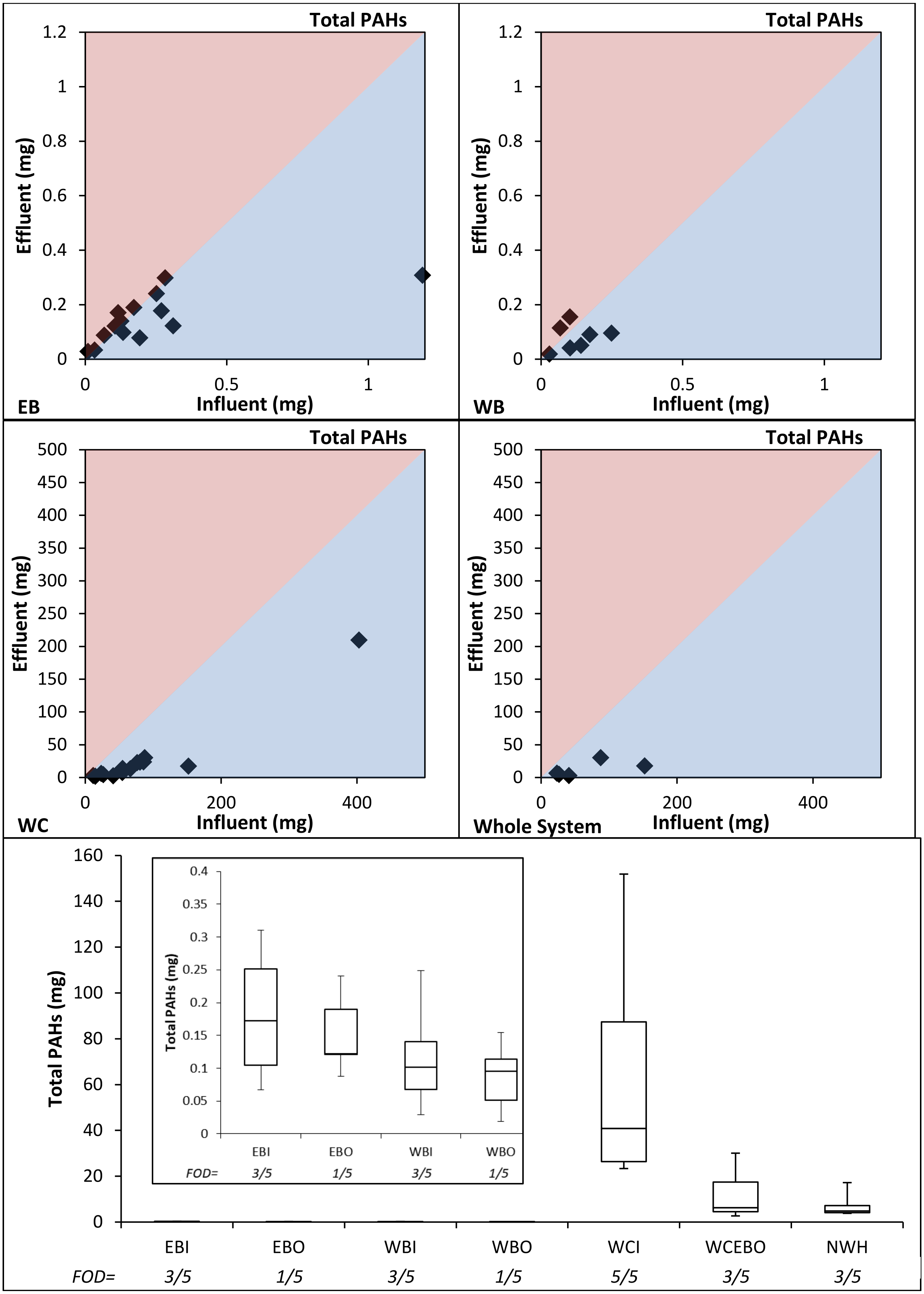

Total Cadmium
Effluent (mg)
Influent (mg)
EB
Total Cadmium
Effluent (mg)
Influent (mg)
WB
Total Cadmium
Effluent (mg)
Influent (mg)
WC
Total Cadmium
Effluent (mg)
Influent (mg)
Whole System
Total Cadmium (mg)
EBI EBO WBI WBO
FOD= 0/5 2/5 0/5 3/5
EBI EBO WBI WBO WCI WCEBO NWH
FOD= 0/5 2/5 0/5 3/5 4/5 0/5 0/5


Total Copper
Effluent (mg)
Influent (mg)
EB
Total Copper
Effluent (mg)
Influent (mg)
WB
Total Copper
Effluent (mg)
Influent (mg)
WC
Total Copper
Effluent (mg)
Influent (mg)
Whole System
Total Copper (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5

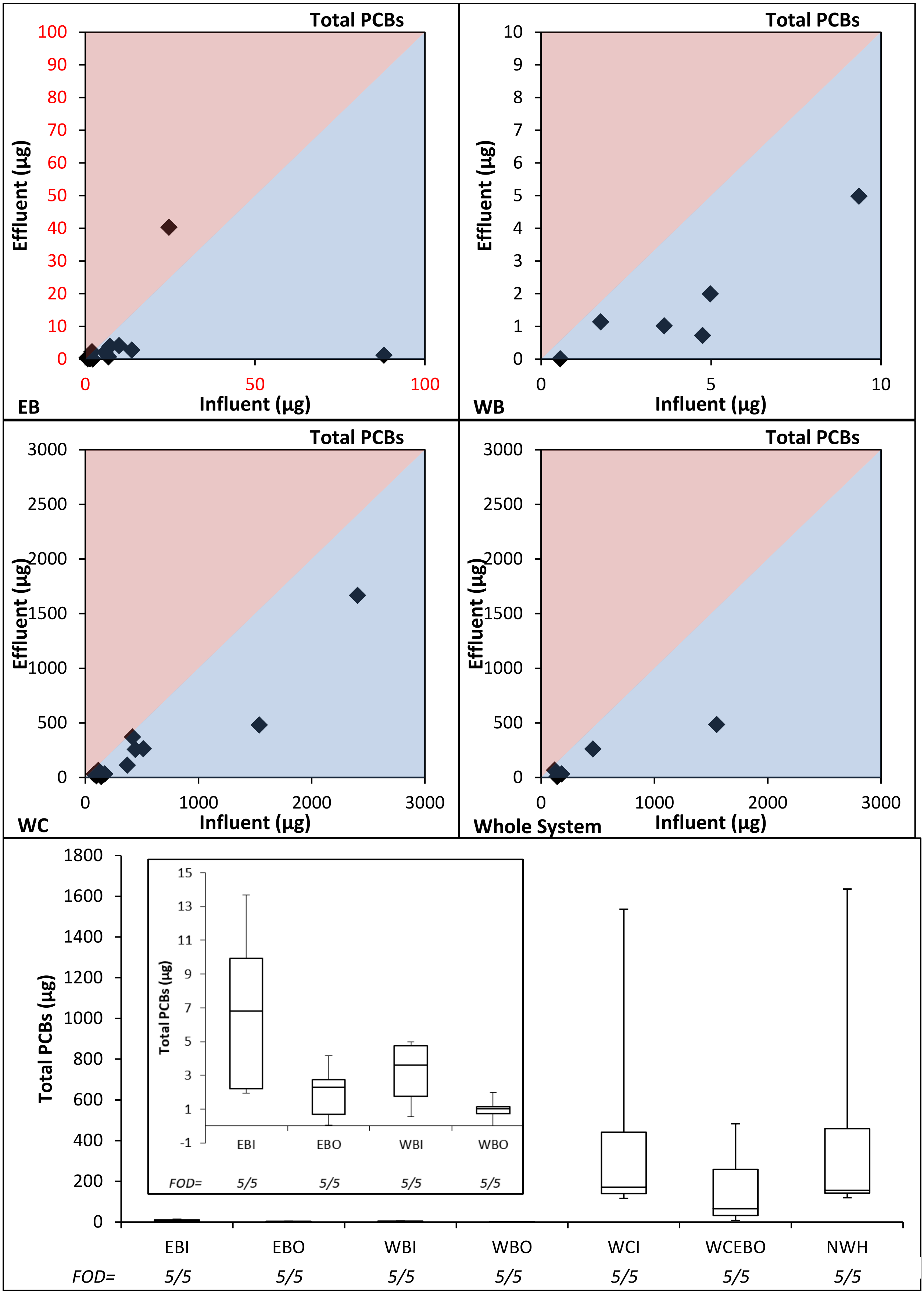


Total Lead
Effluent (mg)
Influent (mg)
EB
Total Lead
Effluent (mg)
Influent (mg)
WB
Total Lead
Effluent (mg)
Influent (mg)
WC
Total Lead
Effluent (mg)
Influent (mg)
Whole System
Total Lead (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5


Total Zinc
Effluent (mg)
Influent (mg)
EB
Total Zinc
Effluent (mg)
Influent (mg)
WB
Total Zinc
Effluent (g)
Influent (g)
WC
Total Zinc
Effluent (g)
Influent (g)
Whole System
Total Zinc (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
5/5
5/5
5/5
5/5



Total PAHs
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Total PAHs (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
3/5
1/5
3/5
1/5
5/5
3/5
3/5


Total PCBs
Effluent (µg)
Influent (µg)
EB
WB
WC
Whole System
Total PCBs (µg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

APPENDIX H3 – TOXICITY TEST RESULTS

Toxicity tests using *Daphnia pulex* (48-hour acute test) and *Ceriodaphnia dubia* (7-day chronic test) were conducted on samples from each location for six storm events as summarized in Table 5. Water hardness differed greatly between the standard control and the environmental samples for each event. Low hardness can impact survival and reproduction of daphnia; therefore an additional low hardness (typically ~10 mg/L) control sample was added after the initial series of toxicity testing for Storm #1.

D. pulex survival was poor in all low hardness control samples. However, most environmental samples were not acutely toxic to *D. pulex*, despite hardness levels that were often lower than the low hardness control samples. Influent samples at EBI and WBI were occasionally acutely toxic to *D. pulex*, but effluent samples were not. Water quality data may help explain the observed differences between influent and effluent toxicity to *D. pulex*. Effluent samples at EBO and WBO consistently had lower total PAH and dissolved zinc concentrations than influent samples at EBI and WBI. While dissolved copper and lead concentrations were commonly higher in the bioretention effluent samples, hardness and DOC concentrations were also much higher than in influent samples, which would help mitigate metals toxicity.

C. dubia reproduction was almost always higher in the environmental samples compared to the standard control, with occasional statistical differences in mean reproduction between influent and effluent sample pairs. Overall, the environmental samples were not toxic to *C. dubia* compared to controls.

Due to logistical constraints, toxicity tests were not always conducted within the recommended sample hold times. This may have impacted toxicity results, as chemical degradation during storage may have reduced the toxic potential of the stormwater.

Table 5. Summary of toxicity test results and water quality parameters.

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
03/09/16 (Event #1)	Standard Control	100	100	17.4	62 / 39	--	--	--	--	--
	EBI	90	100	22.7	6.5	1.05	1.8 J	0.10 UJ	18.2 J	0.011 J
	EBO	100	100	22.6	10	1.18	1.6 J	0.11 J	3.44 J	0.0089 J
	WBI	100	100	20.2	6.2	1.77	1.9 J	0.10 UJ	17.7 J	0.011 J
	WBO	100	80	28.4	33	12.6	3.26 J	0.524 J	6.29 J	0.0089 J
	WCI	75	100	25.1	11	1.91	3.02 J	0.10 UJ	24.9 J	0.293 J
	WCEBO	95	100	20.2*	13	1.86	2.71 J	0.13 J	30.5 J	0.0334 J
	NFH	100	100	24.9	35	4.6	2.96 J	0.20 J	15.1 J	0.017 J

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
10/20/16 (Event #3)	Standard Control	100	90	27.1	93.5 / 40.3	--	--	--	--	--
	Low Hard. Control [a]	0	100	31.1	10.3 / 10.4	--	--	--	--	--
	EBI	10	100	31.8	5.68	0.8	2.16 J	0.10 UJ	14.9 J	0.0143 J
	EBO	100*	100	34.7	22.7	10.4	7.09 J	0.35 J	3.88 J	0.0094 U
	WBI	70	100	29.2	7.73	1.46	1.9 J	0.10 UJ	16.4 J	0.0107 J
	WBO	100	100	41.8*	47.0	28.1	14.1 J	0.785 J	13.9 J	0.0094 U
	WCI	95	100	30.6	10.4	2.29	2.64 J	0.11 J	22.3 J	0.265 J
	WCEBO	100	100	35.1*	14.7	2.83	5.94 J	0.17 J	28.7 J	0.0430 J
	NFH	95	100	35.1	40.4	7.72	3.13 J	0.34 J	13.7 J	0.0259 J
10/31/16 (Event #5)	Standard Control	100	100	30.5	97.4 / 42.4	--	--	--	--	--
	Low Hard. Control [a]	50	90	25.8	9.7 / 11.3	--	--	--	--	--
	EBI	100	100	31.9	7.42	1.62	1.5 J	0.10 UJ	15.9 J	0.0158 J
	EBO	100	90	34.6*	34.9	13.5	6.52 J	0.56 J	4.86 J	0.0079 J
	WBI	90	100	32.1	7.74	1.25	1.8 J	0.10 UJ	16.6 J	0.012 J
	WBO	100	100	33.1	41.6	20.7	7.63 J	0.897 J	10.6 J	0.0056 J
	WCI	95	100	30.4	13.1	3.03	3.37 J	0.23 J	29.8 J	0.167 J
	WCEBO	100	100	30.9	15.2	2.96	3.45 J	0.19 J	31.3 J	0.0268 J
	NFH	100	100	30.7	40.6	5.82	2.77 J	0.24 J	16.6 J	0.011 J
01/17/17 (Event #7)	Standard Control	95	--	--	131	--	--	--	--	--
	Low Hard. Control [a]	--	100	31.0	36.0	--	--	--	--	--
	EBI	100	90	34.6	8.6	1.25	1.7 J	0.10 UJ	21.1 J	0.0958 J
	EBO	100	90	35.0	16	3.16	2.35 J	0.10 UJ	2.2 J	0.0094 U
	WBI	100	100	37.7	8.5	1.32	1.7 J	0.10 UJ	21.7 J	0.113 J
	WBO	100	100	41.5	64	9.6	2.83 J	0.12 J	4.96 J	0.0094 U
	WCI	95	100	39.2	17	1.8	2.96 J	0.11 J	31.2 J	0.641 J
	WCEBO	100	100	38.9	20	1.8	2.96 J	0.12 J	40.6 J	0.238 J
	NFH	100	100	38.1†	37	4.12	2.29 J	0.21 J	15.7 J	0.0780 J

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
03/07/17 (Event #10)	Standard Control	60	100	33.7	103 / 39.5	--	--	--	--	--
	Low Hard. Control [a]	0	100	33.2	11.3 / 9.74	--	--	--	--	--
	EBI	30	100	35.5	5.26	1.54	2.22 J	0.11 J	18.8 J	0.0158 J
	EBO	100*	100	40.2	12.4	5.85	3.84 J	0.29 J	3.41 J	0.0094 U
	WBI	5	100	35.4	5.21	1.77	2.17 J	0.11 J	18.4 J	0.012 J
	WBO	100*	100	32.1	43.8	18.1	6.18 J	1.14 J	8.26 J	0.0094 U
	WCI	85	100	34.9	16.4	3.23	3.1 J	0.12 J	21.3 J	0.403 J
	WCEBO	100	100	45.3*	21.5	3.12	3.36 J	0.15 J	29.4 J	0.0820 J
	NFH	100	100	49.0	47.1	4.9	2.45 J	0.24 J	15.4 J	0.011 J
04/19/17 (Event #17)	Standard Control	100	--	--	134	--	--	--	--	--
	Low Hard. Control [a]	0	--	--	10.7	--	--	--	--	--
	EBI	65	--	--	8.88	2.71	3.33 J	0.10 UJ	24.6 J	0.024 U
	EBO	100*	--	--	19.3	8.35	3.64 J	0.21 J	3.84 J	0.024 U
	WBI	75	--	--	9.41	3.1	3.40 J	0.10 UJ	25.4 J	0.024 U
	WBO	90	--	--	34.4	19.8	5.22 J	0.695 J	8.57 J	0.024 U
	WCI	95	--	--	14.8	3.53	3.60 J	0.12 J	27.6 J	0.189 J
	WCEBO	95	--	--	26.0	4.45	3.32 J	0.18 J	32.4 J	0.024 U
	NFH	100	--	--	62.5	6.3	2.63 J	0.18 J	12.3 J	0.024 U
04/23/17 (Event #18)	Standard Control	100	--	--	134	--	--	--	--	--
	Low Hard. Control [a]	5	--	--	10.7	--	--	--	--	--
	EBI	100	--	--	8.66	2.81	3.78 J	0.11 J	25.0 J	0.024 U
	EBO	100	--	--	20.0	8.73	3.77 J	0.24 J	3.57 J	0.024 U
	WBI	95	--	--	8.62	2.68	3.38 J	0.10 UJ	24.4 J	0.024 U
	WBO	100	--	--	30.6	17.5	4.57 J	0.642 J	7.47 J	0.024 U
	WCI	100	--	--	17.0	3.51	4.65 J	0.15 J	27.9 J	0.360 J
	WCEBO	100	--	--	22.8	3.8	3.30 J	0.15 J	29.2 J	0.024 U
	NFH	100	--	--	59.1	5.33	2.42 J	0.16 J	12.5 J	0.024 U

* Statistically significant result compared to inlet response ($p<0.05$; Appendix E).

† Statistically significant result at NFH compared to control response ($p< 0.05$; Appendix E).

-- not analyzed; J – estimated value; U – non-detect value;

[a] Low hardness controls were added after the first storm

[b] There are two hardness and alkalinity results for control samples; the first represents results for the *D. pulex* test and the second represents results for *C. dubia* test.

Shaded cells indicate unacceptable quality based on <90% control survival.

APPENDIX H4 – PCB PATTERNS FOR INDIVIDUAL SAMPLING LOCATIONS

Total polychlorinated biphenyl (PCB) concentrations generally decreased between influent and effluent. On average, homolog patterns were fairly similar between the bioretention influent (i.e., EBI and WBI), as well as between the wetland complex influent and the effluent (i.e., WCI and WCEBO). The hexa-PCBs were the most prevalent homolog, representing about a third of the total on average, followed by penta-PCBs which comprised about one quarter of the total on average (Figure 1).

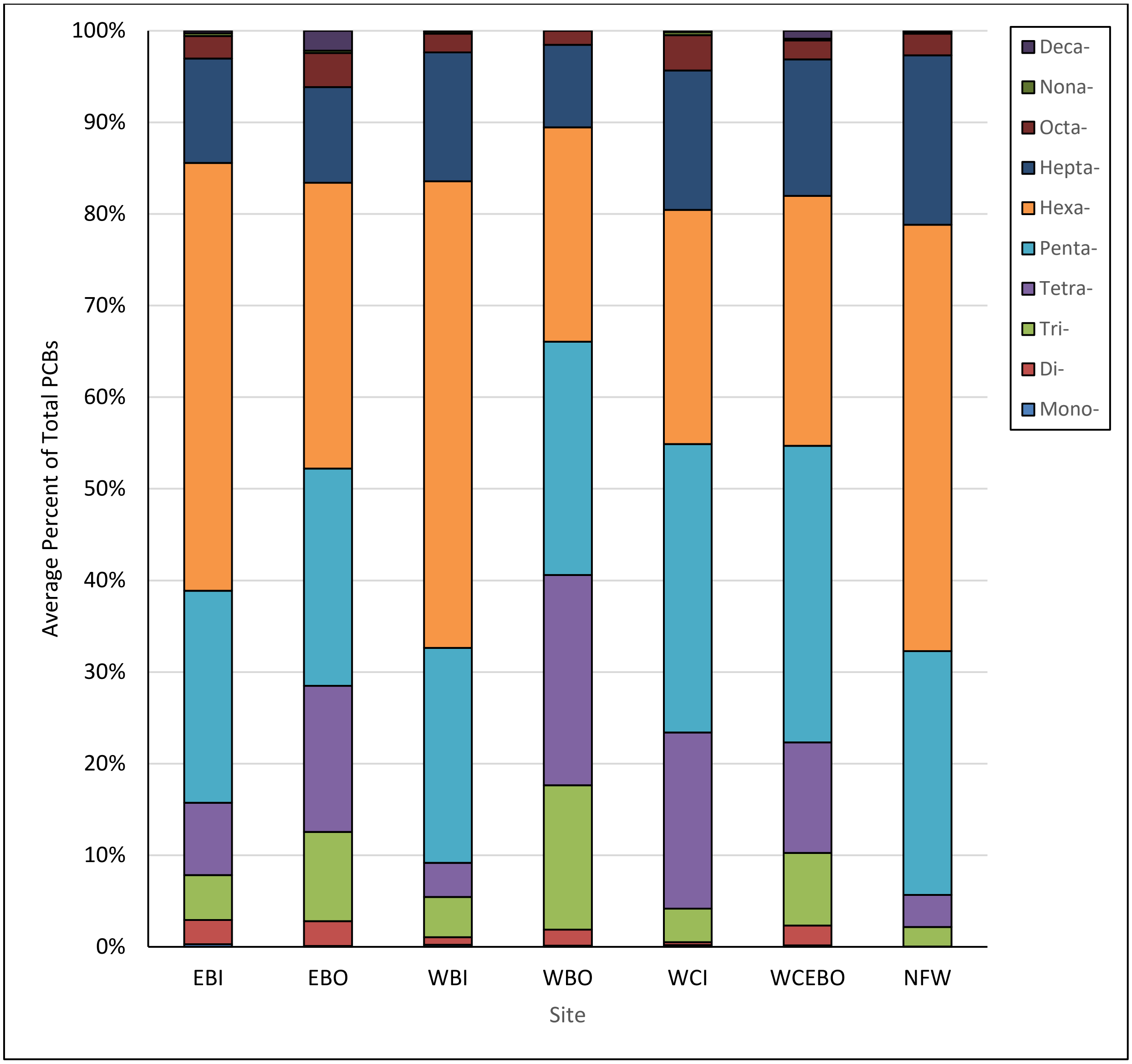


Figure 1. Homolog Patterns – Average Percent of Total PCB Concentrations (n=10)

Appendix I: Summary of Flow Monitoring Results

APPENDIX I – SUMMARY OF FLOW MONITORING RESULTS

Continuous flow was monitored at seven sampling locations according to methods described in the Quality Assurance Project Plan (QAPP; King County 2016) and Appendix C. Autosamplers were programmed to collect 36 flow-weighted aliquots into a single collection bottle. Occasionally, if a storm was less intense than predicted or if the sampler malfunctioned, fewer than 36 samples were collected. Sampling criteria were met if the aliquots were collected over an interval that included the peak flow rate or at least 50% of the flow volume that occurred at that location within 24 hours of the beginning of the storm event.

Data from each sampled storm are summarized in the following tables and figures. The summary statistics in the tables reflect the measurements taken during each storm event and sampling interval. The information included in the tables is described in Tables 1 and 2 below.

Table 1. Definitions of precipitation summary statistics provided for each storm.

Precipitation Information	Storm #
	Date
Dry antecedent period (hr)	Number of hours before start of storm event in which there was no more than a total sum of 0.04 inches of rain.
Rainfall in 4 days before storm (in)	Cumulative rainfall during the four days before the start of the storm event.
Rainfall in 48 hours before storm (in)	Cumulative rainfall during the 48 hours before the start of the storm event.
Rainfall in 24 hours before storm (in)	Cumulative rainfall during the 24 hours before the start of the storm event.
Rainfall in 6 hours before storm (in)	Cumulative rainfall during the six hours before the start of the storm event.
Rainfall during storm (in)	Cumulative rainfall between the beginning and end of the storm event.
Peak rainfall (date, time)	The time at which the greatest amount of rainfall was recorded.
Rainfall volume in bioretention basin (cf)	The estimated total volume of rainfall on the basins that contribute flow to the bioretention facilities; calculation is area of basins multiplied by rainfall depth.
Rainfall volume in wetland complex basin (cf)	The estimated total volume of rainfall on the basins that contribute flow to the wetland complex; calculation is area of basins multiplied by rainfall depth.

Table 2. Definitions of sampling information summarized in tables for each storm event.

Sampling Information	Storm # - Date						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	Cumulative volume of water measured passing through sampling location during each storm event; beginning and end times were estimated visually.						
Start of flow (hhmm)	Beginning of storm event, identified by rising hydrograph.						
Average flow rate for entire storm (cfs)	Average flow rate from the beginning and end of the storm event.						
Duration of flow (hr)	Number of hours between the beginning and end of the storm event.						
Runoff first 24 hrs of event (start at time of first sample) (cf)	Cumulative volume of water measured passing through sampling location for 24 hours, starting when the first sample aliquot was collected.						
Runoff volume sampled (cf)	Cumulative volume of water measured passing through sampling location between the time the first and last sample aliquots were collected.						
% of runoff volume sampled	The percent of total water volume measured in 24 hours that was sampled. If the sampler collected the first and last aliquot exactly 24 hours apart, this value would be 100%.						
Average flow rate during sampling interval (cfs)	Average flow rate between the time the first and last aliquots were collected.						
Peak of hydrograph captured?	A yes or know question about whether the sampling interval included the time at which the maximum flow rate for that event was recorded.						
Number of aliquots collected	The number of aliquots collected and combined for the storm event.						
Peak flow rate (cfs)	The maximum measured flow rate during the storm event.						
Peak hydrograph (date, time)	The time that the maximum flow rate was measured during the storm event.						
Time difference: peak rain to peak hydrograph (hr:min)	The difference in time between the maximum measured rainfall (in 15 minute intervals) and the maximum flow rate.						

The figures illustrate the depth of water in each pipe and the calculated flow rate at each location during each storm. In addition, rainfall recorded at rain gage 24V during each storm is also plotted. The red diamonds on each figure illustrate when each aliquot was collected. The figures often include time before and after the storm event and sampling period to give context.

Precipitation Information	Storm 1 3/9/2016
Dry antecedent period (hr)	12
Rainfall in 4 days before storm (in)	0.75
Rainfall in 48 hours before storm (in)	0.3
Rainfall in 24 hours before storm (in)	0.25
Rainfall in 6 hours before storm (in)	0.02
Rainfall during storm (in)	0.86
Peak rainfall (date, time)	3/10/16 2:00 AM
Rainfall volume in bioretention basin (cf)	70553
Rainfall volume in wetland complex basin (cf)	610624

Sampling Information	Storm 1 - 3/9/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	10503	19133	18587	(a)	226303	406531	430388
Start of flow (hhmm)	1320	1320	1325	(a)	1210	1328	1225
Average flow rate for entire storm (cfs)	0.137	0.108	0.252	(a)	2.754	2.283	2.45
Duration of flow (hr)	21.3	49.2	20.5	(a)	22.8	49.5	48.8
Runoff first 24 hrs of event (start at time of first sample) (cf)	10370	12600	18658	(a)	222909	238255	272265
Runoff volume sampled (cf)	6890	5978	14546	(a)	200755	197620	210972
% of runoff volume sampled	66.4	47.4	78.0	(a)	90.1	82.9	77.5
Average flow rate during sampling interval (cfs)	0.182	0.127	0.322	(a)	3.27	2.737	3.261
Peak of hydrograph captured?	yes	yes	yes	likely	yes	yes	yes
Number of aliquots collected	36	36	36	36	36	32	26
Peak flow rate (cfs)	0.36	0.18	0.46	(a)	9.33	3.6	5.27
Peak hydrograph (date, time)	3/10/2016 2:10:00 AM	3/10/2016 10:35:00 AM	3/10/2016 2:10:00 AM	(a)	3/10/2016 2:10:00 AM	3/10/2016 4:35:00 AM	3/10/2016 2:25:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	0:10	8:35	0:10	(a)	0:10	2:35	0:25

(a) Spikes in flow level due to backflow caused by high flow in adjacent pipe. Spikes obscure beginning and end of event, as well as the peak.

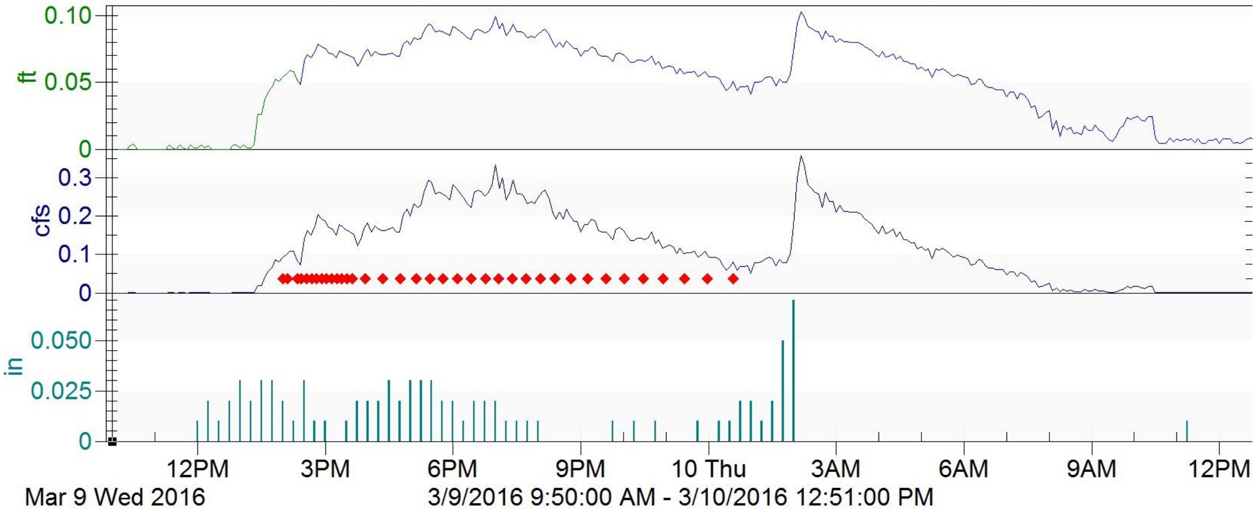


Figure 1. **EBI, Storm 1.**

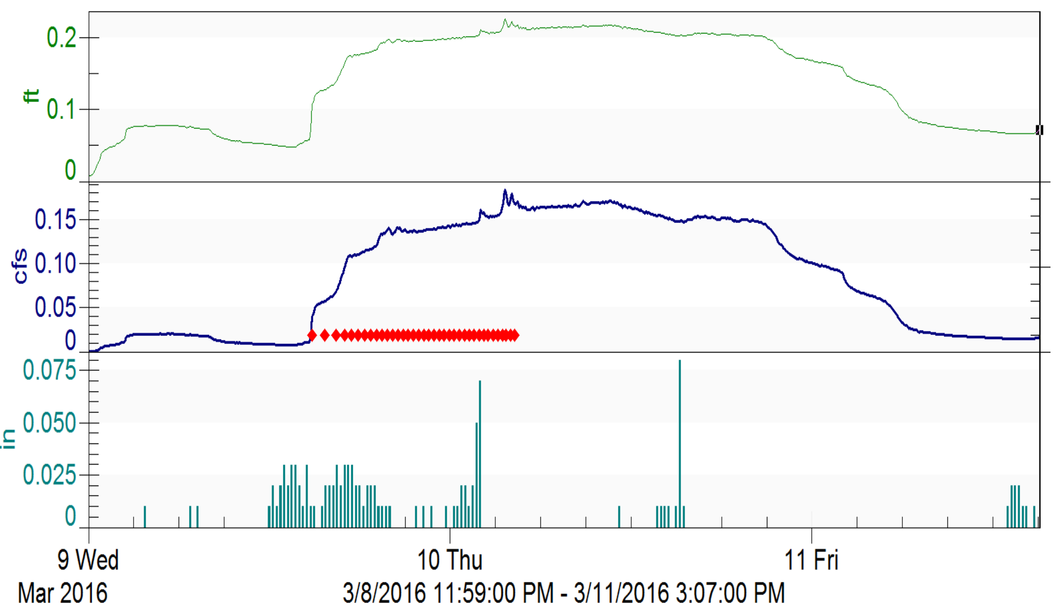


Figure 2. **EBO, Storm 1.**

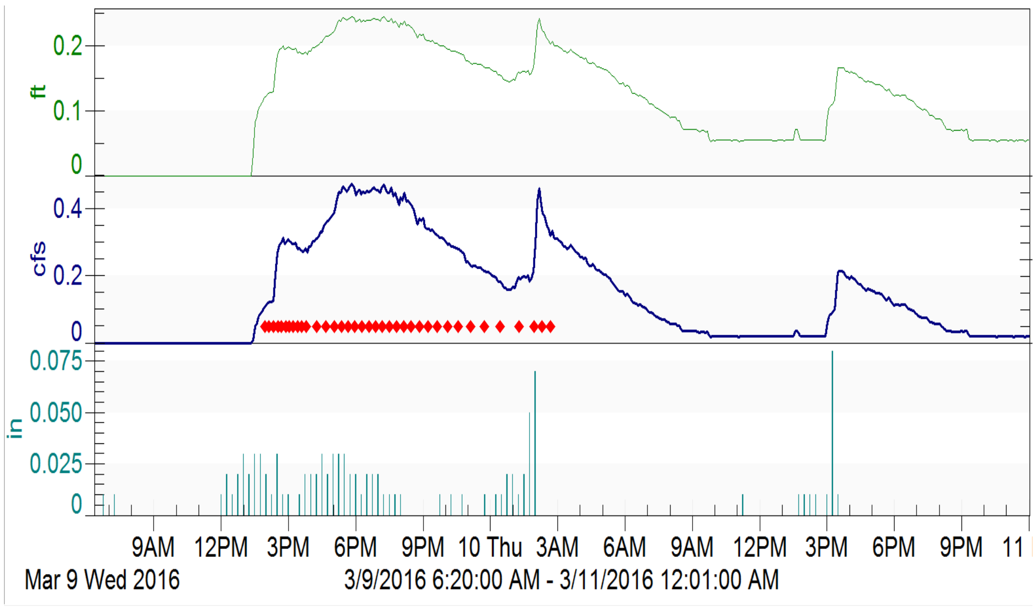


Figure 3. WBI, Storm 1.

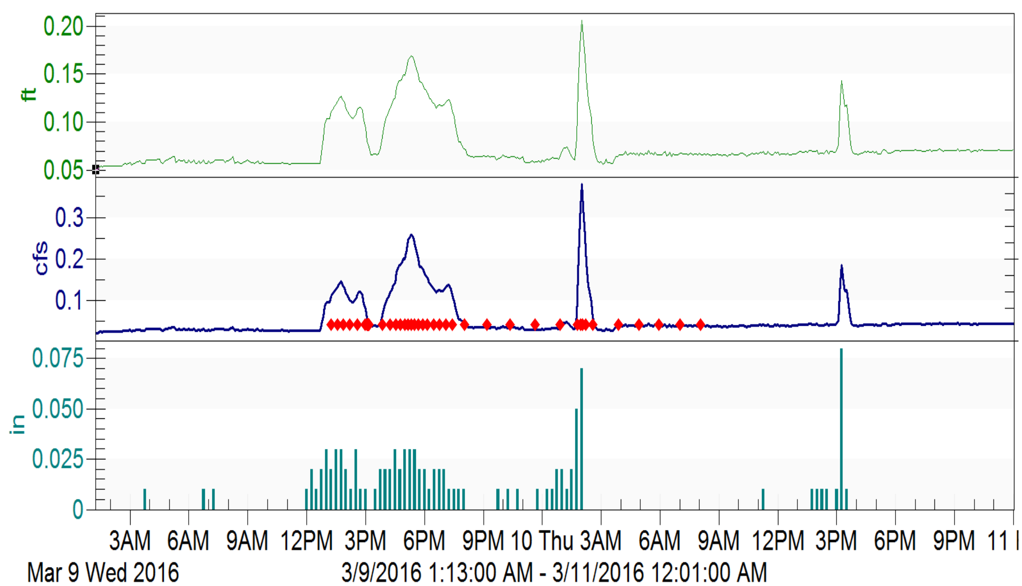


Figure 4. WBO, Storm1.

Note: Spikes in water level in WBO are due to backflow into pipe; flow rates are not accurate.

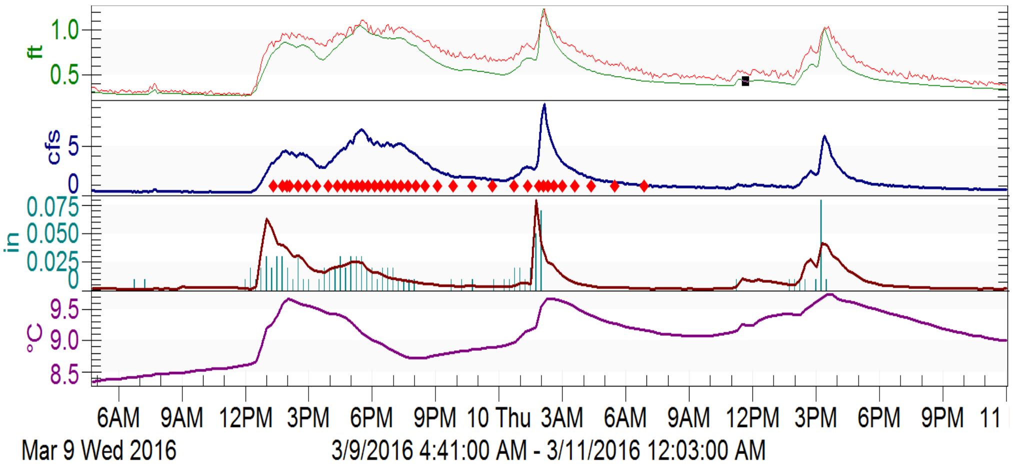


Figure 5. WCI, Storm 1.

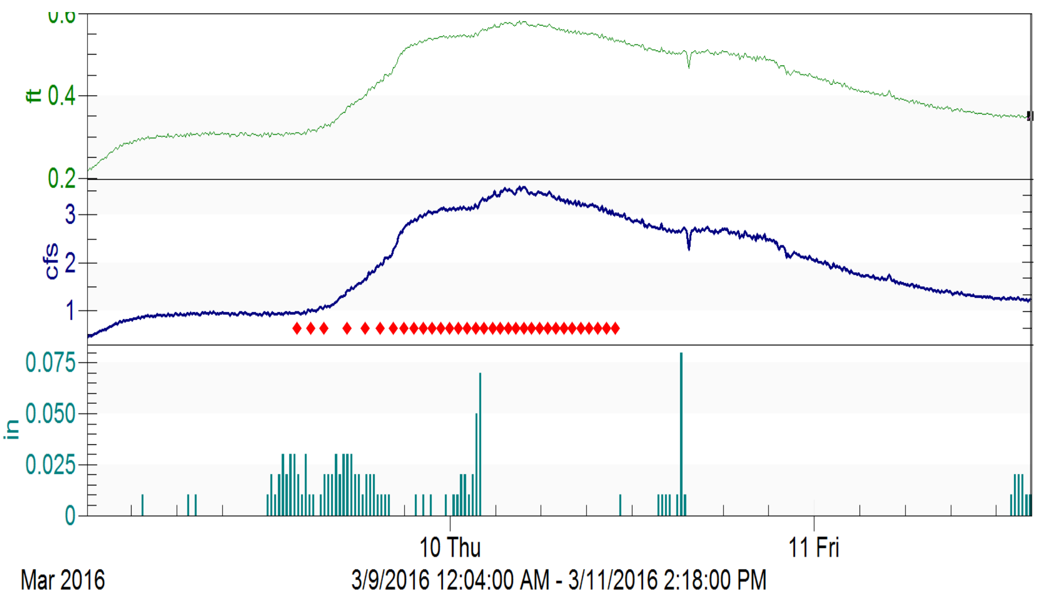


Figure 6. WCEBO, Storm 1.

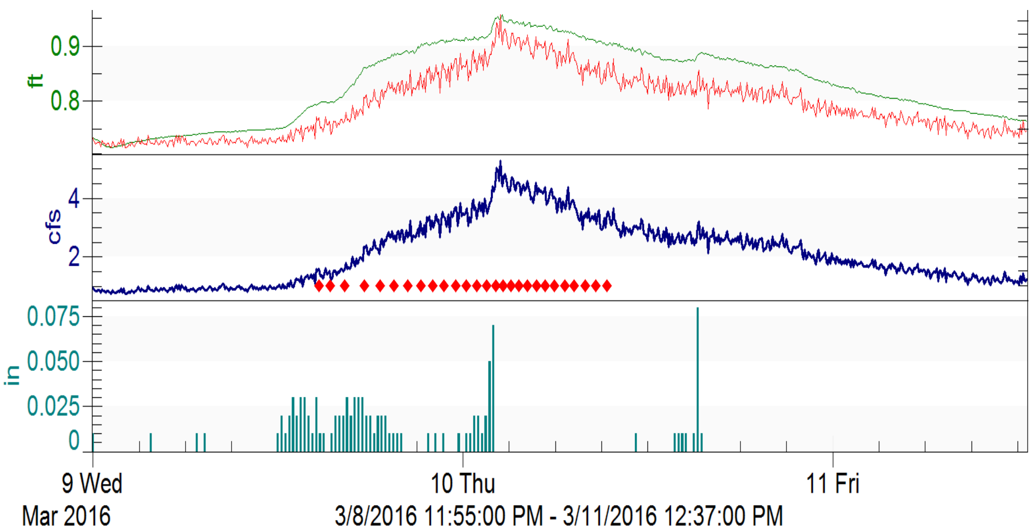


Figure 7. NFWHC, Storm 1.

Precipitation Information	Storm 2 3/23/2016
Dry antecedent period (hr)	39
Rainfall in 4 days before storm (in)	0.54
Rainfall in 48 hours before storm (in)	0.19
Rainfall in 24 hours before storm (in)	0
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.29
Peak rainfall (date, time)	3/23/16 11:00 PM
Rainfall volume in bioretention basin (cf)	23791
Rainfall volume in wetland complex basin (cf)	205908

Sampling Information	Storm 2 - 3/23/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	886	3948	276	(a)	60126	143208	139481
Start of flow (hhmm)	1730	1845	1145	(a)	230	1655	1350
Average flow rate for entire storm (cfs)	0.017	0.015	0.009	(a)	0.499	0.512	0.578
Duration of flow (hr)	14.5	73.1	8.5	(a)	33.5	77.7	67.0
Runoff first 24 hrs of event (start at time of first sample) (cf)	867	2458	259	(b)	51647	69661	62412
Runoff volume sampled (cf)	737	1280	225	(b)	44309	38007	32398
% of runoff volume sampled	85.01	52.07	86.87	(b)	85.79	54.56	51.91
Average flow rate during sampling interval (cfs)	0.017	0.033	0.013	(b)	0.727	0.79	0.765
Peak of hydrograph captured?	yes	yes	yes	no	yes	yes	yes
Number of aliquots collected	36	36	6	0 (b)	21	19	13
Peak flow rate (cfs)	0.035	0.06	0.02	(c)	2.3	1.06	0.94
Peak hydrograph (date, time)	3/24/2016 1:35:00 AM	3/24/2016 6:25:00 AM	3/24/2016 12:45:00 AM	(c)	3/23/2016 11:15:00 PM	3/24/2016 8:25:00 AM	3/24/2016 7:45:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	2:35	7:25	1:45	(c)	0:15	9:25	8:45

(a) Unable to discern beginning and end of storm flow.

(b) No aliquots taken during storm. 4L grab sample collected on 3/25/16.

(c) Flow spikes obscure actual peak hydrograph.

