2012 Monitoring Report for King County Stormwater Monitoring Under S8.D of the NPDES Phase 1 Municipal Permit WAR04-4501 (Issued February 2007)

Final

March 2013

King County

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Alternate Formats Available

206-296-6519 TTY Relay: 711

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Certification

I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations.

Distribution List

Rachael McCrae Washington Department of Ecology

1.0. INTRODUCTION

The Washington State Phase I Municipal Stormwater Permit (Permit) applies to all entities in Washington State required to have permit coverage under current (Phase I) U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) stormwater regulations. This includes cities and unincorporated portions of counties whose populations exceed 100,000. The Permit includes requirements to conduct stormwater-related monitoring in Special Condition 8 (S8). The required monitoring program detailed in S8 includes three components:

- S8.D Stormwater Monitoring
- S8.E Targeted Stormwater Management Program Effectiveness Monitoring
- S8.F Stormwater Treatment and Hydrologic Management Best Management Practice (BMP) Evaluation Monitoring.

Reporting for all three monitoring components is required as part of Special Condition S8.H and S9. These sections require permittees to complete an annual stormwater monitoring report for each component, to be submitted no later than March 31, detailing monitoring that occurred during the previous water year. A water year starts on October 1 and ends on September 30 of the following year.

This document serves as King County's (County) Water Year 2012 (WY12) Stormwater Monitoring Report, and documents the stormwater characterization monitoring conducted under S8.D of the Permit. The stormwater characterization monitoring is intended to characterize stormwater runoff based on land use type and to detect trends from these same land uses in stormwater quality and quantity over time.

2.0. SUMMARY OF MONITORING STATIONS

Stormwater monitoring, to fulfill requirements of the Permit (per Permit §S8.D), was performed by King County in accordance with their project Quality Assurance Project Plan (QAPP) entitled Quality Assurance Project Plan for King County Stormwater Monitoring Under the NPDES Phase 1 Municipal Permit WAR04-4501 (Issued February 2007) (King County, 2010). This QAPP was issued in February 2007, approved by Ecology on March 9, 2009, and updated November 2010. A QAPP addendum was approved that provided an update to the monitoring program schedule. The updated QAPP and addendum are included as Appendix A.

The Permit requires each permittee to monitor stormwater and sediment from three different land use types: commercial, high density residential, and low density residential. A description of the monitoring sites selected to represent these land uses are provided below.

2.1 Site Descriptions

Monitoring site locations for the commercial (COM), high density residential (HDR), and low density residential (LDR) land use types were selected based on a number of factors. An attempt was made to locate sites both outside of incorporated areas and outside of the potential annexation areas identified in King County. Other factors included logistics, such as proximity to where sampling crews are based (to reduce hold-time violations, transit time and costs, etc.), proximity of power for sample refrigeration, and site access. Attributes of the three monitoring sites that were proposed by the County, and approved by Ecology, are presented in Table 1 and described below. There have been no changes in land use within any of the monitored drainage basins as compared to land use defined in the QAPP, or reported in King County's Water Years 2010 and 2011 Stormwater Monitoring Reports.

Table 1. King County NPDES S8.D Monitoring Site Characteristics

Site Characteristics	Monitoring Site Name		
	COM	HDR	LDR
Location	Fall City	Fall City	Near Renton
Drainage Area (acres)	5	5.25	42.7
% Commercial	80	0	0
% Low Density Residential	0	0	100
% High Density Residential	20	100	0
% Impervious Area	80	50	17
Rain Gage Location (State Plane NAD83)	1,378,430E 208,006N	1,378,430E 208,006N	1,308,856E 178,651N

2.1.1 Commercial Site (COM)

The COM site selected and monitored by King County is located in Fall City. The 5-acre drainage area is situated near the intersection of Highway 202 (which parallels the Snoqualmie River) and Preston-Fall City Road (Figure 1). This site was selected because the area includes several different types of businesses and is an older development, with a few structures built as early as the 1920s. Businesses along Highway 202 and Preston-Fall City Road consist of commercial areas that include a gas station, taverns, restaurants, and various other small shops. This site is intended to represent an older commercial development that has a storm drain system without mitigation BMPs or stormwater treatment of any kind.

The COM drainage basin is 80 percent impervious surfaces, which consist predominantly of roads, parking lots, and rooftops. The pervious surfaces within the basin are mostly lawn. Separate storm drain systems collect runoff from along Highway 202 and from along Preston-Fall City Road through a series of ditches, culverts, and catch basins. The two storm drain systems combine at a catch basin near the corner of Highway 202 and Preston-Fall City Road. This catch basin serves as the monitoring location for the COM site (Figure 1). A photo of the catch basin and sampler housing is presented in Figure 2. Stormwater from this system drains from the bottom of the monitoring catch basin, flows under Highway 202, and discharges directly to the Snoqualmie River.

The catch basin selected for monitoring does not store water between storm events or provide any water quality treatment or attenuation. The autosampler intake tubing is installed in the catch basin in a location that is downstream of the inlet pipes from the Highway 202 and Preston-Fall City Road drainage systems. This location ensures that if both drainage systems are flowing, sampled stormwater will represent runoff from both the Highway 202 and Preston-Fall City Road systems. The primary rain gage for COM is located at the HDR monitoring site, as described in Section 2.1.2.

