

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.

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

*Significantly different from the control ^φ 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 $4 \pm 2^\circ\text{C}$ 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 #:	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 ($^\circ\text{C}$)	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 ($\mu\text{mhos/cm}$)	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
$\text{NO}_2 + \text{NO}_3$ (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 $60 \mu\text{m}$ with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at $20 \pm 1^\circ\text{C}$.

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 $60 \mu\text{m}$ 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	LWW	Units
	1-18-16	2-29-16	
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

+ 45 cmpds not detectable

** 68 cmpds not detectable

++ 68 cmpds not detectable

*** 28 cmpds not detected

+++ 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 $25 \pm 1.0^\circ\text{C}$ 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.

	<i>Daphnia</i>	<i>Ceriodaphnia</i>
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 ($\mu\text{g/L}$)		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 \pm 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				Mean	# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)					
			Rep 1	Rep 2	Rep 3	Rep 4		
----	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* [‡]	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)

[‡]Significantly 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)										Mean Reprod	Mean % Surv
			1	2	3	4	5	6	7	8	9	10		
---	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 ^φ	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 ^φ	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 ^{φ+}	100
L65007-7	FW-NFWHC	100	26	24	29	26	24	25	22	27	24	22	24.9	100

^φSignificantly 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) ^ΩOutlier 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:	<i>Ceriodaphnia</i>	<i>Daphnia</i>
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.

Sample #↓	Station	Test #/ Date → Site	<i>Daphnia</i>	<i>Ceriodaphnia</i>	
			8170/ 10-25-16 Mean % Surv	8160/ 10-21-16 Mean % Surv	Mean Reprod
Control	---	WW (<i>D.p.</i>); LWW (<i>C.d</i>)	100	90	27.1
Low Hardness	---	WW (<i>D.p.</i>); LWW (<i>C.d</i>)	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
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 $4 \pm 2^\circ\text{C}$ 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 ($^\circ\text{C}$)	*	*	*	*	*	*	*
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 ($\mu\text{mhos/cm}$)	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
$\text{NO}_2 + \text{NO}_3$ (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 $4 \pm 2^\circ\text{C}$.

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 $60 \mu\text{m}$ with Nitex screen before use. *D. pulex* are routinely maintained in static-renewal cultures of well water (WW) at $20 \pm 1^\circ\text{C}$.

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 $60 \mu\text{m}$ 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 #:	<i>Daphnia</i>	<i>Ceriodaphnia</i>
	8199	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					# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /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)										Mean Reprod	Mean % Surv
			1	2	3	4	5	6	7	8	9	10		
---	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:	<i>Ceriodaphnia</i>	<i>Daphnia</i>
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	Test #/Date →	<i>Daphnia</i>	<i>Ceriodaphnia</i>	
		Site	8203/ 11-08-16	8202/ 11-04-16	
			Mean % Surv	Mean Surv	Mean Reprod**
Control	---	WW (<i>D.p.</i>); LWW (<i>C.d.</i>)	100	100	30.5
Low Hardness	---	WW (<i>D.p.</i>); LWW (<i>C.d.</i>)	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 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 $4 \pm 2^\circ\text{C}$ 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 ($^\circ\text{C}$)*	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 ($\mu\text{mhos/cm}$)	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
$\text{NO}_2 + \text{NO}_3$ (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 $20 \pm 1^\circ\text{C}$.

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 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	# Repts/ 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	# Repts/ 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 #:	<i>Daphnia</i>	<i>Ceriodaphnia</i>
	8199	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				Mean % Survival	# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)					
			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 following table:

Test Organism:	<i>Ceriodaphnia</i>	<i>Daphnia</i>
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 acceptability criteria regarding: control performance and test variability, including survival and 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.