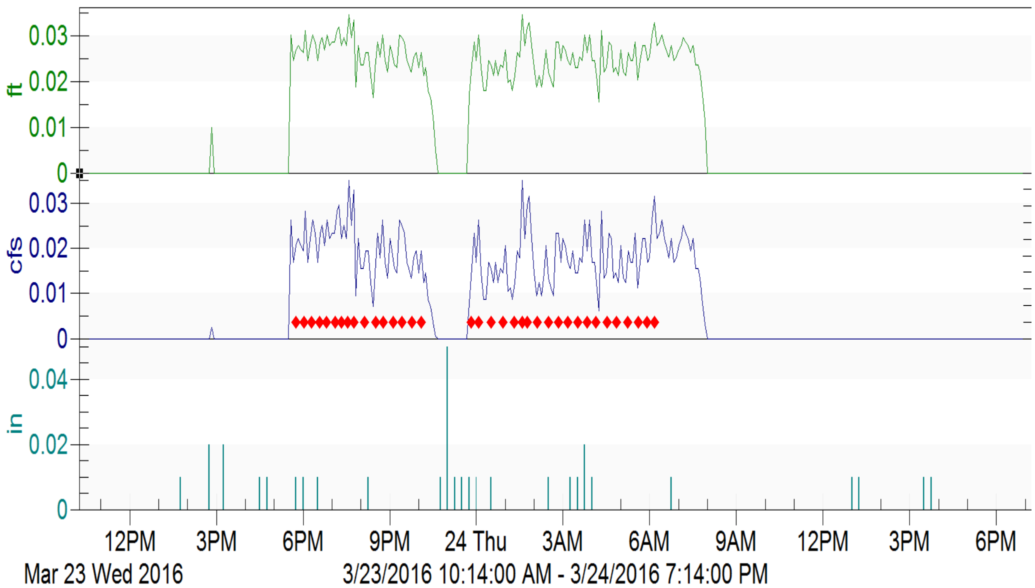


Figure 8. EBI, Storm 2.

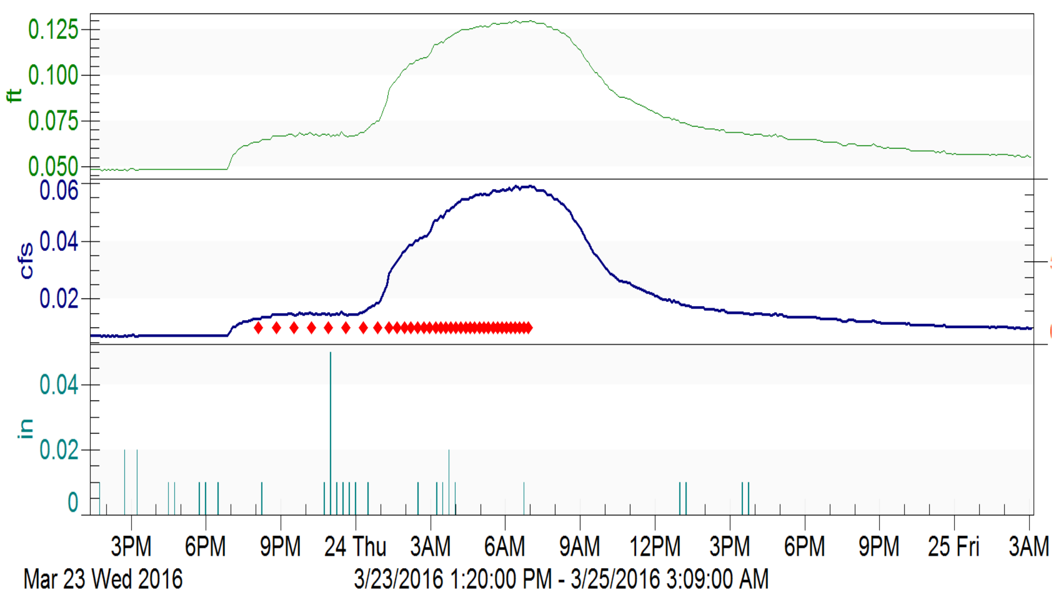


Figure 9. EBO, Storm 2.

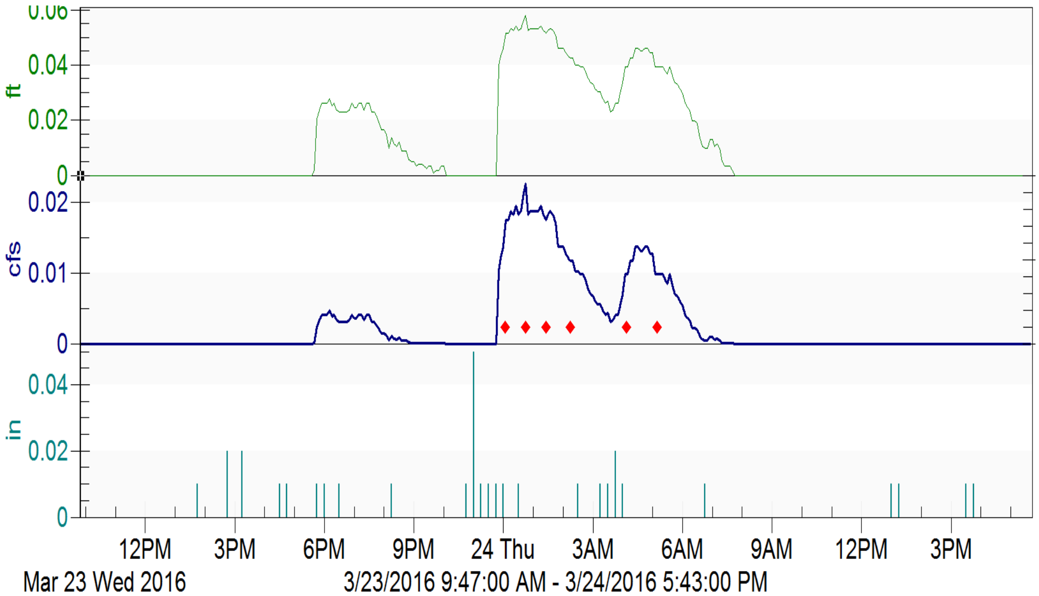


Figure 10. WBI, Storm 2.

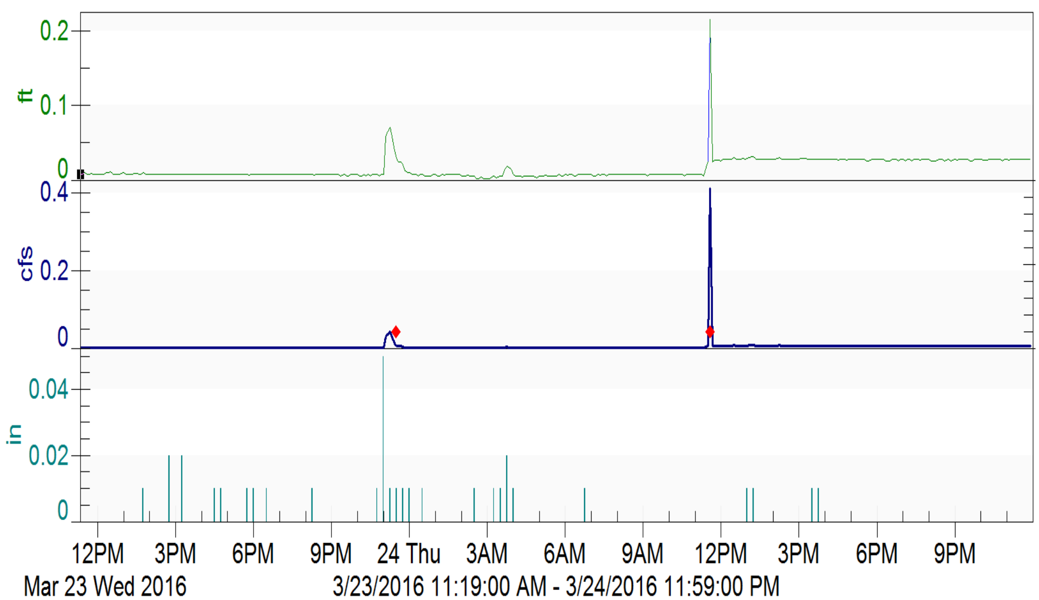


Figure 11. WBO, Storm 2.

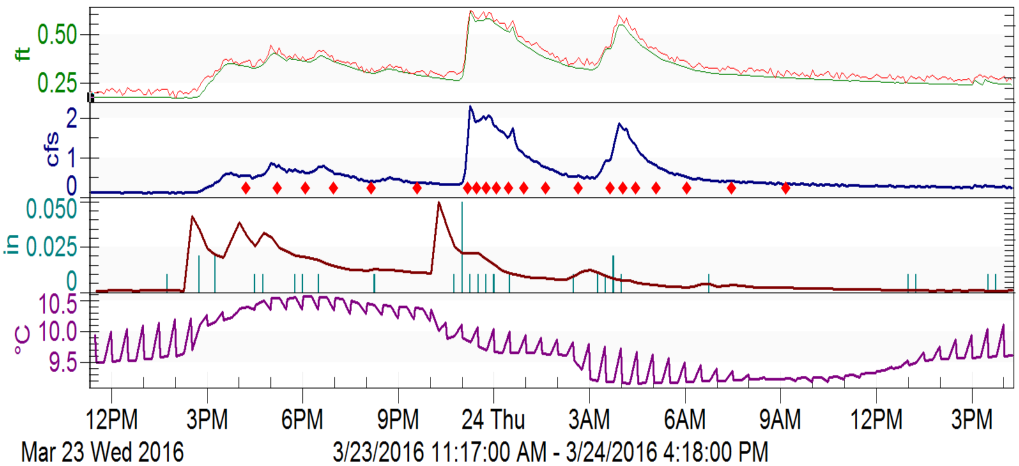


Figure 12. WCI, Storm 2.

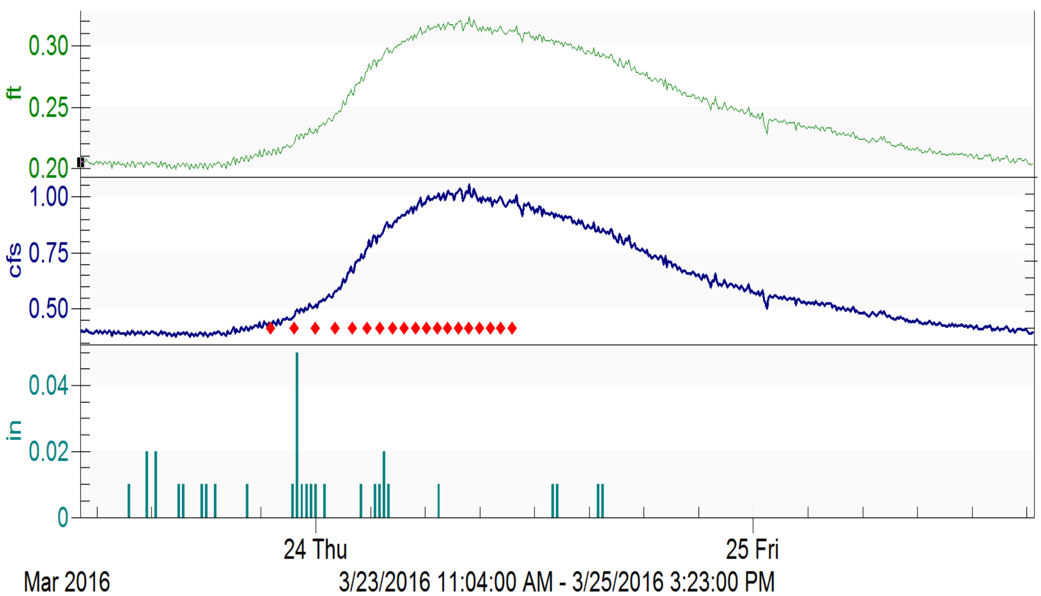


Figure 13. WCEBO, Storm 2.

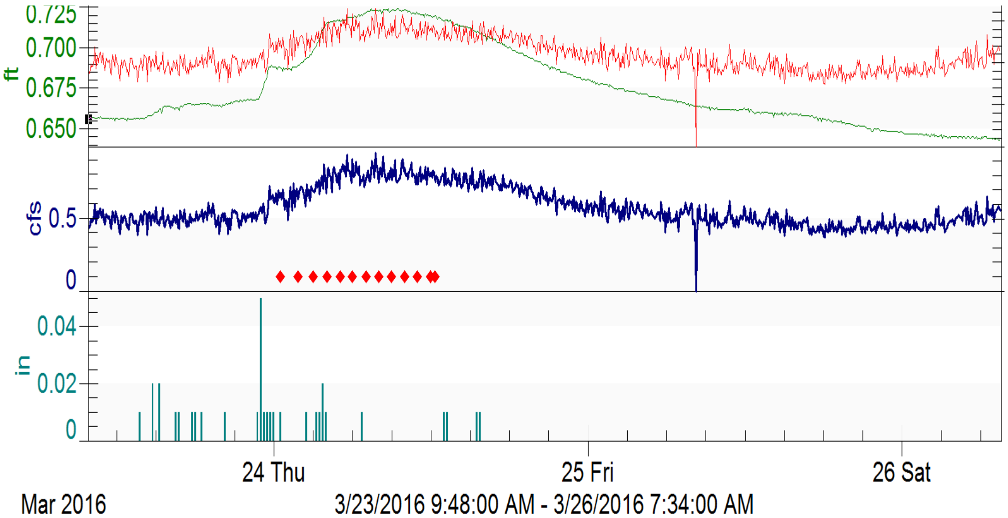


Figure 14. NFWHC, Storm 2.

Precipitation Information	Storm 3 10/19/2016
Dry antecedent period (hr)	35
Rainfall in 4 days before storm (in)	1.32
Rainfall in 48 hours before storm (in)	0.18
Rainfall in 24 hours before storm (in)	0
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	1.16
Peak rainfall (date, time)	10/20/16 3:30 AM
Rainfall volume in bioretention basin (cf)	95164
Rainfall volume in wetland complex basin (cf)	823632

Sampling Information	Storm 3 - 10/19/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	(a)	17624	16083	9593	323365	553795	741207
Start of flow (hhmm)	(a)	1240	20	245	1940	2150	2115
Average flow rate for entire storm (cfs)	(a)	0.119	0.231	0.03	3.422	3.439	4.654
Duration of flow (hr)	(a)	41.1	19.3	88.8	26.2	44.7	44.2
Runoff first 24 hrs of event (start at time of first sample) (cf)	(a)	16675	16083	5356	316102	277571	568579
Runoff volume sampled (cf)	(a)	12200	3634	1902	152738	198533	302177
% of runoff volume sampled	(b)	73.16	22.60	35.51	48.32	71.53	53.15
Average flow rate during sampling interval (cfs)	(a)	0.326	0.234	0.052	4.052	2.726	5.632
Peak of hydrograph captured?	(b)	yes	yes	no	yes	yes	yes
Number of aliquots collected	32	34	36	36	36	33	32
Peak flow rate (cfs)	(a)	0.46	0.53	0.08	11.68	6.9	10.59
Peak hydrograph (date, time)	(a)	10/20/2016 10:45:00 AM	10/20/2016 4:20:00 AM	10/20/2016 2:20:00 PM	10/20/2016 4:20:00 AM	10/20/2016 1:50:00 PM	10/20/2016 10:25:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	(a)	7:15	0:50	10:50	0:50	10:20	6:55

(a) Flow meter malfunctioned during storm. Aliquots sampled using time pacing.

(b) Based on flow at WBI, which was likely very similar to flow at EBI, it appears we missed the peak hydrograph but likely sampled over 50% of the storm volume.

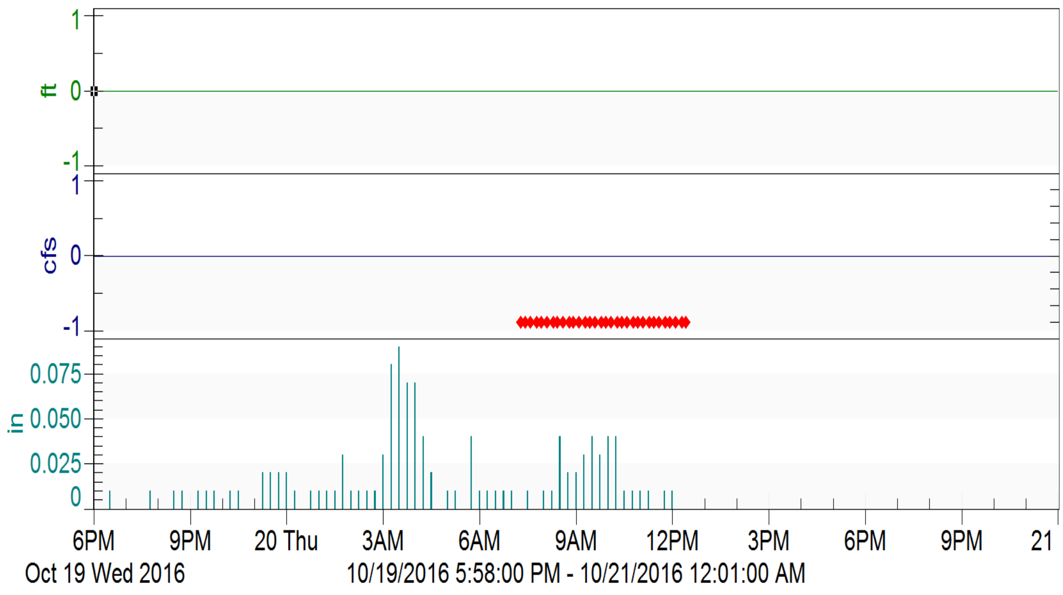


Figure 15. EBI, Storm 3.

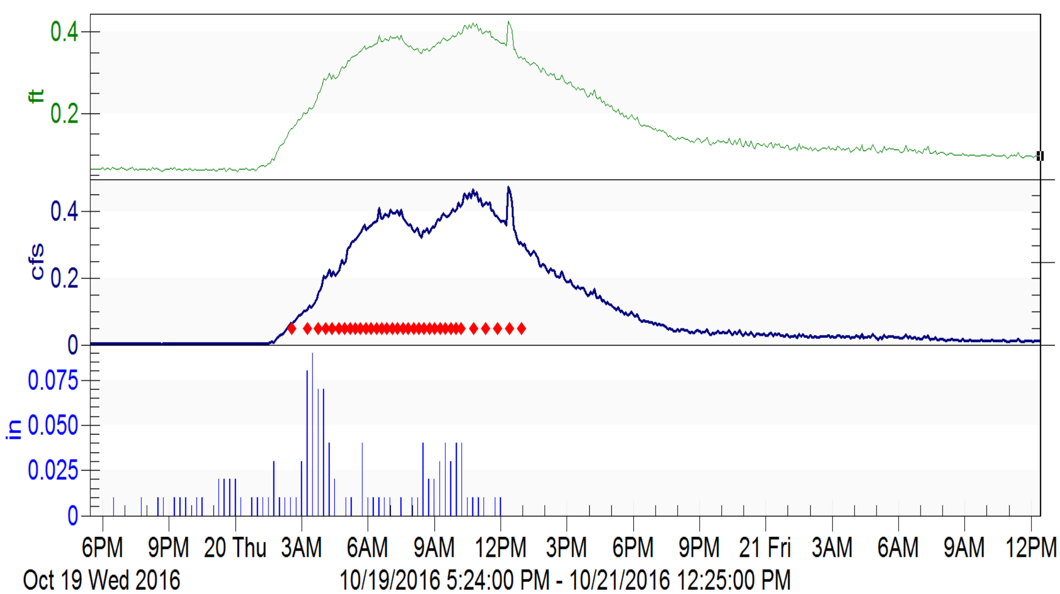


Figure 16. EBO, Storm 3.

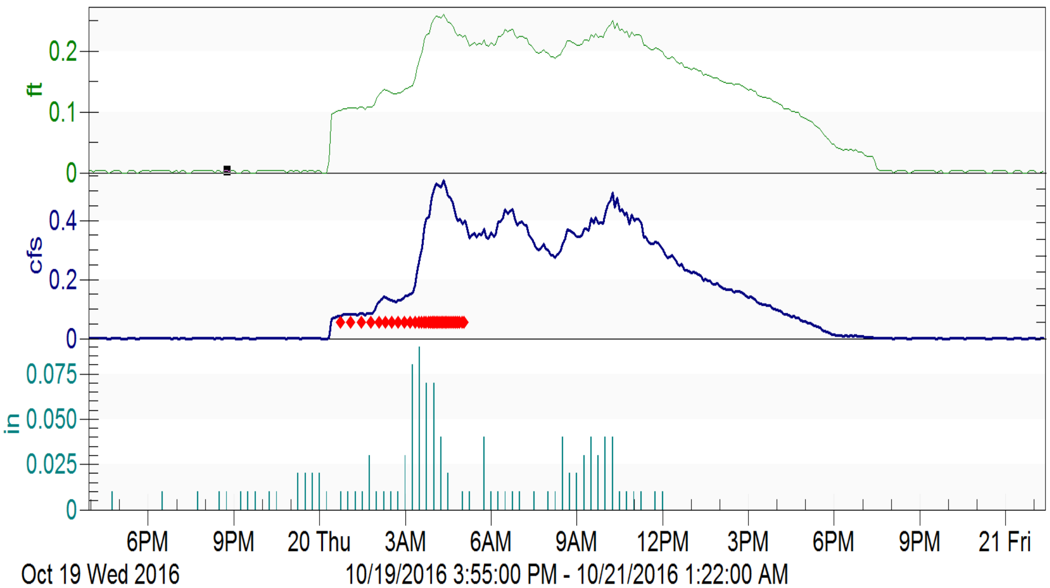


Figure 17. WBI, Storm 3.

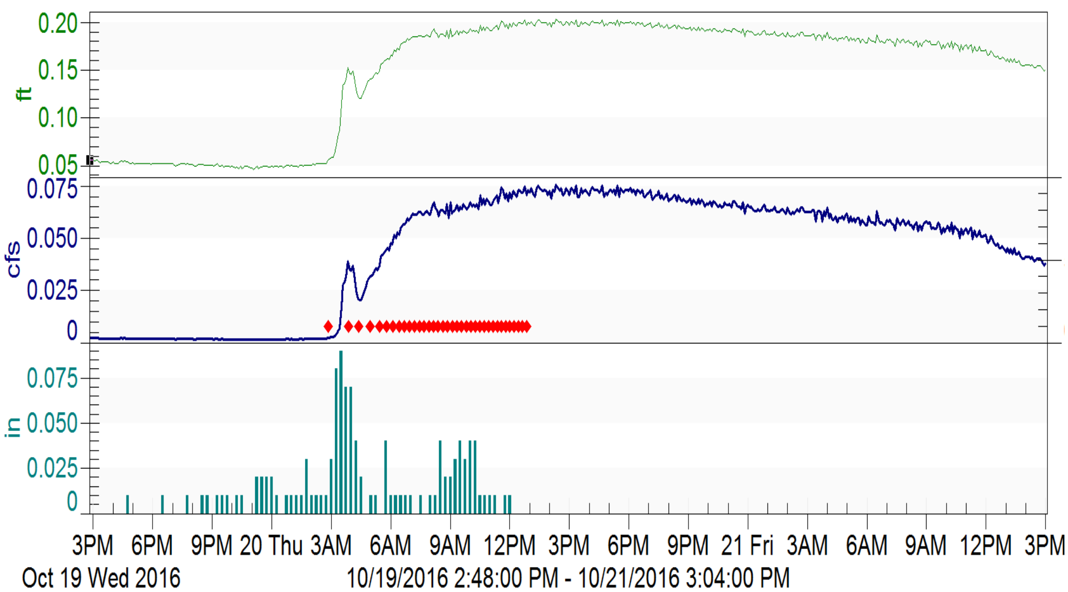


Figure 18. WBO, Storm 3.

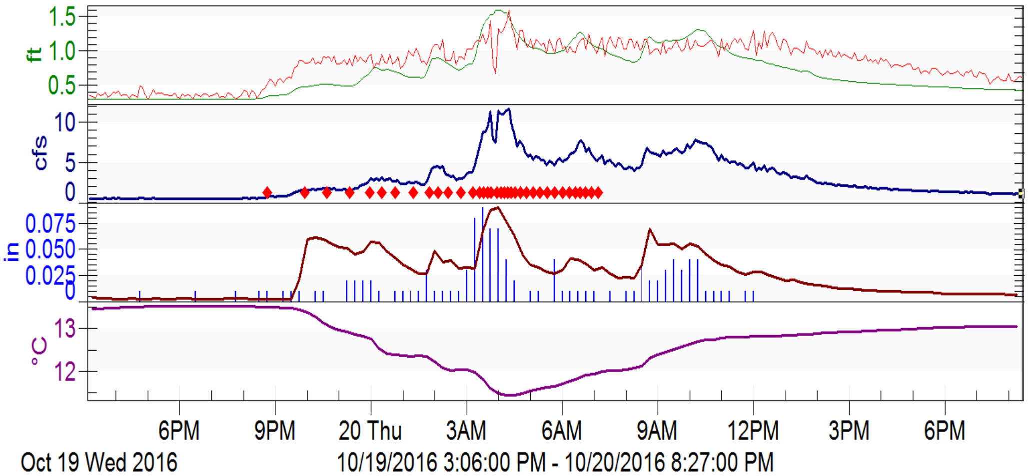


Figure 19. WCI, Storm 3.

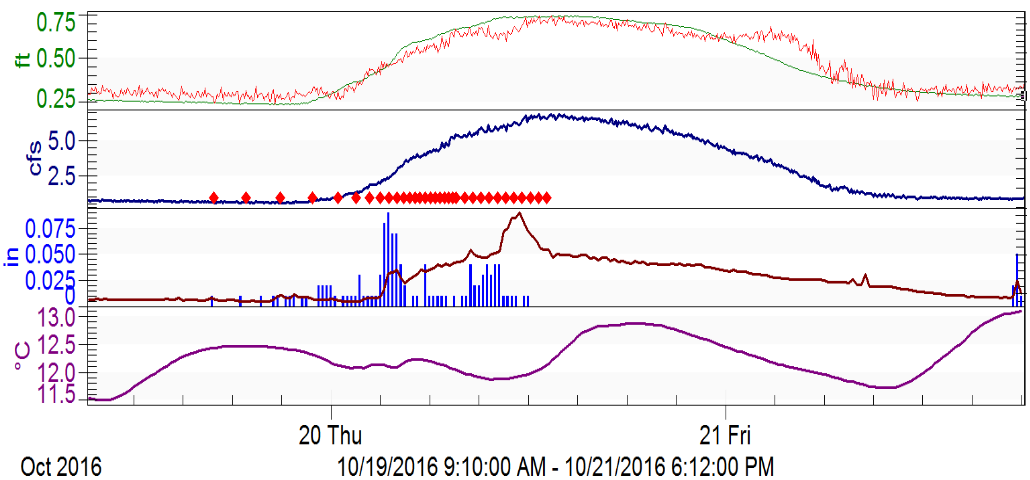


Figure 20. WCEBO, Storm 3.

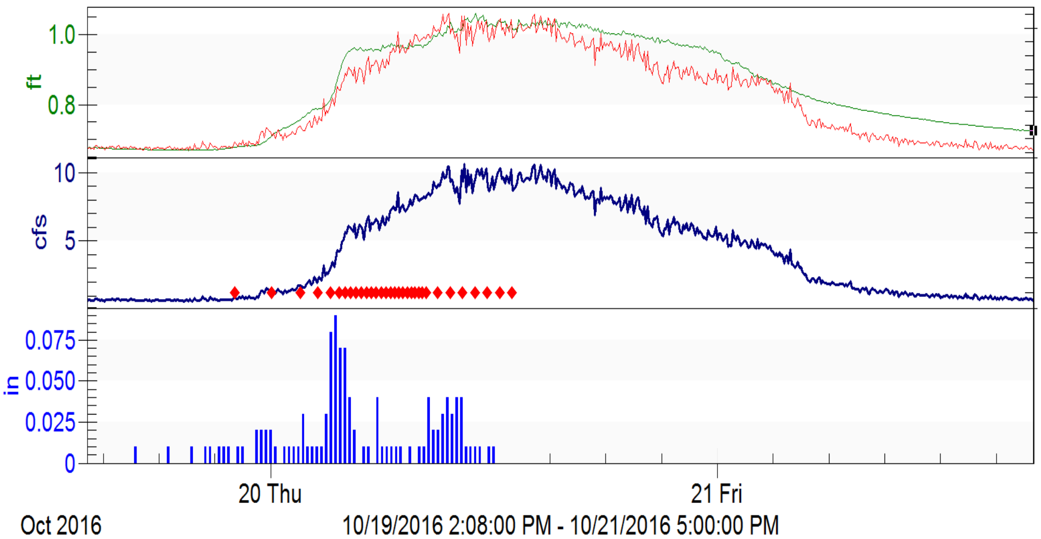


Figure 21. NFWHC, Storm 3.

Precipitation Information	Storm 4 10/26/2016
Dry antecedent period (hr)	29.5
Rainfall in 4 days before storm (in)	0.26
Rainfall in 48 hours before storm (in)	0.15
Rainfall in 24 hours before storm (in)	0.01
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	1.29
Peak rainfall (date, time)	10/26/16 8:30 AM
Rainfall volume in bioretention basin (cf)	105829
Rainfall volume in wetland complex basin (cf)	915936

Sampling Information	Storm 4 - 10/26/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	32254	25584	17017	10154	392706	693404	946079
Start of flow (hhmm)	825	840	830	700	546	810	700
Average flow rate for entire storm (cfs)	0.415	0.1	0.21	0.028	3.979	2.645	4.411
Duration of flow (hr)	21.6	71.1	22.5	100.7	27.4	72.8	59.6
Runoff first 24 hrs of event (start at time of first sample) (cf)	32149	19665	17017	4598 (a)	378743	388339	301446
Runoff volume sampled (cf)	6342	9673	5558	4598 (a)	133854	84230	137662
% of runoff volume sampled	19.73	49.19	32.66	100 (a)	35.34	21.69	45.67
Average flow rate during sampling interval (cfs)	0.454	0.211	0.2	0.049 (a)	3.602	2.783	3.953
Peak of hydrograph captured?	no	no	no	yes (a)	no	no	no
Number of aliquots collected	36	36	32	18 (a)	23 (b)	15 (c)	17 (d)
Peak flow rate (cfs)	1.36	0.66	0.65	0.06 (a)	18.63	7.46	12.11
Peak hydrograph (date, time)	10/26/2016 9:05:00 PM	10/26/2016 9:50:00 PM	10/26/2016 7:30:00 PM	10/27/2016 1:35:00 AM	10/26/2016 7:35:00 PM	10/27/2016 12:50:00 AM	10/26/2016 9:35:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	12:35	13:20	11:00	17:05	11:05	16:20	13:05

(a) Sampler inadvertantly turned off @ ~1400 on 10/26 after collecting 6 aliquots. Additional aliquots sampled using time pacing, starting the next morning. Spike likely not accurate; possibly due to black flow in pipe. Peak is estimated. Because of this facility's typical low flow rate, we decided aliquots collected morning after the event would be representative of the effluent (see WBO figure).

(b) Sampler inadvertently programmed to stopped sampling at 1626 on 10/26.

(c) Sampler inadvertently programmed to stop sampling at 1650 on 10/26.

(d) Sampler inadvertently programmed to stop sampling at 1725 on 10/26.

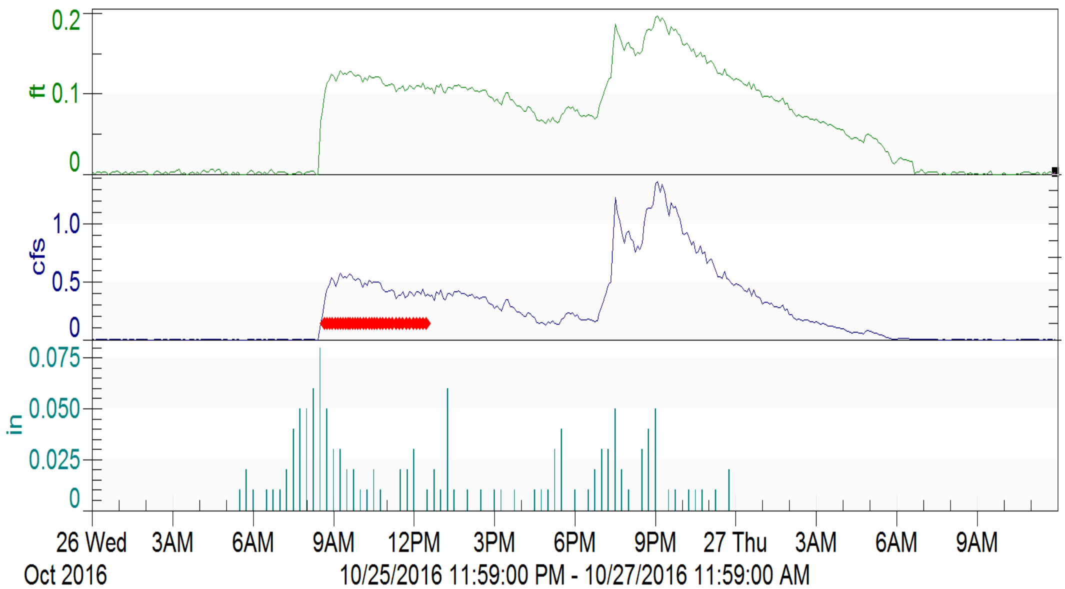


Figure 22. EBI, Storm 4.

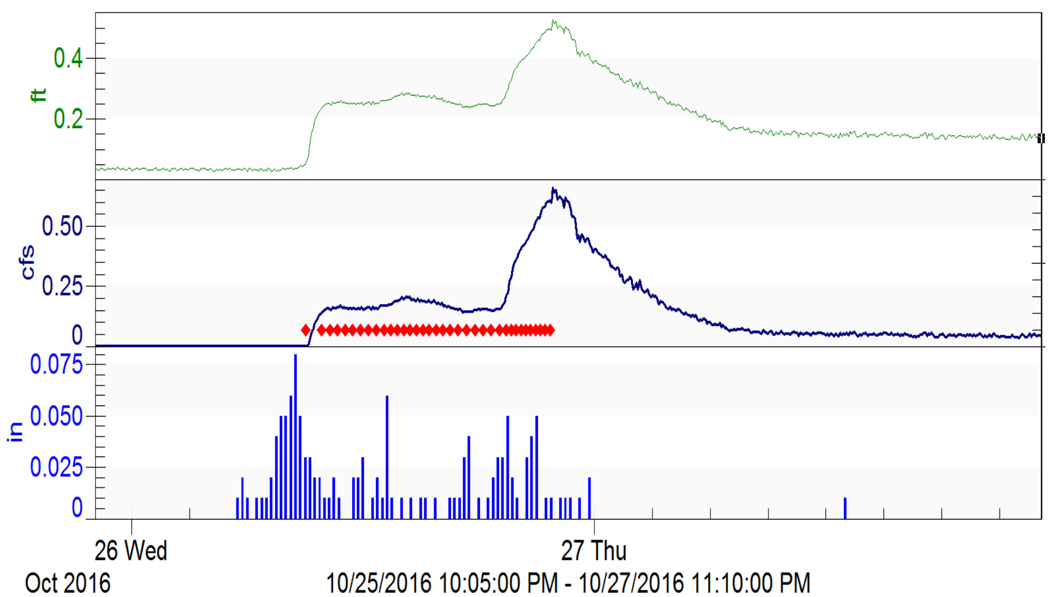


Figure 23. EBO, Storm 4.

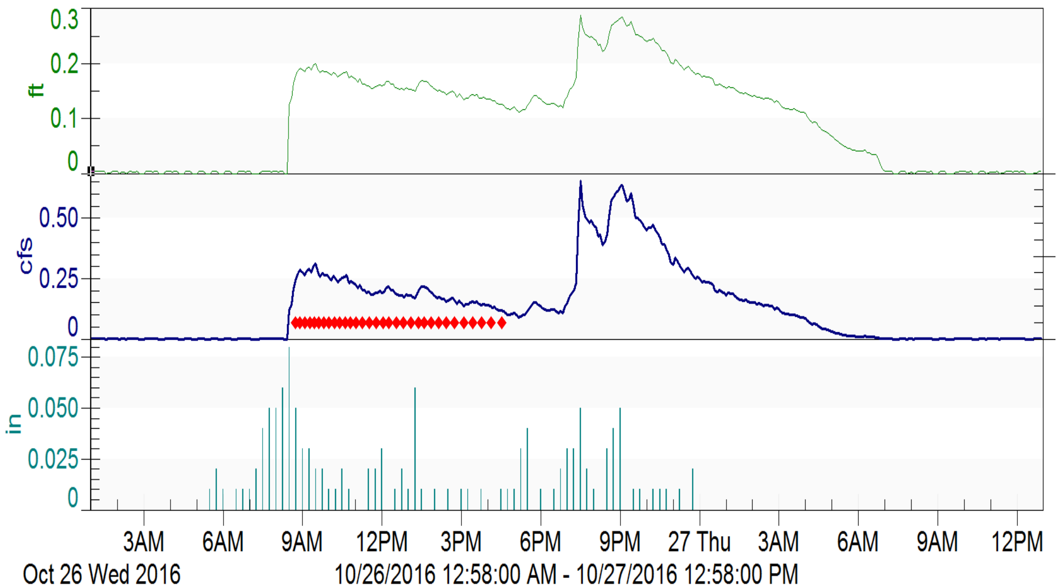


Figure 24. WBI, Storm 4.

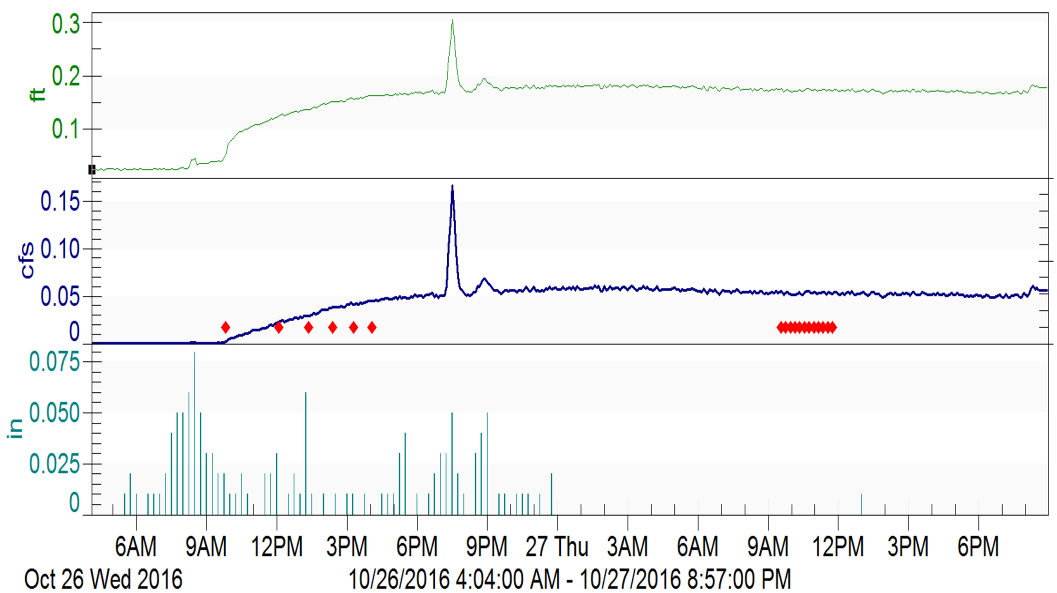


Figure 25. WBO, Storm 4.

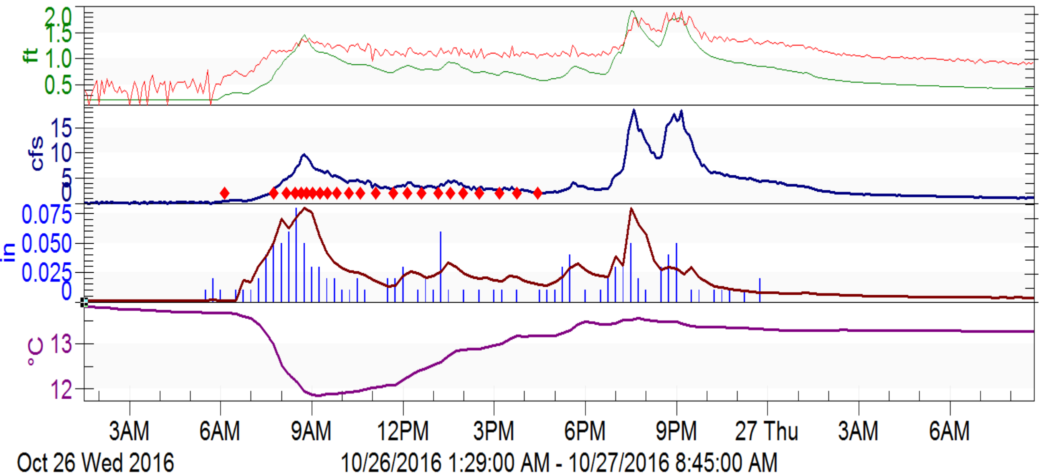


Figure 26. WCI, Storm 4.

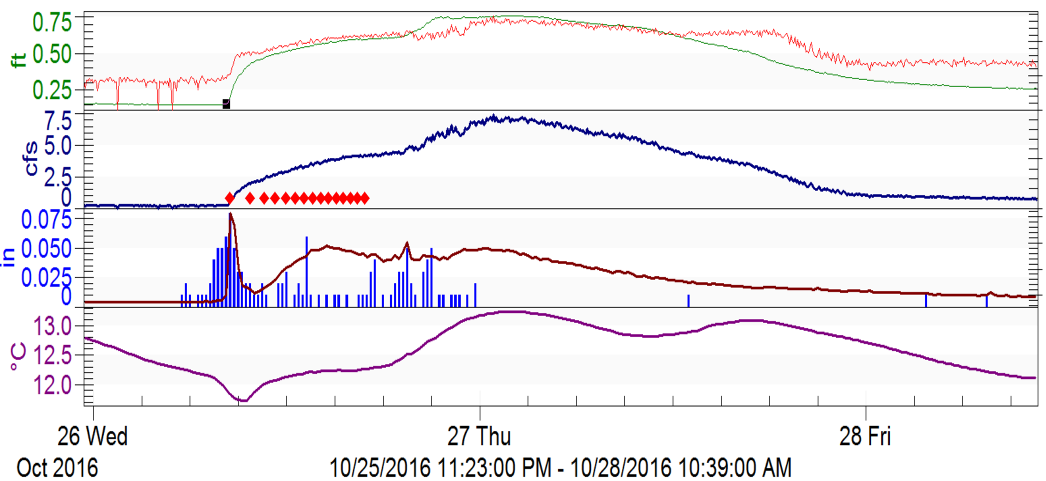


Figure 27. WCEBO, Storm 4.