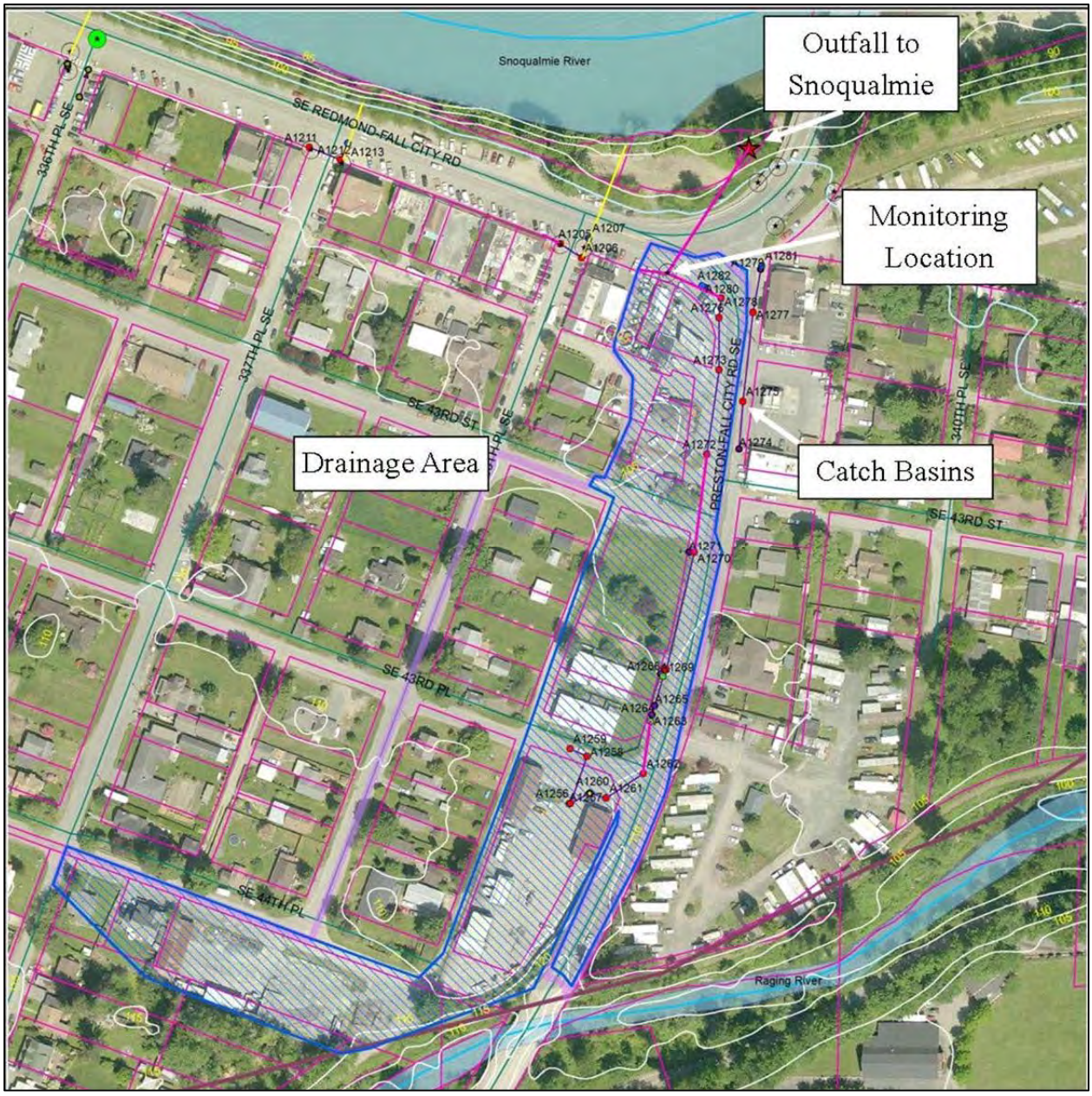

Figure 1. Drainage area and drainage system for the Fall City commercial (COM) monitoring site.

Figure 2. Catch basin monitoring site and sampler housing at COM site.

2.1.2 High Density Residential (HDR)

The HDR site selected and monitored by King County is located in Fall City (Figure 3). For this study, high density is defined as four houses or more per acre. Density in the HDR drainage basin is approximately four houses to an acre.

The HDR drainage basin is 5.25 acres consisting of a neighborhood of 21 single family homes. The neighborhood is accessed by 335th Place SE and 44th Lane. Approximately 50 percent of the drainage basin is impervious surfaces, which are predominantly streets and rooftops. The pervious surfaces are predominantly lawns.

The neighborhood was developed in the early 1970s and the street, drainage, and house construction are all typical of this time period. The storm drain system serving the neighborhood is a curb and catch basin system that flows into an infiltration vault. The monitoring location (Figure 4) is set up to collect stormwater immediately prior to flowing into the infiltration vault. This site also includes the primary rain gage that is used for both the HDR and COM monitoring sites.

Figure 3. Drainage area and drainage system for the Fall City high density residential (HDR) monitoring site.

Figure 4. Automated sampler and downstream vault at HDR monitoring site.

2.1.3 Low Density Residential (LDR)

The LDR site selected and monitored by King County is located in a neighborhood near Renton (Figure 5). Density is the drainage basin is approximately one house per 1 to 5 acres, which is the definition of low density for this study. The nearly 43 acre drainage basin is 17 percent impervious and 83 percent pervious. The majority of the impervious areas are roads and rooftops while the pervious surfaces are predominantly lawns and forested areas.

Drainage within the basin consists of an open ditch that runs along the east shoulder of 148th Avenue SE. The ditch, which transitions to a 12-inch culvert when bisected by residential driveways, flows north from State Route (SR) 900 and drains into May Creek. Runoff is primarily from the rural residential properties on the east side of 148th Ave SE with additional runoff from SR 900.

The monitoring site is located at the southwest corner of a lot at 10222 148th Avenue SE. Flow is measured by a trapezoidal flume placed in the ditch, as shown in Figure 6. The monitoring station is located within King County road right-of-way on the east side of the ditch. The primary rain gage used for this site is located at the King County Roads Renton Maintenance Facility.