Sample #	Station	Site	Test #/ Date →	<i>Daphnia</i>		<i>Ceriodaphnia</i>	
				8246/ 1-20-17		8245/ 1-19-17	
				Mean % Surv	Mean Surv	Mean Reprod	
Control	---	WW (<i>Daphnia</i>)		95			
		LWW (<i>Ceriodaphnia</i>)			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
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 $4 \pm 2^\circ\text{C}$ 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	1-17-17/	1-17-17/	1-17-17/	1-17-17/	1-17-17/	1-17-17/	1-17-17/
From:	1654h	1707h	1436h	1710h	1430h	1450h	1502h
to:	1-17-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/
	2132h	1127h	0329h	1146h	0312h	1041h	1024h
Rec'd Date/Time	1-18-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/	1-18-17/
	1530h	1530h	1530h	1530h	1530h	1530h	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 $20 \pm 1^\circ\text{C}$. 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	WW	LWW	Units
	1-18-17	(adjusted TH)	1-9-17	
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.

	<i>Daphnia</i>	<i>Ceriodaphnia</i>
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					# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)				Mean	
			Rep 1	Rep 2	Rep 3	Rep 4		
-----	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-WPCBPO	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)										Mean 6d Reprod	Mean 7d % Surv
			1	2	3	4	5	6	7	8	9	10		
---	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:	<i>Ceriodaphnia</i>	<i>Daphnia</i>
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.

Sample #↓	Station	Test #/ Date →			
		Site			
		Mean % Surv	Mean Surv	Mean Reprod	
Control	---	WW (<i>D.p.</i>); LWW (<i>C.d.</i>)	60	100	33.7
Low Hardness	---	WW (<i>D.p.</i>); LWW (<i>C.d.</i>)	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
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 <i>Daphnia</i> Acute	03/08/2017
	8261 <i>Ceriodaphnia</i> 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 $4 \pm 2^\circ\text{C}$ 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 $20 \pm 1^\circ\text{C}$.

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

+ 45 cmpds not detectable

** 68 cmpds not detectable

++ 68 cmpds not detectable

*** 28 cmpds not detectable

+++ 28 cmpds not detectable

#< RDL: RDL = 1.89

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 inhouse 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
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 #:	<i>Daphnia</i>	<i>Ceriodaphnia</i>
	8255	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 (USEPA, 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 #8262 with storm water samples are listed in the table below.

Sample #	Station/ Site	% Sample	Percent Survival at 48 Hours				Mean % Survival	# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)					
			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 was 85% 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:	<i>Ceriodaphnia</i>	<i>Daphnia</i>
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 →
			<i>Daphnia</i> 8283/ 4-21-17 Mean % Surv
Control	---	WW (<i>Daphnia</i>)	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 $4 \pm 2^\circ\text{C}$ 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	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
From:							
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 $20 \pm 1^\circ\text{C}$. 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	Units
		(adjusted TH)	
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	*		
<u>Organic Analysis (BNA'S):</u>	**		
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 #:	<i>Daphnia</i>
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					# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)				Mean	
			Rep 1	Rep 2	Rep 3	Rep 4		
----	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:	<i>Daphnia</i>
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.

Sample #	Station	Site	Test #/ Date →
			<i>Daphnia</i> 8284/ 4-25-17 Mean % Surv
Control	---	WW (<i>Daphnia</i>)	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 $4 \pm 2^\circ\text{C}$ 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 CaCO ₃)	8.5	24.2	8.53	37.8	10.9	21.3	52.4
Tot. Hard (mg/L as CaCO ₃)	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
NO ₂ + NO ₃ (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 NH ₃ (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 $20 \pm 1^\circ\text{C}$. 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	Units
		(adjusted TH)	
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	*		
<u>Organic Analysis (BNA'S):</u>	**		
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 #:	<i>Daphnia</i>
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					# <i>Daphnia</i> Tested
			% Survival in each rep. (n=5 <i>Daphnia</i> /rep)				Mean	
			Rep 1	Rep 2	Rep 3	Rep 4		
----	Well Water Control	0	100	100	100	100	100	20
	Low Hardness Con	0	0	0	0	5	5	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:	<i>Daphnia</i>
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.