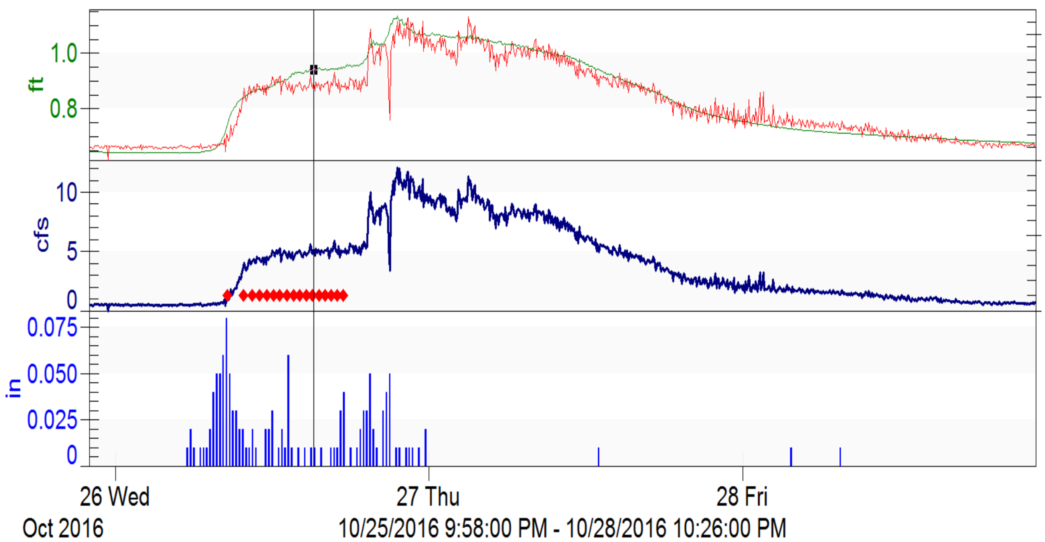


Figure 28. NFWHC, Storm 4.

Precipitation Information	Storm 5 10/31/2016
Dry antecedent period (hr)	9.5
Rainfall in 4 days before storm (in)	0.85
Rainfall in 48 hours before storm (in)	0.71
Rainfall in 24 hours before storm (in)	0.6
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.36
Peak rainfall (date, time)	10/31/16 9:15 PM
Rainfall volume in bioretention basin (cf)	29534
Rainfall volume in wetland complex basin (cf)	255610

Sampling Information	Storm 5 - 10/31/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	4236	11105	2442	3332 (a)	140052	234200	346520
Start of flow (hhmm)	2200	2210	2205	1:45	2055	2125	2100
Average flow rate for entire storm (cfs)	0.076	0.086	0.043	0.025	1.548	2.065	3.063
Duration of flow (hr)	15.5	35.9	15.8	37.0	25.1	31.5	31.4
Runoff first 24 hrs of event (start at time of first sample) (cf)	4001	8822	2442	2689	137390	157659	297222 (b)
Runoff volume sampled (cf)	3900	6339	2369	1845	115010	102049	71715
% of runoff volume sampled	97.48	71.85	97.01	68.61	83.71	64.73	24.13
Average flow rate during sampling interval (cfs)	0.085	0.122	0.049	0.035	2.173	2.283	3.622
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	no
Number of aliquots collected	21	30	24	20	29	30	34
Peak flow rate (cfs)	0.24	0.19	0.12	0.04	5.37	3.19	4.5
Peak hydrograph (date, time)	10/31/2016 10:45:00 PM	11/1/2016 1:00:00 AM	10/31/2016 10:45:00 PM	11/1/2016 4:15:00 AM	10/31/2016 9:55:00 PM	11/1/2016 4:50:00 AM	10/31/2016 11:45:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	1:30	3:45	1:30	7:00	0:40	7:35	2:30

(a) Flow high initially from the previous storm. Flow values begin when the first sample was triggered by rising flow in pipe.

(b) Sampler did not start at the beginning of storm; sampler turned on manually morning after. Sampler set to flow pace sample every 2000 cf starting at 0700 on 11/1/2016.

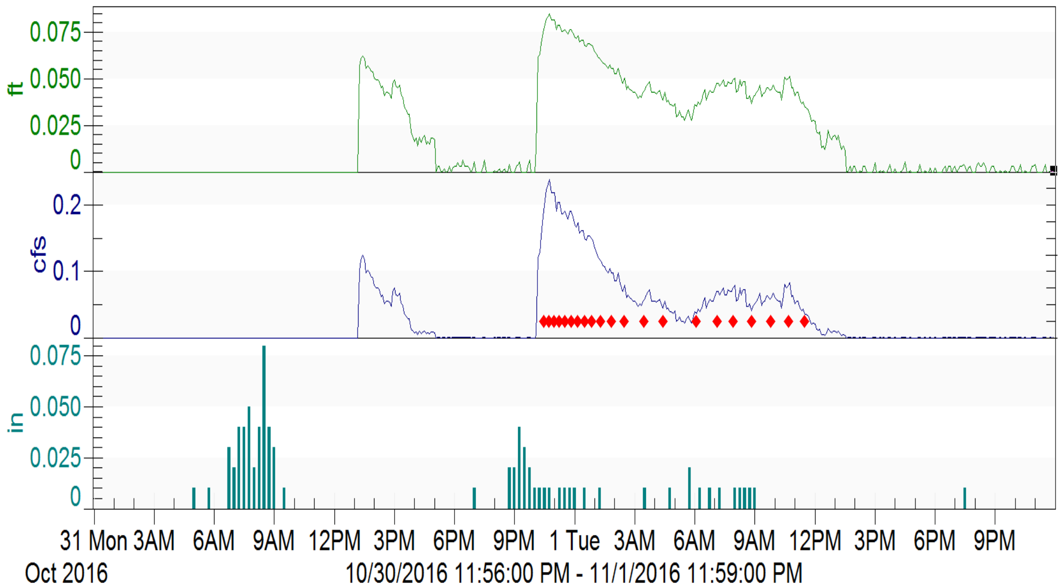


Figure 29. EBI, Storm 5.

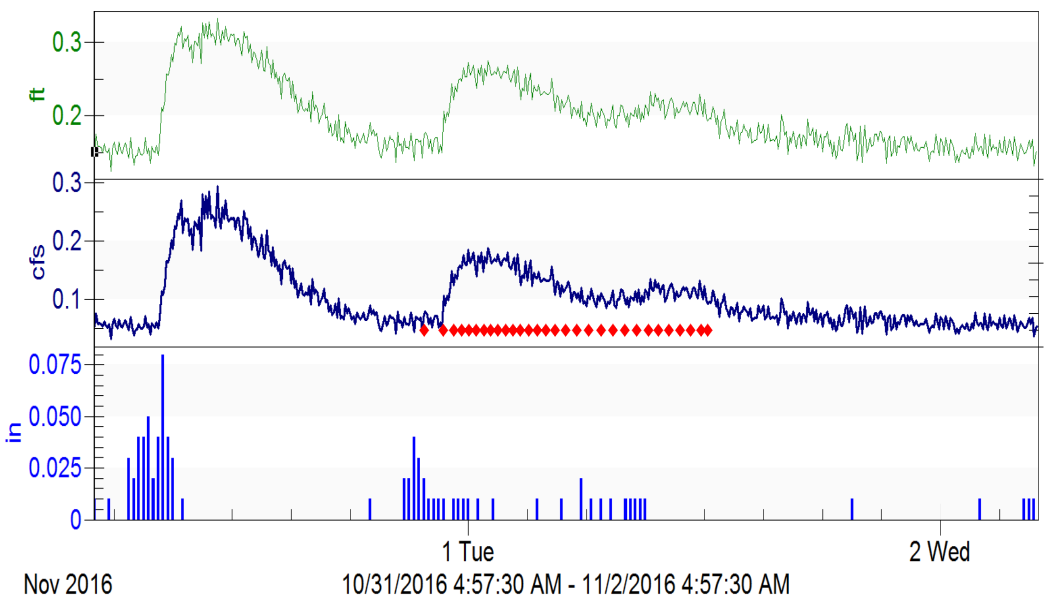


Figure 30. EBO, Storm 5.

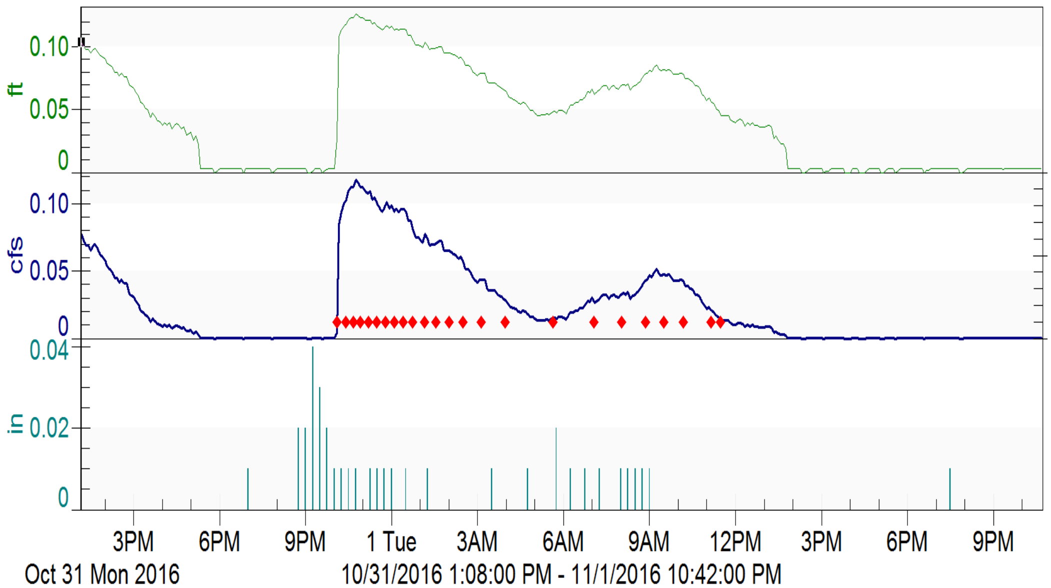


Figure 31. WBI, Storm 5.

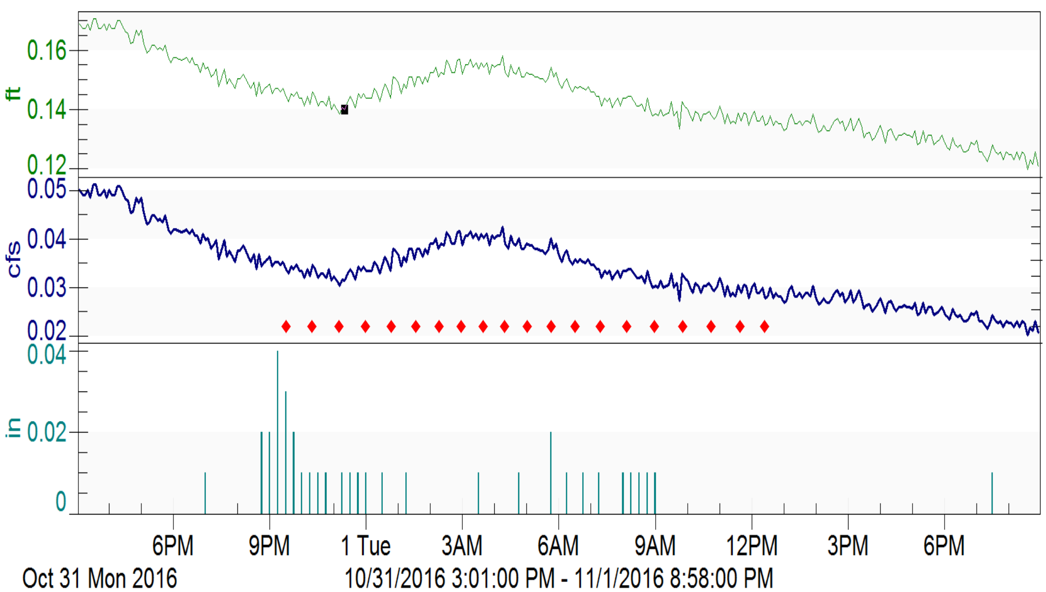


Figure 32. WBO, Storm 5.

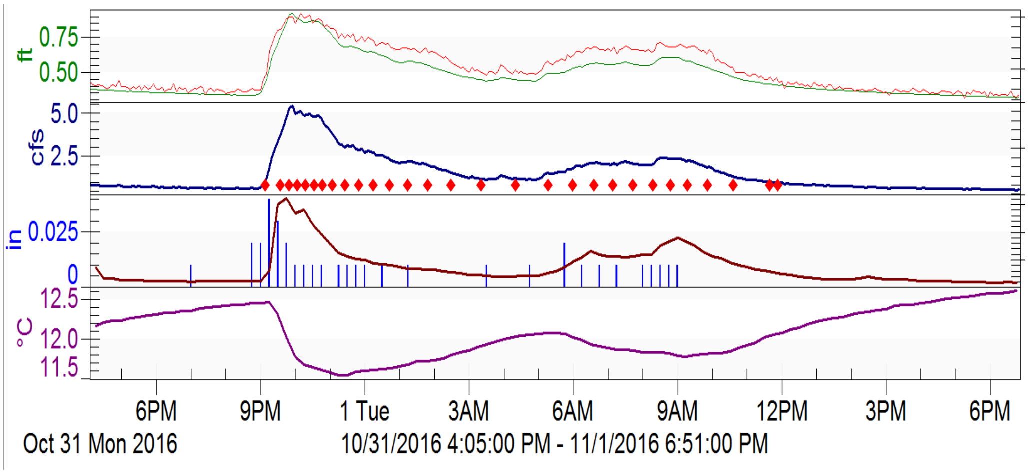


Figure 33. WCI, Storm 5.

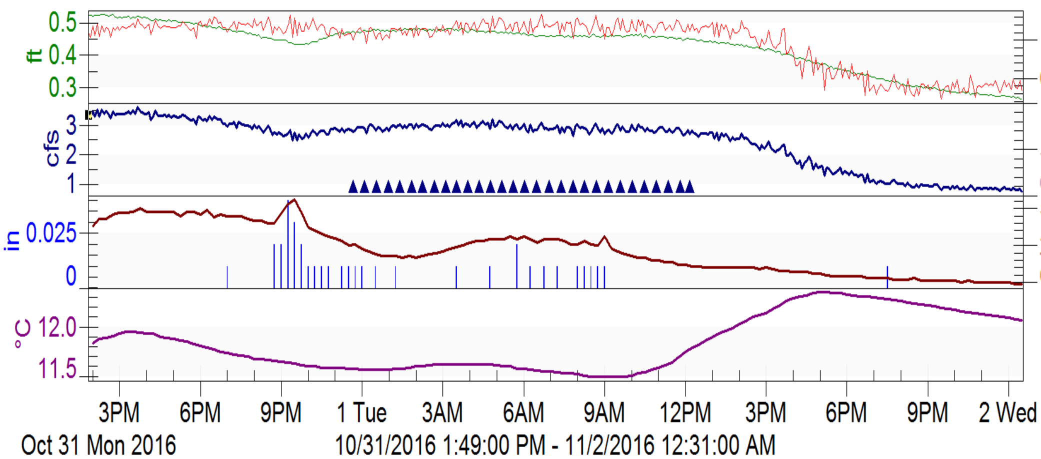


Figure 34. WCEBO, Storm 5.

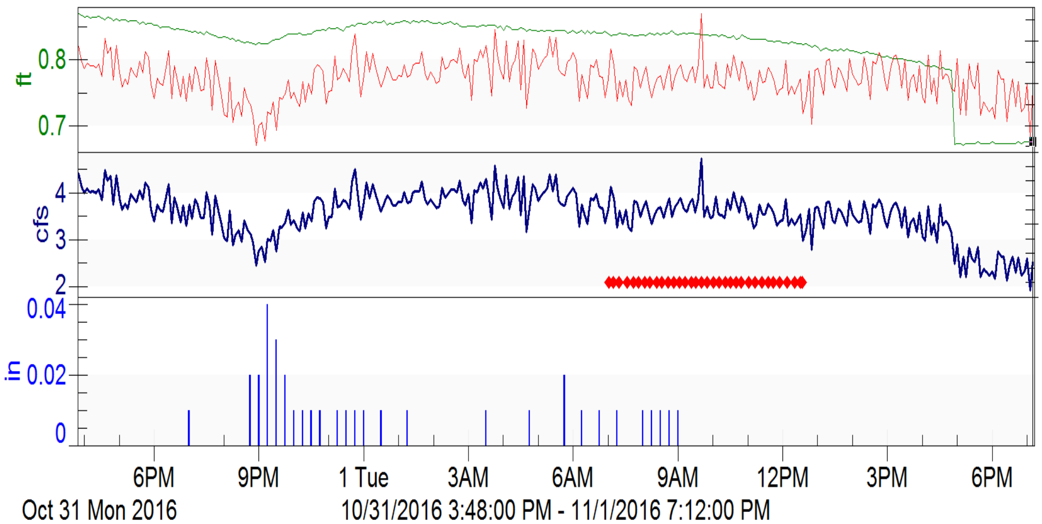


Figure 35. NFWHC, Storm 5.

Precipitation Information	Storm 6
	12/19/2016
Dry antecedent period (hr)	10
Rainfall in 4 days before storm (in)	0.37
Rainfall in 48 hours before storm (in)	0.37
Rainfall in 24 hours before storm (in)	0.37
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.31
Peak rainfall (date, time)	12/19/16 8:30 PM
Rainfall volume in bioretention basin (cf)	25432
Rainfall volume in wetland complex basin (cf)	220109

Sampling Information	Storm 6 - 12/19/2016						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	3587	6606 (a)	2267	(b)	106249	144624	285526
Start of flow (hhmm)	2130	2150	2145	(b)	1942	2055	2015
Average flow rate for entire storm (cfs)	0.098	0.07	0.062	(b)	0.938	0.954	1.624
Duration of flow (hr)	10.2	26.2	10.2	(b)	31.5	42.1	48.8
Runoff first 24 hrs of event (start at time of first sample) (cf)	3592	6134	2267	(b)	96797	117028	202140
Runoff volume sampled (cf)	3131	5468	1955	(b)	79352	77649	136812
% of runoff volume sampled	87.17	89.14	86.24	(b)	81.98	66.35	67.68
Average flow rate during sampling interval (cfs)	0.104	0.126	0.073	(b)	1.656	1.743	2.759
Peak of hydrograph captured?	yes	yes	yes	no	yes	yes	yes
Number of aliquots collected	8	12	9	36	14	11	13
Peak flow rate (cfs)	0.29	0.31 (a)	0.13	(b)	4.25	2.24	3.51
Peak hydrograph (date, time)	12/19/2016 11:45:00 PM	12/20/2016 1:20:00 AM	12/19/2016 11:40:00 PM	12/20/2016 4:40:00 AM	12/19/2016 10:20:00 PM	12/20/2016 5:25:00 AM	12/20/2016 3:55:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	3:15	4:50	3:10	8:10	1:50	8:55	7:25

(a) Flow meter likely clogged, cleared at 0300. Spike is likely not accurate; peak flow rate estimated.

(b) Flow meter clogged and reading abnormally high; flow data from this site for this storm are unreliable. Because meter was reading high, aliquots were all collected in a short period of time (~2 hrs).

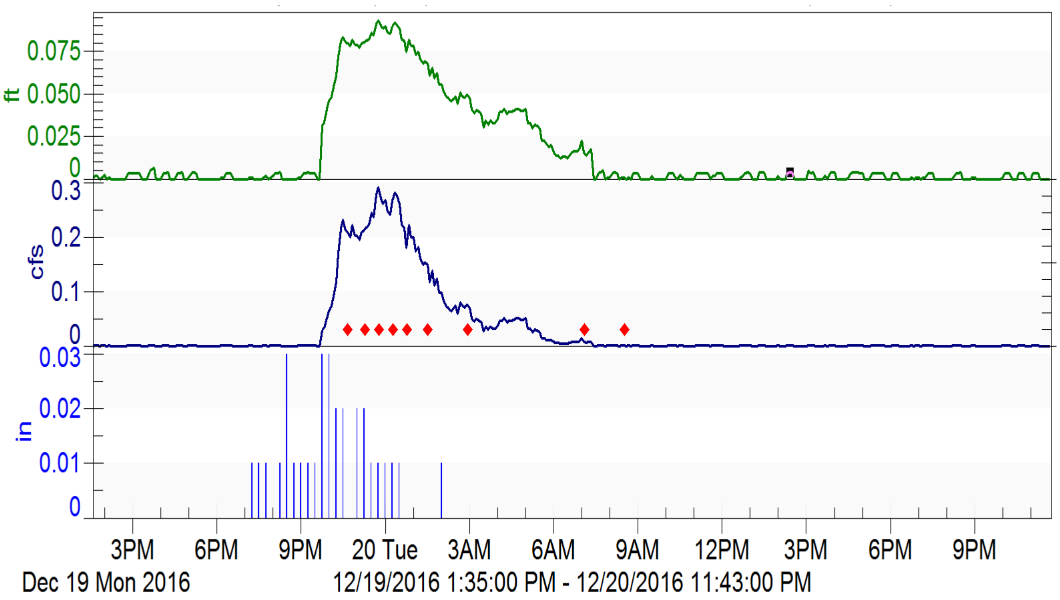


Figure 36. EBI, Storm 6.

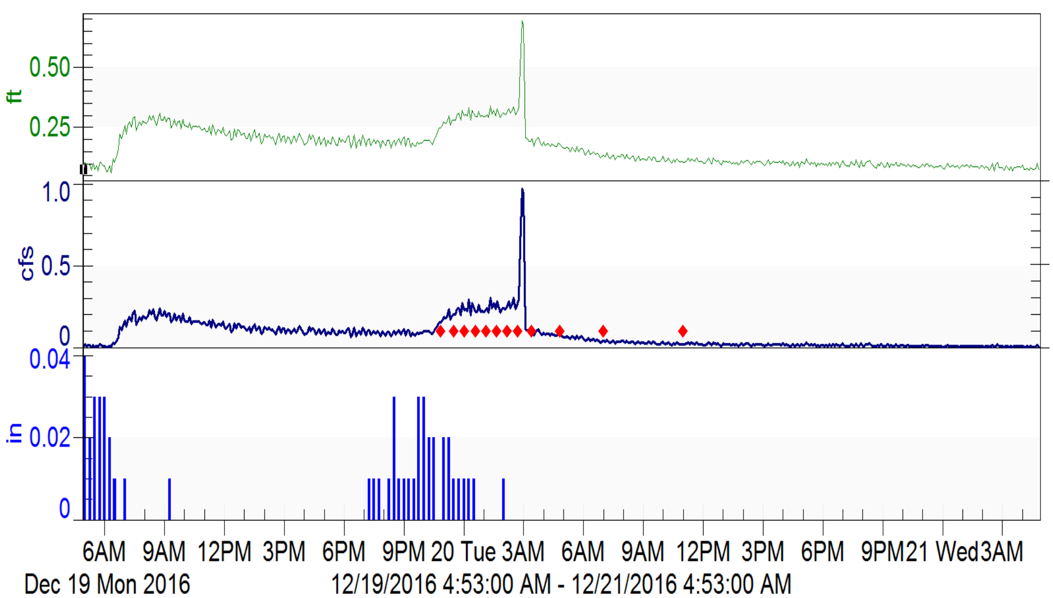


Figure 37. EBO, Storm 6.

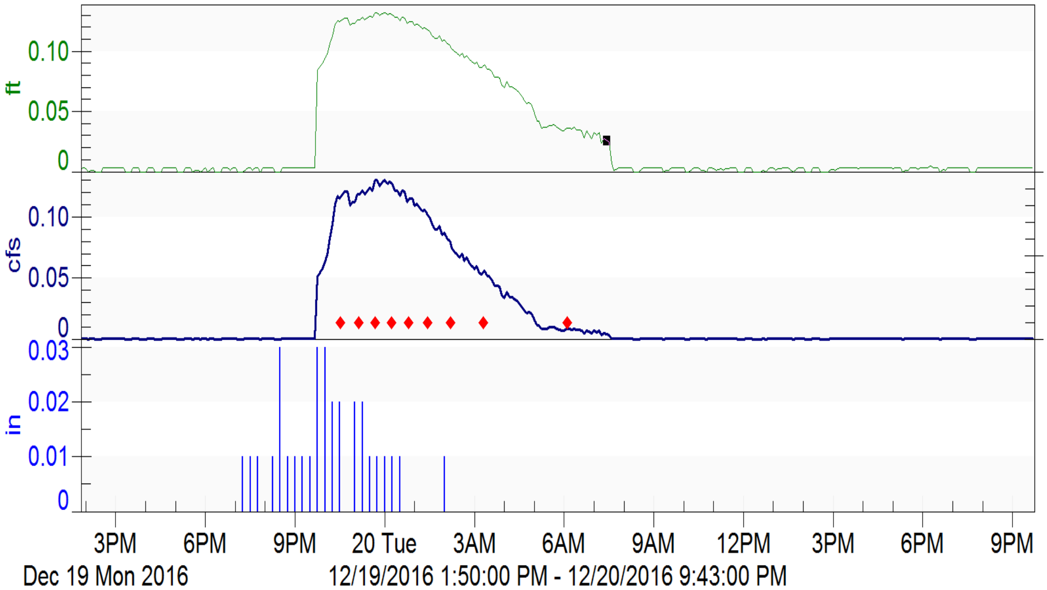


Figure 38. WBI, Storm 6.

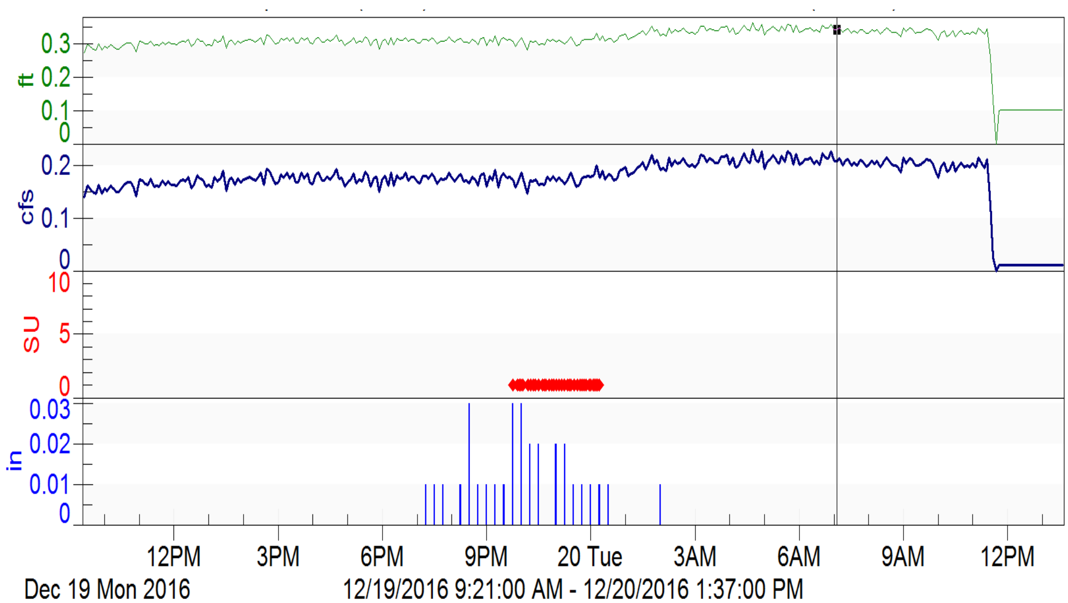


Figure 39. WBO, Storm 6.

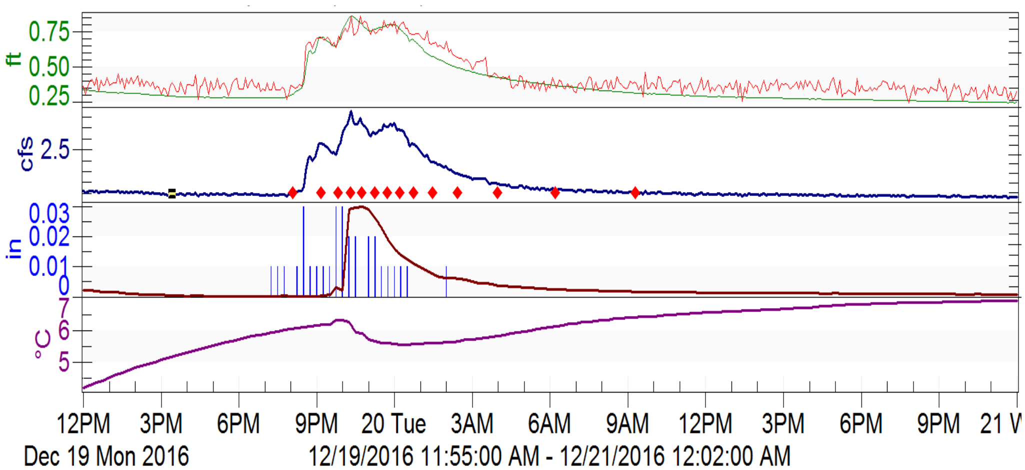


Figure 40. **WCI, Storm 6.**

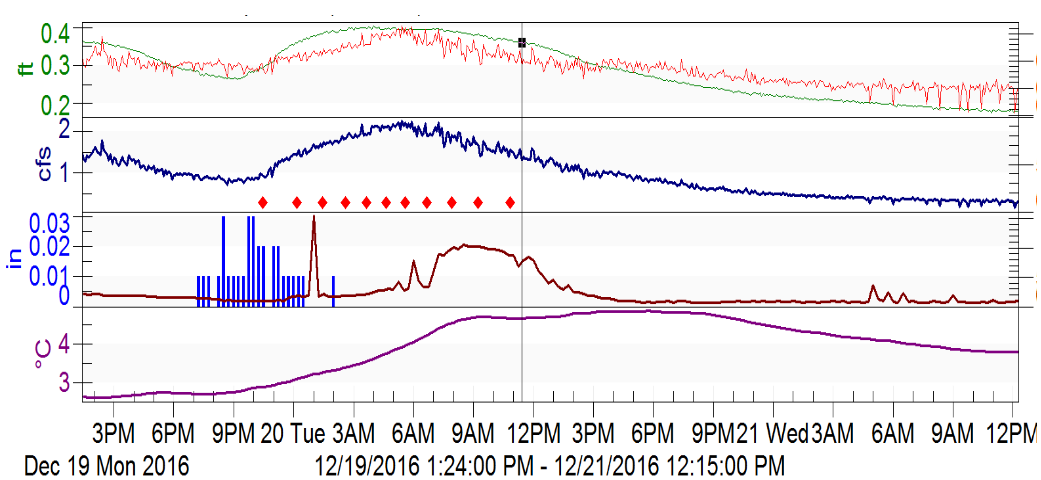


Figure 41. **WCEBO, Storm 6.**

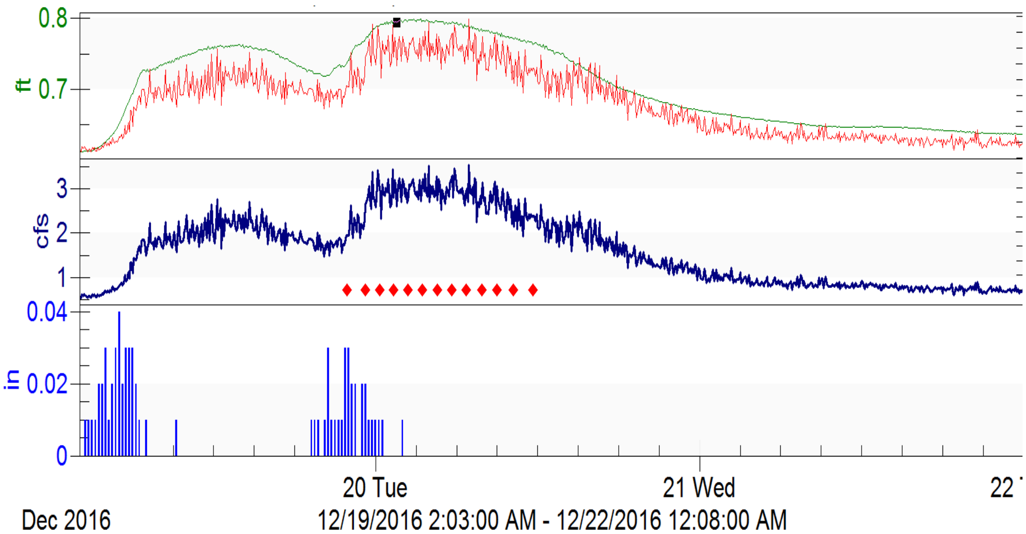


Figure 42. NFWHC, Storm 6.

Precipitation Information	Storm 7 1/17/2017
Dry antecedent period (hr)	161.5
Rainfall in 4 days before storm (in)	0
Rainfall in 48 hours before storm (in)	0
Rainfall in 24 hours before storm (in)	0
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	2.08
Peak rainfall (date, time)	12/19/16 8:30 PM
Rainfall volume in bioretention basin (cf)	170639
Rainfall volume in wetland complex basin (cf)	1476858

Sampling Information	Storm 7 - 1/17/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	(a)	27124	21386	14100	628598	882707	1411030
Start of flow (hhmm)	(a)	1525	1425	1605	414	1430	1130
Average flow rate for entire storm (cfs)	(a)	0.23	0.212	0.022	2.697	3.528	5.096
Duration of flow (hr)	(a)	32.8	28.0	178.0	64.7	69.5	76.9
Runoff first 24 hrs of event (start at time of first sample) (cf)	19160 (a)	25639	21215	4635	484854	475048	788049
Runoff volume sampled (cf)	13636 (a)	22820	13932	3245	301152	370453	593546
% of runoff volume sampled	>50% (b)	89.01	65.67	70.01	62.11	77.98	75.32
Average flow rate during sampling interval (cfs)	0.823	0.343	0.3	0.048	6.594	5.167	8.462
Peak of hydrograph captured?	yes	yes	yes	no	yes	yes	no
Number of aliquots collected	20	28	36	34	36	36	36
Peak flow rate (cfs)	1.1 (c)	0.53	0.45	0.06	10.8	7.46	14.18
Peak hydrograph (date, time)	see WBI (c)	1/17/2017 9:35:00 PM	1/17/2017 8:40:00 PM	1/18/2017 12:35:00 PM	1/17/2017 8:45:00 PM	1/18/2017 12:00:00 PM	1/18/2017 11:50:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	~5:55 (c)	6:50	5:55	21:50	6:00	21:15	21:05

(a) Flow meter malfunctioned at 21:35 and stopped sampling. No flow data after 21:35.

(b) Based on flow at WBI, it appears samples were collected over an interval that inlcuded the peak flow and more than 50% of the storm volume.

(c) Assumed peaks at WBI and EBI were at similar times; if so, peak at EBI was recorded before meter malfunctioned.

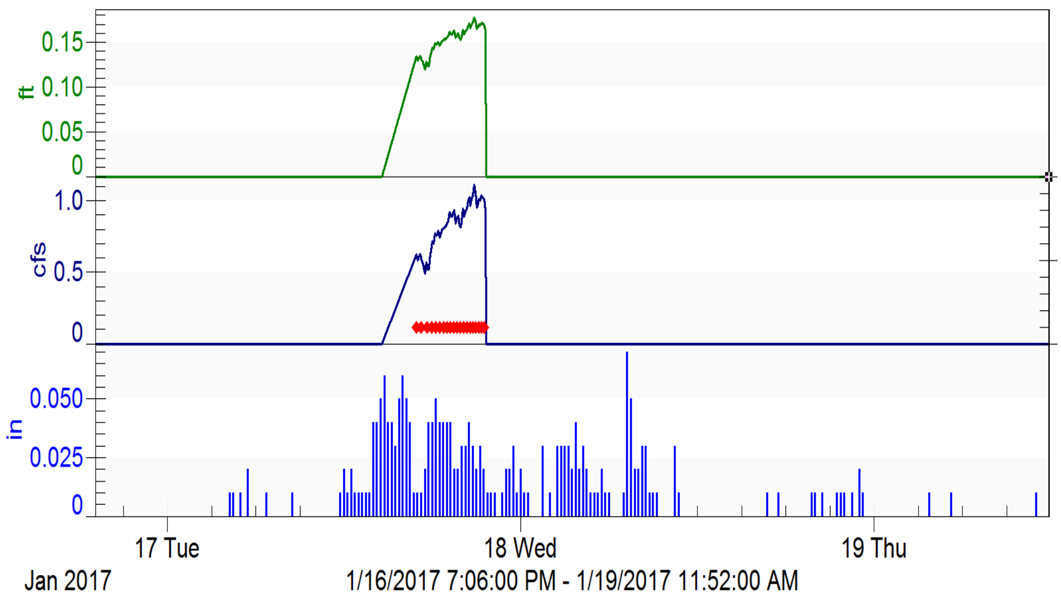


Figure 43. EBI, Storm 7.

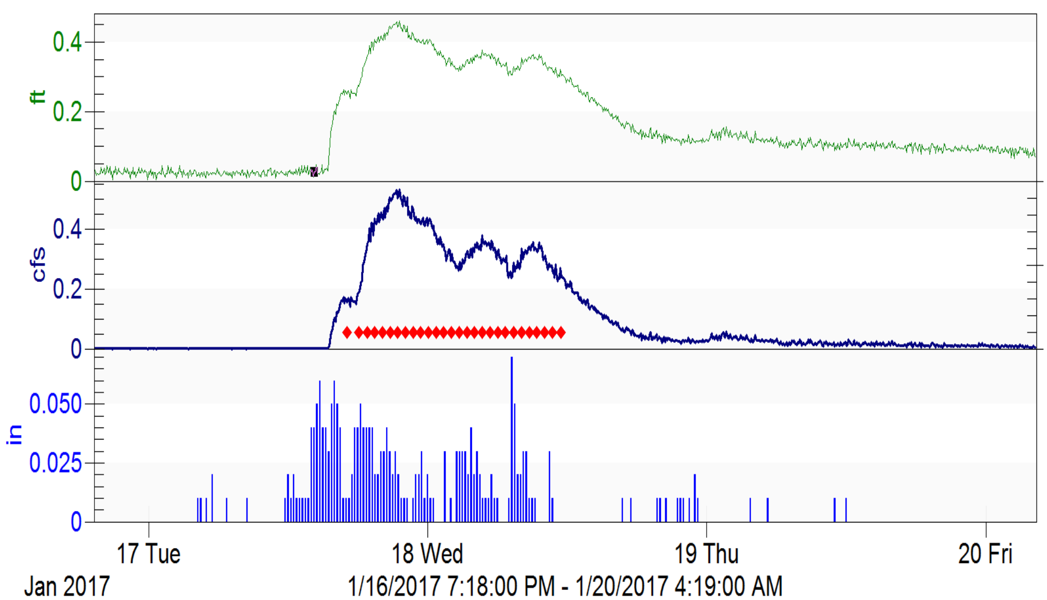


Figure 44. EBO, Storm 7.

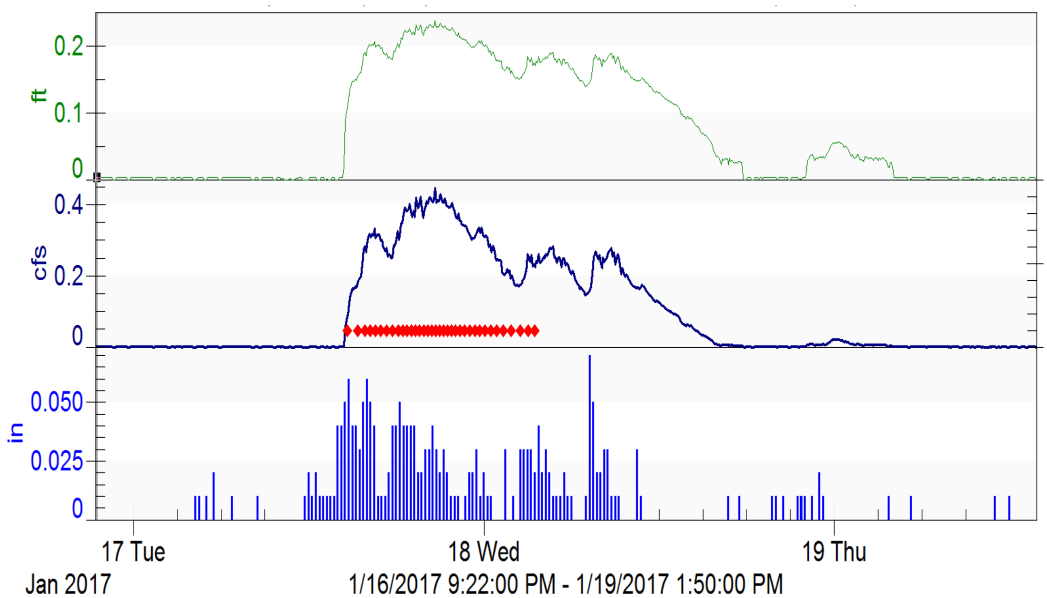


Figure 45. WBI, Storm 7.

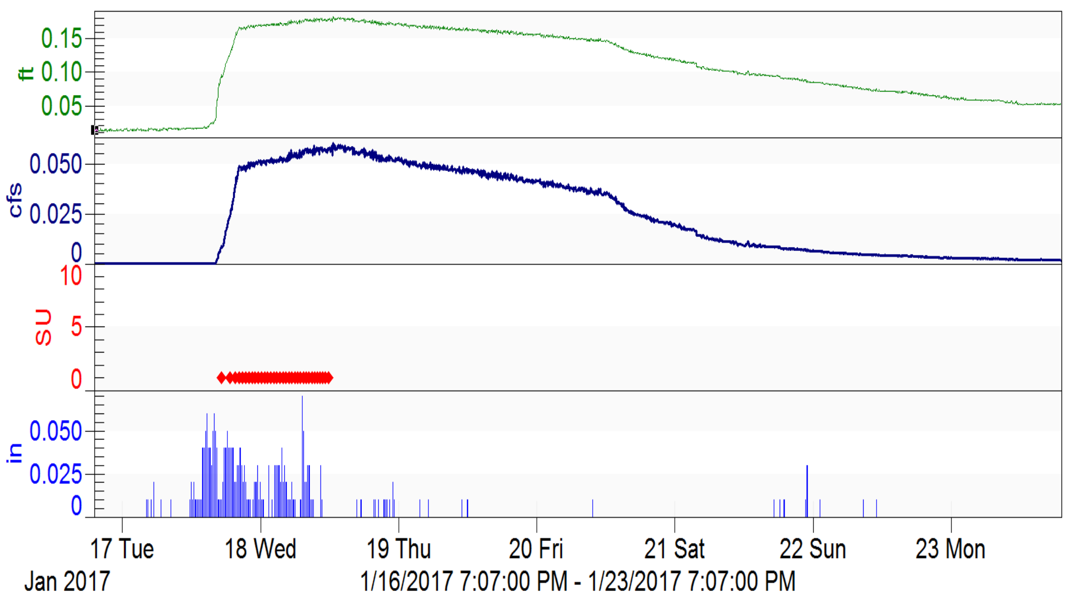


Figure 46. WBO, Storm 7.

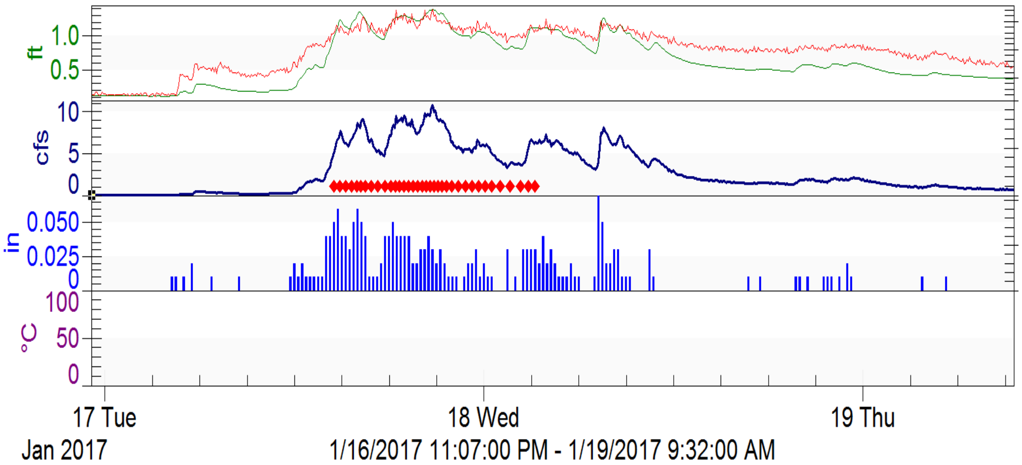


Figure 47. WCI, Storm 7.