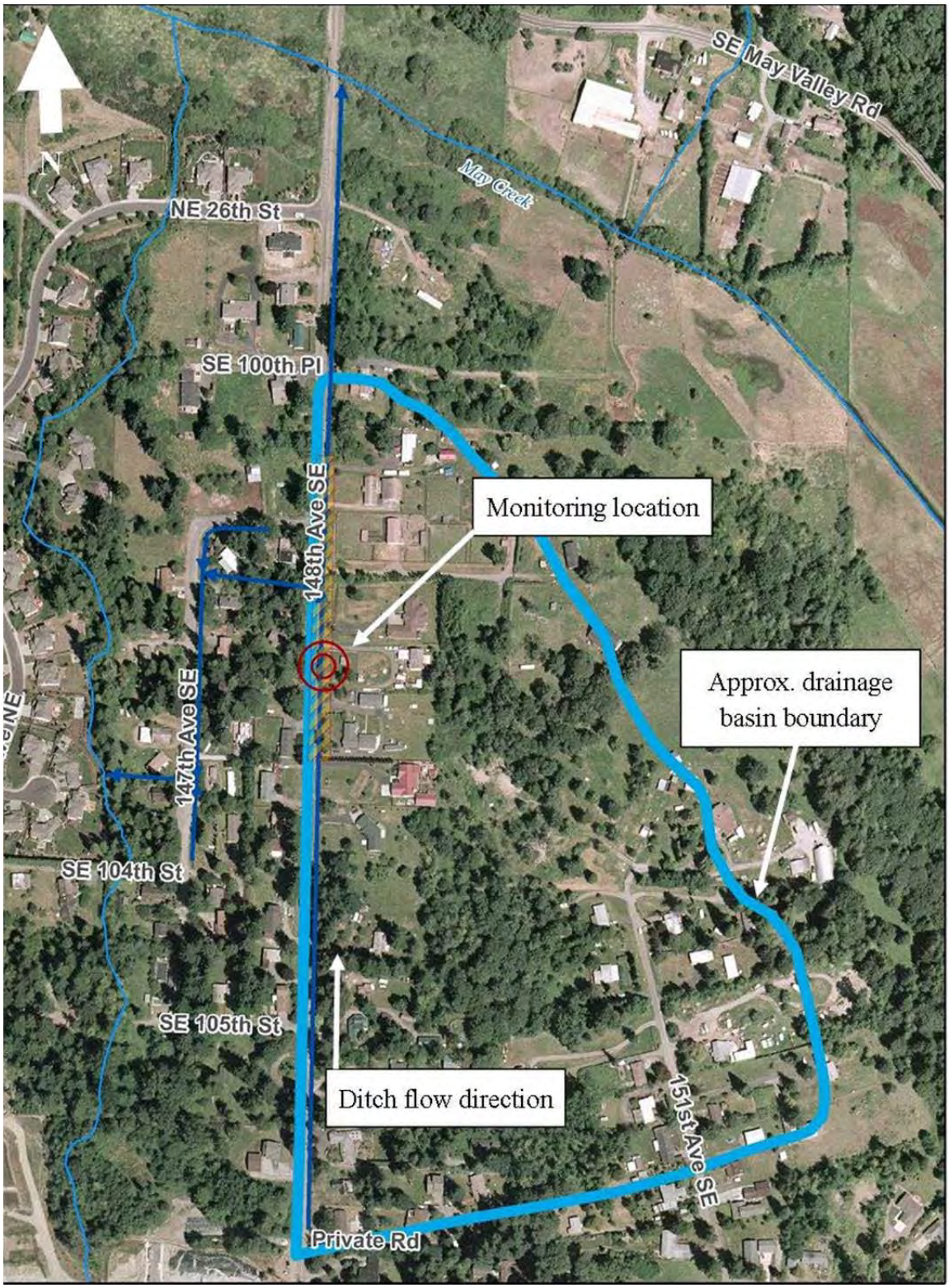

Figure 5. Drainage area and drainage system for the low density residential (LDR) monitoring site.

Figure 6. Flume and autosampler suction line at LDR monitoring site.

3.0. COMPREHENSIVE DATA REPORT

This section presents information about the storm and sediment sampling events at the COM, HDR, and LDR sites during WY12. There was no baseflow at any of the monitoring sites therefore no baseflow samples were collected during WY12. All stormwater and sediment samples were collected following procedures outlined in the project QAPP.

3.1 Summary of Storm Events

Storms were initially targeted for sampling between October 1 and December 31, 2011. In January 2012, after completing two and one-quarter years of sampling, the County stopped collecting stormwater samples. County officials erroneously believed that other ongoing sampling and testing could substitute for the NPDES S8.D permit-required monitoring. Ecology and the County worked together and signed an agreement to resume the WY12 stormwater monitoring program on June 15, 2012. Monitoring for WY12 then continued through September 30, 2012. The monitoring program is now scheduled to be completed in June 2013 at the end of the three-year permit term.

For all grab and composite samples collected across the three monitoring sites, the storm event criteria (Table 2) were met. Two grab samples were collected at each of the three stations and one composite sample was collected at HDR during the dry-season months (June 15 through September). All remaining samples were collected during the wet season months (October through December).

Table 2. NPDES S8.D storm criteria for stormwater sampling.

	Wet Season	Dry Season
Seasonal Period	October 1 through April 30	May 1 through September 30
Minimum Amount of Rainfall	0.20 min. no fixed max.	0.20 min. no fixed max.
Rainfall Duration	No fixed min. or max.	No fixed min. or max.
Antecedent Dry Period	≤0.02 rain in previous 24-hours	≤0.02 rain in previous 72-hours
Inter-event Dry Period	6 hours	6 hours

As outlined in Table 3, archived weather forecasts show that during the abbreviated WY12 there were 11 events at COM, 11 at HDR, and 12 at LDR that were forecasted to be qualifying storms. Grab and/or composite samples were targeted for 8 storms at each of the 3 monitoring locations. Of the storms targeted for sampling, a total of 4 grab and 3 composite samples were collected at COM, 3 grab and 2 composite samples at HDR, and 3 grab and 3 composite samples at LDR. The remaining targeted events either didn't meet the storm size criterion, were larger than forecasted and therefore the flow pacing resulted in non-qualifying samples, or were considered "false starts" due to equipment issues.

Of the sampled storm events, qualifying composite samples were collected from zero storms at COM, one storm at HDR, and three storms at LDR. Three additional composite samples were collected at COM and one at HDR that did not meet one of the sampling criterion listed in permit §S8.D.2.b[1]. Qualifying grab samples were collected from one storm at COM, one storm at HDR, and three storms at LDR. Another four grab samples were collected at COM and two at HDR that did not comply with the Permit language from §S8.D.2.f.i stating "sample must be collected early in the storm event". More details of the sample events and how they compared to Permit criteria are provided in Section 3.2.

Table 3. Number of targeted and sampled storm events at COM, HDR, and LDR.

	COM		HDR		LDR	
	Grab	Composite	Grab	Composite	Grab	Composite
Total # of storms forecasted to be qualifying	11	11	11	11	12	12
Total # of targeted storms	8 (72%)	8 (72%)	8 (72%)	8 (72%)	8 (67%)	8 (67%)
Total # of samples collected	5	3	3	2	3	3
Total # of samples that met weather and sampling criteria	1	0	1	1	3	3

While the Permit criterion of collecting 11 qualifying grab and composite samples per water year was not met, King County made good faith efforts with good professional practice to fulfill the established sampling objectives within the abbreviated water year. King County targeted almost all of the storms within the active sampling period that were forecasted to be qualifying events. At the COM and HDR sites 8 out of 11, or 72 percent, of storms that were forecasted to be qualifying were targeted. At LDR 8 out of 12, or 67 percent, of storms that were forecasted to be qualifying were targeted. A table providing a list of the targeted and sampled storm events for each site is included in Appendix B.

Toxicity testing was required for King County for WY11. Toxicity testing was completed at all sites in October 2011 and results from the toxicity sampling were included in King County's WY11 NPDES Annual Report.

3.2 Characteristics of Individual Sampled Events

Continuous precipitation and flow data were collected between October 1 through December 31, 2011, and June 15 through September 30, 2012. Sample event information was documented for all sampled storm events. A summary of the event data for each site, including precipitation, flow, and sample information are included in the following sections. Sample event files presenting the storm hydrographs for each sampled event are included in Appendix C.