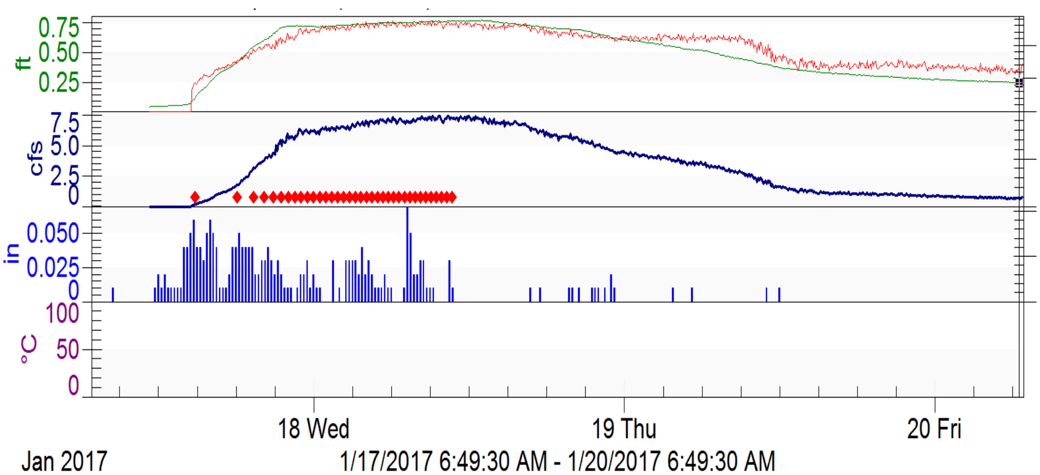


Figure 48. WCEBO, Storm 7.

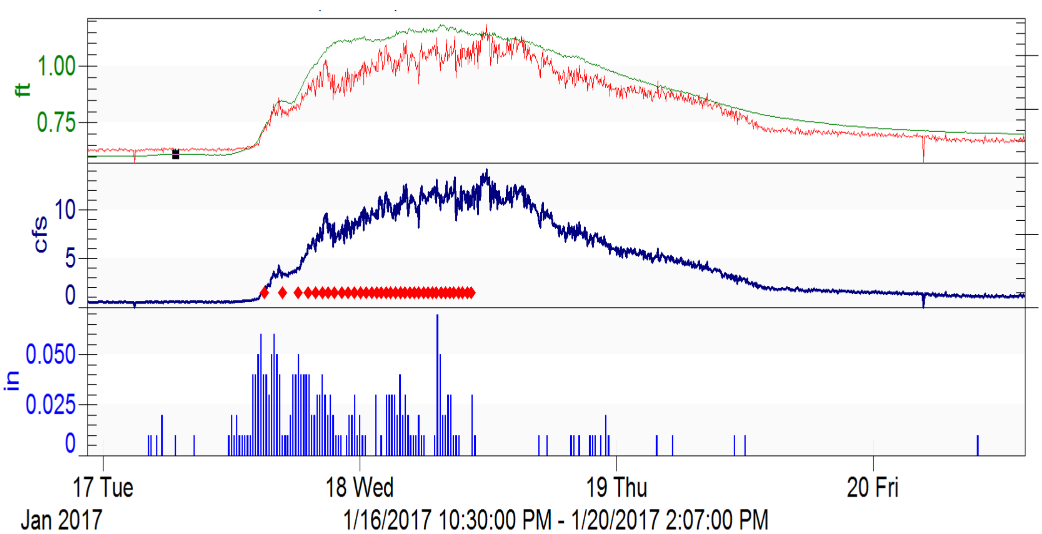


Figure 49. NFWHC, Storm 7.

Precipitation Information	Storm 8 2/8/2017
Dry antecedent period (hr)	12
Rainfall in 4 days before storm (in)	2.22
Rainfall in 48 hours before storm (in)	0.87
Rainfall in 24 hours before storm (in)	0.4
Rainfall in 6 hours before storm (in)	0.01
Rainfall during storm (in)	1.68
Peak rainfall (date, time)	2/9/17 8:15 AM
Rainfall volume in bioretention basin (cf)	137824
Rainfall volume in wetland complex basin (cf)	1192847

Sampling Information	Storm 8 - 2/8/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	47779	26000~	21404	17791	584197	983970	(b)
Start of flow (hhmm)	1140	(a)	1245	1335	740	1000	(b)
Average flow rate for entire storm (cfs)	0.387	(a)	0.177	0.032	2.929	3.582	(b)
Duration of flow (hr)	34.3	(a)	33.6	154.4	55.4	76.3	(b)
Runoff first 24 hrs of event (start at time of first sample) (cf)	47778	22151	19362	4372	417244	399415	452202
Runoff volume sampled (cf)	40464	18392	17567	3398	372560	312789	385972
% of runoff volume sampled	84.69	83.03	90.73	77.72	89.29	78.31	85.35
Average flow rate during sampling interval (cfs)	0.529	0.285	0.23	0.048	4.984	4.145	6.057
Peak of hydrograph captured?	yes	yes	yes	yes	yes	no	yes
Number of aliquots collected	33	20	26	24	27	19	15
Peak flow rate (cfs)	1.37	0.54	0.47	0.06	13.53	8.09	12.86
Peak hydrograph (date, time)	2/9/2017 8:20:00 AM	2/9/2017 10:20:00 AM	2/9/2017 9:05:00 AM	2/9/2017 12:45:00 PM	2/9/2017 8:35:00 AM	2/9/2017 3:35:00 PM	2/9/2017 8:55:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	0:05	2:05	0:50	4:30	0:20	7:20	0:40

(a) Flow meter started shortly after rain event had started.

(b) Flow meter became buried by cobble at ~930 and we lost velocity measurements.

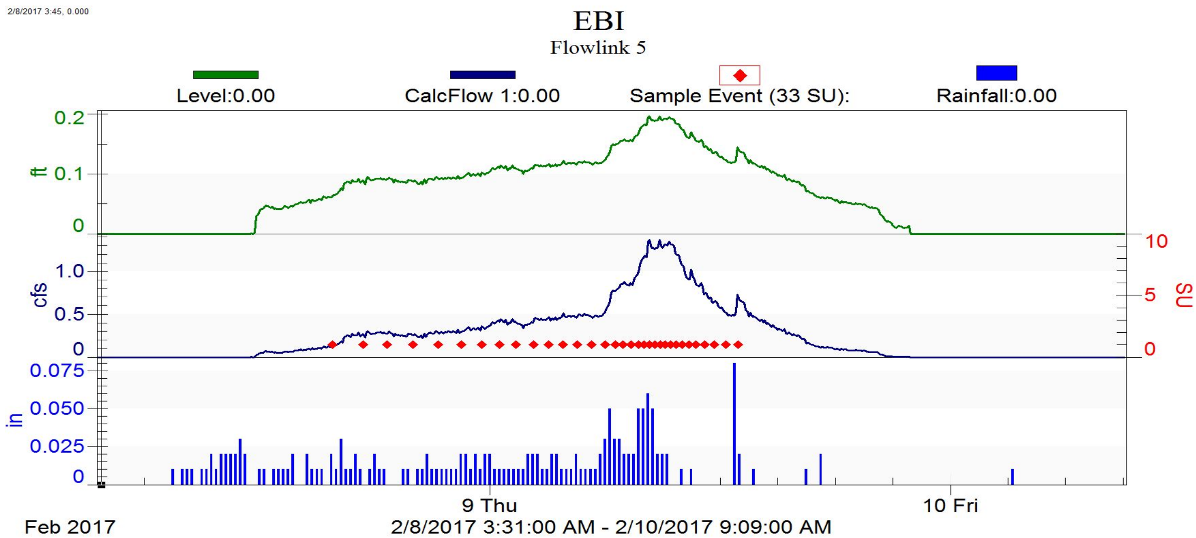


Figure 50. EBI, Storm 8.

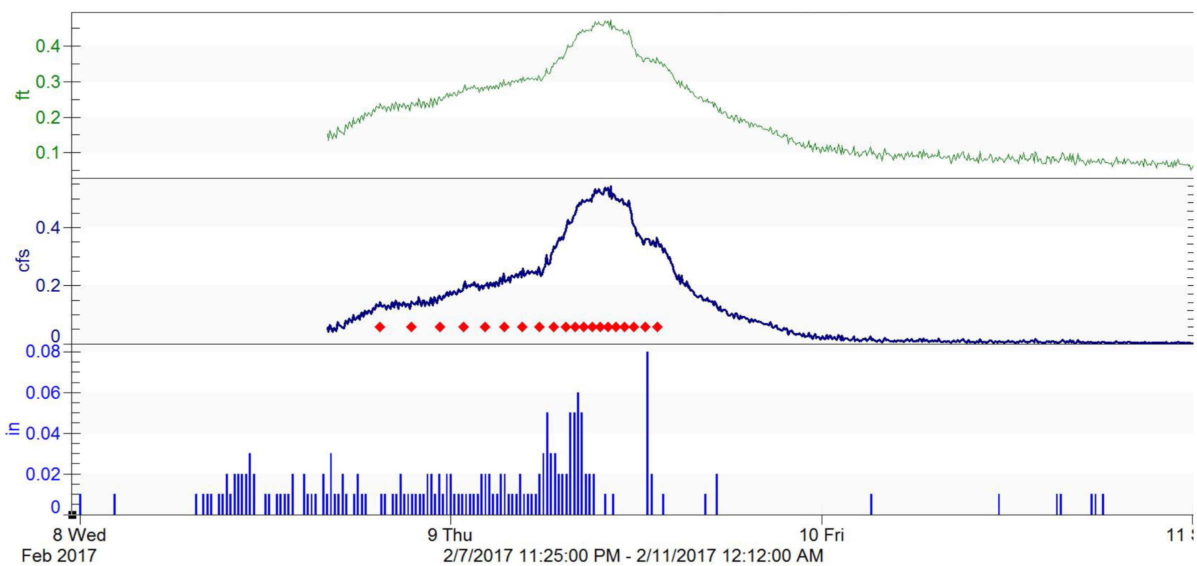


Figure 51. EBO, Storm 8.

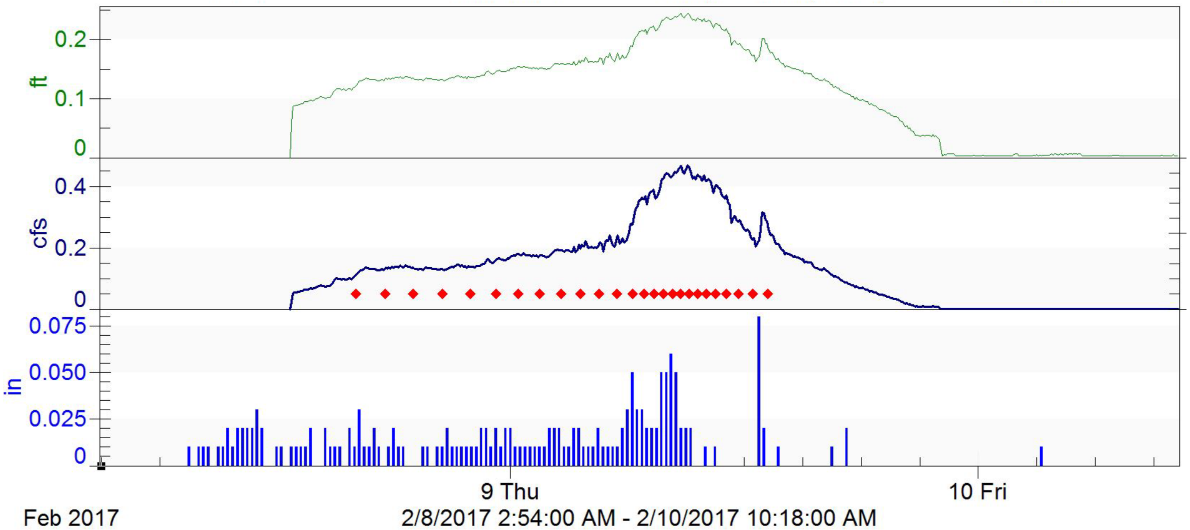


Figure 52. WBI, Storm 8.

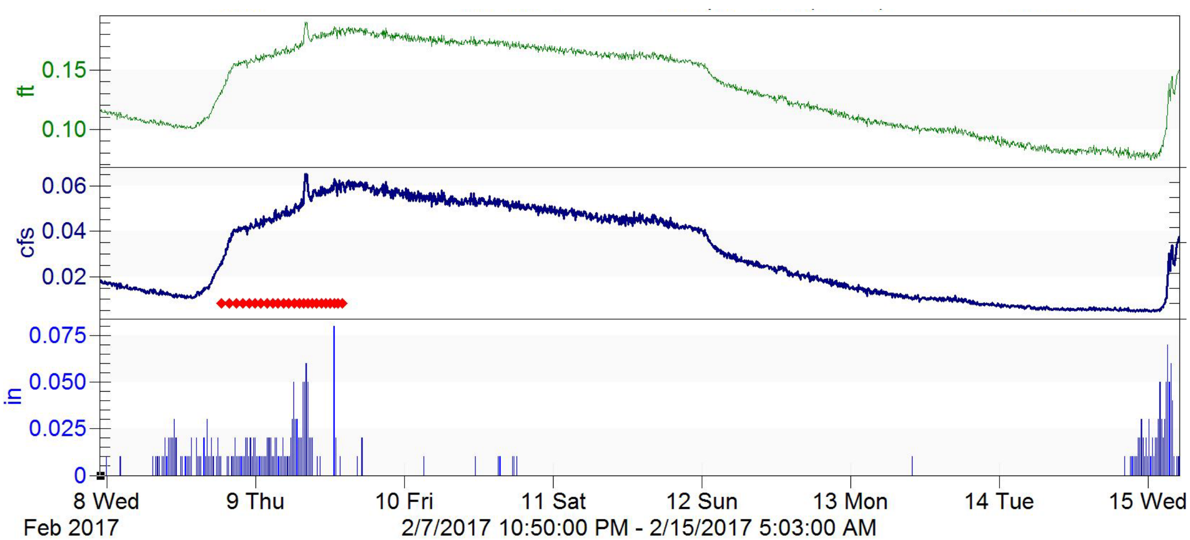


Figure 53. WBO, Storm 8.

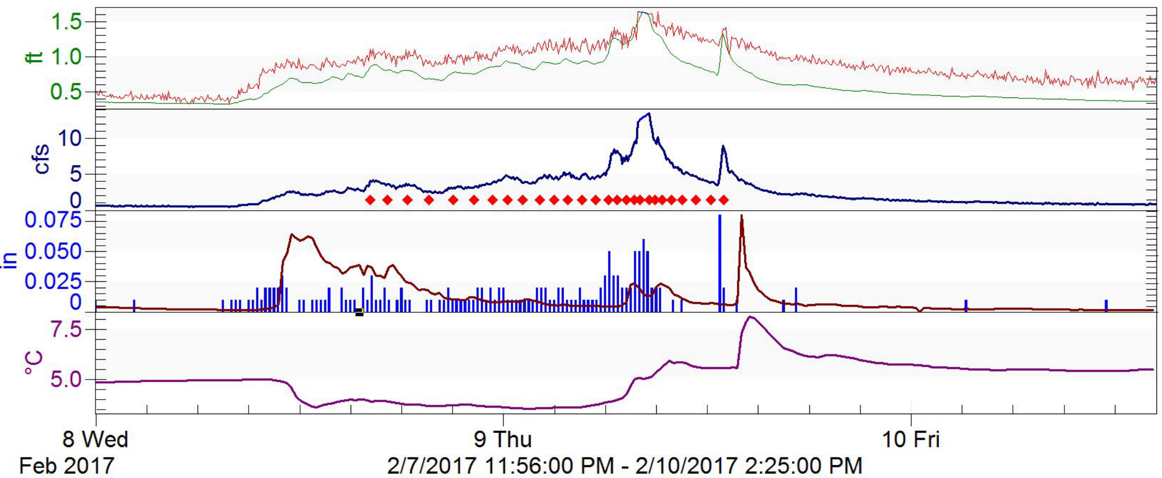


Figure 54. WCI, Storm 8.

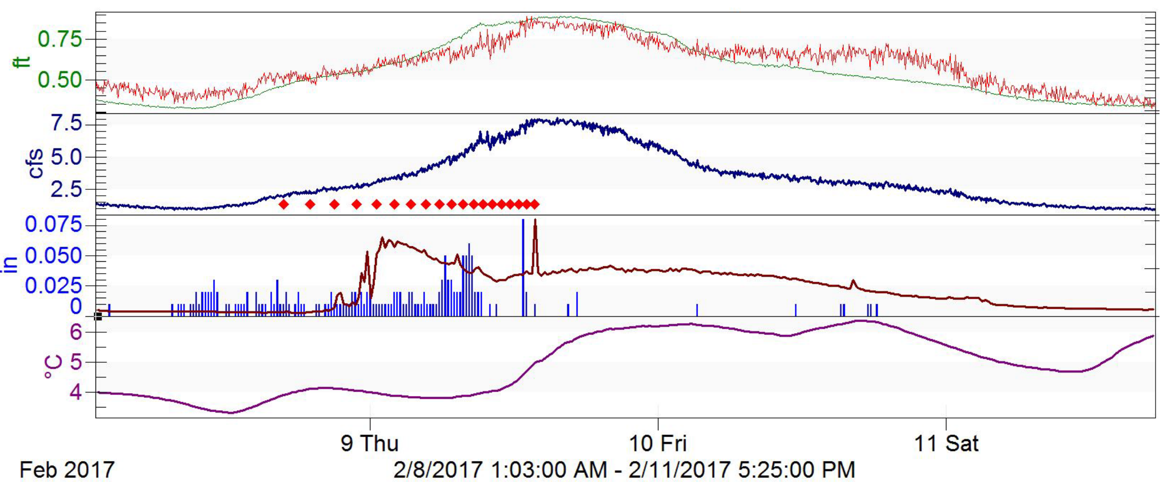


Figure 55. WCEBO, Storm 8.

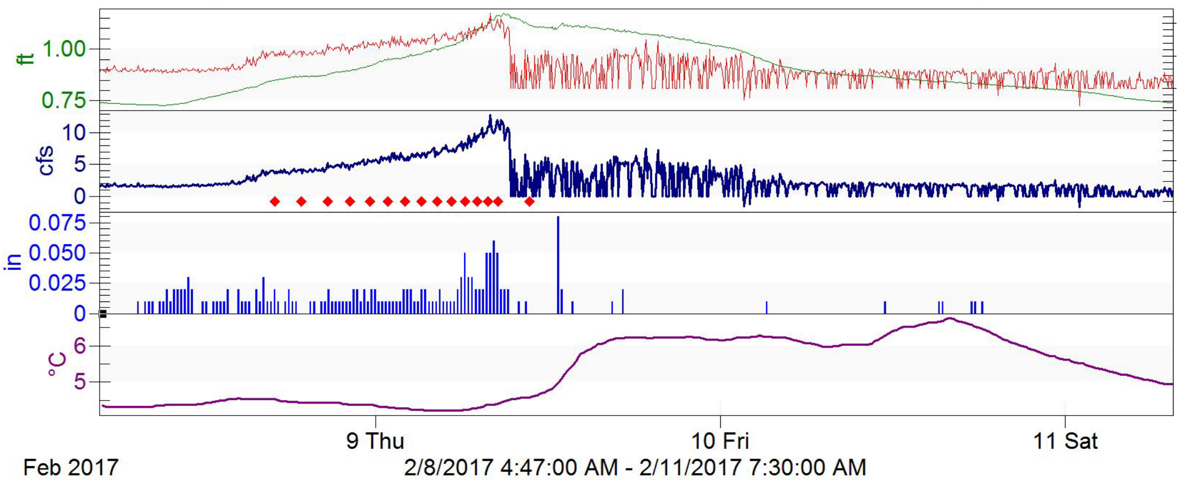


Figure 56. NFWHC, Storm 8.

Precipitation Information	Storm 9 2/15/2017
Dry antecedent period (hr)	98
Rainfall in 4 days before storm (in)	0.01
Rainfall in 48 hours before storm (in)	0.01
Rainfall in 24 hours before storm (in)	0
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	2.38
Peak rainfall (date, time)	2/16/17 5:00 AM
Rainfall volume in bioretention basin (cf)	195250
Rainfall volume in wetland complex basin (cf)	1689867

Sampling Information	Storm 9 - 2/15/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	62077	32689	29678	26109 (a)	(b)	1136490	1740240
Start of flow (hhmm)	2345	110	2355	130 (a)	(b)	2300	2100
Average flow rate for entire storm (cfs)	0.43	0.198	0.206	0.055 (a)	(b)	5.374	6.866
Duration of flow (hr)	40.1	45.9	40.0	131.9 (a)	(b)	58.7	70.4
Runoff first 24 hrs of event (start at time of first sample) (cf)	41627	20489	19536	5771	392030	493341	869002
Runoff volume sampled (cf)	27946	19980	15458	4472	329300	402278	654610
% of runoff volume sampled	67.13	97.52	79.13	77.49	84.00	81.54	75.33
Average flow rate during sampling interval (cfs)	0.369	0.235	0.195	0.063	4.675	5.191	8.54
Peak of hydrograph captured?	no	yes	no	no	no	no	no
Number of aliquots collected	36	31	36	36	36	36	36
Peak flow rate (cfs)	2.23	0.64	0.98	0.07	19.85	11.54	27.61
Peak hydrograph (date, time)	2/16/2017 5:05:00 AM	2/16/2017 6:40:00 AM	2/16/2017 5:05:00 AM	2/16/2017 6:45:00 AM	2/16/2017 5:00:00 AM	2/16/2017 8:20:00 AM	2/16/2017 5:20:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	0:05	1:40	0:05	1:45	0:00	3:20	0:20

(a) Flow rates questionable; spikes likely due to backflow in catch basin and high levels after storm may be due to bubbler line clogging. Confirmatory sample collected on 2/16/17 to assess if back flow may have affected chemical concentrations in composite sample.

(b) Flow meter malfunctioned during high flow @ 0450. Later discovered large chunk of concrete was blocking velocity meter sensor. All samples had been collected prior to malfunction.

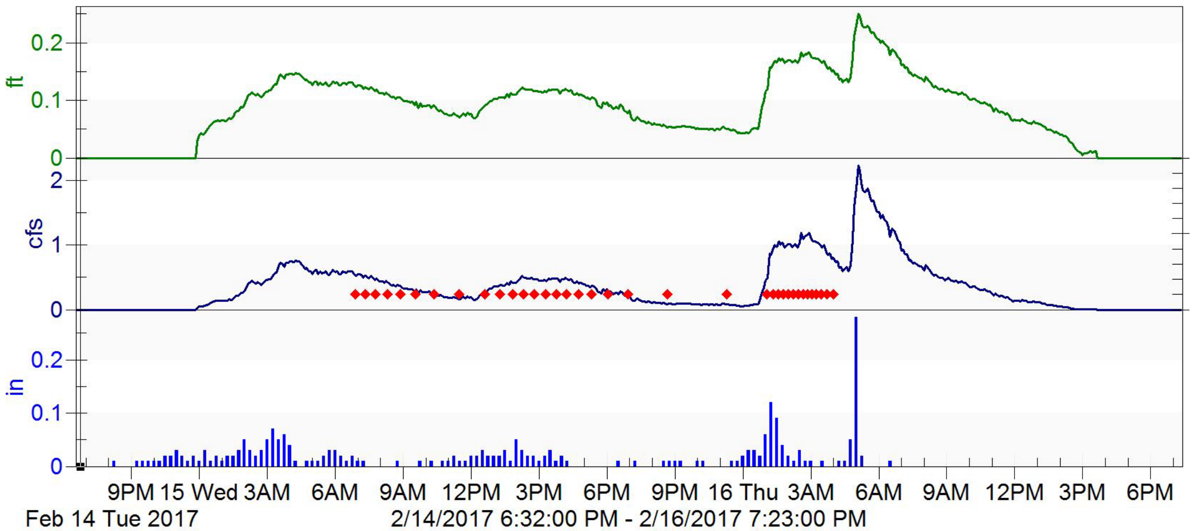


Figure 57. EBI, Storm 9.

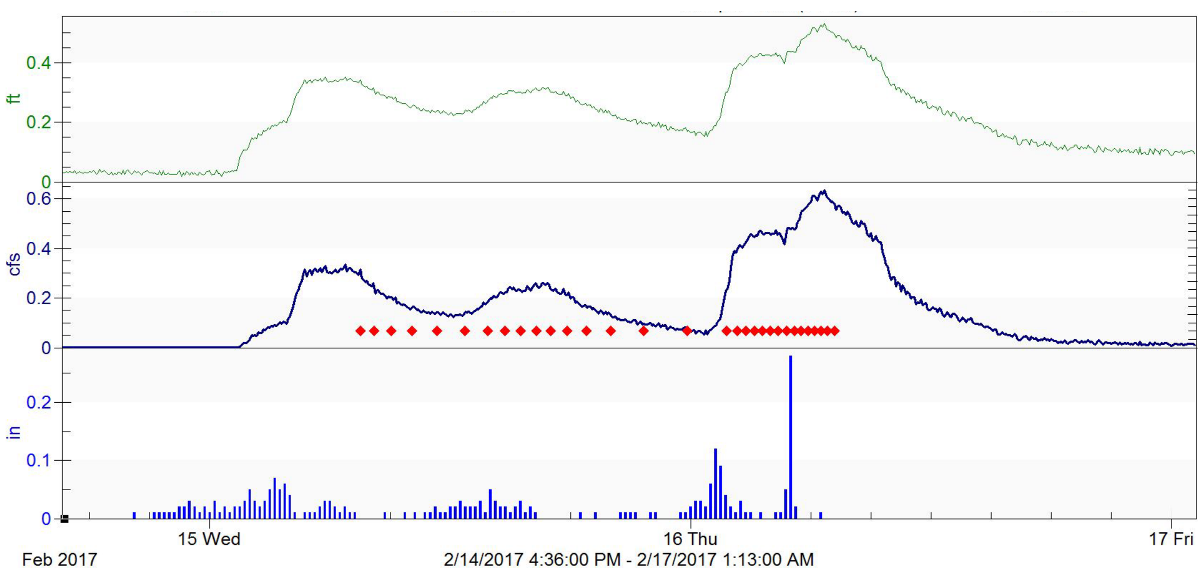


Figure 58. EBO, Storm 9.

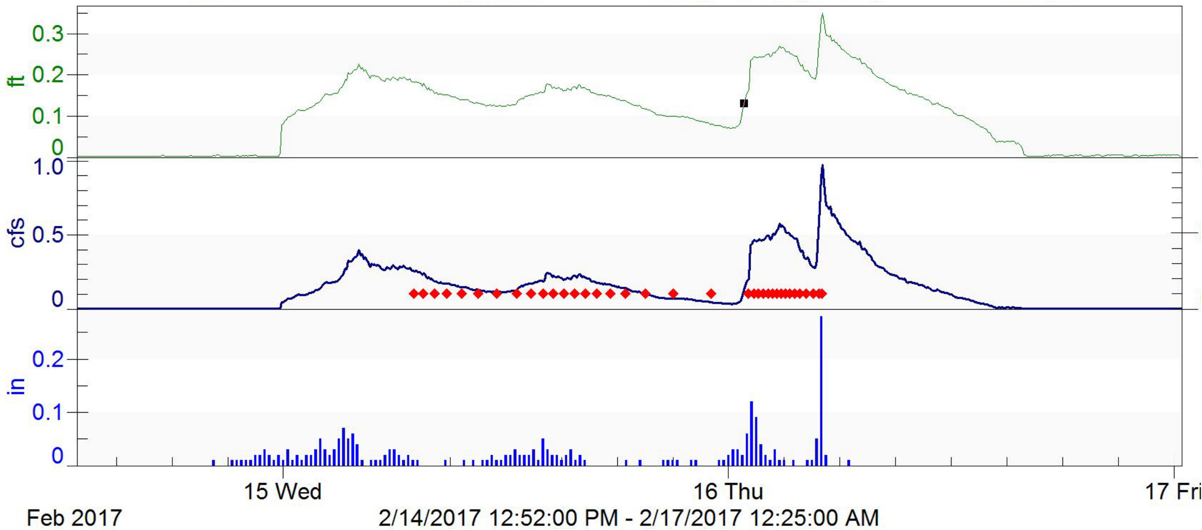


Figure 59. WBI, Storm 9.

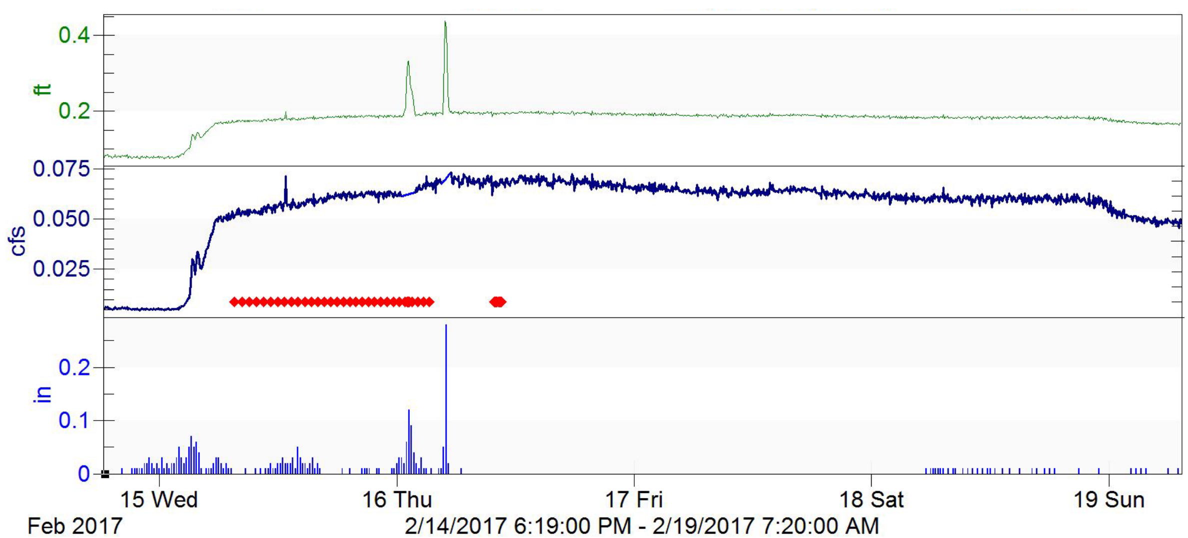


Figure 60. WBO, Storm 9.

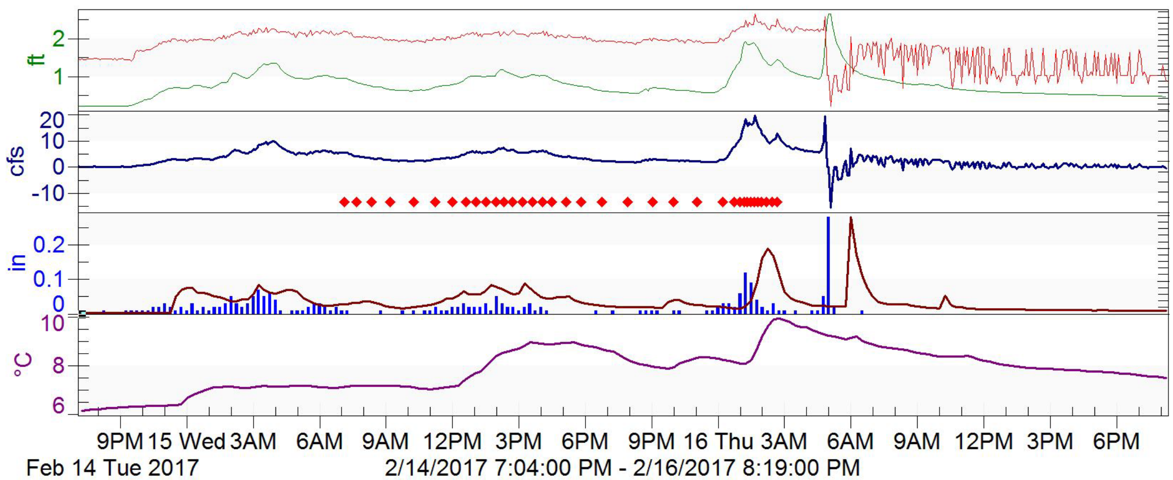


Figure 61. WCI, Storm 9.

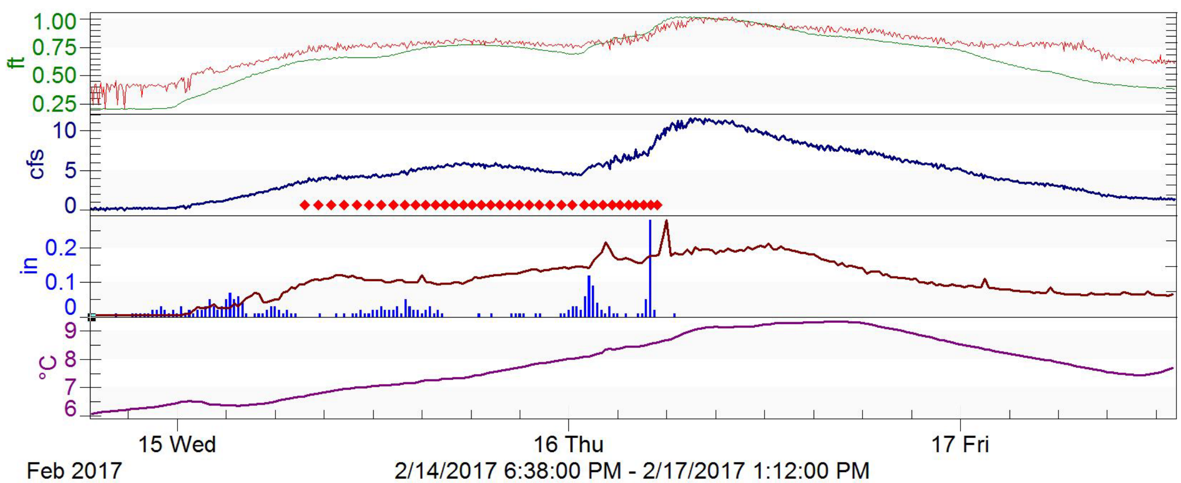


Figure 62. WCEBO, Storm 9.

Figure 63. NFWHC, Storm 9.

Precipitation Information	Storm 10 3/7/2017
Dry antecedent period (hr)	10.75
Rainfall in 4 days before storm (in)	0.58
Rainfall in 48 hours before storm (in)	0.24
Rainfall in 24 hours before storm (in)	0.22
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.72
Peak rainfall (date, time)	3/7/17 4:15 PM
Rainfall volume in bioretention basin (cf)	59067
Rainfall volume in wetland complex basin (cf)	511220

Sampling Information	Storm 10 - 3/7/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	12197	8278	6492	(a)	199635	284633	303841
Start of flow (hhmm)	625	647	630	(a)	110	630	435
Average flow rate for entire storm (cfs)	0.16	0.063	0.084	(a)	1.473	1.762	1.829
Duration of flow (hr)	21.2	36.5	21.5	(a)	37.6	44.9	46.1
Runoff first 24 hrs of event (start at time of first sample) (cf)	12197	7513	6295	(a)	170594	186477	185229
Runoff volume sampled (cf)	10299	7353	5637	(a)	156980	168959	168972
% of runoff volume sampled	84.44	97.87	89.55	(a)	92.02	90.61	91.22
Average flow rate during sampling interval (cfs)	0.229	0.096	0.118	(a)	2.374	2.161	2.172
Peak of hydrograph captured?	yes	yes	yes	no	yes	yes	yes
Number of aliquots collected	36	24	36	36	36	33	20
Peak flow rate (cfs)	0.45	0.2	0.18	(a)	5.16	2.89	3.21
Peak hydrograph (date, time)	3/7/2017 5:05:00 PM	3/7/2017 5:50:00 PM	3/7/2017 5:00:00 PM	3/7/2017 7:45:00 PM	3/7/2017 4:50:00 PM	3/7/2017 8:00:00 PM	3/7/2017 6:40:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	0:50	1:35	0:45	3:30	0:35	3:45	2:25

(a) Flow meter clogged and reading high; flow data not usable.

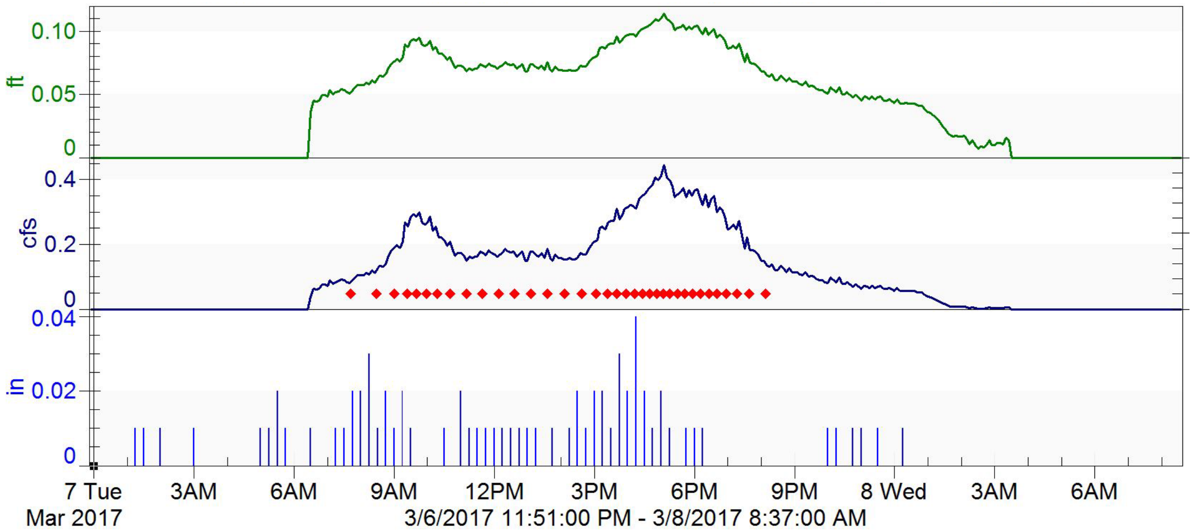


Figure 64. EBI, Storm 10.

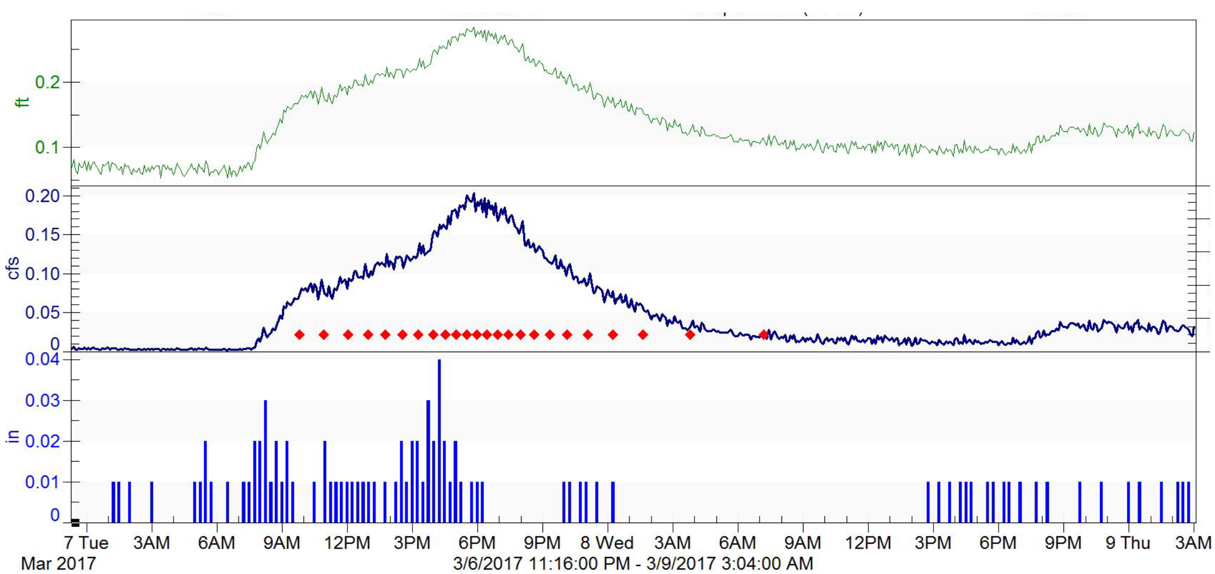


Figure 65. EBO, Storm 10.

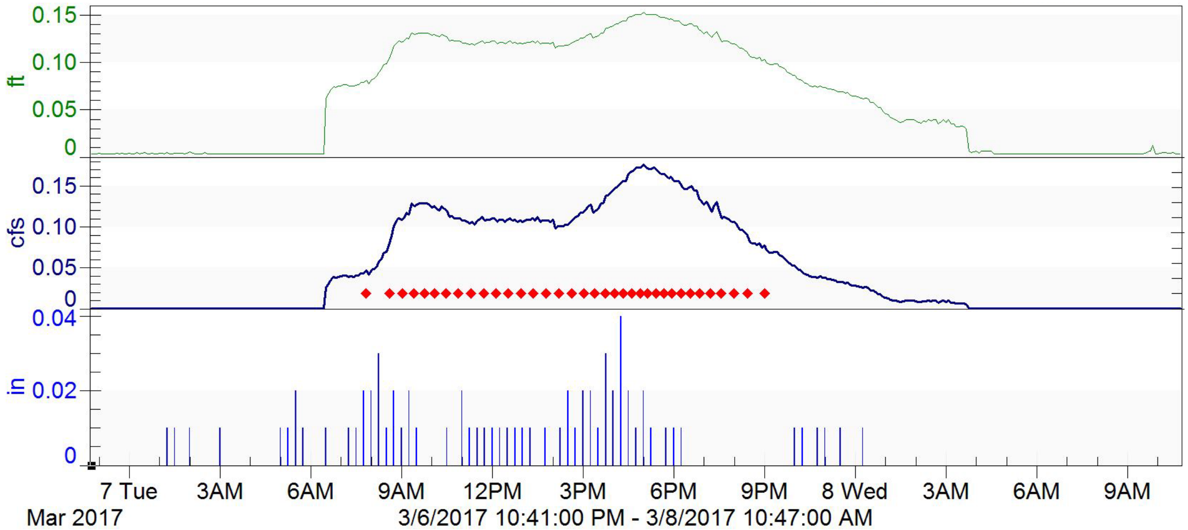


Figure 66. WBI, Storm 10.

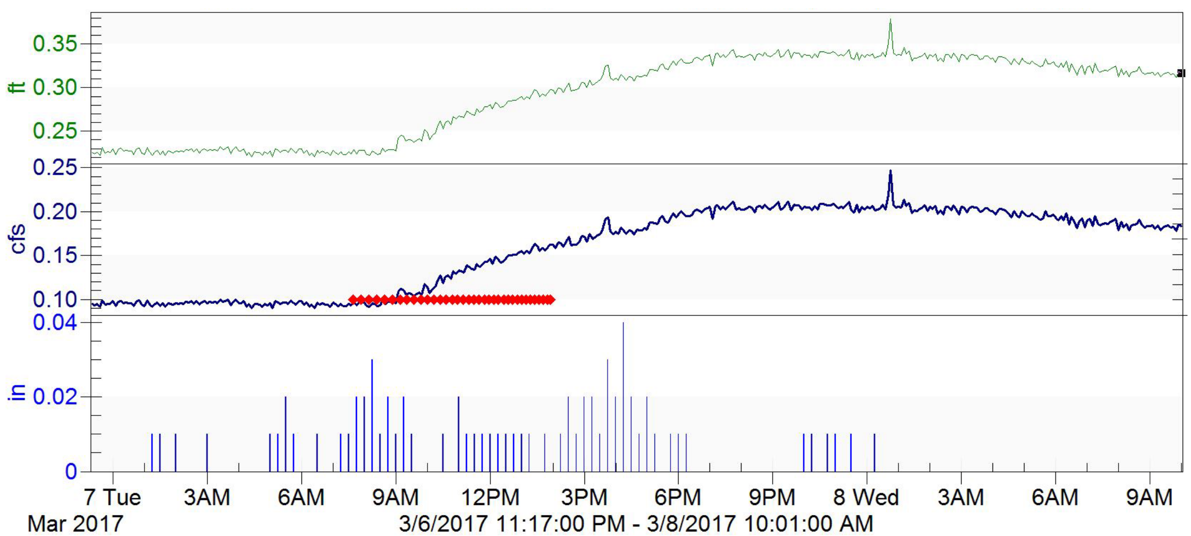


Figure 67. WBO, Storm 10.

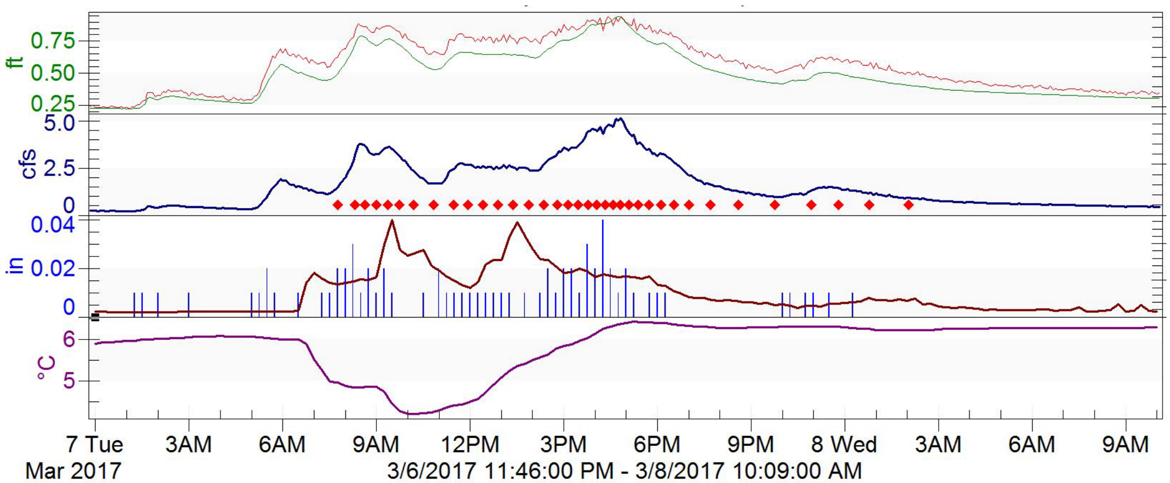


Figure 68. WCI, Storm 10.

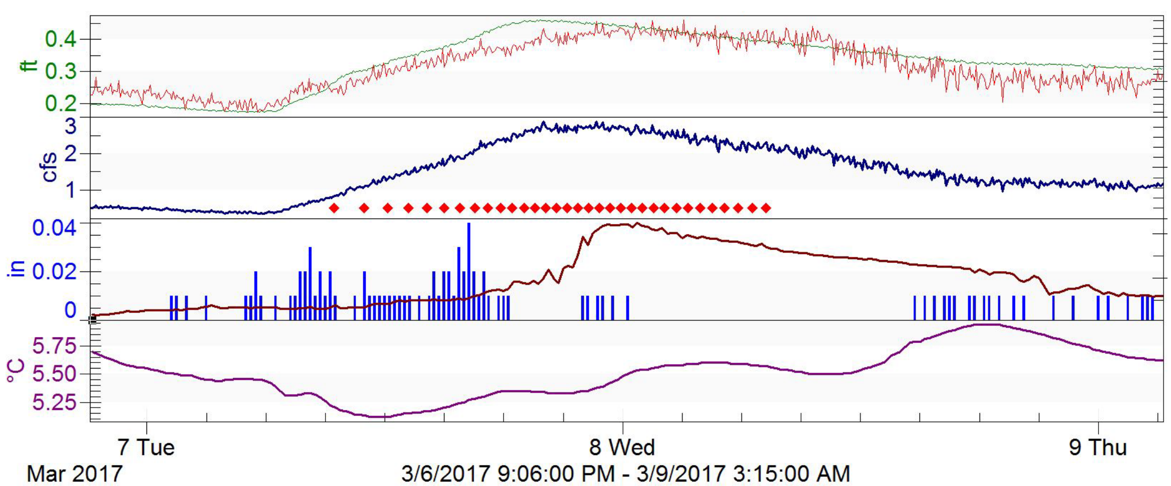


Figure 69. WCEBO, Storm 10.

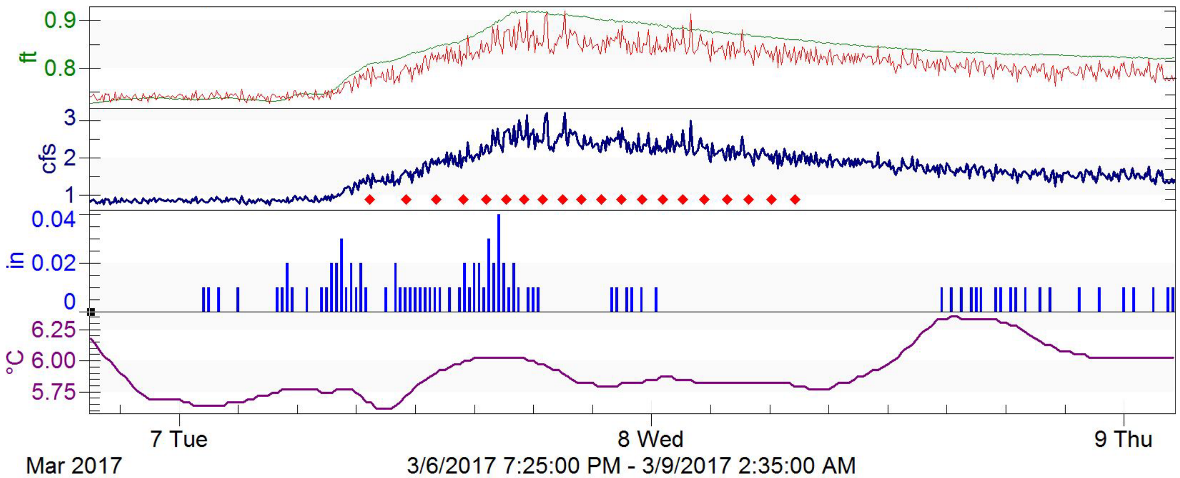


Figure 70. NFWHC, Storm 10.

Precipitation Information	Storm 11 3/9/2017
Dry antecedent period (hr)	14.5
Rainfall in 4 days before storm (in)	0.98
Rainfall in 48 hours before storm (in)	0.84
Rainfall in 24 hours before storm (in)	0.3
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	1.01
Peak rainfall (date, time)	3/9/17 6:00 PM
Rainfall volume in bioretention basin (cf)	82858
Rainfall volume in wetland complex basin (cf)	717128

Sampling Information	Storm 11 - 3/9/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	19162	13010	9017	5388 (a)	255706	380238	377637
Start of flow (hhmm)	1735	1900	1745	555	925	1000	1000
Average flow rate for entire storm (cfs)	0.137	0.066	0.064	0.028	1.486	2.214	2.247
Duration of flow (hr)	38.9	54.8	39.1	53.5	47.8	47.7	46.7
Runoff first 24 hrs of event (start at time of first sample) (cf)	14476	9526	6594	2988	198178	238399	231754
Runoff volume sampled (cf)	14393	9145	6551	2751	190796	215225	212000
% of runoff volume sampled	99.43	96.00	99.35	92.07	96.28	90.28	91.48
Average flow rate during sampling interval (cfs)	0.237	0.132	0.099	0.035	2.513	2.809	2.76
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	yes
Number of aliquots collected	36	24	30	26	35	33	20
Peak flow rate (cfs)	0.57	0.31	0.24	0.04	6.84	3.54	4.31
Peak hydrograph (date, time)	3/9/2017 6:35:00 PM	3/9/2017 7:35:00 PM	3/9/2017 6:40:00 PM	3/9/2017 10:05:00 PM	3/9/2017 6:25:00 PM	3/10/2017 12:30:00 AM	3/9/2017 7:35:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	0:35	1:35	0:40	4:05	0:25	6:30	1:35

(a) Tail of this stormflow runs in to another storm, so reported volume is likely underestimate of actual volume.

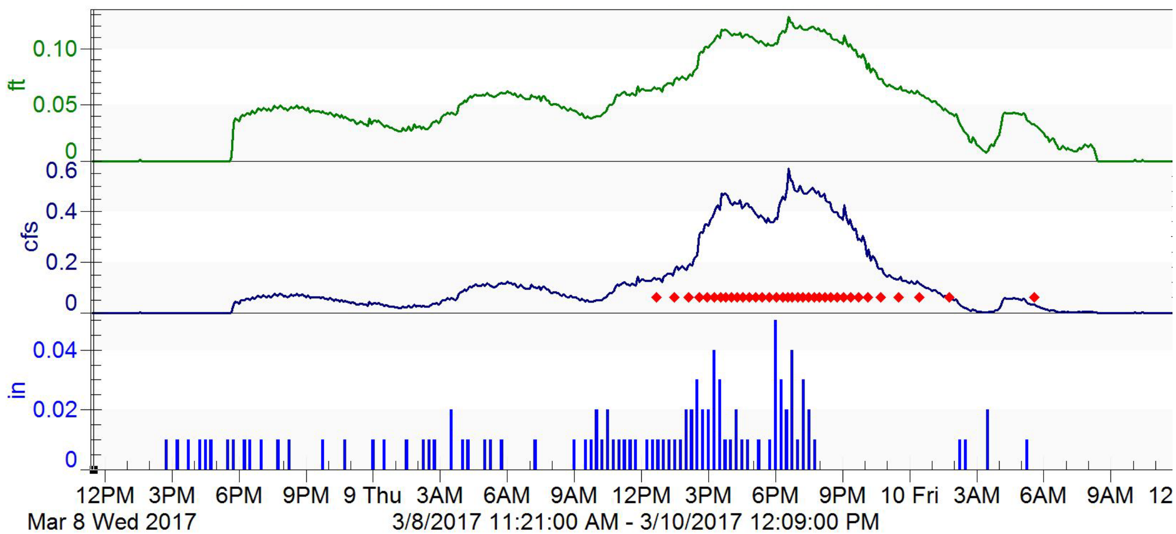


Figure 71. EBI, Storm 11.

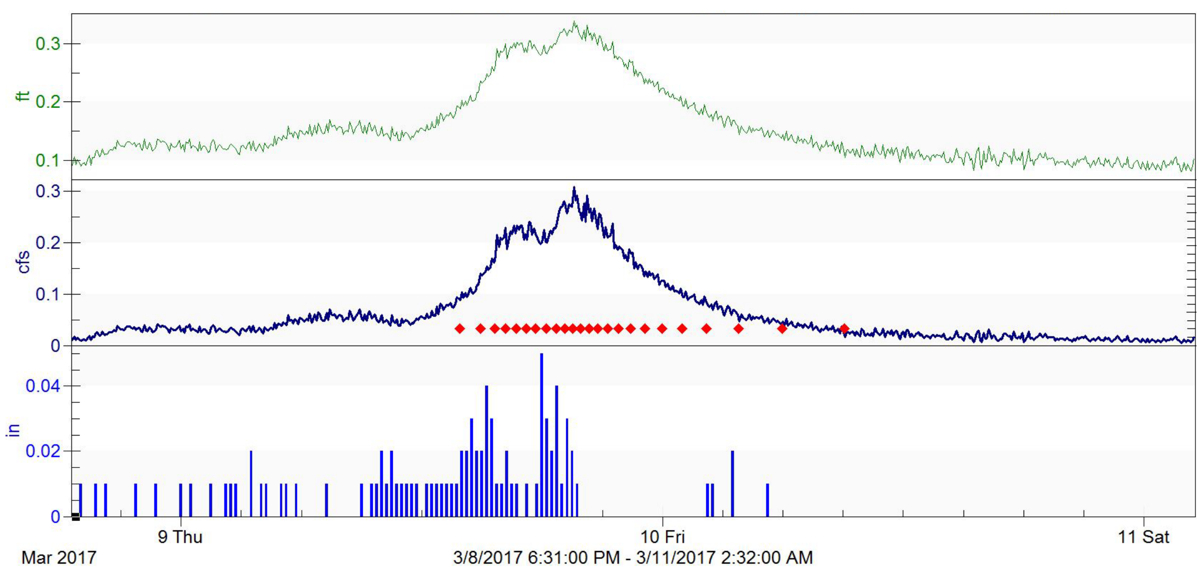


Figure 72. EBO, Storm 11.

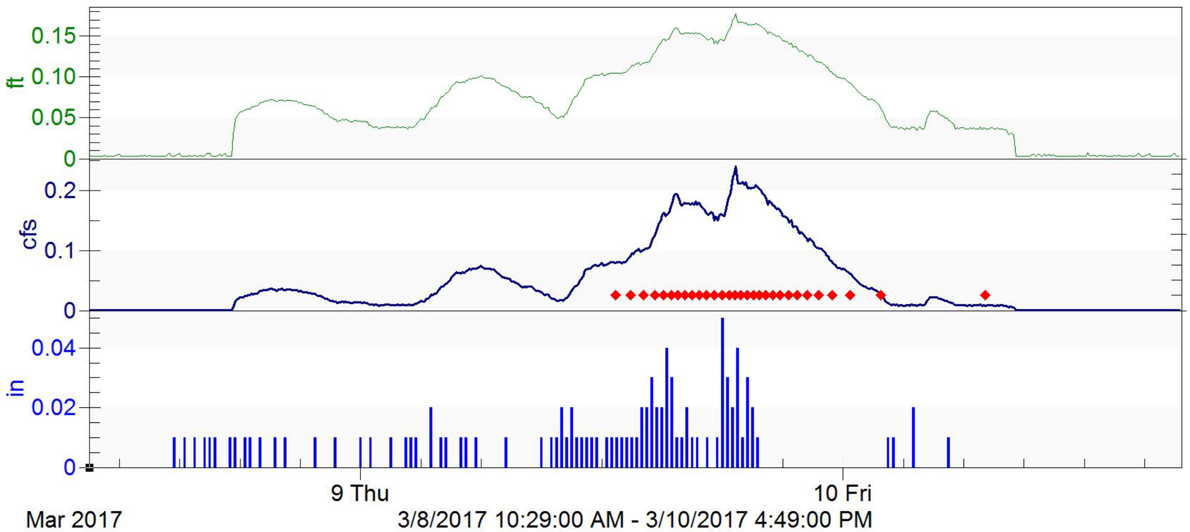


Figure 73. WBI, Storm 11.

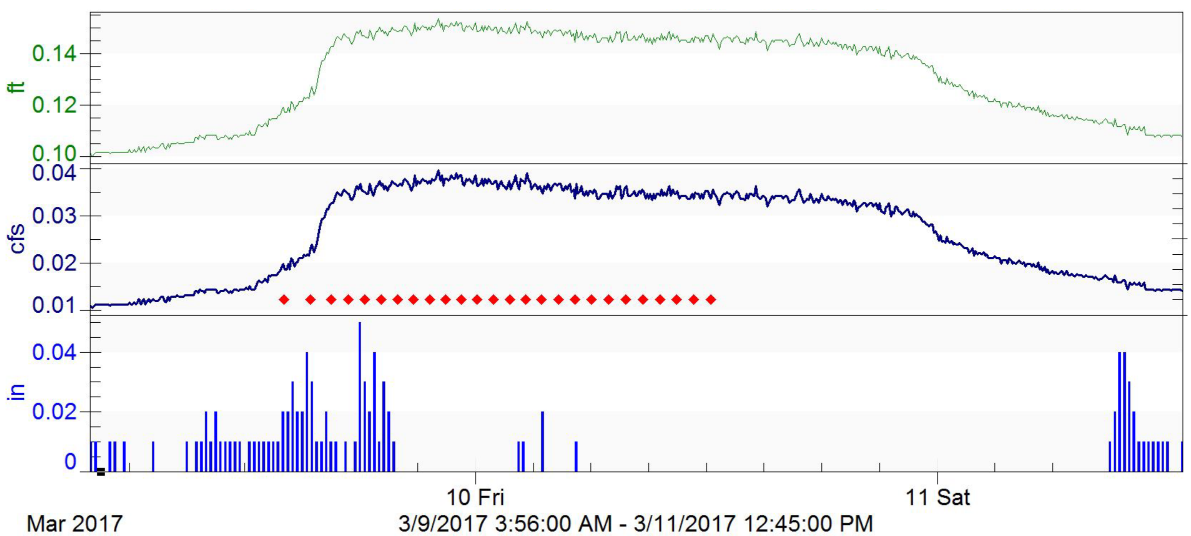


Figure 74. WBO, Storm 11.

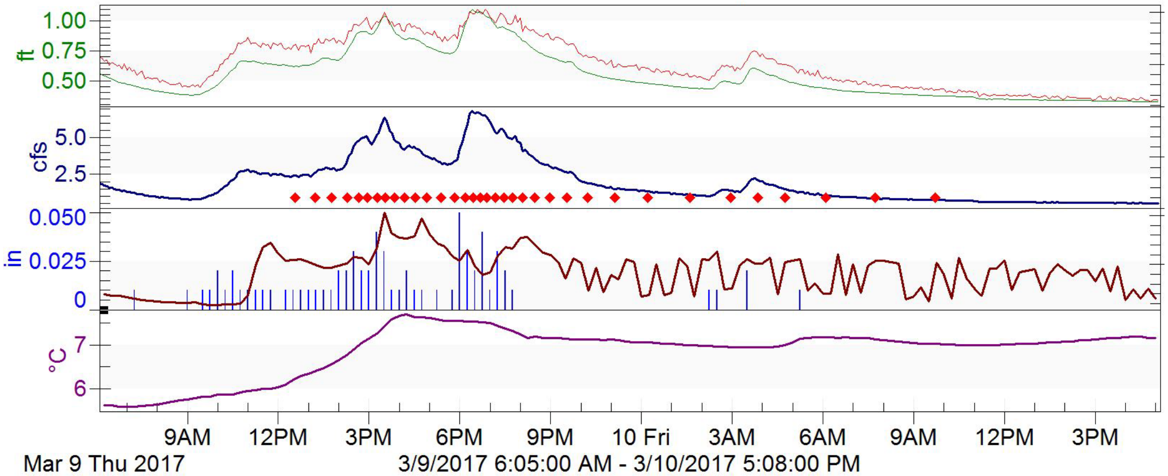


Figure 75. WCI, Storm 11.

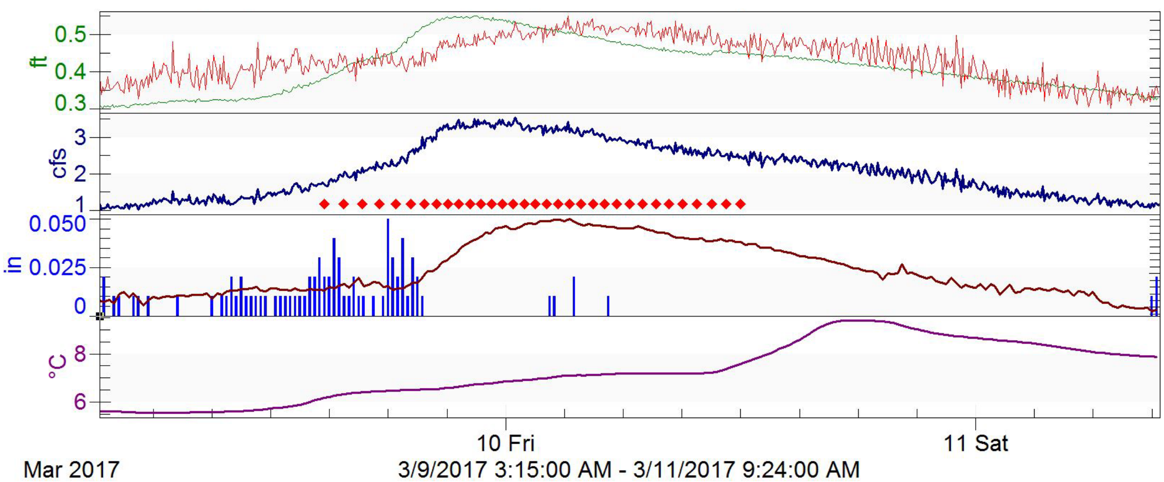


Figure 76. WCEBO, Storm 11.

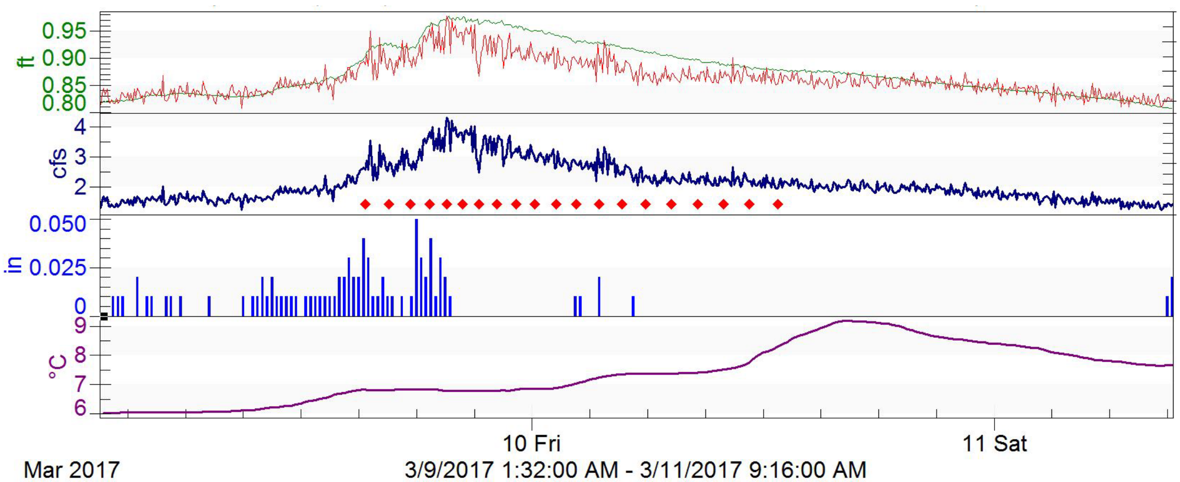


Figure 77. NFWHC, Storm 11.

Precipitation Information	Storm 12 3/13/2017
Dry antecedent period (hr)	39
Rainfall in 4 days before storm (in)	1.03
Rainfall in 48 hours before storm (in)	0.25
Rainfall in 24 hours before storm (in)	0.01
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.99
Peak rainfall (date, time)	3/13/17 10:00 AM
Rainfall volume in bioretention basin (cf)	81218
Rainfall volume in wetland complex basin (cf)	702928

Sampling Information	Storm 12 - 3/13/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	(a)	12065	8319	4347 (b)	272237	294196	288554
Start of flow (hhmm)	(a)	830	805	950	505	650	545
Average flow rate for entire storm (cfs)	(a)	0.088	0.071	0.031	2.08	2.137	2.071
Duration of flow (hr)	(a)	38.1	32.5	39.0 (b)	36.4	38.2	38.7
Runoff first 24 hrs of event (start at time of first sample) (cf)	(a)	9827	7292	2869	224823	204119	201414
Runoff volume sampled (cf)	(a)	8994	7157	2439	224823	169791	201414
% of runoff volume sampled	(a)	91.52	98.15	85.01	100.00	83.18	100.00
Average flow rate during sampling interval (cfs)	(a)	0.123	0.087	0.033	2.456	2.334	2.288
Peak of hydrograph captured?	(a)	yes	yes	yes	yes	yes	yes
Number of aliquots collected	8	16	19	17	27 (c)	17	17 (d)
Peak flow rate (cfs)	(a)	0.31	0.22	0.04	5.78	2.92	3.24
Peak hydrograph (date, time)	(a)	3/13/2017 4:30:00 PM	3/13/2017 3:40:00 PM	3/13/2017 8:15:00 PM	3/13/2017 3:05:00 PM	3/13/2017 9:25:00 PM	3/13/2017 5:10:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	(a)	6:30	5:40	10:15	5:05	11:25	7:10

(a) Flow meter malfunctioned halfway through sampling event; flow data missing from 1610 through 2400.

(b) Flow is still quite high when the next storm starts; therefore, volume is underestimate of actual runoff from sampled event.

(c) Sampler ran for 25.5 hours.

(d) Sampler ran for 24.5 hours.

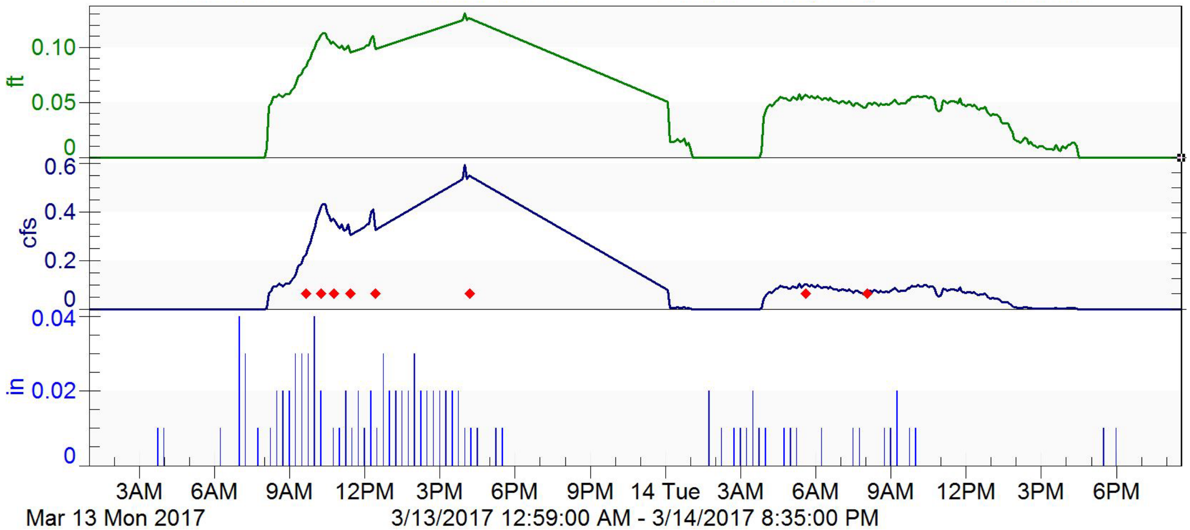


Figure 78. EBI, Storm 12.

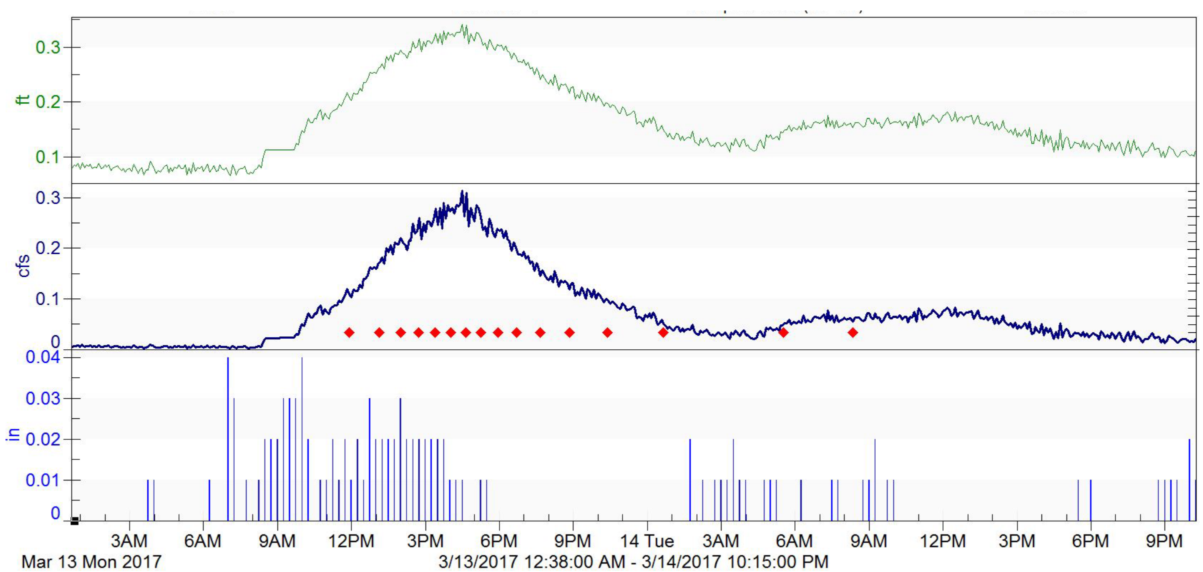


Figure 79. EBO, Storm 12.

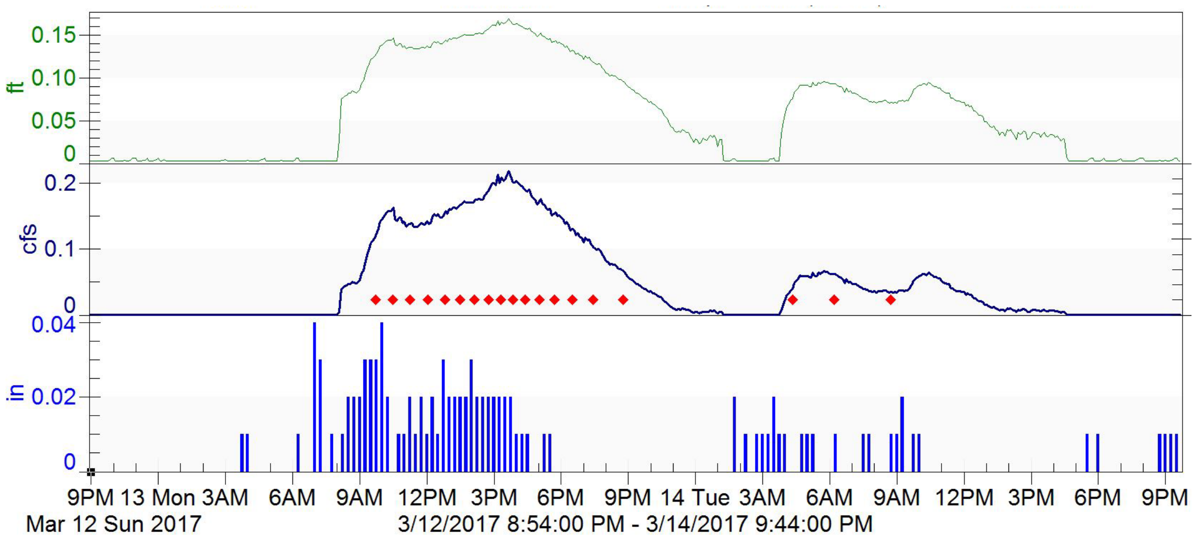


Figure 80. WBI, Storm 12.

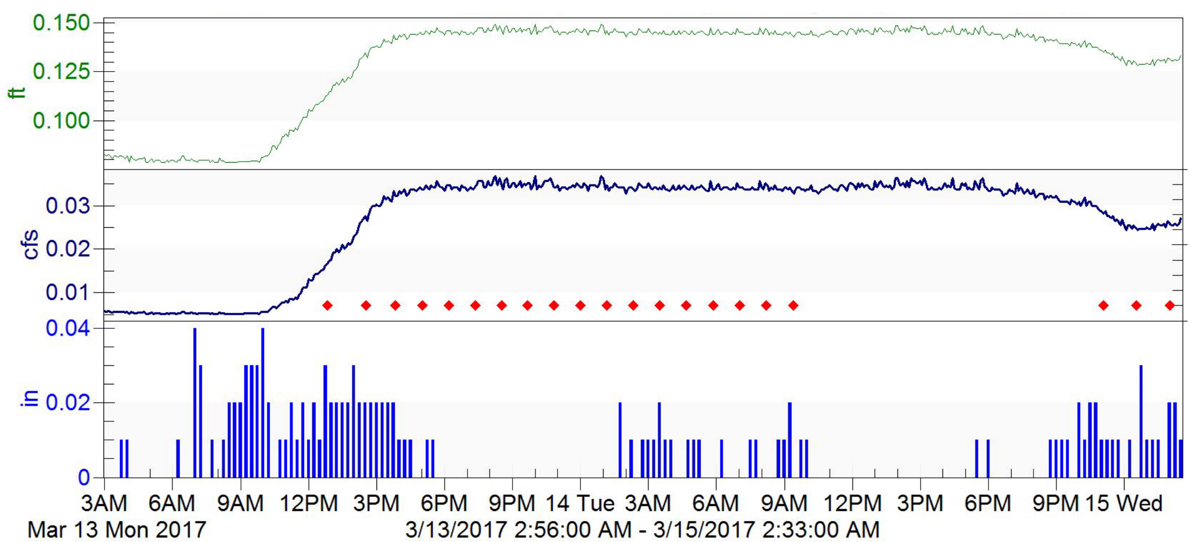


Figure 81. WBO, Storm 12.

Note: The last three samples included in the WBO figure were collected as part of Storm 13, and were not included in the Storm 12 sample.

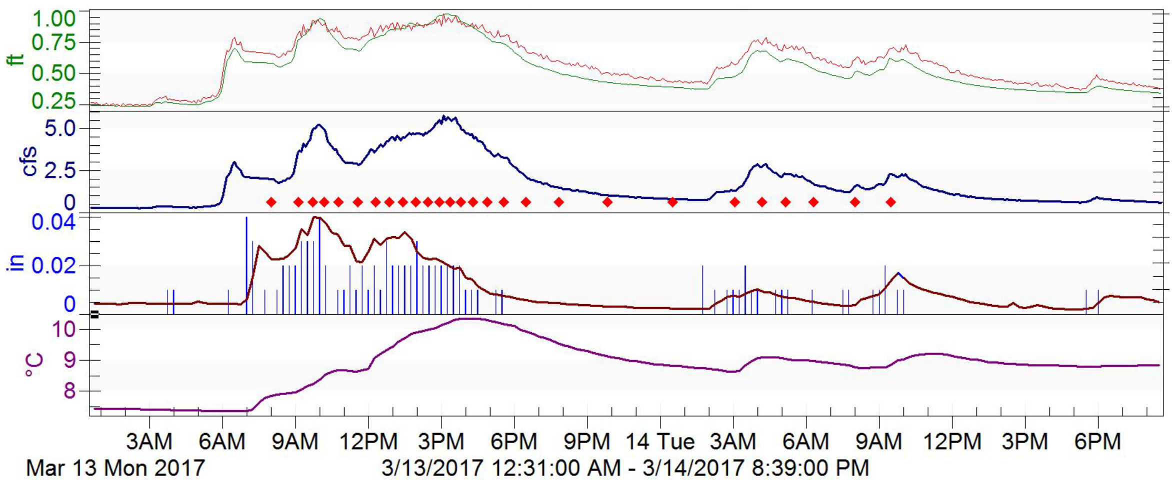


Figure 82. WCI, Storm 12.

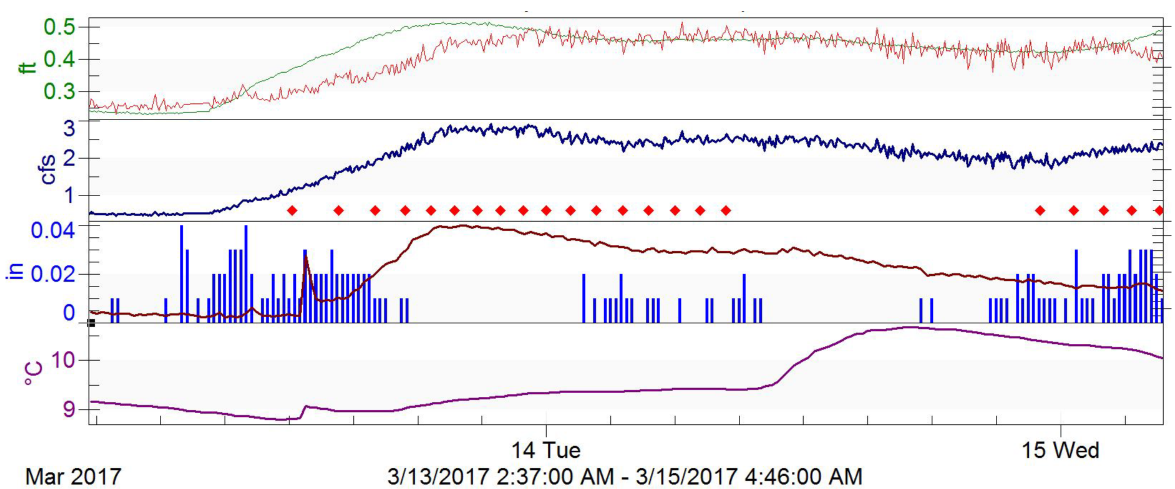


Figure 83. WCEBO, Storm 12.

Note: The last five samples included in the WCEBO figure were collected as part of Storm 13, and were not included in the Storm 12 sample.

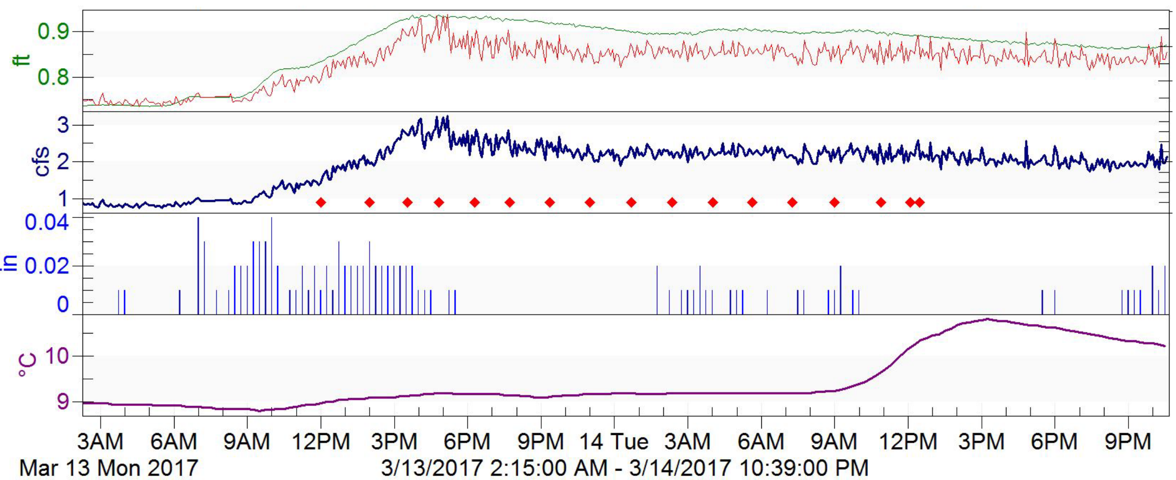


Figure 84. NFWHC, Storm 12.

Precipitation Information	Storm 13
	3/14/2017
Dry antecedent period (hr)	7.5
Rainfall in 4 days before storm (in)	1.24
Rainfall in 48 hours before storm (in)	0.99
Rainfall in 24 hours before storm (in)	0.22
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	1.17
Peak rainfall (date, time)	3/15/17 3:15 AM
Rainfall volume in bioretention basin (cf)	95984
Rainfall volume in wetland complex basin (cf)	830733

Sampling Information	Storm 13 - 3/14/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	28602	18874	12918	9097 (a)	421871	605799	760488
Start of flow (hhmm)	2230	2255	2235	15	2040	2150	2150
Average flow rate for entire storm (cfs)	0.31	0.142	0.137	0.038	1.829	2.769	3.317
Duration of flow (hr)	25.6	36.9	26.2	66.5	64.1	60.8	63.7
Runoff first 24 hrs of event (start at time of first sample) (cf)	28586	17669	12877	3163	329631	335536	486449
Runoff volume sampled (cf)	25235	17478	12762	3124	302687	328408	427512
% of runoff volume sampled	88.28	98.92	99.11	98.77	91.83	97.88	87.88
Average flow rate during sampling interval (cfs)	0.408	0.206	0.161	0.037	4.377	3.875	5.685
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	yes
Number of aliquots collected	36	30	33	23	36	32	36
Peak flow rate (cfs)	0.68	0.41	0.3	0.05	7.34	5.53	9.88
Peak hydrograph (date, time)	3/15/2017 9:40:00 AM	3/15/2017 10:40:00 AM	3/15/2017 9:45:00 AM	3/15/2017 5:30:00 PM	3/15/2017 7:55:00 AM	3/15/2017 2:35:00 PM	3/15/2017 11:25:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	6:25	7:25	6:30	14:15	4:40	11:20	8:10

(a) Flow high initially, when sampled storm starts, and flow remains high as next storm starts. Flow volume is an estimate.

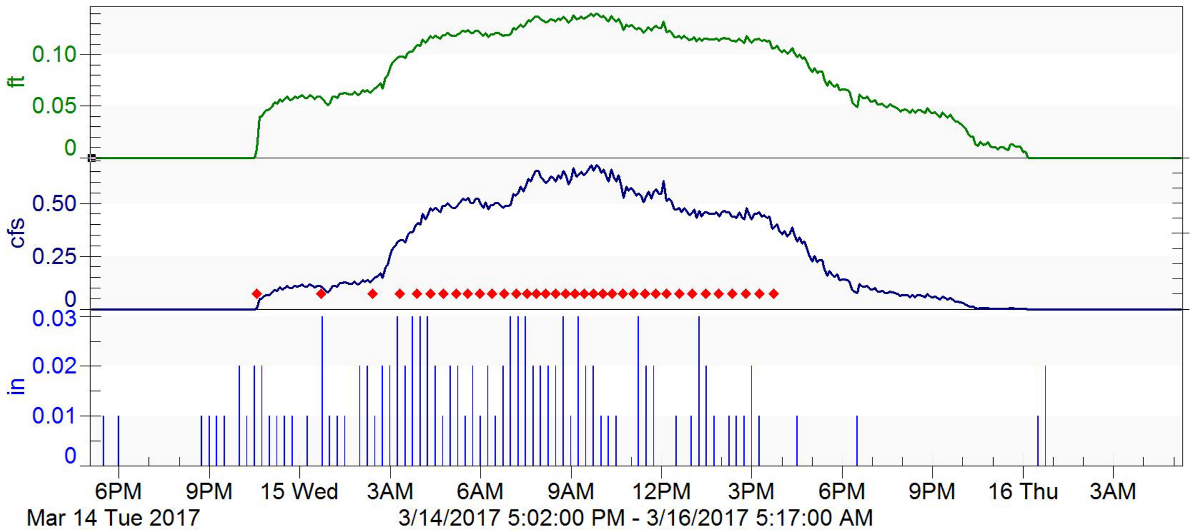


Figure 85. EBI, Storm 13.