[1] Permit §S8.D.2.b lists as one criterion "For storm events lasting less than 24 hours, samples shall be collected for at least seventy-five percent (75%) of the storm event hydrograph. For storm events lasting longer than 24 hours, samples shall be collected for at least seventy-five percent of the hydrograph of the first 24 hours of the storm."

3.2.1 Sampled Events at Commercial (COM) Site

During the abbreviated WY12 there were 13 qualifying storm events measured by the Fall City rain gage, which serves as the gage for the COM monitoring site. Of these 13 qualifying events, 10 were forecasted. Forecasts for the remaining 3 events indicated the antecedent dry period and/or storm size criteria would not be met. The 10 forecasted qualifying events, plus 1 storm that was forecasted and targeted but did not meet the storm size criterion, are outlined in Table 4. Details of each successfully sampled event are presented in Table 5.

There was sufficient sample volume to complete the full analysis of the five stormwater grab and three stormwater composite samples collected at COM. Table 6 and Table 7 indicate the analyses completed and laboratory methods for the grab and composite samples.

Table 4. Details of targeted storms and forecasted qualifying storms at COM monitoring site.

Event Date	Description of sampling attempts
10/24/11	Event was not targeted.
10/28/11	Rainfall totaled 0.47-inches and was preceded by a 41 hour antecedent dry period. The event was successfully targeted for grab and composite samples. The composite sample was composed of 18 aliquots and represented 47 percent of the runoff from the first 24 hours of the event.
11/2/11	A successful sample collection of a 0.27-inch storm preceded by almost 70 hours of antecedent dry period. A grab and composite sample were submitted to the laboratory. The composite sample represented 65 percent of the first 24 hours of the storm runoff, and was composed of 35 aliquots.
11/11/11	The event was forecast for 0.27-inches of rain and was targeted for both grab and composite samples. Actual rainfall totaled 0.77-inches, therefore, the flow pacing was off and the sample did not represent 75 percent of the hydrograph. No samples were submitted.
11/16/11	Event was preceded by 37 hours of antecedent dry period, and totaled 0.75-inches. The event was successfully targeted for grabs and composite samples, with the composite sample representing 54 percent of the first 24 hours of the storm runoff and composed of 35 aliquots.
11/21/11	Event was not targeted. Event was several days prior to Thanksgiving.
11/27/11	Event was not targeted. Event was Thanksgiving weekend.
6/22/12	The event totaled 0.81-inches with an antecedent dry period of over 87 hours. The storm was targeted for grab and composite samples; however, the storm was much larger than predicted. The auto-sampler was flow paced for a smaller storm and resulted in a composite sample that did not represent 75 percent of the hydrograph. The composite sample was discarded and the grab sample was submitted to the lab.
6/30/12	Storm forecasted to be a qualifying event and was targeted for both grab and composite samples. Rainfall totaled only 0.09-inches so the storm was not qualifying and no samples were submitted.
7/20/12	Rainfall totaled 0.37-inches with an almost 400 hour antecedent dry period. The storm was targeted for grab and composite samples; however, the composite sample did not represent 75 percent of the hydrograph. The grab sample was submitted to the lab; however, the composite sample was discarded.
9/10/12	The event was targeted for a composite sample; however, the sample did not represent 75 percent of the hydrograph and was therefore not submitted to the lab for analysis.

Table 5. Characteristics of sampled storms at COM.

	Rainfall total (in)	Storm duration (hrs)	Interevent Dry Period <6 hrs?	Antecedent period w/ ≤ 0.02" rain (hrs)		Grab sample analyzed?	Composite sample analyzed?	Number of aliquots	Average flow rate (cfs)	Runoff volume 1st 24 hours (cf)	Runoff volume sampled (cf)	Percent runoff sampled
Permit Criteria	**≥ 0.2**	**NA**	**Y**	**≥ 24[a]**	**≥ 72[b]**	**NA**	**NA**	**10[c]**	**NA**	**NA**	**NA**	**≥ 75**
10/28/11	0.47	8.25	Y	40.8	NA	Y	Y	18	0.127	1835	864	47, j
11/2/11	0.27	7.25	Y	69.8	NA	Y	Y	35	0.097	1261	821	65, j
11/16/11	0.75	12.25	Y	37.5	NA	Y	Y	35	0.088	5871	3190	54, j
6/22/12	0.81	17.33	Y	NA	87.2	Y	N [d]	-	-	-	-	-
7/20/12	0.37	7.92	Y	NA	399.2	Y	N[d]	-	-	-	-	-

Notes:
(a) applies to wet season (October 1 through April 30).
(b) applies to dry season (May 1 through September 30).
(c) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.
(d) composite sample collected, but it did not represent 75 percent of the hydrograph so it was not submitted for analysis.
NA - not applicable.

"-" – no data, composite sample not submitted.
j - did not meet Permit criterion.

Table 6. Parameters analyzed in composite stormwater samples at COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
COMPOSITE SAMPLE PARAMETERS					
Conventionals					
Total Suspended Solids (mg/L)	mg/L	SM2540D	x	x	x
Turbidity (NTU)	NTU	SM2130B	x	x	x
Conductivity	µmhos/cm	SM2510B	x	x	x
Chloride	mg/L	SM4110B	x	x	x
Biochemical Oxygen Demand	mg/L	SM5210B	x	x	x
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	x	x	x
Methylene Blue Act. Substance	mg/L	SM5540C	x	x	x
Nutrients					
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	x	x	x
Total Kjeldahl Nitrogen	mg/L	EPA 351.2	x	x	x
Total Phosphorus	mg/L	SM4500-P-B,F	x	x	x
Orthophosphate Phosphorus	mg/L	SM4500-P-F	x	x	x
Metals					
Cadmium, Dissolved	µg/L	EPA 200.8	x	x	x
Cadmium, Total	µg/L		x	x	x
Calcium, Total	µg/L		x	x	x
Copper, Dissolved	µg/L		x	x	x
Copper, Total	µg/L		x	x	x
Lead, Dissolved	µg/L		x	x	x
Lead, Total	µg/L		x	x	x
Magnesium, Total	µg/L		x	x	x
Mercury, Dissolved	µg/L	EPA 245.1	x	x	x
Mercury, Total	µg/L		x	x	x
Zinc, Dissolved	µg/L	EPA 200.8	x	x	x
Zinc, Total	µg/L		x	x	x
Organics					
PAHs					
Acenaphthene	µg/L	SW846-8270D	x	x	x
Acenaphthylene	µg/L		x	x	x
Anthracene	µg/L		x	x	x
Benzo(a)anthracene	µg/L		x	x	x
Benzo(a)pyrene	µg/L		x	x	x
Benzo(b,j,k)fluoranthene	µg/L		x	x	x
Benzo(g,h,i)perylene	µg/L		x	x	x
Chrysene	µg/L		x	x	x
Dibenzo(a,h)anthracene	µg/L		x	x	x
Fluoranthene	µg/L		x	x	x
Fluorene	µg/L		x	x	x
Indeno(1,2,3-Cd)Pyrene	µg/L		x	x	x
2-Methylnaphthalene	µg/L		x	x	x
Naphthalene	µg/L		x	x	x
Phenanthrene	µg/L		x	x	x