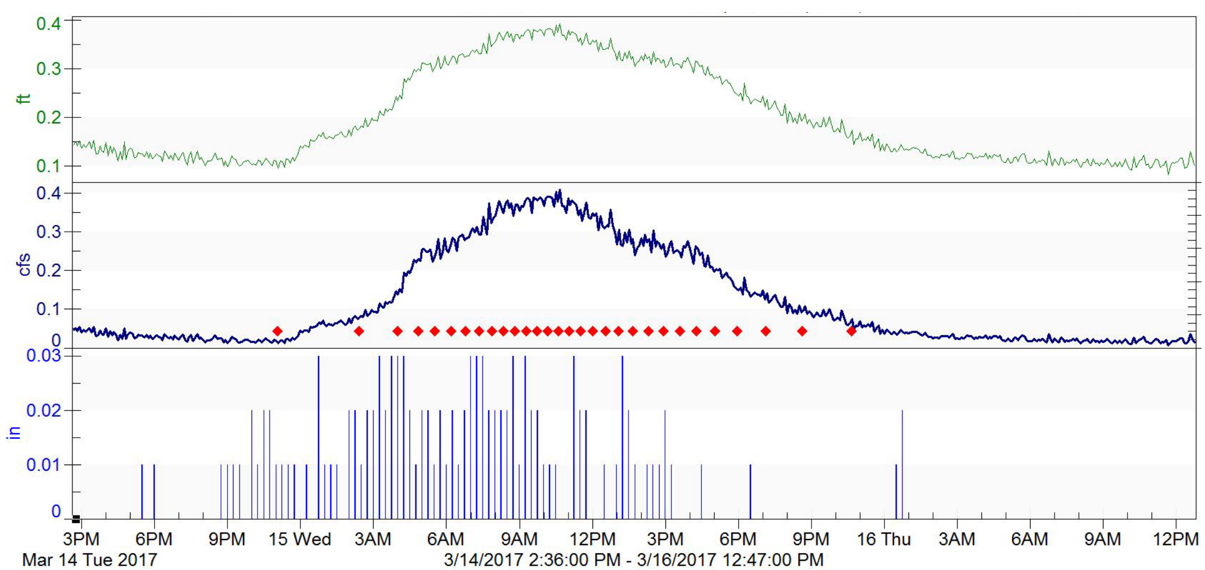


Figure 86. EBO, Storm 13.

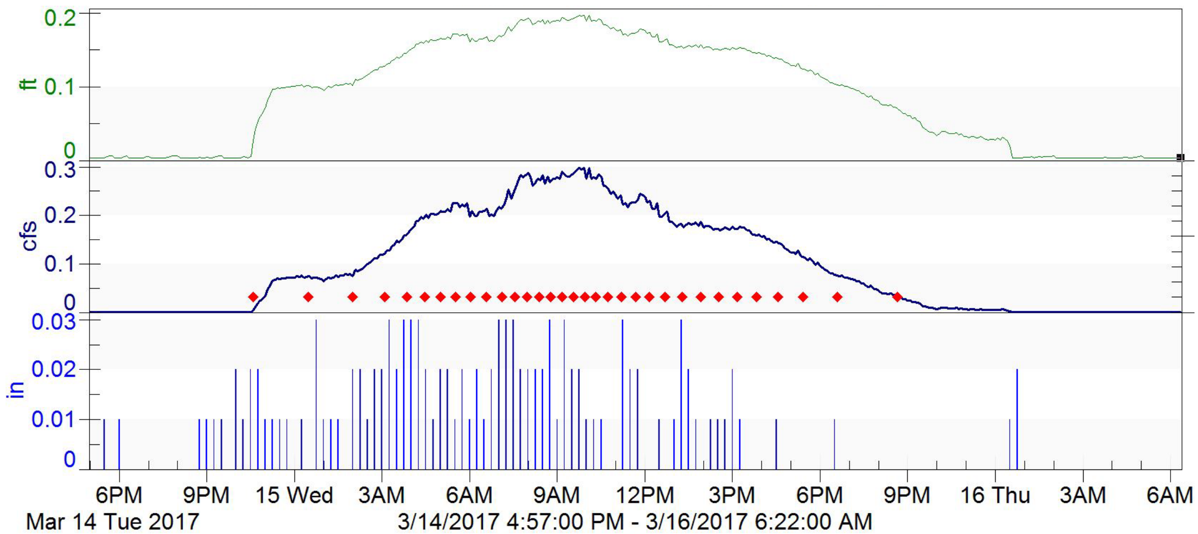


Figure 87. WBI, Storm 13.

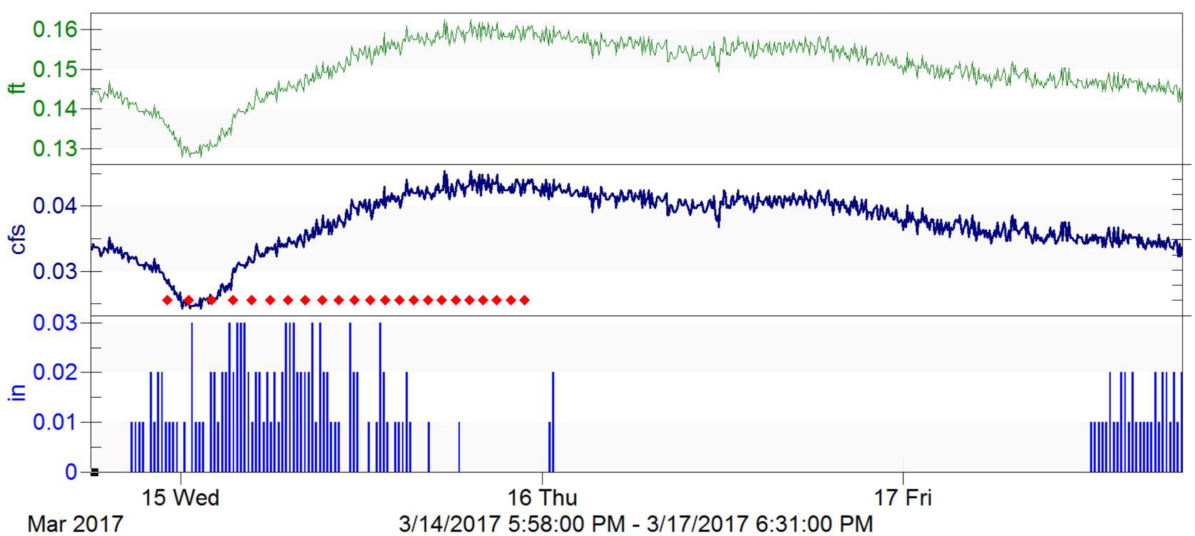


Figure 88. WBO, Storm 13.

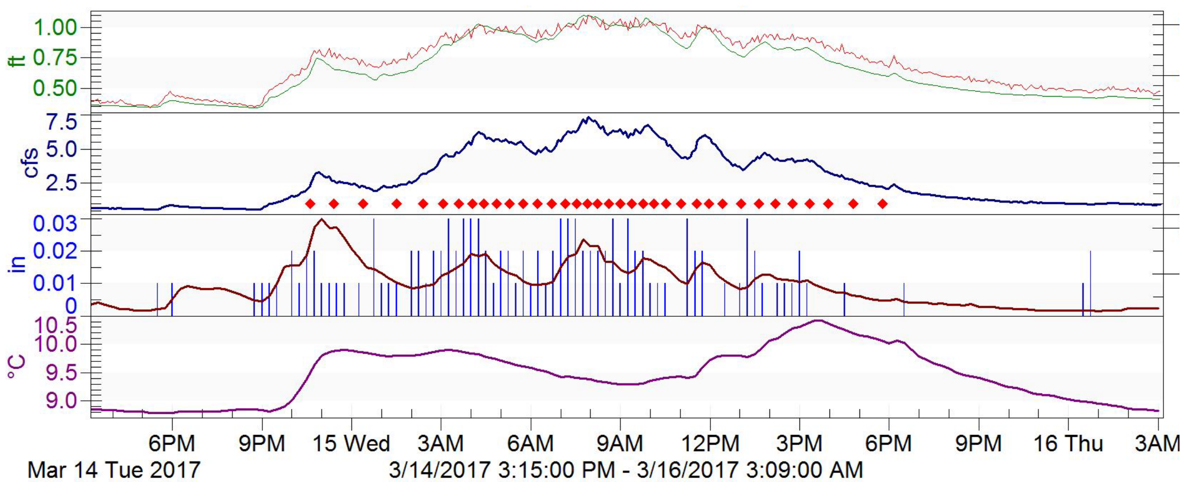


Figure 89. WCI, Storm 13.

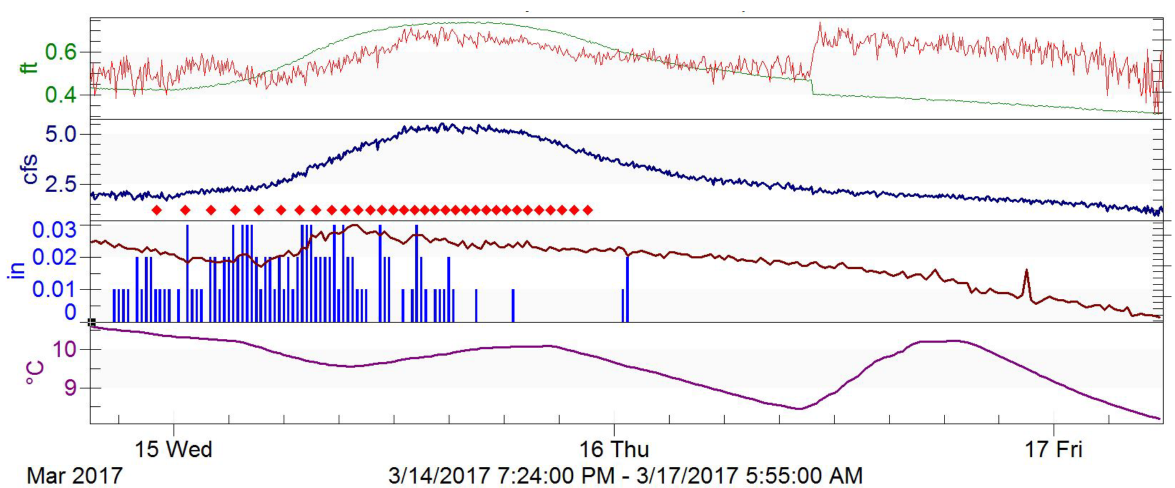


Figure 90. WCEBO, Storm 13.

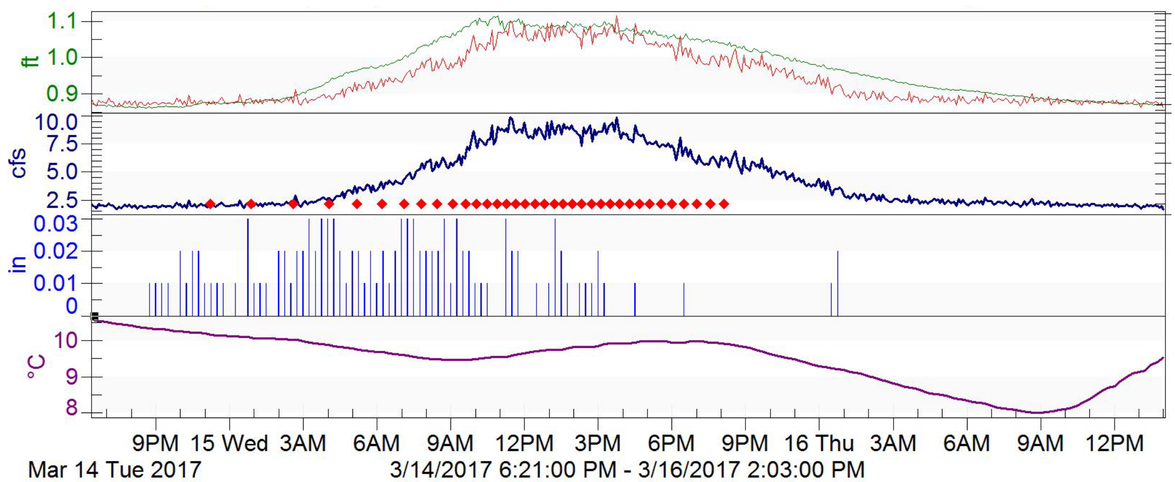


Figure 91. NFWHC, Storm 13.

Precipitation Information	Storm 14 3/26/2017
Dry antecedent period (hr)	27.45
Rainfall in 4 days before storm (in)	0.44
Rainfall in 48 hours before storm (in)	0.12
Rainfall in 24 hours before storm (in)	0.01
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.38
Peak rainfall (date, time)	3/26/17 1:30 PM
Rainfall volume in bioretention basin (cf)	31174
Rainfall volume in wetland complex basin (cf)	269811

Sampling Information	Storm 14 - 3/26/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	3465	3562	2315	(a)	96073	184604 (b)	239039
Start of flow (hhmm)	1130	1255	1130	(a)	900	1140	940
Average flow rate for entire storm (cfs)	0.053	0.039	0.035	(a)	0.913	0.897	1.096
Duration of flow (hr)	18.2	25.4	18.4	(a)	29.2	57.2	60.6
Runoff first 24 hrs of event (start at time of first sample) (cf)	3356	3448	2259	(a)	82480	98238	101331
Runoff volume sampled (cf)	3279	3053	1849	(a)	79528	88766	89695
% of runoff volume sampled	97.71	88.54	81.85	(a)	96.42	90.36	88.52
Average flow rate during sampling interval (cfs)	0.065	0.048	0.046	(a)	1.018	1.181	1.18
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	yes
Number of aliquots collected	34	17	36	26	32	32	18
Peak flow rate (cfs)	0.12	0.09	0.08	(a)	3.01	1.49	1.56
Peak hydrograph (date, time)	3/26/2017 3:35:00 PM	3/27/2017 12:45:00 AM	3/26/2017 4:50:00 PM	3/27/2017 3:30:00 AM	3/26/2017 3:30:00 PM	3/27/2017 12:15:00 AM	3/27/2017 4:05:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	2:05	11:15	3:20	14:00	2:00	10:45	14:35

(a) Flow meter reading high because of clogged bubbler tube.

(b) Grass caught on flow meter may have elevated flow readings.

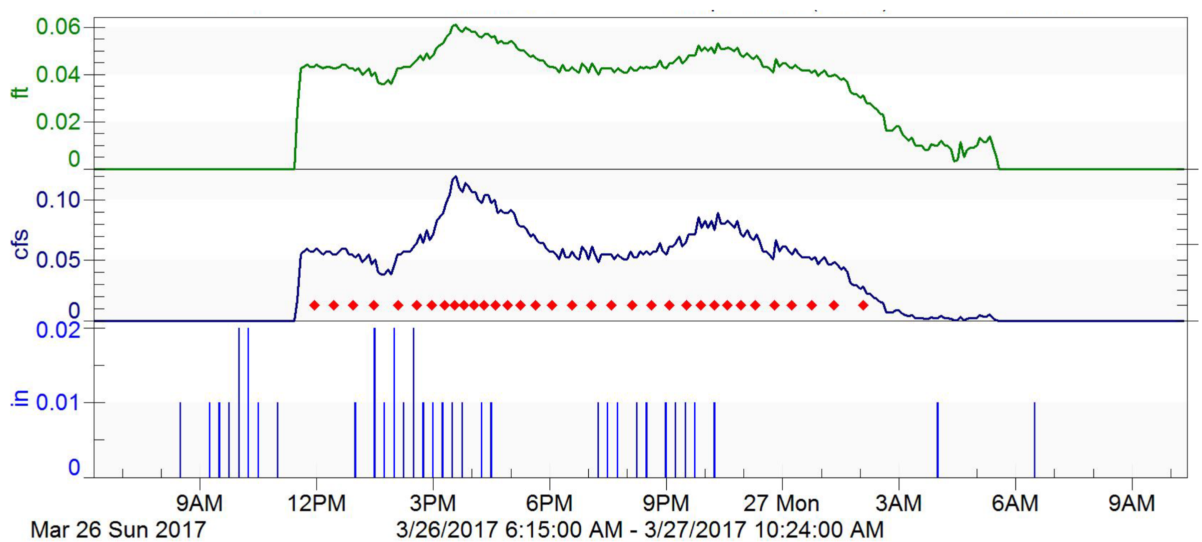


Figure 92. EBI, Storm 14.

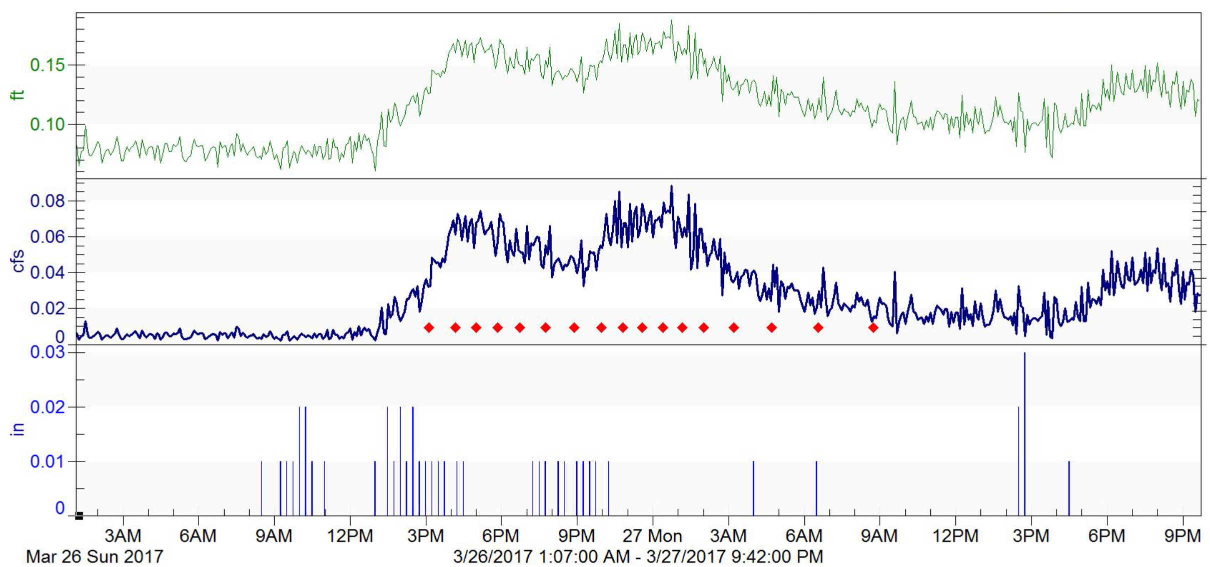


Figure 93. EBO, Storm 14.

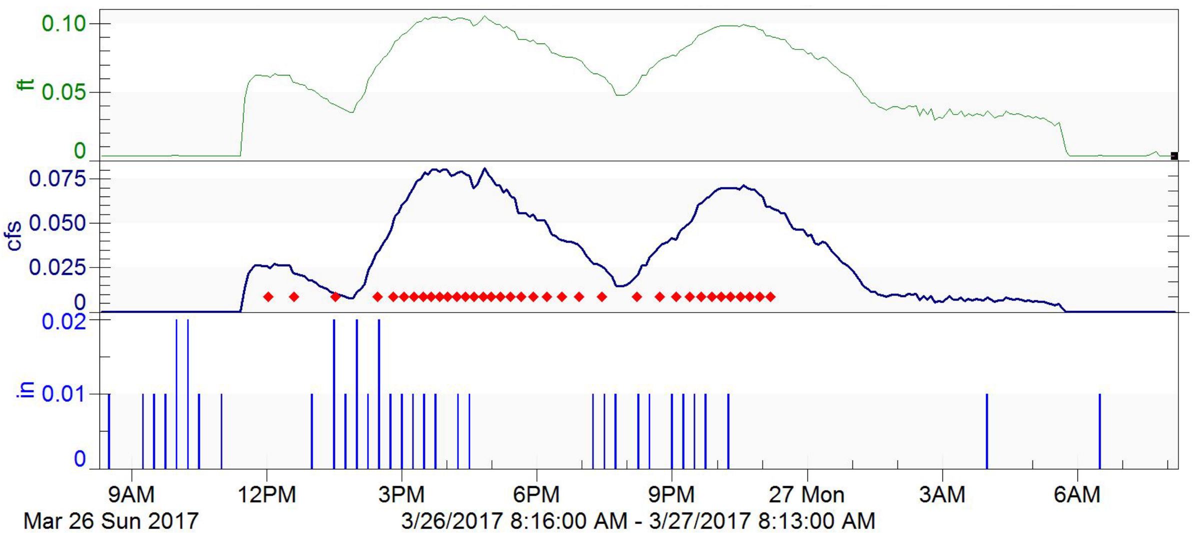


Figure 94. WBI, Storm 14.

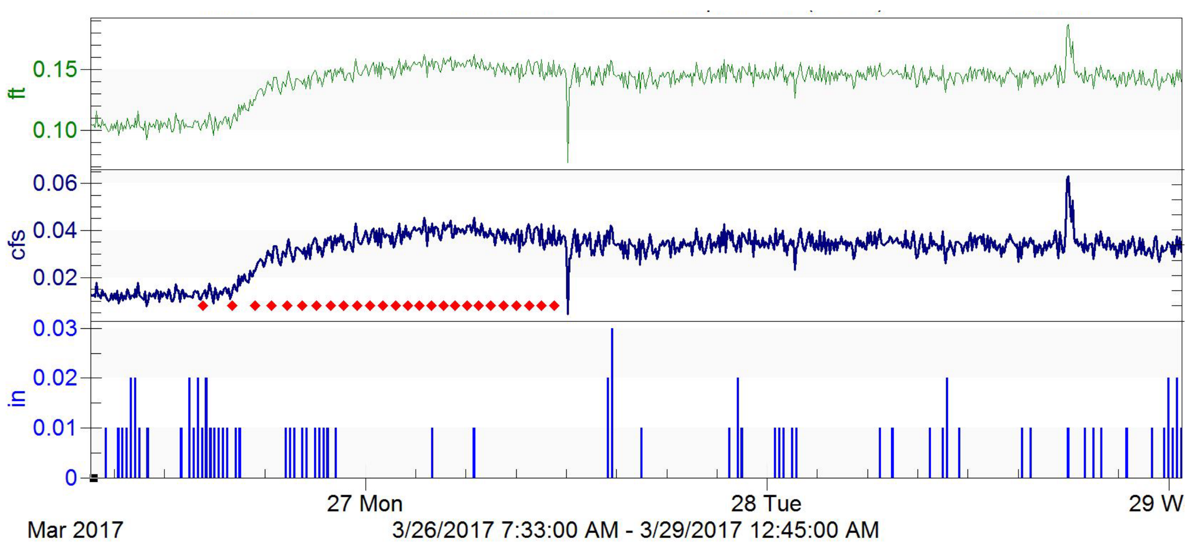


Figure 95. WBO, Storm 14.

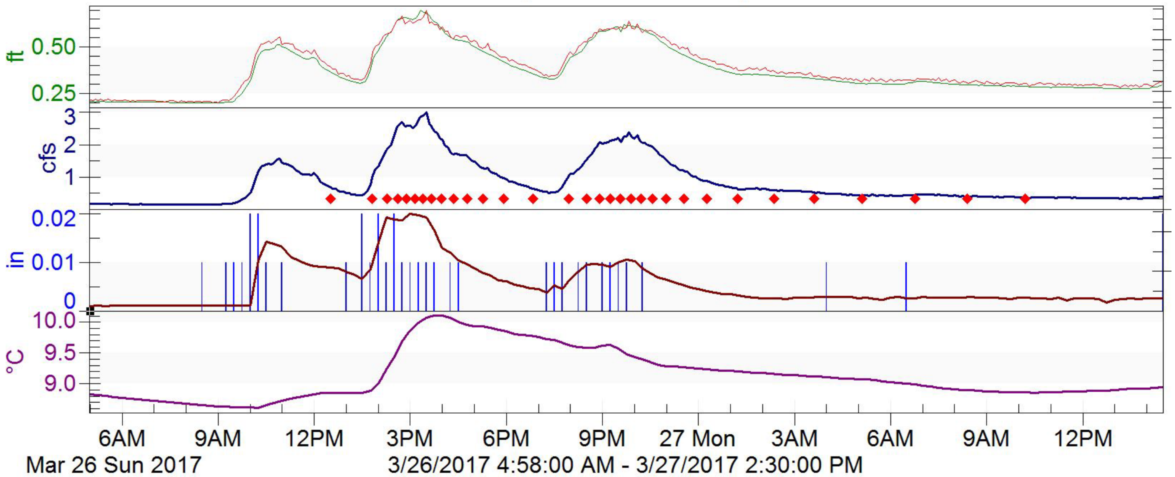


Figure 96. WCI, Storm 14.

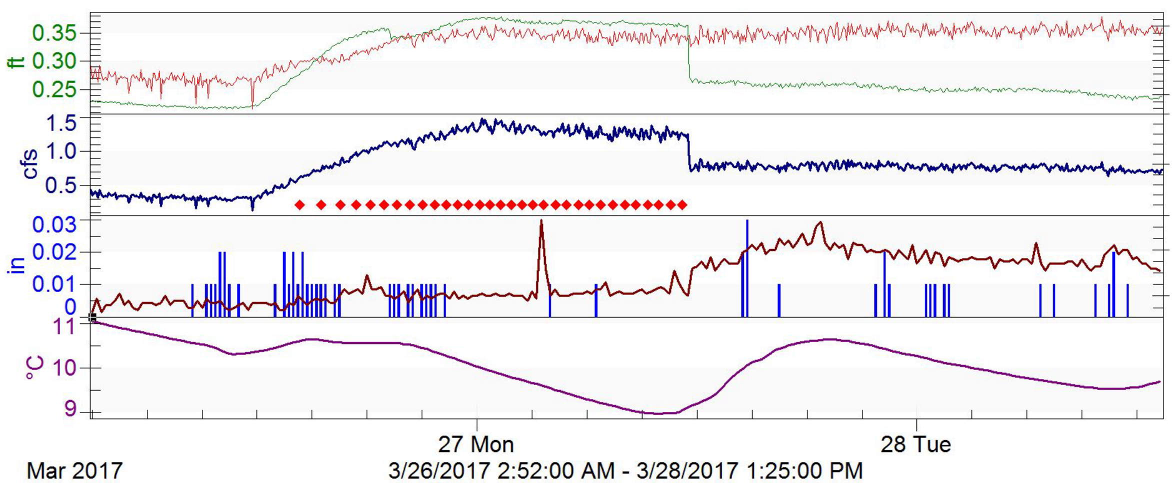


Figure 97. WCEBO, Storm 14.

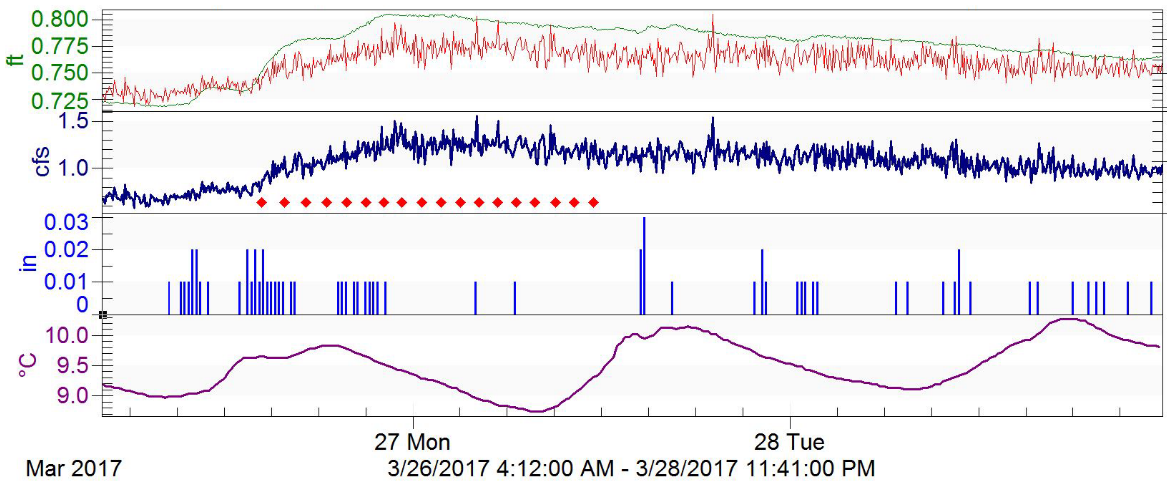


Figure 98. NFWHC, Storm 14.

Precipitation Information	Storm 15 3/29/2017
Dry antecedent period (hr)	6.5
Rainfall in 4 days before storm (in)	0.72
Rainfall in 48 hours before storm (in)	0.36
Rainfall in 24 hours before storm (in)	0.18
Rainfall in 6 hours before storm (in)	0.02
Rainfall during storm (in)	0.6
Peak rainfall (date, time)	3/29/17 4:15 AM
Rainfall volume in bioretention basin (cf)	49222.8
Rainfall volume in wetland complex basin (cf)	426016.8

Sampling Information	Storm 15 - 3/29/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	14190	10380	6398	(a)	(b)	279216	381724
Start of flow (hhmm)	25	2340	30	(a)	(b)	100	2340
Average flow rate for entire storm (cfs)	0.237	0.061	0.106	(a)	(b)	0.933	1.258
Duration of flow (hr)	16.6	47.3	16.8	(a)	(b)	83.1	84.3
Runoff first 24 hrs of event (start at time of first sample) (cf)	14002	8924	6364	(a)	(b)	135587	157171
Runoff volume sampled (cf)	13601	8763	6325	(a)	(b)	116416	139248
% of runoff volume sampled	97.14	98.20	99.39	(a)	(b)	85.86	88.60
Average flow rate during sampling interval (cfs)	0.332	0.111	0.124	(a)	(b)	1.614	1.862
Peak of hydrograph captured?	yes	yes	yes	no	(b)	yes	yes
Number of aliquots collected	34	24	29	36	(b)	18	13
Peak flow rate (cfs)	0.6	0.33	0.24	(a)	7.17	2.08	2.48
Peak hydrograph (date, time)	3/29/2017 6:35:00 AM	3/29/2017 7:10:00 AM	3/29/2017 4:40:00 AM	3/29/2017 5:15:00 PM	3/29/2017 4:30:00 AM	3/29/2017 1:15:00 PM	3/29/2017 8:15:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	2:20	2:55	0:25	13:00	0:15	9:00	4:00

(a) Flow meter reading incorrectly high because of clogged bubbler tube.

(b) Autosampler malfunctioned after sampling event; data missing data from the end of event.

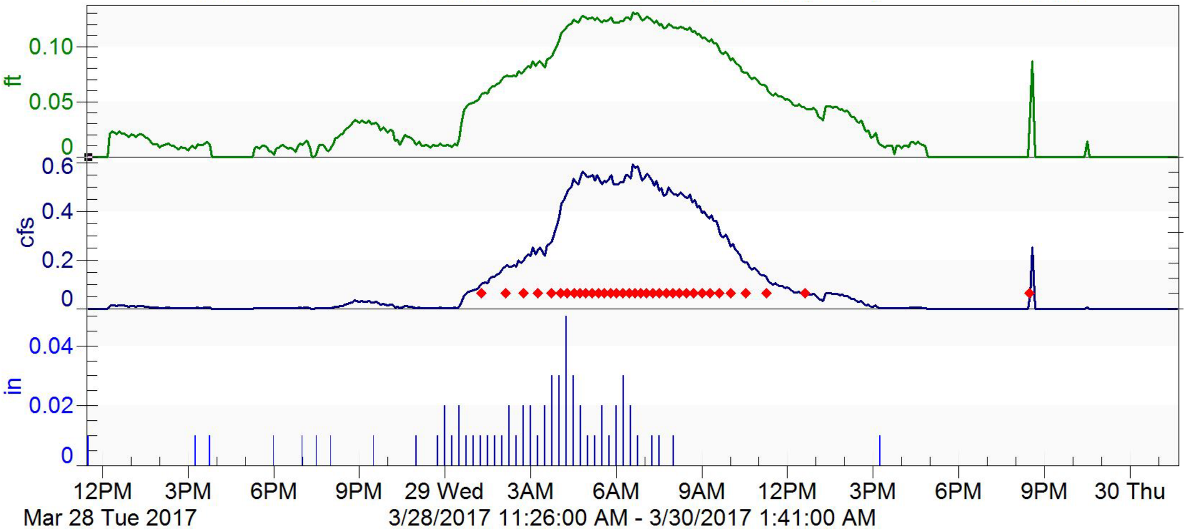


Figure 99. EBI, Storm 15.

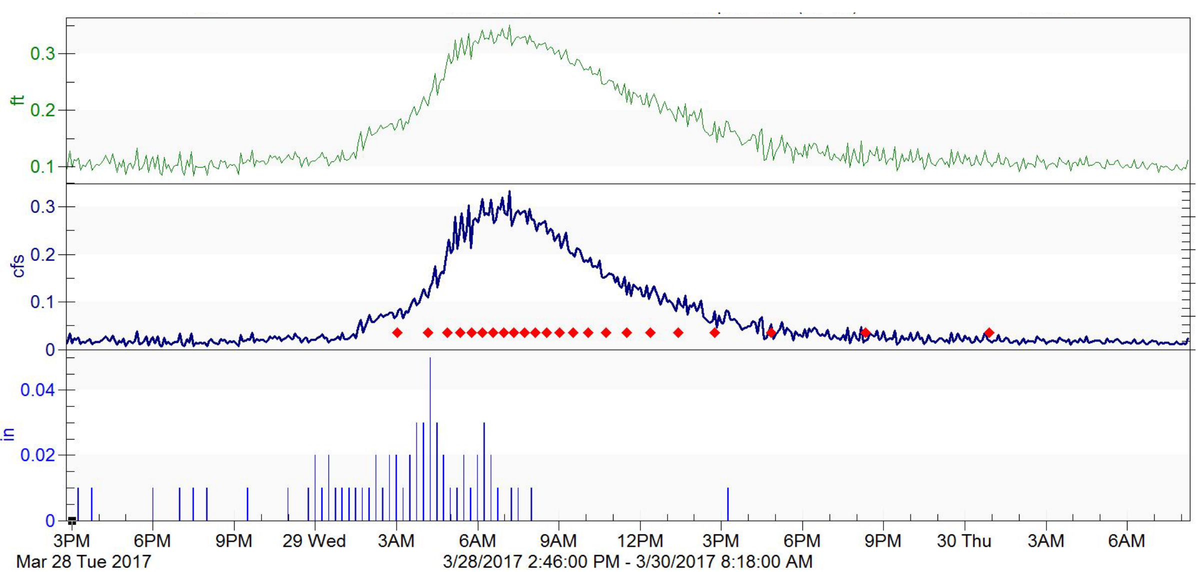


Figure 100. EBO, Storm 15.

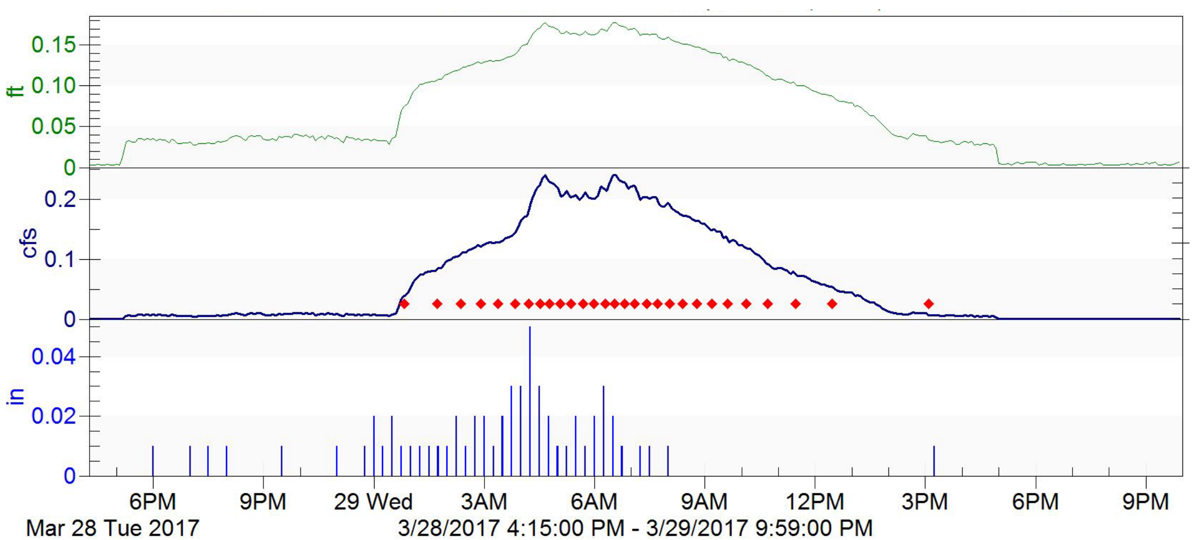


Figure 101. WBI, Storm 15.

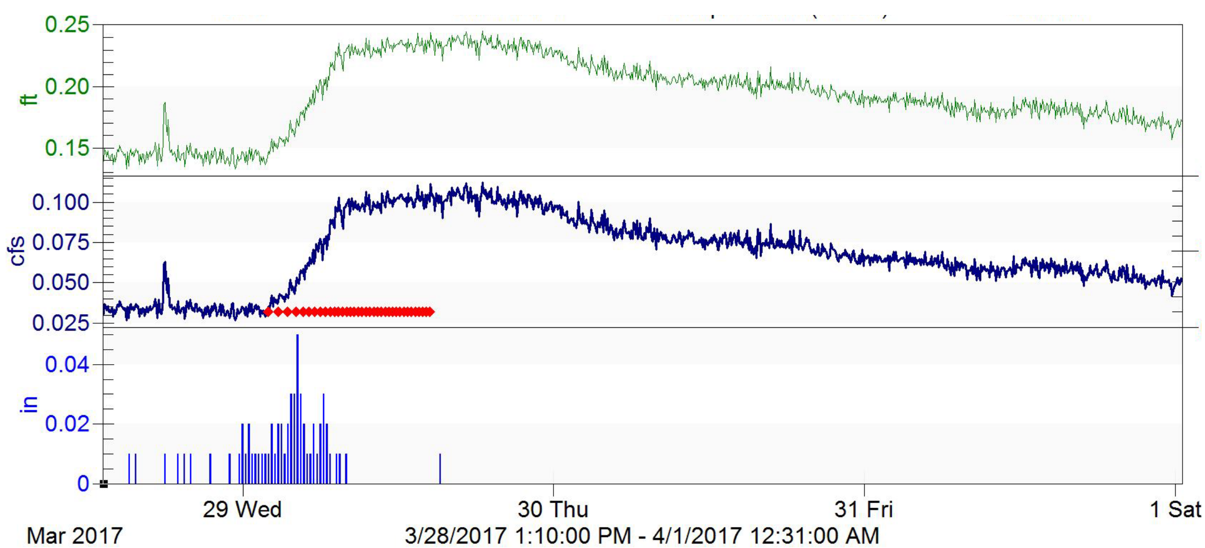


Figure 102. WBO, Storm 15.

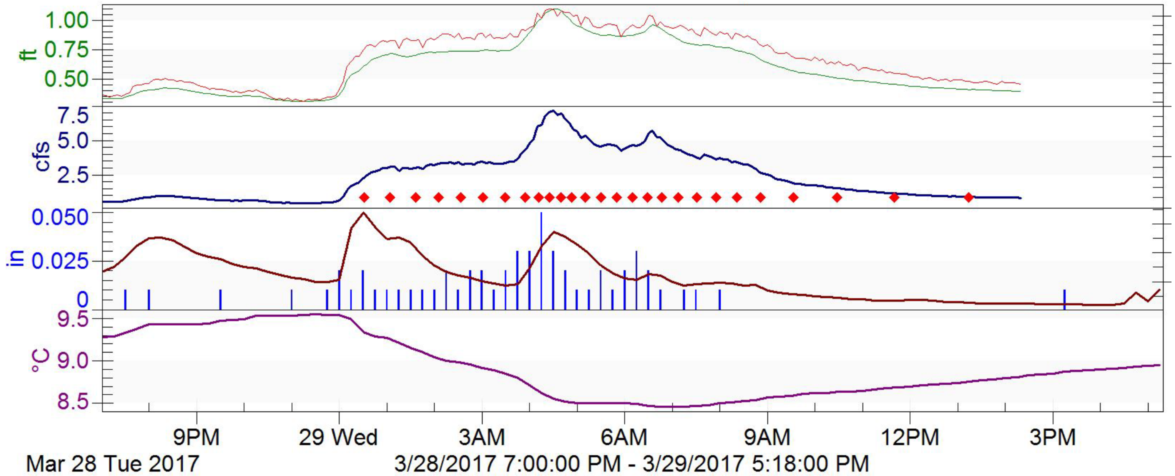


Figure 103. WCI, Storm 15.

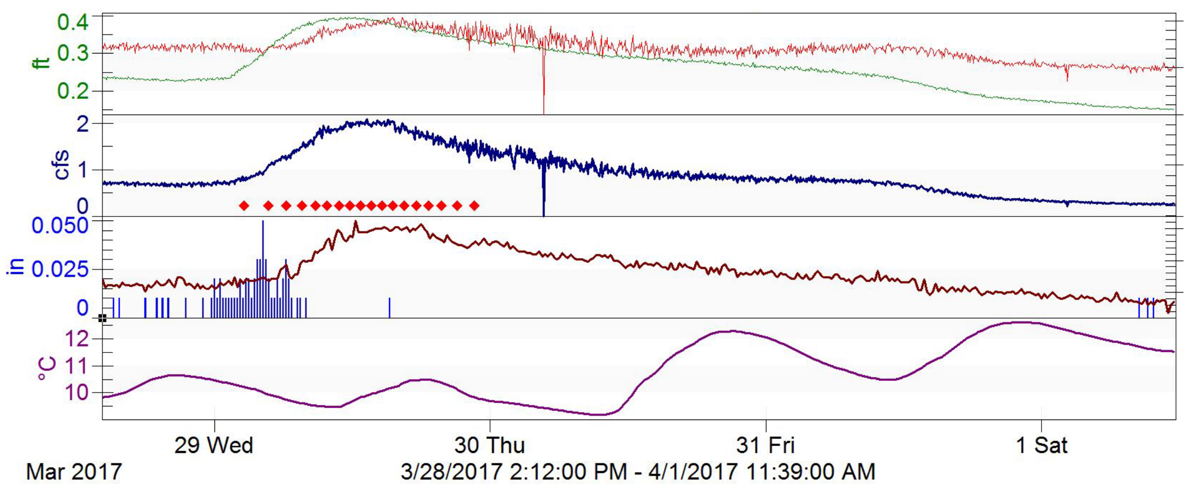


Figure 104. WCEBO, Storm 15.

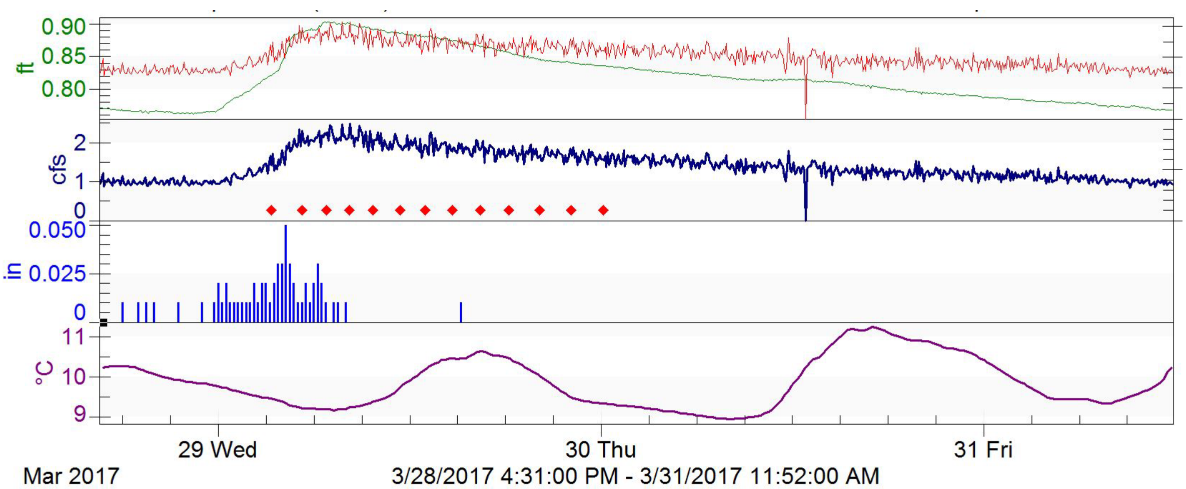


Figure 105. NFWHC, Storm 15.