Table 6. Parameters analyzed in composite stormwater samples at COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
Pyrene	µg/L		x	x	x
Phthalates					
Benzyl Butyl Phthalate	µg/L	SW846-8270D	x	x	x
Bis(2-Ethylhexyl)Phthalate	µg/L		x	x	x
Diethyl Phthalate	µg/L		x	x	x
Dimethyl Phthalate	µg/L		x	x	x
Di-N-Butyl Phthalate	µg/L		x	x	x
Di-N-Octyl Phthalate	µg/L		x	x	x
Pesticides					
2,4-D	µg/L	SW846-8270D-SIM	x	x	x
Chlorpyrifos	µg/L		x	x	x
Diazinon	µg/L		x	x	x
Dichlobenil	µg/L		x	x	x
Malathion	µg/L		x	x	x
MCPP	µg/L		x	x	x
Pentachlorophenol	µg/L		x	x	x
Prometon	µg/L		x	x	x
Triclopyr	µg/L		x	x	x

Table 7. Parameters analyzed in grab stormwater samples at COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date				
			10/28/11	11/2/11	11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS							
Bacteria							
Fecal Coliform	cfu/100mL	SM9222D	x	x	x	x	x
Organics							
TPH							
Diesel Range (>C12-C24)	mg/L	NWTPH-Dx	x	x	x	x	x
Lube Oil Range (>C24)	mg/L		x	x	x	x	x
Gasoline Range (C7-C12)	µg/L	NWTPH-Gx	x	x	x	x	x

3.2.2 Sampled Events at High Density Residential (HDR) Site

During the abbreviated WY12 there were 13 qualifying storm events measured by the Fall City rain gage, which serves as the rain gage for the HDR monitoring site. Of these 13 qualifying events, 10 were forecasted. Forecasts for the remaining 3 events indicated the antecedent dry period and/or storm size criteria would not be met. The 10 forecasted qualifying events, plus 1 storm that was forecasted and targeted but did not meet the storm size criterion, are outlined in Table 8. Details of each successfully sampled event are presented in Table 9.

For both successful composite samples there was sufficient volume for complete laboratory analysis. In addition, all three grab samples were submitted for full analysis with the exception of the 11/16/11 grab sample, which was not analyzed for fecal coliform. Table 10 and Table 11 indicate the analyses completed and laboratory methods for the composite and grab samples for HDR.

Table 8. Details of targeted storms and forecasted qualifying storms at HDR monitoring site.

Event Date	Description of sampling attempts
10/24/11	Event was not targeted.
10/28/11	The 0.47-inch event was targeted for grab and composite samples. A tripped GFI switch resulted in a loss of power to the auto-sampler so no samples were collected or submitted.
11/2/11	The event was targeted but was unsuccessful for both grab and composite samples.
11/11/11	The event was forecast for 0.27-inches of rain and was targeted for both grab and composite samples. Actual rainfall totaled 0.77-inches, therefore the flow pacing was off and the sample did not represent 75 percent of the hydrograph. No samples were submitted.
11/16/11	Event was preceded by 37 hours of antecedent dry period, and totaled 0.75-inches. The event was successfully targeted for grabs and composite samples, with the composite sample representing 82 percent of the first 24 hours of the storm runoff and composed of 26 aliquots.
11/21/11	Event was not targeted. Event was several days prior to Thanksgiving.
11/27/11	Event was not targeted. Event was Thanksgiving weekend.
6/22/12	The event totaled 0.81-inches with an antecedent dry period of over 87 hours and was successfully targeted for both grab and composite samples. The composite sample consisted of 34 aliquots representing 50 percent of the hydrograph.
6/30/12	Storm was forecasted to be a qualifying event and was targeted for both grab and composite samples. Rainfall totaled only 0.09-inches so the storm was not qualifying and no samples were submitted.
7/20/12	Rainfall totaled 0.37-inches with an almost 400 hour antecedent dry period. The storm was targeted for grab and composite samples; however, the composite sample did not represent 75 percent of the hydrograph. The grab sample was submitted to the lab; however, the composite sample was discarded.
9/10/12	The event was targeted for a composite sample; however, the sample did not represent 75 percent of the hydrograph and was therefore not submitted to the lab for analysis.

Table 9. Characteristics of sampled storms at HDR.

	Rainfall total (in)	Storm duration (hrs)	Interevent Dry Period <6 hrs?	Antecedent period w/ ≤ 0.02" rain (hrs)		Grab sample analyzed?	Composite sample analyzed?	Number of aliquots	Average flow rate (cfs)	Runoff volume 1st 24 hours (cf)	Runoff volume sampled (cf)	Percent runoff sampled
Permit Criteria	**≥ 0.2**	**NA**	**Y**	**≥ 24[a]**	**≥ 72[b]**	**NA**	**NA**	**10[c]**	**NA**	**NA**	**NA**	**≥ 75**
11/16/11	0.75	12.25	Y	37.5	NA	Y	Y	26	0.071	3716	3051	82
6/22/12	0.81	17.33	Y	NA	87.2	Y	Y	34	0.032	859	432	50, j
7/20/12	0.37	7.92	Y	NA	399.2	Y	N [d]	-	-	-	-	-

Notes:
(a) applies to wet season (October 1 through April 30).
(b) applies to dry season (May 1 through September 30).
(c) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.
(d) composite sample collected, but it did not represent 75 percent of the hydrograph so it was not submitted for analysis.
NA - not applicable.
"-" – no data, composite sample not submitted.
j - did not meet Permit criterion.

Table 10. Parameters analyzed in composite stormwater samples at HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date	
			11/16/11	6/22/12
COMPOSITE SAMPLE PARAMETERS				
Conventionals				
Total Suspended Solids	mg/L	SM2540D	x	x
Turbidity	NTU	SM2130B	x	x
Conductivity	µmhos/cm	SM2510B	x	x
Chloride	mg/L	SM4110B	x	x
Biochemical Oxygen Demand	mg/L	SM5210B	x	x
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	x	x
Methylene Blue Act. Substance	mg/L	SM5540C	x	x
Nutrients				
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	x	x
Total Kjeldahl Nitrogen	mg/L	EPA 351.2	x	x
Total Phosphorus	mg/L	SM4500-P-B,F	x	x
Orthophosphate Phosphorus	mg/L	SM4500-P-F	x	x
Metals				
Cadmium, Dissolved	µg/L	EPA 200.8	x	x
Cadmium, Total	µg/L		x	x
Calcium, Total	µg/L		x	x
Copper, Dissolved	µg/L		x	x
Copper, Total	µg/L		x	x
Lead, Dissolved	µg/L		x	x
Lead, Total	µg/L		x	x
Magnesium, Total	µg/L		x	x
Zinc, Dissolved	µg/L	EPA 200.8	x	x
Zinc, Total	µg/L		x	x
Organics				
PAHs				
Acenaphthene	µg/L	SW846-8270D	x	x
Acenaphthylene	µg/L		x	x
Anthracene	µg/L		x	x
Benzo(a)anthracene	µg/L		x	x
Benzo(a)pyrene	µg/L		x	x
Benzo(b,j,k)fluoranthene	µg/L		x	x
Benzo(g,h,i)perylene	µg/L		x	x
Chrysene	µg/L		x	x
Dibenzo(a,h)anthracene	µg/L		x	x
Fluoranthene	µg/L		x	x
Fluorene	µg/L		x	x
Indeno(1,2,3-Cd)Pyrene	µg/L		x	x
2-Methylnaphthalene	µg/L		x	x
Naphthalene	µg/L		x	x
Phenanthrene	µg/L		x	x
Pyrene	µg/L		x	x

Table 10. Parameters analyzed in composite stormwater samples at HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date	
			11/16/11	6/22/12
Phthalates				
Benzyl Butyl Phthalate	µg/L	SW846-8270D	x	x
Bis(2-Ethylhexyl)Phthalate	µg/L		x	x
Diethyl Phthalate	µg/L		x	x
Dimethyl Phthalate	µg/L		x	x
Di-N-Butyl Phthalate	µg/L		x	x
Di-N-Octyl Phthalate	µg/L		x	x
Pesticides				
2,4-D	µg/L	SW846-8270D-SIM	x	x
Chlorpyrifos	µg/L		x	x
Diazinon	µg/L		x	x
Dichlobenil	µg/L		x	x
Malathion	µg/L		x	x
MCPP	µg/L		x	x
Pentachlorophenol	µg/L		x	x
Prometon	µg/L		x	x
Triclopyr	µg/L		x	x

Table 11. Parameters analyzed in grab stormwater samples at HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS					
Bacteria					
Fecal Coliform	cfu/100mL	SM9222D	-	x	x
Organics					
TPH					
Diesel Range (>C12-C24)	mg/L	NWTPH-Dx	x	x	x
Lube Oil Range (>C24)	mg/L		x	x	x
Gasoline Range (C7-C12)	µg/L	NWTPH-GX	x	x	x

3.2.3 Sampled Events at Low Density Residential (LDR) Site

During the abbreviated WY12 there were 11 qualifying storm events measured by the King County Roads Renton Maintenance Facility rain gage, which serves as the gage for the LDR site. Of these 11 qualifying events, 9 were forecasted. Forecasts for the remaining 2 events indicated the antecedent dry period and/or storm size criteria would not be met. The 9 forecasted qualifying events, plus 3 storms that were forecasted to be qualifying and were targeted but did not meet the storm size criterion, are outlined in Table 12. Details of each successfully sampled event are presented in Table 13.

There was sufficient volume to complete the full analysis of the three stormwater composite samples and three stormwater grab samples. Table 14 and Table 15 indicate the analyses completed and laboratory methods for the composite and grab samples for LDR.

Table 12. Details of targeted storms and forecasted qualifying storms at LDR monitoring site.

Event Date	Description of sampling attempts
10/2/11	Event was not targeted.
10/28/11	The 0.46-inch event was preceded by 37 hours of antecedent dry period. A composite sample consisting of 50 aliquots and representing 100 percent of the hydrograph from the first 24 hours of the event was collected. There was no storm flow during the site visits so a grab sample was not collected.
11/2/11	The event totaled 0.39-inches with an antecedent dry period of 43 hours. A grab sample was not collected. The composite sample was composed of 37 aliquots representing 100 percent of the runoff from the first 24 hours of the event.
11/16/11	The event was successfully targeted for both a grab and composite sample. Rainfall totaled 0.44-inches with an antecedent dry period of 44 hours. The composite sample was composed of 50 aliquots representing 88 percent of the hydrograph.
11/21/11	Event was not targeted. Event was several days prior to Thanksgiving.
11/27/11	Event was not targeted. Event was Thanksgiving weekend.
12/18/11	Event was not targeted.
6/15/12	Storm was targeted but was much smaller than forecast. Did not meet storm size criterion and did not collect enough aliquots for a qualifying sample.
6/22/12	The event was targeted for both grab and composite samples; however, the rainfall totals were significantly larger than forecasted. As a result the composite sample did not represent 75 percent of the hydrograph and was not submitted. A qualifying grab sample was submitted.
6/28/12	Storm was targeted but was smaller than forecast and was not a qualifying event. Samples were not submitted.
7/20/12	Rainfall totaled 0.48-inches after an antecedent dry period of 413 hours. The auto-sampler was paced for a smaller storm, resulting in a composite sample that did not represent 75 percent of the hydrograph. A grab sample was submitted and the composite sample was discarded.
9/7/12	Storm targeted but was non-qualifying. No samples were submitted.

Table 13. Characteristics of sampled storms at LDR.

	Rainfall total (in)	Storm duration (hrs)	Interevent Dry Period <6 hrs?	Antecedent period w/ ≤ 0.02" rain (hrs)		Grab sample analyzed?	Composite sample analyzed?	Number of aliquots	Average flow rate (cfs)	Runoff volume 1st 24 hours (cf)	Runoff volume sampled (cf)	Percent runoff sampled
Permit Criteria	**≥ 0.2**	**NA**	**Y**	**≥ 24[a]**	**≥ 72[b]**	**NA**	**NA**	**10[c]**	**NA**	**NA**	**NA**	**≥ 75**
10/28/11	0.46	4	Y	37	NA	N	Y	50	0.017	319	319	100
11/2/11	0.39	2.5	Y	43	NA	N	Y	37	0.014	236	236	100
11/16/11	0.44	14	Y	44	NA	Y	Y	50	0.005	368	324	88
6/22/12	0.88	19	Y	NA	75	Y	N [d]	-	-	-	-	-
7/20/12	0.48	9	Y	NA	413	Y	N [d]	-	-	-	-	-

Notes:
(a) applies to wet season (October 1 through April 30).
(b) applies to dry season (May 1 through September 30).
(c) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.
(d) composite sample collected, but it did not represent 75 percent of the hydrograph so it was not submitted for analysis.
NA - not applicable.
"-" – no data, composite sample not submitted.