Precipitation Information	Storm 16 4/5/2017
Dry antecedent period (hr)	71.25
Rainfall in 4 days before storm (in)	0.17
Rainfall in 48 hours before storm (in)	0
Rainfall in 24 hours before storm (in)	0
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.64
Peak rainfall (date, time)	4/5/17 6:00 AM
Rainfall volume in bioretention basin (cf)	52504.32
Rainfall volume in wetland complex basin (cf)	454417.92

Sampling Information	Storm 16 - 4/5/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	5238	5799	4034	(a)	(b)	267937 (c)	374593 (c)
Start of flow (hhmm)	2245	110	2240	(a)	(b)	2050	1940
Average flow rate for entire storm (cfs)	0.064	0.051	0.048	(a)	(b)	0.751	1.069
Duration of flow (hr)	22.7	31.6	23.3	(a)	(b)	99.1	97.3
Runoff first 24 hrs of event (start at time of first sample) (cf)	4220	4896	3341	(a)	92290	92694	117402
Runoff volume sampled (cf)	3507	4696	1859	(a)	62177	84612	101809
% of runoff volume sampled	83.10	95.92	55.64	(a)	>50% (b)	91.28	86.72
Average flow rate during sampling interval (cfs)	0.105	0.061	0.09	(a)	2.096	1.092	1.363
Peak of hydrograph captured?	yes	yes	yes	yes	unclear	yes	yes
Number of aliquots collected	36	29	36	36	36	34	18
Peak flow rate (cfs)	0.14	0.13	0.1	(a)	(b)	1.43	1.74
Peak hydrograph (date, time)	4/5/2017 11:40:00 AM	4/5/2017 1:25:00 PM	4/5/2017 11:50:00 AM	4/5/2017 7:30:00 PM	(b)	4/5/2017 5:30:00 PM	4/5/2017 3:35:00 PM
Time difference: peak rain to peak hydrograph (hr:min)	5:40	7:25	5:50	13:30	(b)	11:30	9:35

(a) Flow meter reading incorrectly high because of clogged bubbler tube.

(b) Sampler malfunctioned prior to sampling event; missing flow data.

(c) Flow values include a second storm that occcured very soon after the first storm.

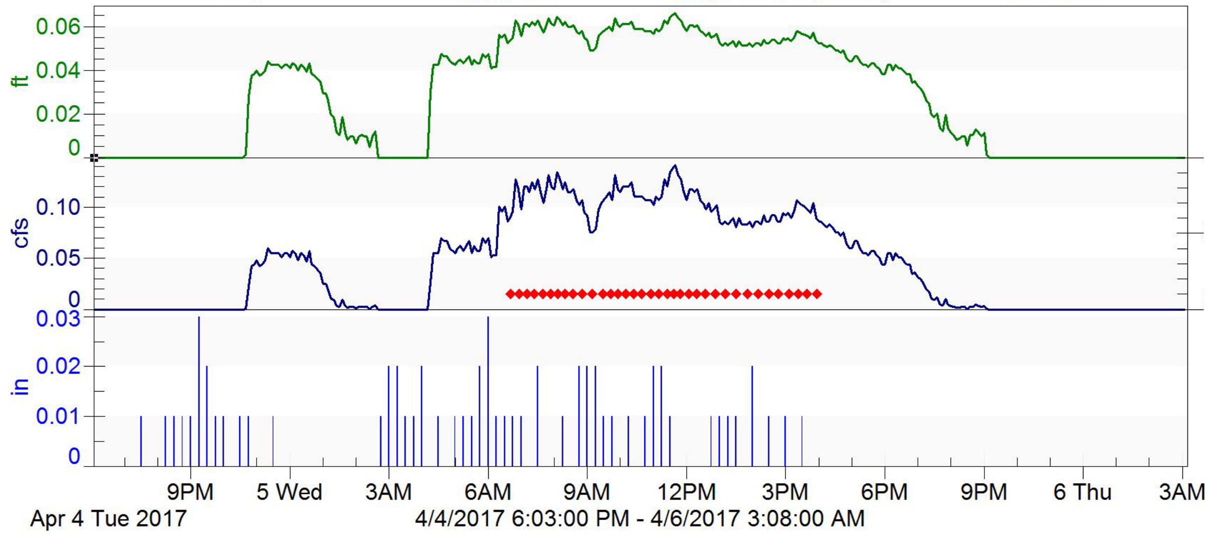


Figure 106. EBI, Storm 16.

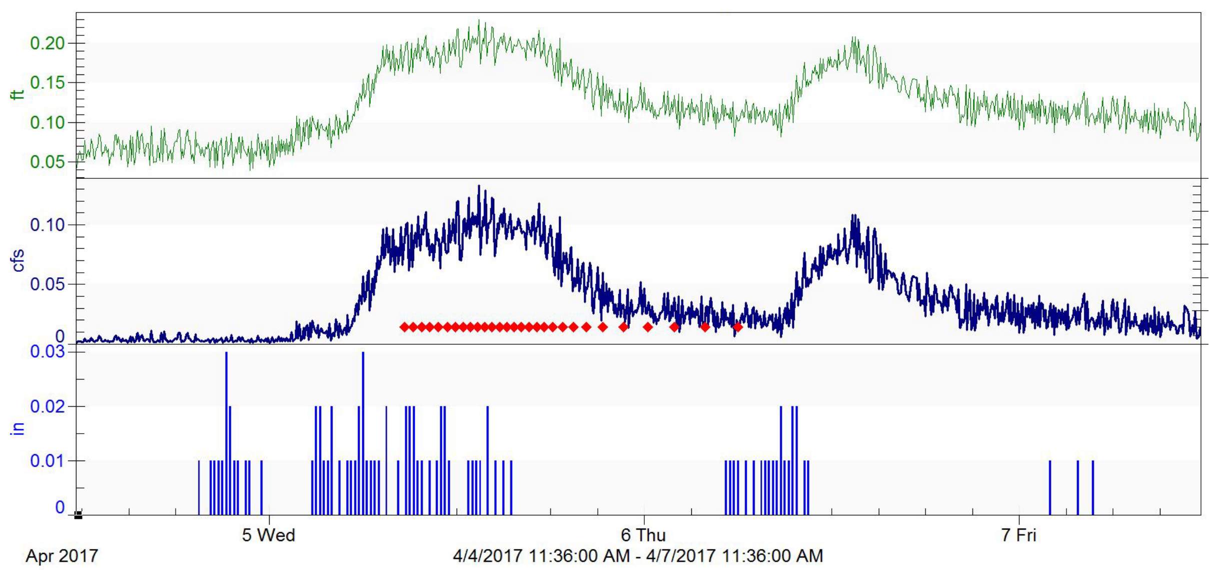


Figure 107. EBO, Storm 16.

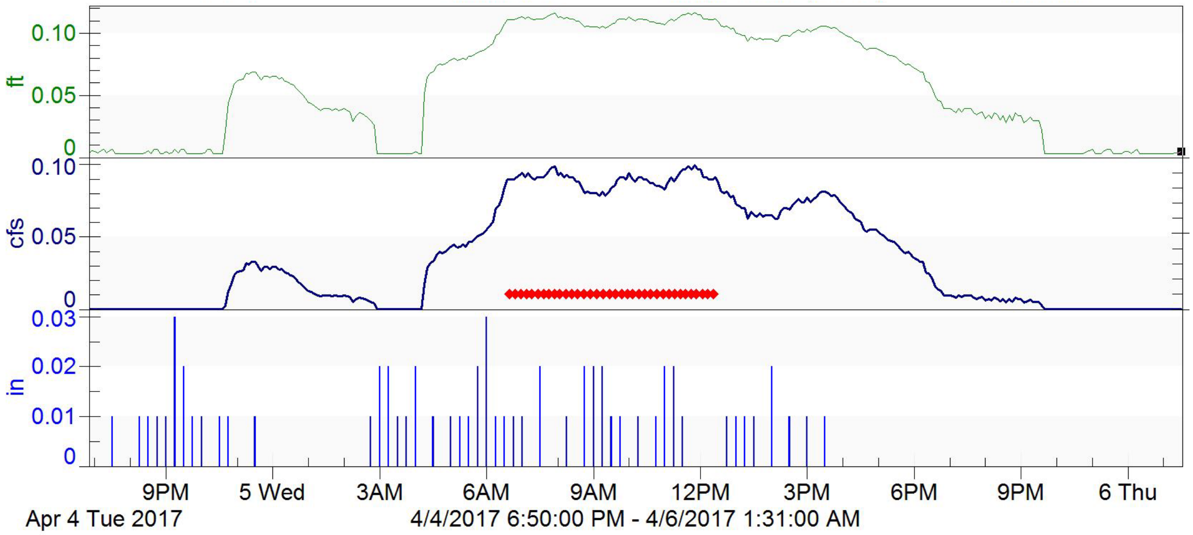


Figure 108. WBI, Storm 16.

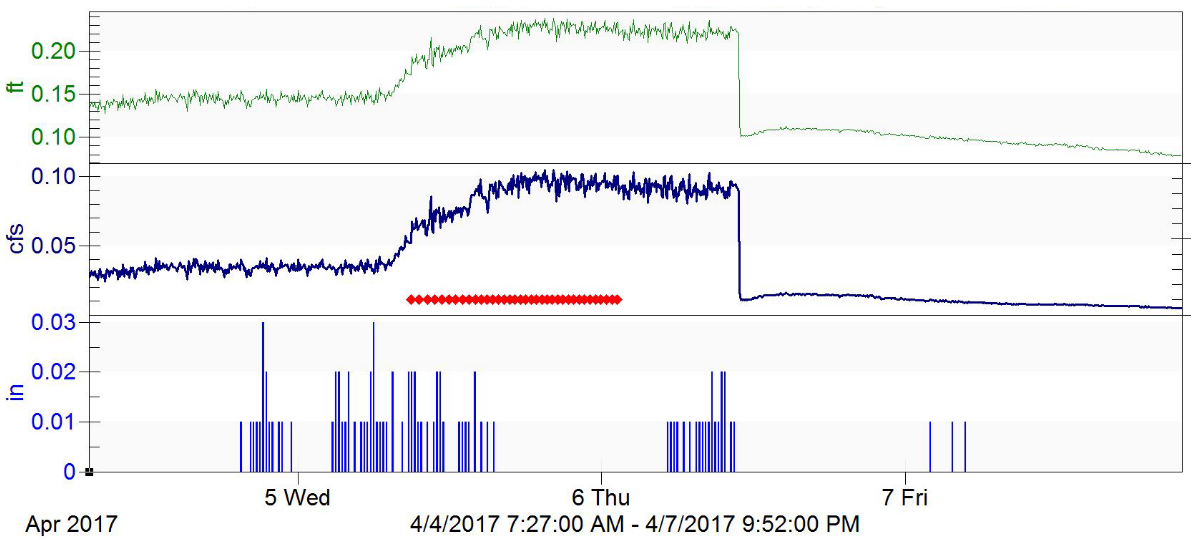


Figure 109. WBO, Storm 16.

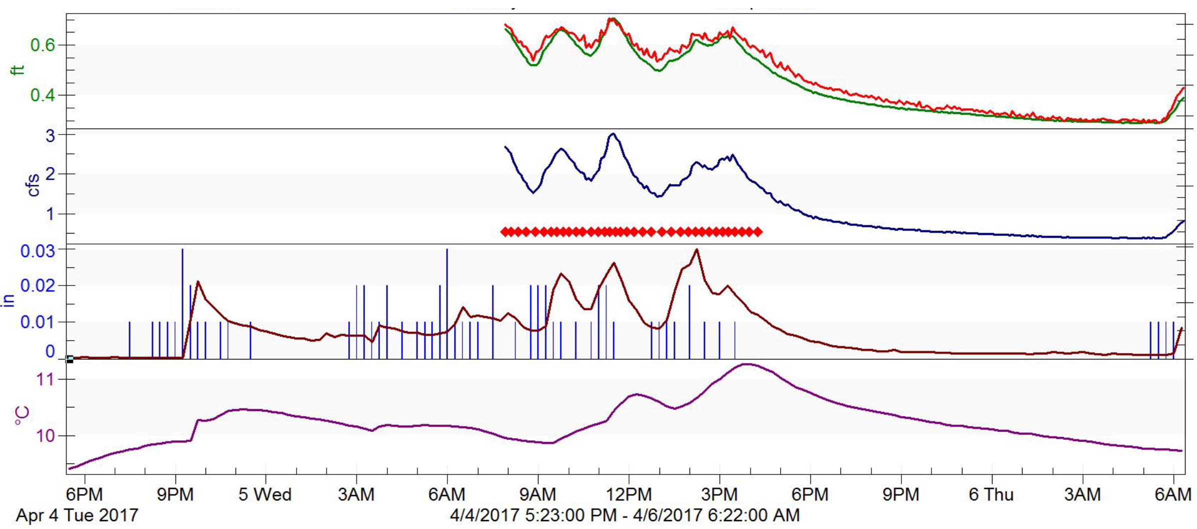


Figure 110. WCI, Storm 16.

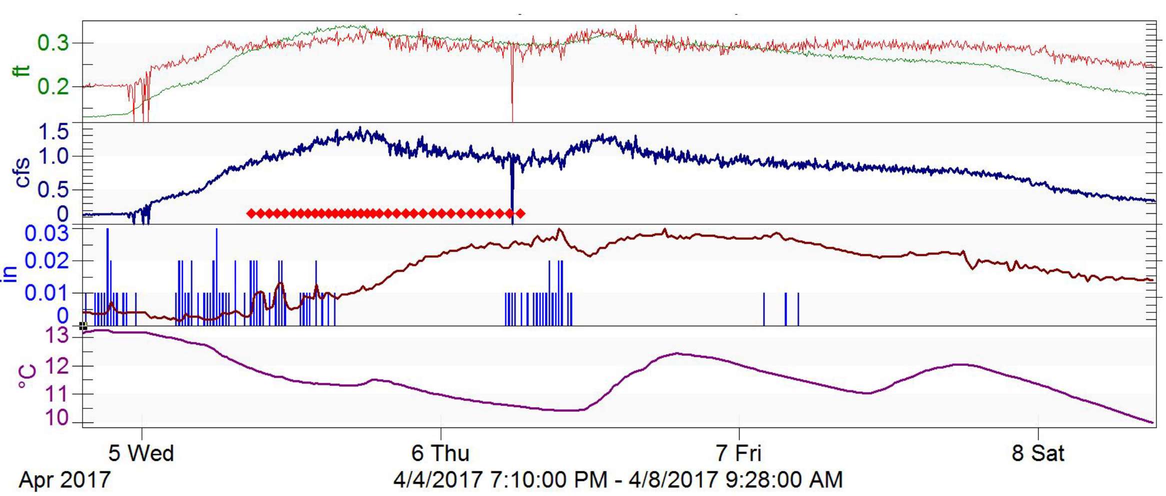


Figure 111. WCEBO, Storm 16.

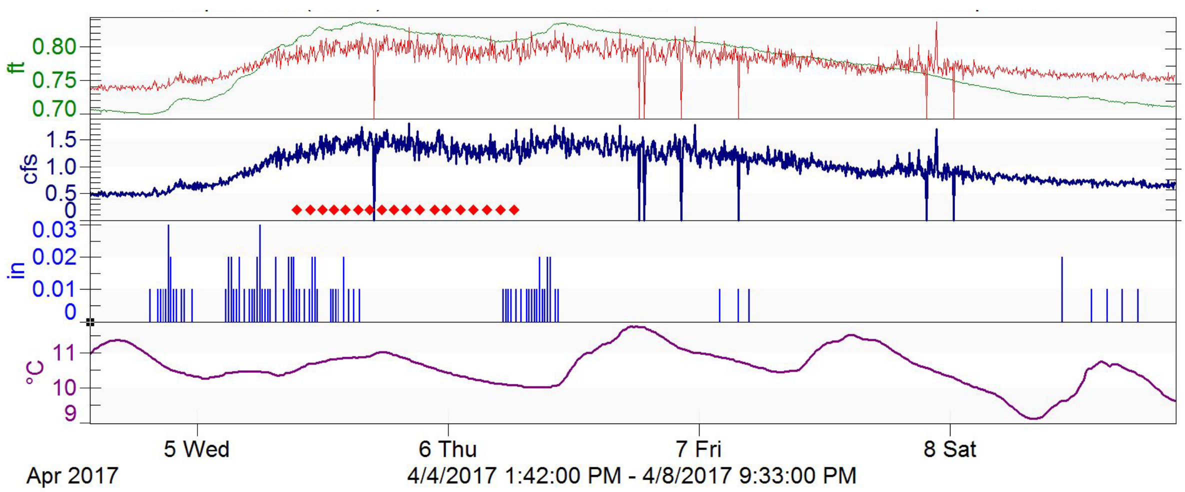


Figure 112. NFWHC, Storm 16.

Precipitation Information	Storm 17 4/19/2017
Dry antecedent period (hr)	13.75
Rainfall in 4 days before storm (in)	0.4
Rainfall in 48 hours before storm (in)	0.4
Rainfall in 24 hours before storm (in)	0.15
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.4
Peak rainfall (date, time)	4/19/17 9:00 PM
Rainfall volume in bioretention basin (cf)	32815.2
Rainfall volume in wetland complex basin (cf)	284011.2

Sampling Information	Storm 17 - 4/19/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	7160	7896	4242	6450	139194	188477	300870
Start of flow (hhmm)	1240	1300	1240	2200	1025	1150	1130
Average flow rate for entire storm (cfs)	0.103	0.071	0.059	0.029	0.951	0.786	1.115
Duration of flow (hr)	19.3	30.9	20.0	61.8	40.7	66.6	75.0
Runoff first 24 hrs of event (start at time of first sample) (cf)	7024	7057	4160	2709	115425	94940	126451
Runoff volume sampled (cf)	4818	5677	2594	1380	103128	53139	72052
% of runoff volume sampled	68.59	80.44	62.36	50.94	89.35	55.97	56.98
Average flow rate during sampling interval (cfs)	0.115	0.106	0.061	0.026	1.638	1.029	1.378
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	yes
Number of aliquots collected	36	27	36	33	36	17	21
Peak flow rate (cfs)	0.42	0.27	0.19	0.05	5.33	1.56	2.53
Peak hydrograph (date, time)	4/19/2017 11:50:00 PM	4/20/2017 12:40:00 AM	4/19/2017 11:50:00 PM	4/20/2017 6:15:00 AM	4/19/2017 10:15:00 PM	4/20/2017 5:20:00 AM	4/20/2017 12:40:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	2:50	3:40	2:50	9:15	1:15	8:20	3:40

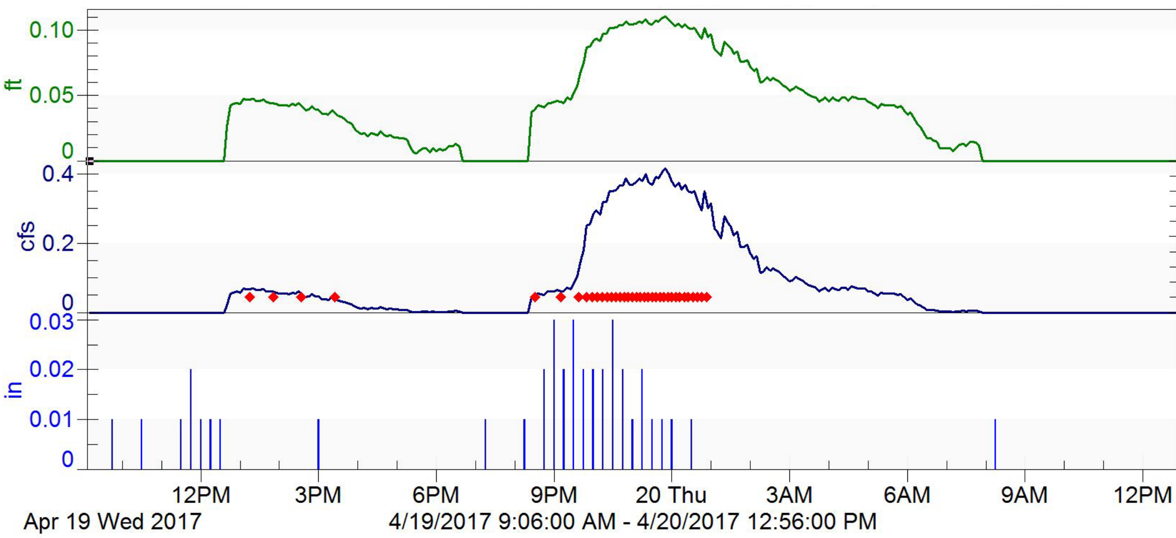


Figure 113. EBI, Storm 17.

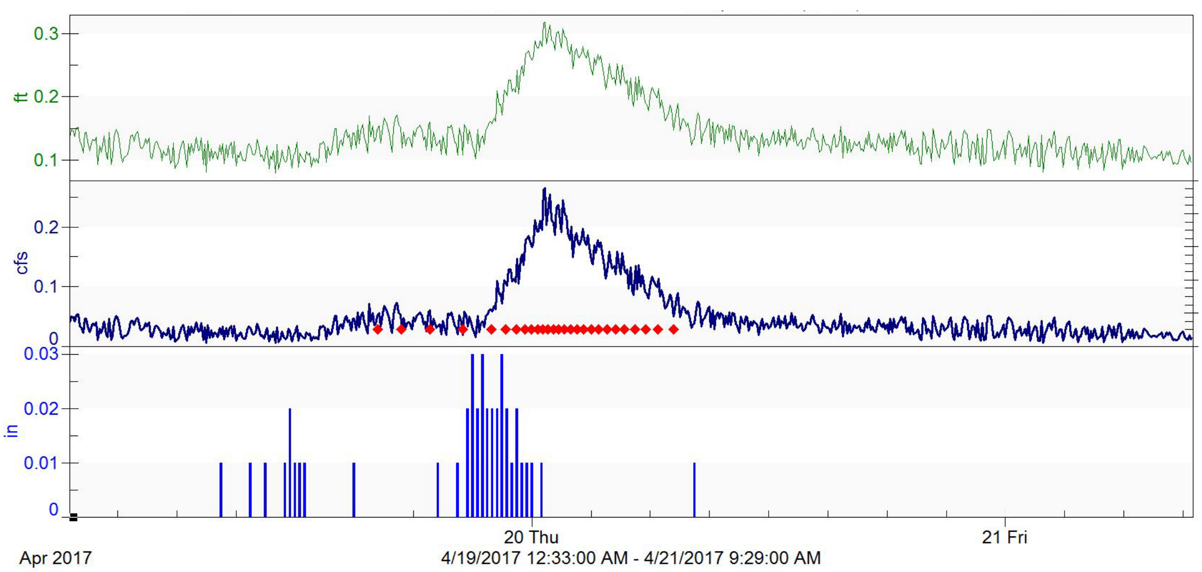


Figure 114. EBO, Storm 17.

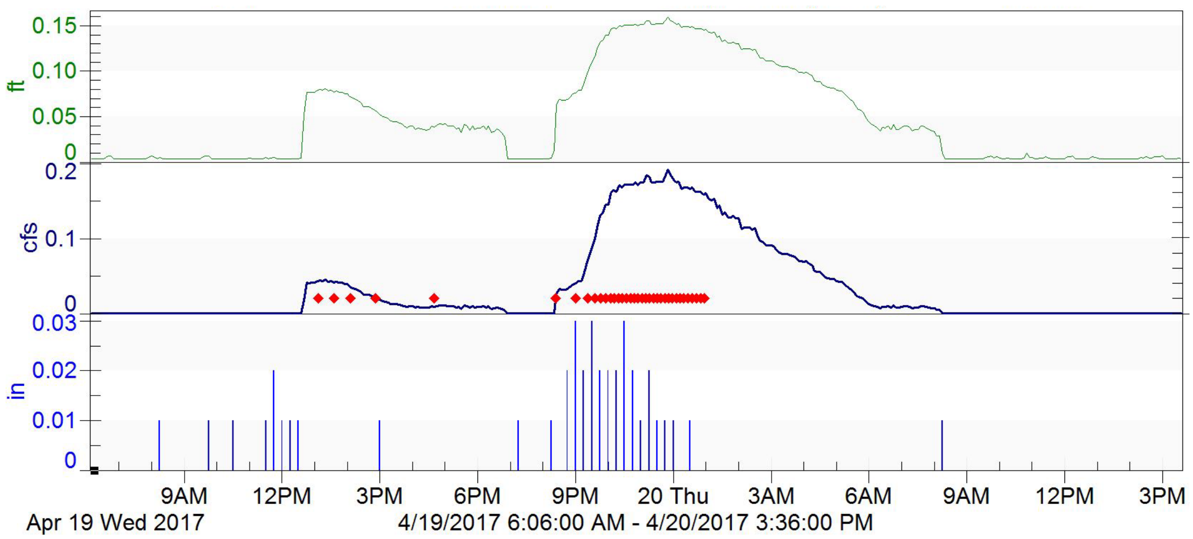


Figure 115. WBI, Storm 17.

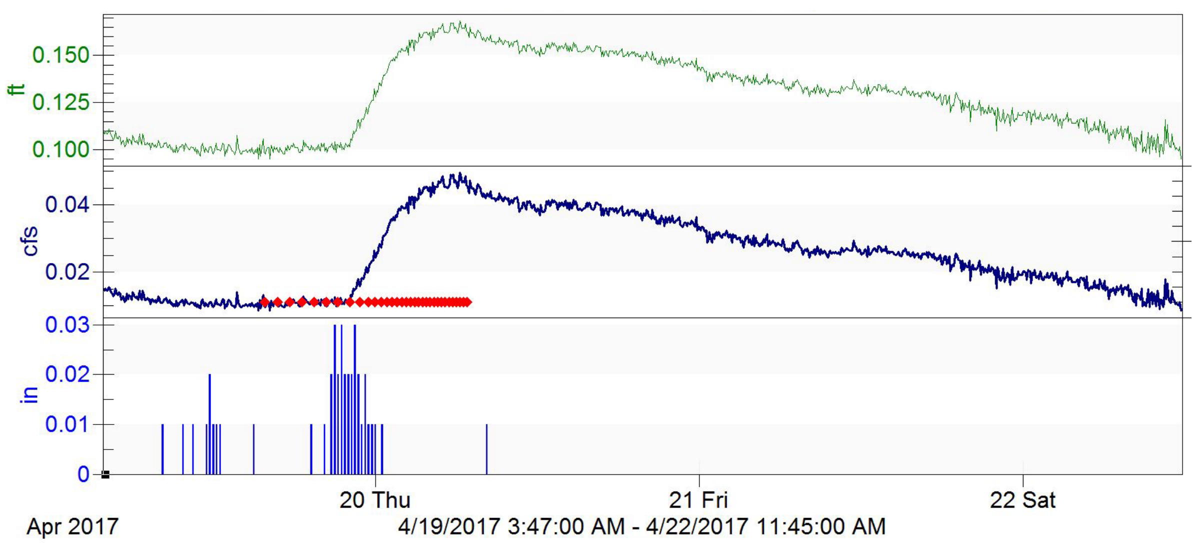


Figure 116. WBO, Storm1 7.

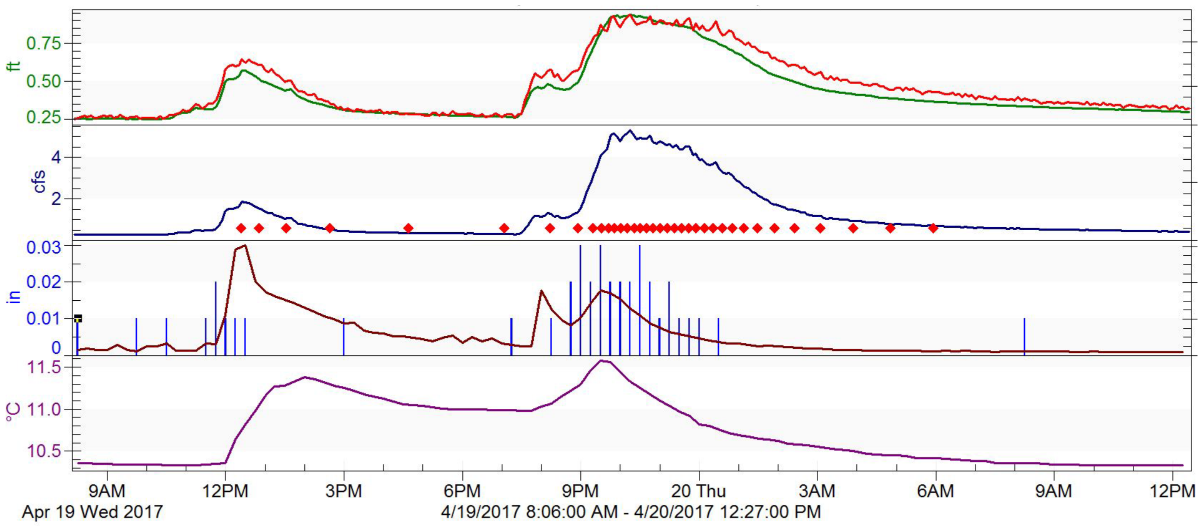


Figure 117. WCI, Storm 17.

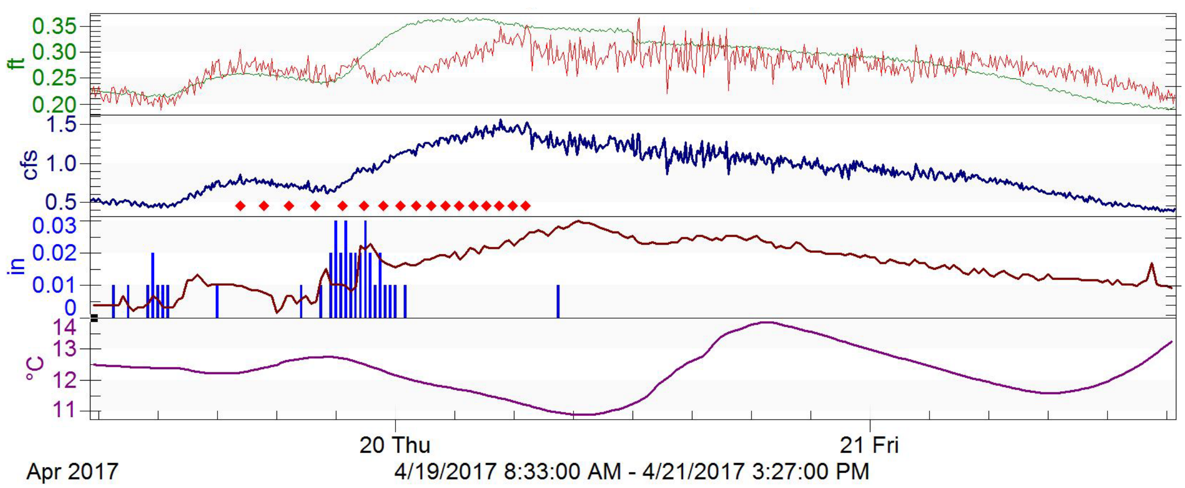


Figure 118. WCEBO, Storm 17.

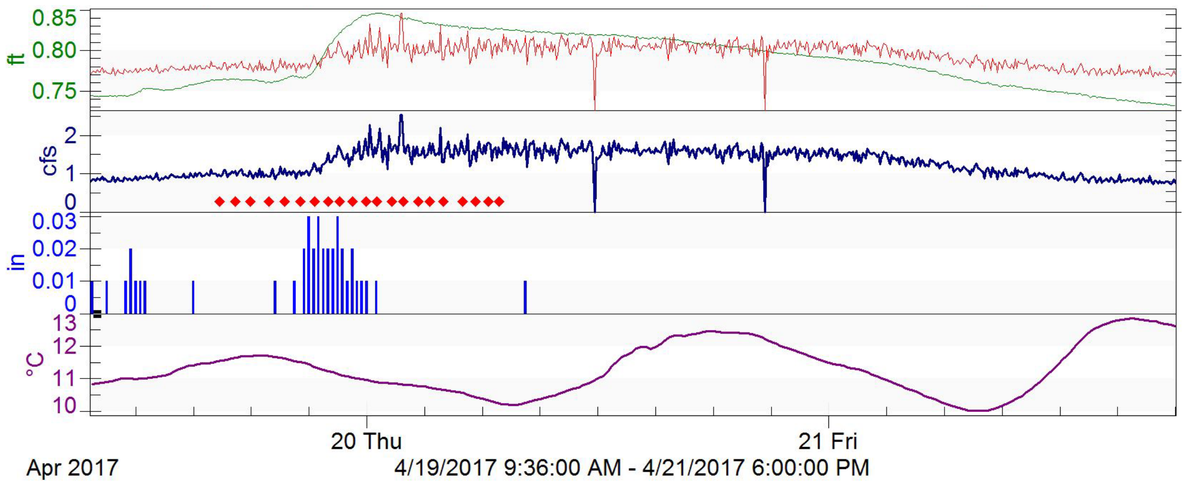


Figure 119. NFWHC, Storm 17.

Precipitation Information	Storm 18
	4/23/2017
Dry antecedent period (hr)	17.75
Rainfall in 4 days before storm (in)	0.46
Rainfall in 48 hours before storm (in)	0.08
Rainfall in 24 hours before storm (in)	0.08
Rainfall in 6 hours before storm (in)	0
Rainfall during storm (in)	0.5
Peak rainfall (date, time)	4/23/17 6:00 PM
Rainfall volume in bioretention basin (cf)	41019
Rainfall volume in wetland complex basin (cf)	355014

Sampling Information	Storm 18 - 4/23/2017						
	EBI	EBO	WBI	WBO	WCI	WCEBO	NFWHC
Total runoff volume for storm (cf)	4365	5047	2834	4756	113487	111810	199780
Start of flow (hhmm)	1550	1620	1550	1855	1310	1620	1400
Average flow rate for entire storm (cfs)	0.07	0.047	0.044	0.035	0.978	1.036	1.248
Duration of flow (hr)	17.3	29.8	17.9	37.7	32.2	30.0	44.5
Runoff first 24 hrs of event (start at time of first sample) (cf)	4138	4432	2711	3226	102154	100177	131859
Runoff volume sampled (cf)	4081	3714	2695	2287	96861	81701	99388
% of runoff volume sampled	98.62	83.80	99.41	70.89	94.82	81.56	75.37
Average flow rate during sampling interval (cfs)	0.082	0.061	0.048	0.038	1.333	1.289	1.607
Peak of hydrograph captured?	yes	yes	yes	yes	yes	yes	yes
Number of aliquots collected	20	15	24	16	27	23	17
Peak flow rate (cfs)	0.32	0.13	0.161	0.04	8.15	1.77	2.17
Peak hydrograph (date, time)	4/23/2017 6:10:00 PM	4/23/2018 8:45:00 PM	4/23/2017 6:10:00 PM	4/24/2017 3:45:00 AM	4/23/2017 6:00:00 PM	4/24/2017 8:10:00 AM	4/24/2017 6:50:00 AM
Time difference: peak rain to peak hydrograph (hr:min)	0:10	2:45	0:10	9:45	0:00	14:10	12:50

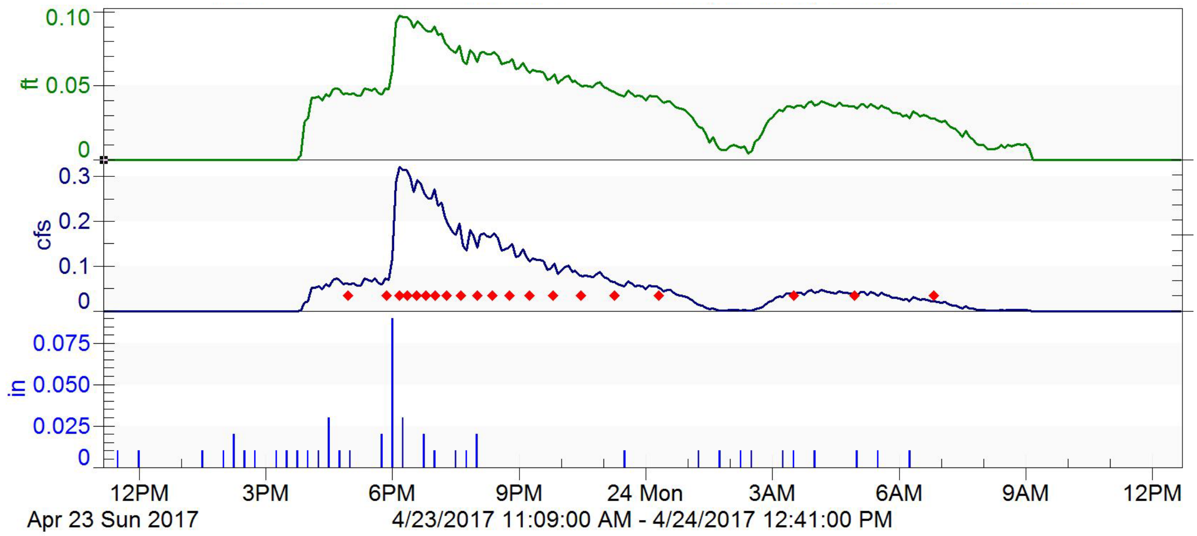


Figure 120. EBI, Storm 18.

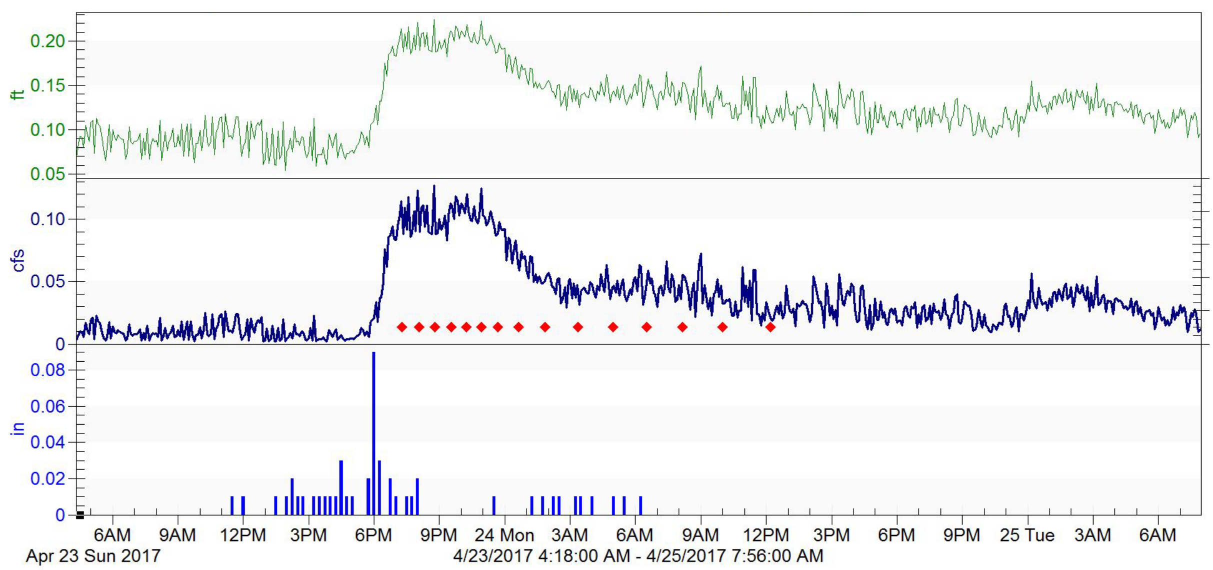


Figure 121. EBO, Storm 18.

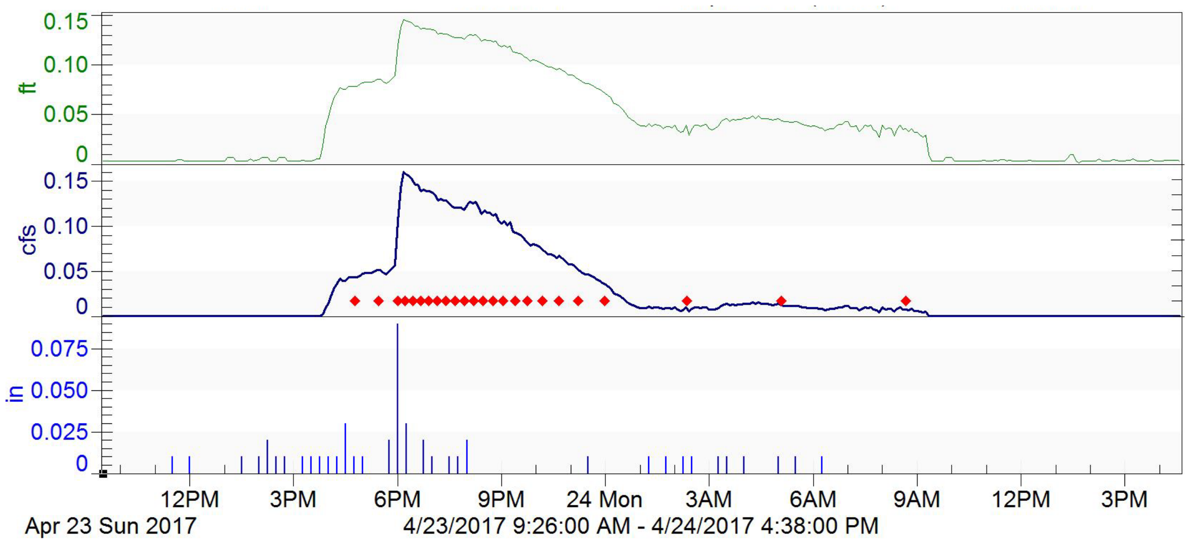


Figure 122. WBI, Storm 18.

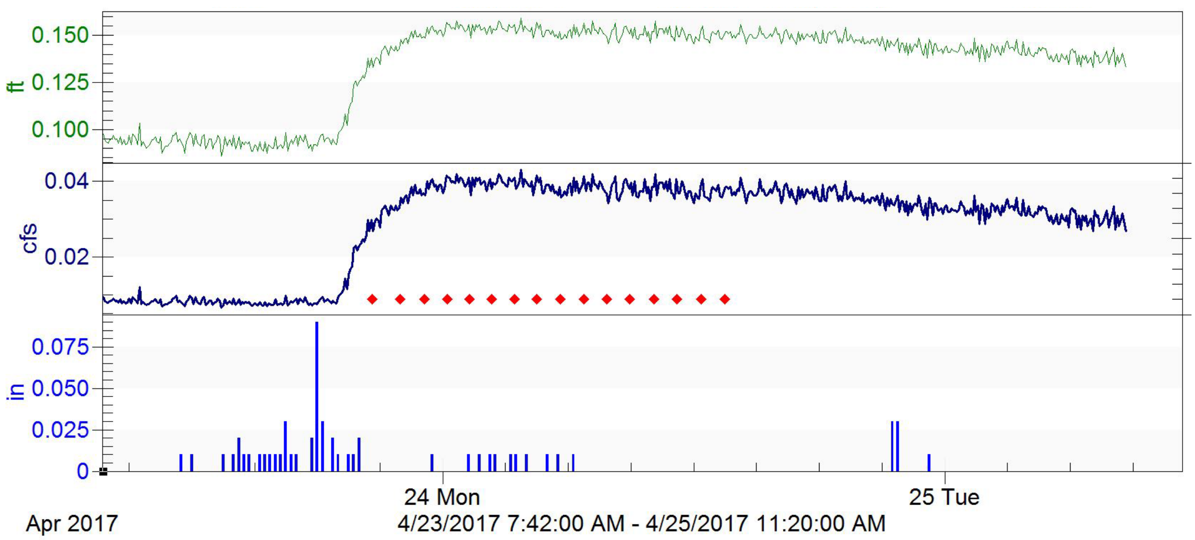


Figure 123. WBO, Storm 18.

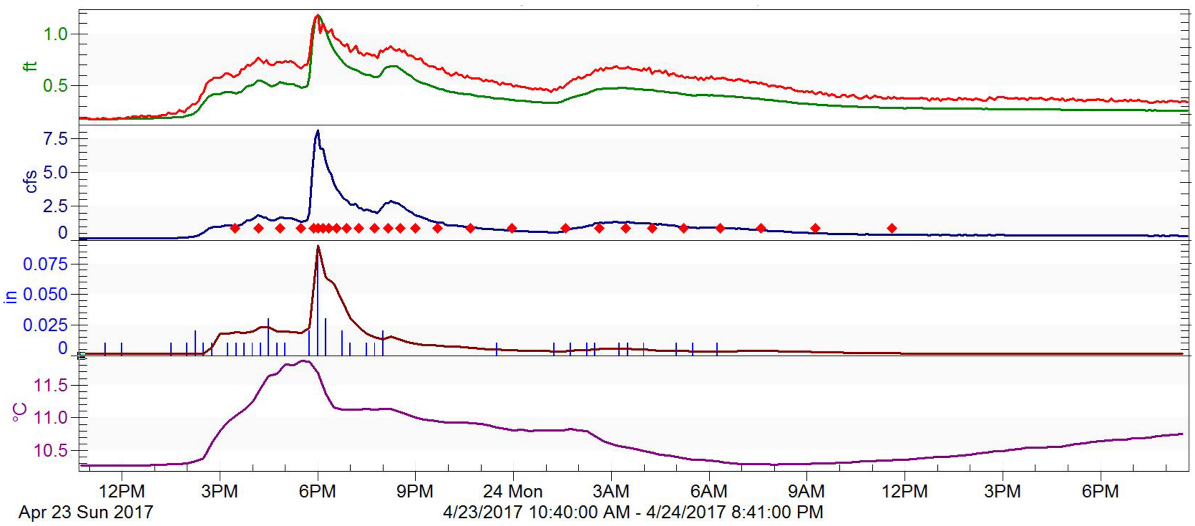


Figure 124. WCI, Storm 18.

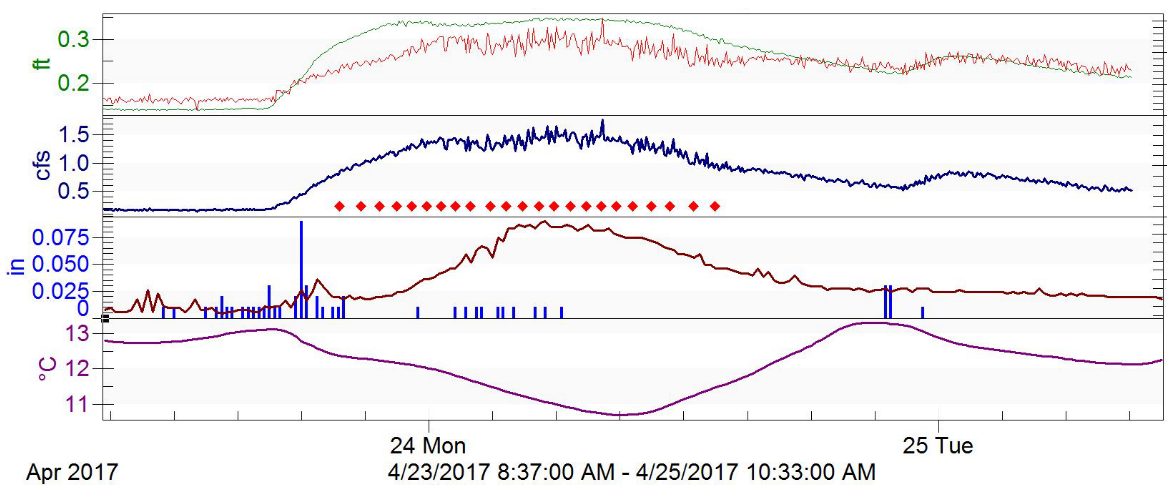


Figure 125. WCEBO, Storm 18.

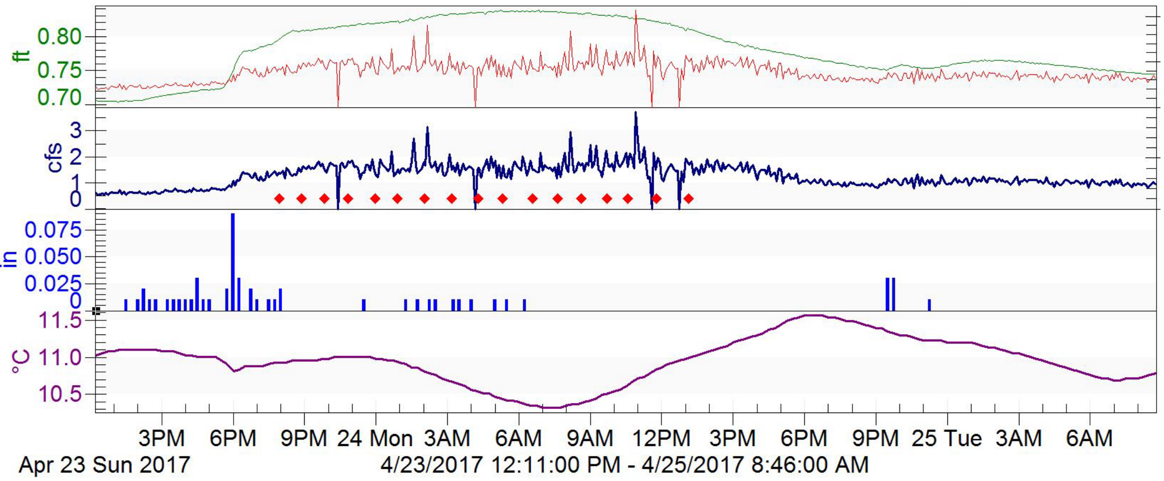


Figure 126. NFWHC, Storm 18.

Appendix I References

King County. 2016. Quality Assurance Project Plan Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA. Prepared by Kate Macneale, Water and Land Resources Division. Seattle, Washington.

Appendix J: Monitoring Water Depth in Bioretention Facilities

APPENDIX J – MONITORING WATER DEPTH MONITORING IN BIORETENTION FACILITIES

Water level loggers were installed in the bioretention facilities to determine when water was pooling, and potentially overflowing, from each facility. As described in the Quality Assurance Project Plan (QAPP; King County 2016), a HOBO U20L-04 water level logger was placed in each of the bioretention facilities, and a third logger used to record air pressure was placed in a tree on site. These loggers recorded barometric pressure (in psi) every 15 minutes, and water level was calculated per manufacturer's instructions as (water logger psi – air logger psi)*2.307.

Water levels were monitored continuously throughout the storm sampling interval (3/1/16 - 4/25/17). Water level accuracy was generally within the manufacturer's specifications (maximum error ± 0.8 cm or 0.03 feet [ft.]), though during two field checks the level measurement error was as much as +0.06 ft. In addition, daily maximum levels occasionally measured ±0.67 ft., even when there had been no recent precipitation. Therefore, accuracy is assumed to be closer to ± 0.07 ft. Because the primary objective was to determine if the facilities were retaining water and overflowing, and not to track exact depth, data were deemed usable if they were within ± 0.07 ft. of field measured values.

Over the entire storm sampling interval, 100% of the data from the east bioretention facility (EB) and 98% of the data from the west bioretention facility (WB) were usable. The rejected WB data were almost exclusively collected on days when temperatures were below freezing and the logger appeared to malfunction (e.g., values were erratic, often negative, and as much as ±1.5 ft. from field measurements). The EB logger appeared to function regardless of occasional sub-freezing temperatures. During sampled storm events (Table 1), 100% and 99.9% of the data were usable from EB and WB, respectively. Two WB data points recorded during Storm 13 were rejected because they exceeded ±0.07 ft. of the true level.

Overflow occurred when water levels exceeded 0.85 ft. in EB and 1.30 ft in WB (Table 1). Water level data corroborated the flow data and indicated EB retained water for a shorter time and was less likely to overflow than WB. From 3/1/16 through 4/25/17, EB overflowed once and WB overflowed four times. These overflow events corresponded with sampled storms (Table 1). Figures 1 – 3 illustrate the maximum daily water levels and rainfall during times when water pooled in the bioretention facilities. For clarity, daily maximum values <0.07 ft. are not plotted.

The implications of overflow differ by bioretention facility. Overflow from WB goes into the new pond and is not accounted for by measurements at the west bioretention outlet (WBO). Thus, volume and loading estimates for WB may overestimate treatment, because the overflow is not measured chemically or volumetrically. In contrast, EB overflow goes into the pipe discharging from EB and is accounted for by measurements at the east bioretention outlet (EBO). Thus, EB volume and loading estimates include overflow and thus accurately reflect the net treatment between EBI and EBO.

Table 1. Maximum water level in bioretention facilities during sampled storms, and whether facilities had untreated overflows during sampling events.

Storm	Date storm started	East Bioretention Facility		West Bioretention Facility	
		Max water level, ft	Facility overflowed	Max water level, ft	Facility overflowed
1	3/9/2016	0.87	yes	0.82	no
2	3/23/2016	0.10	no	*	no
3	10/19/2016	*	no	*	no
4	10/26/2016	*	no	0.91	no
5	10/31/2016	*	no	*	no
6	12/19/2016	*	no	*	no
7	1/17/2017	*	no	1.39	yes
8	2/8/2017	0.31	no	1.39	yes
9	2/15/2017	0.47	no	1.51	yes
10	3/7/2017	*	no	0.30	no
11	3/9/2017	*	no	0.71	no
12	3/13/2017	*	no	0.54	no
13	3/14/2017	0.14	no	1.35	yes
14	3/26/2017	*	no	*	no
15	3/29/2017	*	no	0.43	no
16	4/5/2017	*	no	*	no
17	4/19/2017	*	no	*	no
18	4/23/2017	*	no	*	no

* Water level did not exceed 0.07 ft during storm.

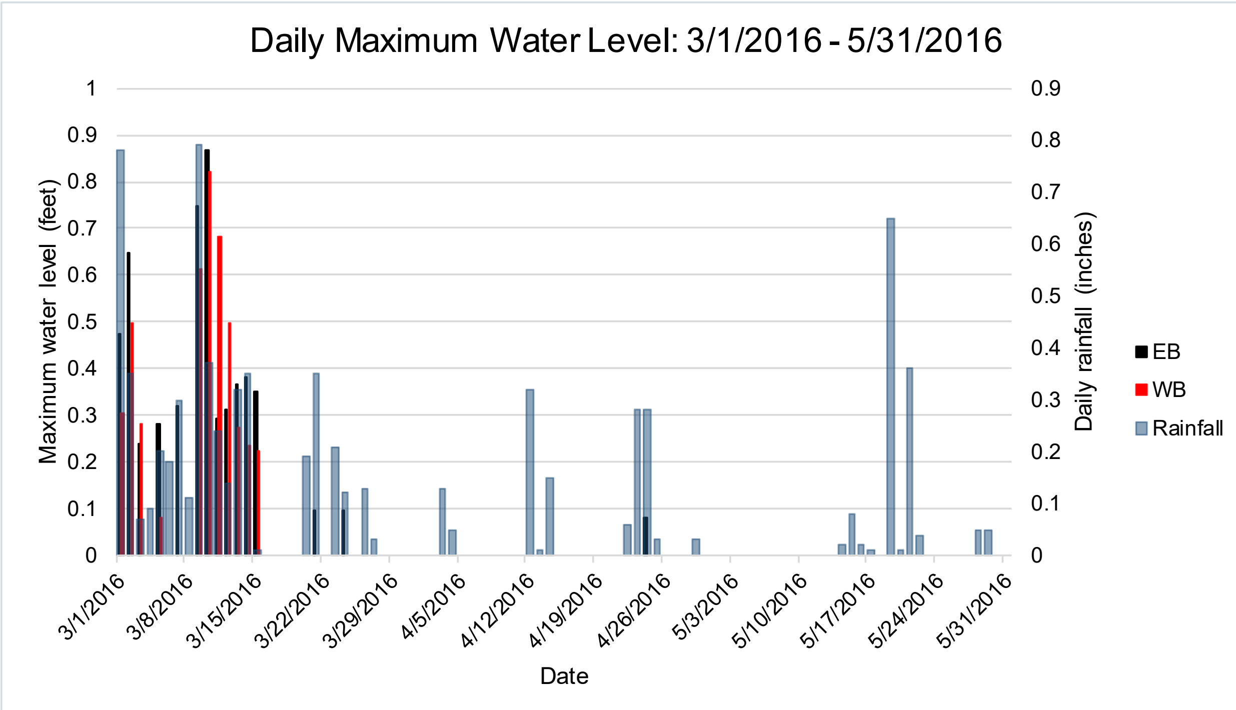


Figure 1. **Maximum daily water levels in the bioretention facilities and daily rainfall, from 3/1/16 – 5/31/16.**

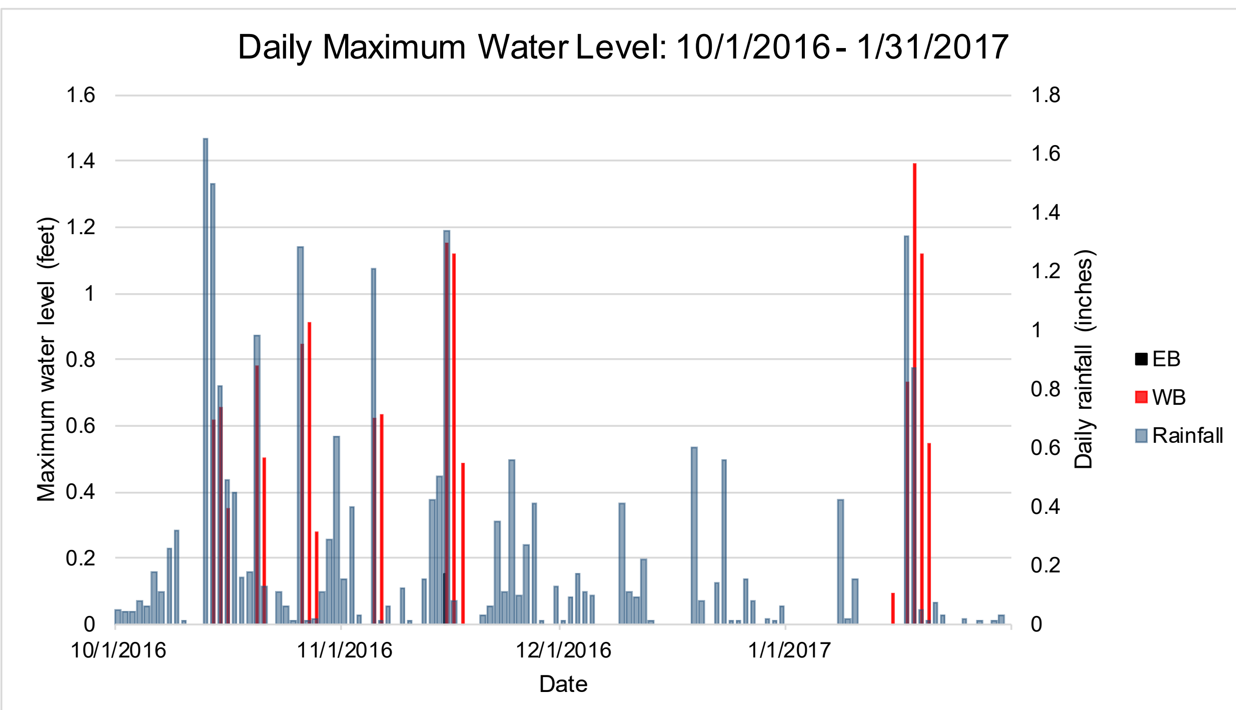


Figure 2. **Maximum daily water levels in the bioretention facilities and daily rainfall, from 10/1/2016 – 1/31/2017.**

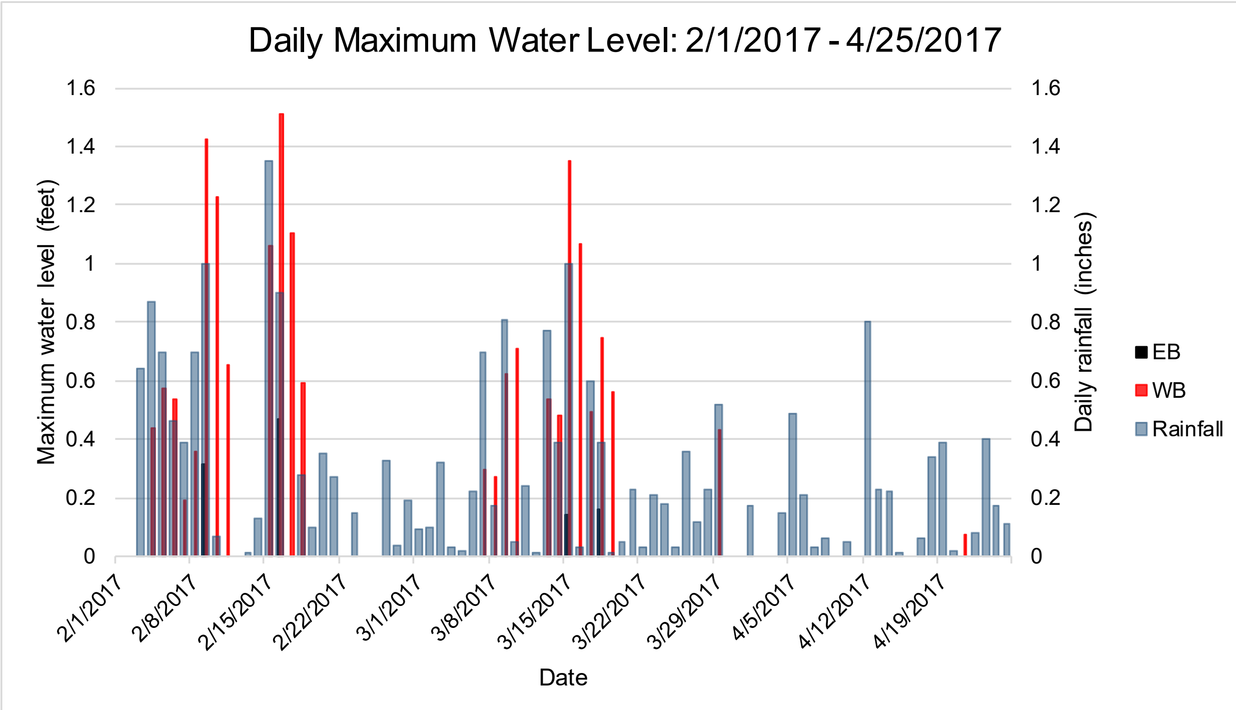


Figure 3. **Maximum daily water levels in the bioretention facilities and daily rainfall, from 2/1/2017 – 4/25/2017.**

Appendix K: Detailed Results of Continuous Turbidity and Temperature Monitoring

APPENDIX K – DETAILED RESULTS OF CONTINUOUS TURBIDITY AND TEMPERATURE MONITORING

To address Goals 3 and 4 related to improved effectiveness of the entire South 356th Street Regional Detention Facility (RDF), following the retrofit and expansion, the study compared pre- and post-retrofit turbidity and temperature data. Turbidity and temperature were measured continuously at the wetland complex inlet (WCI) and discharge point to the creek (DPC) downstream of the RDF for several years before the retrofit and expansion was complete, and for one year following the expansion (Tables 1 and 2). In addition, pre- and post-retrofit temperature data from the inlet and the North Fork of West Hylebos Creek at S. 359th Street were compared to assess whether any rise in temperature associated with the expanded RDF resulted in a temperature increase in the receiving waters.

Table 1. Summary of continuous turbidity measurements recorded at inlet (IN) and outlet (OUT) of S. 356th St. RDF, pre- and post-retrofit.

Continuous Turbidity Measured at RDF Inlet and Outlet		Pre-Retrofit	Post-Retrofit
Date Range (excluding all data from Jul, Aug and Sep)		5/11/2011 - 3/11/2014	5/1/2016 - 4/30/2017
IN (at WCI)	Mean Daily Average Turbidity (NTU)	5.38	4.13
	Standard Deviation of Average Turbidity	5.96	4.17
	Number of days included in analysis of average values	572	272
	Mean Daily Max Turbidity (NTU)	30.38	24.74
	Standard Deviation of Max Turbidity	41.17	45.18
	Number of days included in analysis of max values	616	273
	Percent of days max turbidity exceeded 10 NTU	52%	49%
OUT (at DPC)	Mean Daily Average Turbidity (NTU)	3.05	2.21
	Standard Deviation of Average Turbidity	2.94	2.62
	Number of days included in analysis of average values	572	272
	Mean Daily Max Turbidity (NTU)	6.52	5.33
	Standard Deviation of Max Turbidity	7.45	6.20
	Number of days included in analysis of max values	616	273
	Percent of days max turbidity exceeded 10 NTU	18%	15%

Table 2. Summary of continuous temperature monitoring at inlet (IN) and outlet (OUT) of the S. 356th St. RDF, and in the North Fork of West Hylebos Creek at S. 359th St. (Creek).

Continuous Temperature Measured at RDF Inlet and Outlet, and in North Fork of West Hylebos Creek		Pre-Retrofit	Post-Retrofit
Date Range		5/12/2011 - 3/11/2014	4/19/2016 - 8/16/2017
IN (at WCI)	Mean Daily Average Temperature (°C)	11.04	12.14
	Standard Deviation of Average Temperature	3.44	3.93
	Number of days included in analysis of average values	836	429
	Mean Daily Max Temperature (°C)	11.50	12.62
	Standard Deviation of Max Temperature	3.42	3.95
	Number of days included in analysis of max values	836	429
	Proportion of days max temp exceeded 17.5 °C	4%	11%
OUT (at DPC)	Mean Daily Average Temperature (°C)	10.73	13.03
	Standard Deviation of Average Temperature	4.64	5.45
	Number of days included in analysis of average values	836	429
	Mean Daily Max Temperature (°C)	11.33	13.74
	Standard Deviation of Max Temperature	4.72	5.62
	Number of days included in analysis of max values	836	429
	Proportion of days max temp exceeded 17.5 °C	8%	29%
Creek (at NFWHC)	Mean Daily Average Temperature (°C)	10.02	10.74
	Standard Deviation of Average Temperature	2.98	3.10
	Number of days included in analysis of average values	836	429
	Mean Daily Max Temperature (°C)	10.55	11.37
	Standard Deviation of Max Temperature	3.04	3.11
	Number of days included in analysis of max values	836	429
	Proportion of days max temp exceeded 17.5 °C	0%	0%

Turbidity levels were expected to decrease in the RDF outlet due to increased settling in the new CDSTW, as well as bioretention treatment of previously untreated runoff from a basin that drained through the outlet pipe. It was also anticipated that increased residence time of water in the RDF would not result in increased outlet and creek temperatures.

Washington State water quality standards (WQS) specify that turbidity in the West Hylebos Creek basin should not exceed 5 NTU above background (Ecology 2016); the City of Federal Way previously described this threshold as 10 NTU (Smith2006). Although the WQS apply to receiving waters, and not RDF inlets and outlets, this report includes the number of days maximum turbidity levels exceeded 10 NTU in the inlet and outlet because the threshold is environmentally relevant (Table 1).

The WQS standards indicate that the highest 7-day average daily maximum (7-DADMax) stream temperature cannot exceed 17.5°C (Ecology 2016). Due to several data gaps, and because the focus of this analysis was on more subtle temperature shifts, this report includes counts of single days exceeding 17.5°C, and not 7-DADMax (Table 2).

As detailed in the QAPP (2016), continuous turbidity and temperature data were collected with two YSI 6920 Multi-parameter sondes and YSI 6560 probes at the RDF inlet and outlet from October through June, from 2011 to 2014 (Tables 1 and 2). In addition, an Onset® Instruments TidBit temperature logger recorded downstream temperature in the creek (Tables 1 and 2). Following the retrofit, King County staff deployed the same YSI sondes and loggers at the same locations. Daily average and daily maximum values are included in this report.

Summary statistics are used to describe the monitoring results (Tables 1 and 2). In addition, linear regression analyses and model selection were used to assess what factors (location: inlet and outlet; time interval: pre- and post-retrofit; the interaction of location and time interval) best explained the daily average and daily max turbidity and temperature values. Analyses were done in R, version 3.4.3, and the stats package for analysis and ggplot2 for graphics.

The range of turbidity data used for this analysis was limited to values equal to or less than the highest inlet value observed in the post-retrofit interval. This was intended to limit the range of inlet values to those comparable pre- and post-retrofit. Turbidity data used for analysis of daily average turbidity was limited to dates with daily average values between 0 and 25 NTU, while analysis of daily max turbidity was limited to dates with values between 0 and 366 NTU. In addition, because pre-retrofit turbidity data were not available for most days during summer months (July, August and September), data analysis was limited to fall, winter and spring months.

Turbidity results and discussion

The differences between inlet and outlet turbidity pre- and post-retrofit indicate the RDF was more effective at reducing turbidity after the retrofit and expansion than before. Results of the linear regression analysis indicate the best models explaining daily average and maximum turbidity values included both location and time, as well as the interaction between location and time. Turbidity in the outlet was reduced significantly compared to inlet turbidity during both time intervals, but was lowest post-retrofit (Figures 1 and 2). The inlet turbidity was not statistically different pre- and post-retrofit (for daily average or daily max values), and yet outlet turbidity pre- and post-retrofit was significantly different. These results, and the significance of the interaction term, indicate that between pre- and post-retrofit, the effectiveness in controlling turbidity improved.

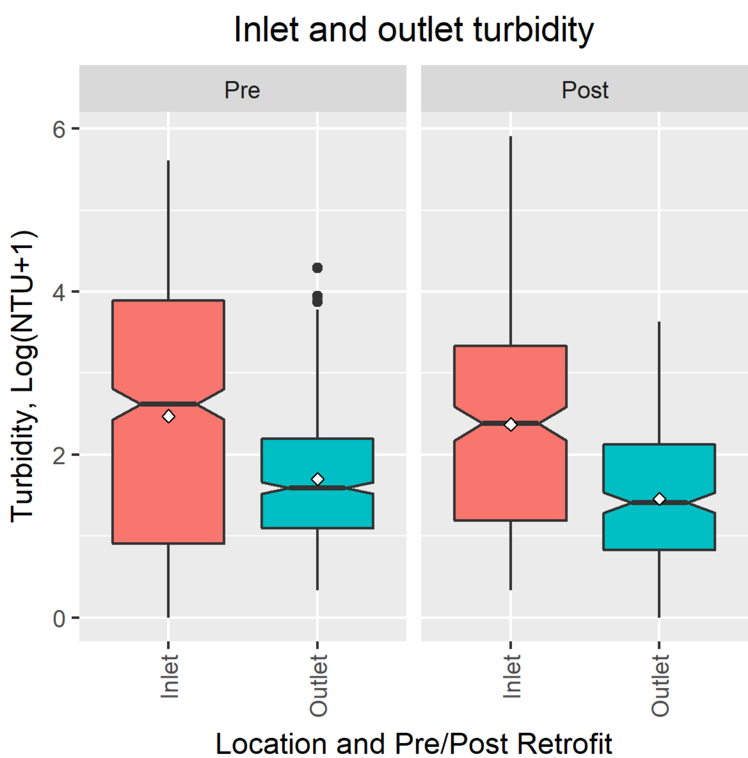


Figure 1. Box plots of log-transformed daily maximum turbidity (NTU) at the RDF inlet and outlet, pre- and post-retrofit.

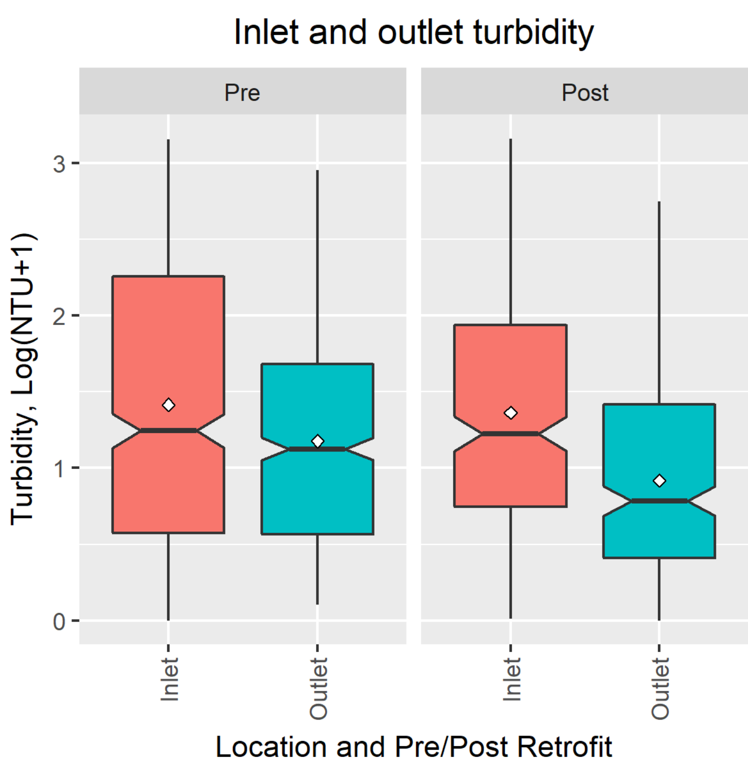


Figure 2. Box plots of log transformed daily average turbidity (NTU) at the RDF inlet and outlet, pre- and post-retrofit.

The linear regression analyses of the daily maximum and daily average turbidity (Figures 3 and 4) suggest a somewhat different interpretation of how effective the RDF is at reducing turbidity when inlet values are high. The significance of the interaction term, in the best models for both average and maximum turbidity, suggest the inlet vs outlet slopes change following the retrofit and expansion. Analysis of the daily maximum turbidity data suggests that when turbidity is low (~<10 NTU) the removal efficiency of RDF is similar for both pre- and post-retrofit conditions; however, removal effectiveness improves when inlet turbidity levels are higher (Figure 3).

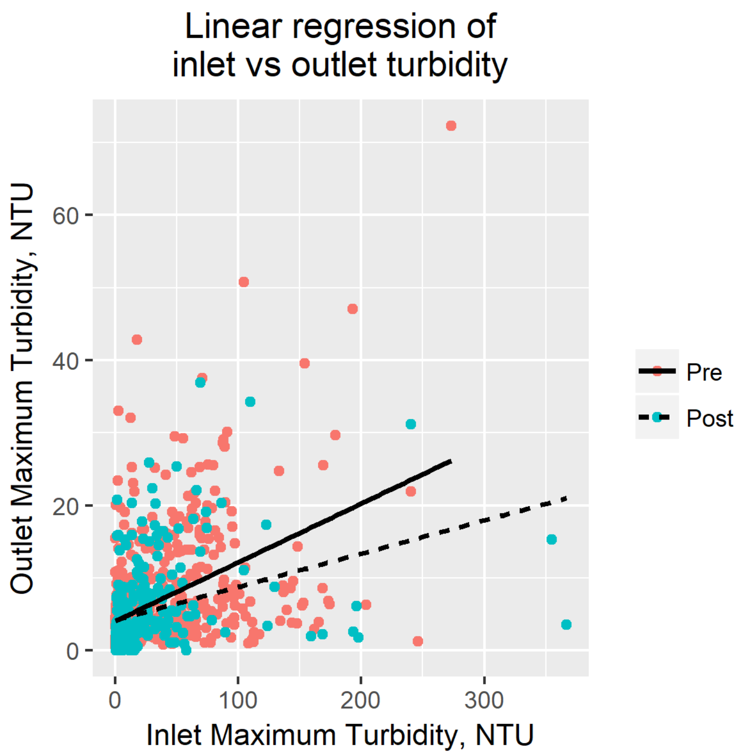


Figure 3. Linear regression of daily maximum turbidity (NTU) in the RDF inlet vs outlet, pre- and post-retrofit.

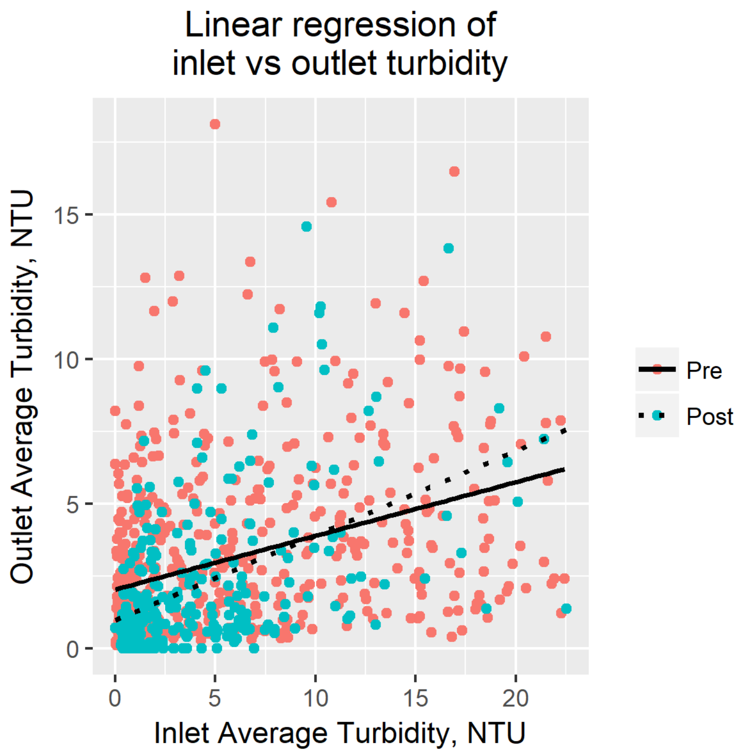


Figure 4. Linear regression of daily average turbidity (NTU) in the RDF inlet vs outlet, pre- and post-retrofit.

In contrast, the daily average turbidity data suggest a slightly different result. Analysis of the daily average turbidity data results in a cross of the pre-and post-retrofit lines, suggesting the greatest improvement is observed when inlet turbidity is less than 10 NTU; at higher concentrations the post-retrofit RDF is less effective (Figure 4). This result may be influenced by the shift in the distribution of inlet turbidity values post-retrofit. Additional monitoring would be helpful to determine how well the RDF reduces turbidity in the outlet when daily average inlet turbidity exceeds 10 NTU.

Water temperature results and discussion

Water temperature in the inlet and outlet was similar during the years immediately preceding the RDF retrofit; however, during the following year post-retrofit, temperature was significantly warmer in the outlet than in the inlet (Figures 5 and 6). The best models describing the RDF average and maximum temperatures include location (inlet and outlet) and time interval (pre- and post-retrofit), but no interaction term. The data distribution (Figures 5 and 6) suggests temperature increased more in the RDF post-retrofit, but the lack of a significant interaction between time and location suggests warmer post-retrofit temperature was likely due to warmer inlet temperature (Figure 7). While this may be the case, the increase in number of days maximum temperature exceeded 17.5°C (the state standard for salmonid spawning, rearing and migration) in the outlet suggests there is increased warming within the RDF post-retrofit and it may be biologically significant (Figures 5-7; Table 2).

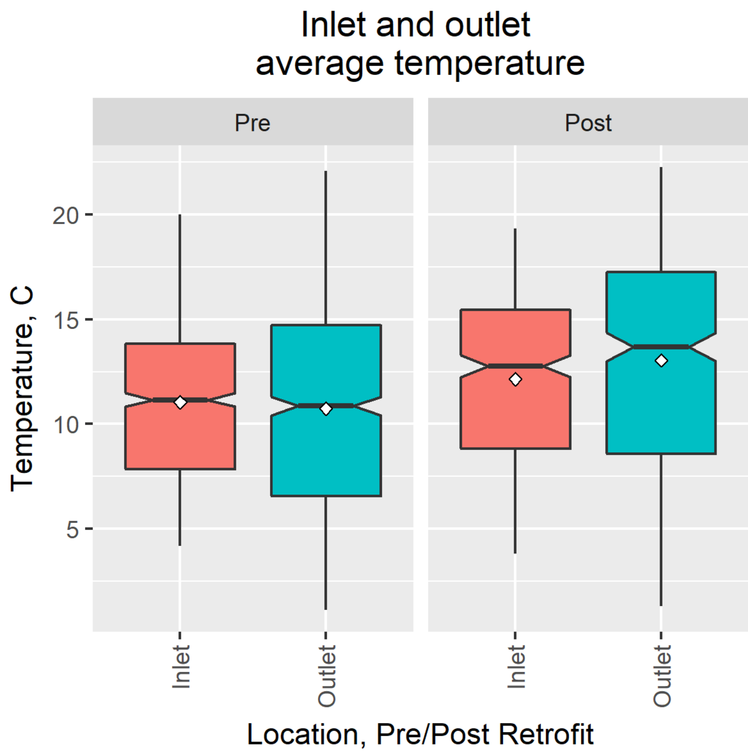


Figure 5. Box plots of daily average temperatures at the RDF inlet and outlet, pre- and post-retrofit.

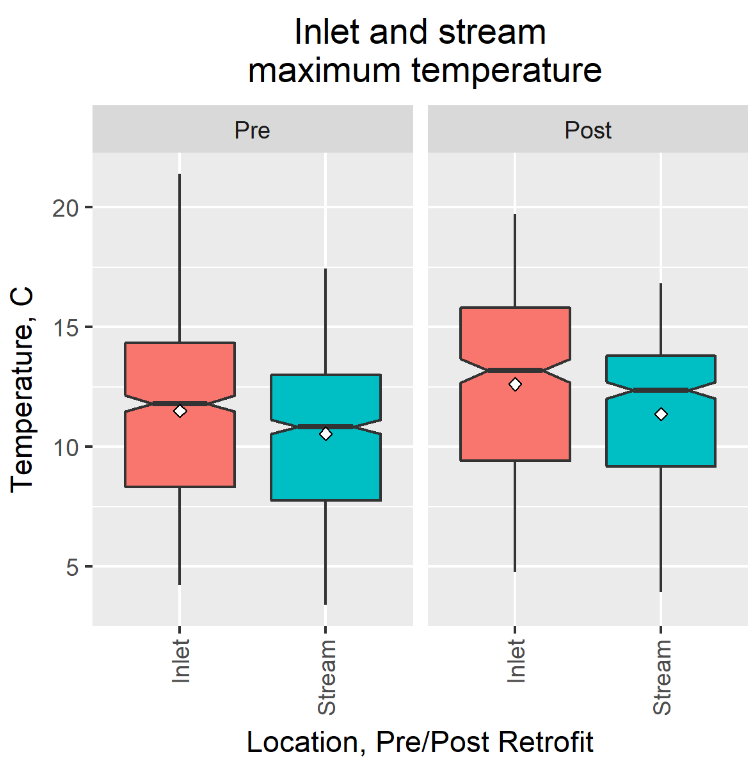


Figure 6. Box plots of daily maximum temperatures at the RDF inlet and outlet, pre- and post-retrofit.

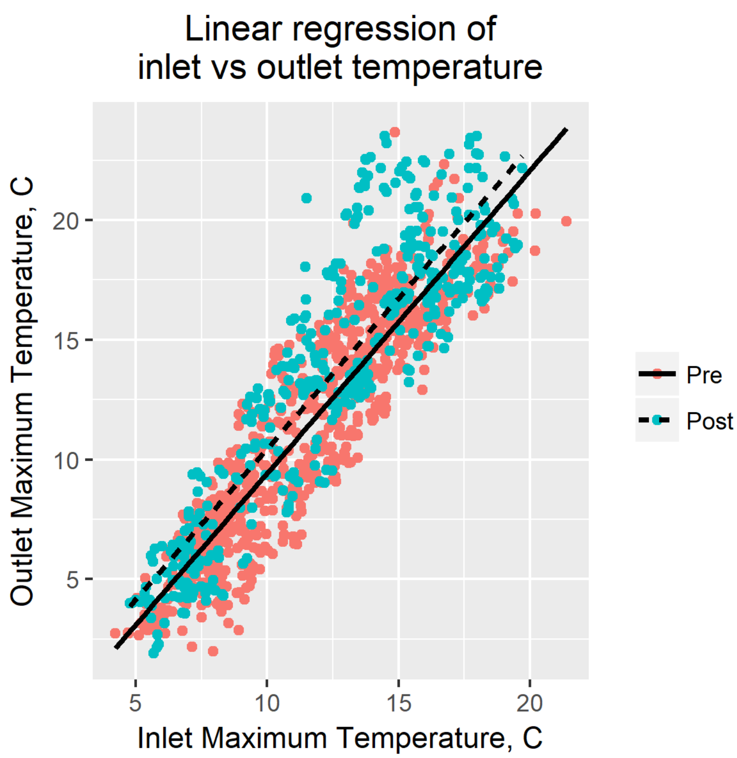


Figure 7. **Linear regression of daily maximum temperatures in S. 356th St. RDF inlet vs outlet, pre- and post-retrofit.**

During both pre- and post-retrofit periods, stream temperature downstream of the RDF was approximately 1°C cooler than inlet water temperatures (Table 2). Although inlet daily max temperatures occasionally exceeded 17.5°C, they never exceeded this threshold (Figure 8). This result is encouraging because it may suggest that cooling from groundwater and shading from riparian vegetation continue to at least partially ameliorate warming that occurs in the basin, and potentially in the RDF.

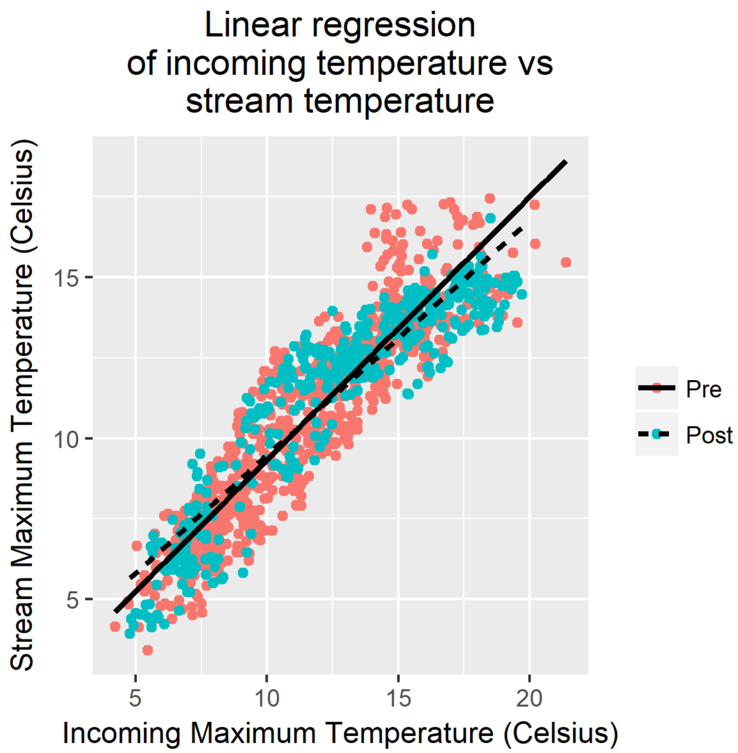


Figure 8. **Linear regression of daily maximum temperatures at the RDF inlet and at North Fork West Hylebos Creek at S. 359th St., pre- and post-retrofit.**

References

Ecology. 2016. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A. Revised October 2017. Publication no. 06-10-091.

Smith, D. 2006. Stormwater Temperature Monitoring. Project description prepared for the City of Federal Way, WA. 16 pages.