Table 14. Parameters analyzed in composite stormwater samples at LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
COMPOSITE SAMPLE PARAMETERS					
Conventionals					
Total Suspended Solids	mg/L	SM2540D	x	x	x
Turbidity	NTU	SM2130B	x	x	x
Conductivity	µmhos/cm	SM2510B	x	x	x
Chloride	mg/L	SM4110B	x	x	x
Biochemical Oxygen Demand	mg/L	SM5210B	x	x	x
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	x	x	x
Methylene Blue Act. Substance	mg/L	SM5540C	x	x	x
Nutrients					
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	x	x	x
Total Kjeldahl Nitrogen	mg/L	EPA 351.2	x	x	x
Total Phosphorus	mg/L	SM4500-P-B,F	x	x	x
Orthophosphate Phosphorus	mg/L	SM4500-P-F	x	x	x
Metals					
Cadmium, Dissolved	µg/L	EPA 200.8	x	x	x
Cadmium, Total	µg/L		x	x	x
Calcium, Total	µg/L		x	x	x
Copper, Dissolved	µg/L		x	x	x
Copper, Total	µg/L		x	x	x
Lead, Dissolved	µg/L		x	x	x
Lead, Total	µg/L		x	x	x
Magnesium, Total	µg/L		x	x	x
Zinc, Dissolved	µg/L	EPA 200.8	x	x	x
Zinc, Total	µg/L		x	x	x
Organics					
PAHs					
Acenaphthene	µg/L	SW846-8270D	x	x	x
Acenaphthylene	µg/L		x	x	x
Anthracene	µg/L		x	x	x
Benzo(a)anthracene	µg/L		x	x	x
Benzo(a)pyrene	µg/L		x	x	x
Benzo(b,j,k)fluoranthene	µg/L		x	x	x
Benzo(g,h,i)perylene	µg/L		x	x	x
Chrysene	µg/L		x	x	x
Dibenzo(a,h)anthracene	µg/L		x	x	x
Fluoranthene	µg/L		x	x	x
Fluorene	µg/L		x	x	x
Indeno(1,2,3-Cd)Pyrene	µg/L		x	x	x
2-Methylnaphthalene	µg/L		x	x	x
Naphthalene	µg/L		x	x	x
Phenanthrene	µg/L		x	x	x
Pyrene	µg/L		x	x	x

Table 14. Parameters analyzed in composite stormwater samples at LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
Phthalates					
Benzyl Butyl Phthalate	µg/L	SW846-8270D	x	x	x
Bis(2-Ethylhexyl)Phthalate	µg/L		x	x	x
Diethyl Phthalate	µg/L		x	x	x
Dimethyl Phthalate	µg/L		x	x	x
Di-N-Butyl Phthalate	µg/L		x	x	x
Di-N-Octyl Phthalate	µg/L		x	x	x
Pesticides					
2,4-D	µg/L	SW846-8270D-SIM	x	x	x
Chlorpyrifos	µg/L		x	x	x
Diazinon	µg/L		x	x	x
Dichlobenil	µg/L		x	x	x
Malathion	µg/L		x	x	x
MCPP	µg/L		x	x	x
Pentachlorophenol	µg/L		x	x	x
Prometon	µg/L		x	x	x
Triclopyr	µg/L		x	x	x

Table 15. Parameters analyzed in grab stormwater samples at LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS					
Bacteria					
Fecal Coliform	cfu/100mL	SM9222D	x	x	x
Organics					
TPH					
Diesel Range (>C12-C24)	µg/L	NWTPH-Dx	x	x	x
Lube Oil Range (>C24)	µg/L		x	x	x
Gasoline Range (C7-C12)	mg/L	NWTPH-GX	x	x	x

3.3 Sediment Sampling

The WY12 annual sediment samples were collected at each stormwater monitoring site on August 7, 2012. Samples were collected at HDR and COM using a Ponar sampler. At the HDR site, sediment was collected from the street catch basin that flows into the infiltration basin. At the COM site, sediment was collected from the catch basin that serves as the stormwater monitoring site. At each site the Ponar sampler was lowered into the catch basin by a rope. Once the sampler was retrieved, it was emptied into a pre-cleaned stainless steel bowl. Repeat subsamples were collected until enough sediment volume was collected for analysis. The sample was well mixed with a pre-cleaned stainless steel spatula and then transferred to appropriately labeled sample jars. The sample jars were placed on ice and delivered to the laboratory.

At LDR, sediment was collected from the sampling location at the Southwest corner of the lot at 10222 148th Avenue SE using a stainless-steel spatula. Sediment was collected (scooped) from the bottom of the ditch, just downstream of the flow monitoring flume, using a pre-cleaned stainless steel spatula and a stainless steel bowl. Once enough sediment was collected for analysis, it was well mixed and transferred to appropriately labeled sample jars. The sample jars were placed on ice and delivered to the laboratory.

All sediment samples were processed and analyzed in accordance with the project QAPP. Sample volume was sufficient for analysis for all parameters listed in the project QAPP. There were several parameters at each site that were below the method detection limit in the sediment samples (detailed in Section 5.3).

4.0. QA/QC REPORT

A data quality assurance quality control report for the stormwater composite samples, stormwater grab samples, and sediment samples is included as Appendix D.

5.0. DISCUSSION OF RESULTS

The following sections discuss the analytical results for the stormwater composite, stormwater grab, and sediment samples collected from all three monitoring sites during WY12. Analytical data for WY12 will be input in the Environmental Information Management database.

5.1 Composite Sample Results

Concentration data for target analytes in the composite samples from COM, HDR, and LDR monitoring sites are discussed in the following sections and presented in Tables 16, 17, and 18, respectively. Values reported as "<" indicate the target analyte was below the method detection limit (MDL) reported by the analytical laboratory. Values reported as "<RDL" indicate a target analyte was above the MDL, but below the reporting detection limit (RDL). Additional lab qualifiers listed in the tables are defined as follows[2]:

H – holding time exceeded
B – method blank is ≥ the MDL and sample result is ≥ MDL but ≤ 5 times the method blank
B2 – for acetone, 2-butanone, methylene chloride, bis(2-ethylhexyl)phthalate, butylbenzyl phthalate, and di-n-butyl phthalate: method blank is ≥ MDL and sample result is > 5 and ≤ 10 times the method blank
B3 – for all other parameters: method blank is ≥ MDL and sample result is > 5 and ≤ 10 times the method blank
SH – sample handling criterion not met
J – estimated value
JG – estimated value with a low bias
JL – estimated value with a high bias
TA – text information available in the lab report

A full explanation of the qualifiers can be found in the individual analytical laboratory reports included electronically (see enclosed CD) as Appendix E.

5.1.1 Commercial (COM) Site

At COM, conventional and nutrient parameters were detected in all composite samples (Table 16). Metals (dissolved and total recoverable) were detected in all samples with the exception of dissolved cadmium and total and dissolved mercury, which were not detected in any sample.

Measured concentrations for polycyclic aromatic hydrocarbons (PAHs) varied between the 3 sampled events (Table 16). Detection frequencies for PAHs ranged from 0 percent (not detected) for 9 different compounds to 100 percent for benzo(g,h,i)perlyne, chrysene, fluoranthene, naphthalene, and pyrene. Phthalates were detected in all composite samples with the exception of diethylphthalate (detected in 2 of 3 samples) and dimethyl phthalate (detected in 1 of 3 samples).

For pesticides, pentachlorophenol was detected in two of the three samples. No other pesticides were detected at the COM site during WY12.

[2] LIMS data qualifiers provided by King County Environmental Laboratory.

Table 16. Concentration data for target analytes in stormwater composite samples collected at COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
COMPOSITE SAMPLE PARAMETERS					
Conventionals					
Total Suspended Solids	mg/L	SM2540D	232	128	120
Turbidity	NTU	SM2130B	180	102	144
Conductivity	µmhos/cm	SM2510B	34	33.4	82
Chloride	mg/L	SM4110B	1.35	1.41	16.3
Biochemical Oxygen Demand	mg/L	SM5210B	13	15.9	13.1
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	26	18.6	22.5
Methylene Blue Act. Substance	mg/L	SM5540C	0.064, H	0.062	0.053
Nutrients					
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	0.21	0.192	0.107
Total Kjeldahl Nitrogen		EPA 351.2	1.83, SH	1.61, SH	1.18, SH
Total Phosphorus		SM4500-P-B,F	0.406	0.334	0.249
Orthophosphate Phosphorus		SM4500-P-F	0.0475, H	0.0637, H	0.0139, H
Metals					
Cadmium, Dissolved	µg/L	EPA 200.8	<0.05, H	<0.05, H	<0.05, H
Cadmium, Total			0.23	0.12, <RDL	0.16, <RDL
Calcium, Total			5380	4260	4970
Copper, Dissolved			6.25, H	6.4, H	4.4, H
Copper, Total			35.4	22.8	22
Lead, Dissolved			0.22, <RDL, H	0.17, <RDL, H	0.29, <RDL,H
Lead, Total			21.7	11.3	11.2
Magnesium, Total			3050	1930	2440
Mercury, Dissolved		EPA 245.1	<0.05, H	<0.05, H	<0.05, H
Mercury, Total			<0.05	<0.05	<0.05
Zinc, Dissolved		EPA 200.8	14.7, H	14.7, H	16.4, H
Zinc, Total			157	91.5	91.4
Organics					
PAHs					
Acenaphthene	µg/L	SW846-8270D	<0.0094	<0.0094	<0.0094
Acenaphthylene			<0.0094	<0.0094	<0.0094
Anthracene			<0.0094	<0.0094	<0.0094
Benzo(a)anthracene			<0.0094	<0.0094	<0.0094
Benzo(a)pyrene			0.116	<0.0094	<0.0094
Benzo(b,j,k)fluoranthene			<0.0094	<0.0094	<0.0094
Benzo(g,h,i)perylene			0.129	0.118	0.131
Chrysene			0.101	0.0874	0.0824
Dibenzo(a,h)anthracene			<0.0094	<0.0094	<0.0094
Fluoranthene			0.106	0.0825	0.0929
Fluorene			<0.0094	<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene			<0.0094	<0.0094	<0.0094
2-Methylnaphthalene			<0.0094	<0.0094	<0.0094
Naphthalene			0.0413	0.0633	0.0474

Table 16. Concentration data for target analytes in stormwater composite samples collected at COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
Phenanthrene			0.0735	<0.0094	0.0703
Pyrene			0.195	0.16	0.18
Phthalates					
Benzyl Butyl Phthalate	µg/L	SW846-8270D	0.25	0.298	0.442
Bis(2-Ethylhexyl)Phthalate			2.59	3.38, B2, JL	3.23, B2
Diethyl Phthalate			0.578	0.671	<0.024
Dimethyl Phthalate			0.0554	<0.024	<0.024
Di-N-Butyl Phthalate			0.138, B	0.173, B	0.172, B
Di-N-Octyl Phthalate			0.666	0.802	1.01, B3
Pesticides					
2,4-D	µg/L	SW846-8270D-SIM	<0.5, J	<0.5	<0.51
Chlorpyrifos			<0.032	<0.032	<0.032
Diazinon			<0.041	<0.041	<0.041
Dichlobenil			<0.047	<0.047	<0.047
Malathion			<0.045	<0.045	<0.045
MCPP			<0.5	<0.5	<0.51
Pentachlorophenol			<0.094	0.536	0.813
Prometon			<0.047	<0.047	<0.047
Triclopyr			<0.5	<0.5	<0.51

Notes:

Values reported with "<" indicate the target analyte was below the MDL.
Values reported with "<RDL" indicate the target analyte was above the MDL but below the RDL.
Values reported with "SH" indicate sample handling criterion was not met.
Values reported with "H" indicate the holding time was exceeded for that analyte.
Values reported with "B", "B2," or "B3" indicate method blank contamination was observed.
Values reported with "J" indicate estimated value.
Values reported with "JL" indicate estimated value with a high bias.

5.1.2 High Density Residential (HDR) Site

At HDR, conventional and nutrient parameters were detected in both composite samples (Table 17) with the exception of methylene blue activated substances (MBAS), which were not detected in either sample. Metals (total and recoverable) were detected in both composite samples with the exception of dissolved cadmium (not detected in either sample), and total cadmium (detected in one sample).

Measured concentrations for PAHs varied between the two sampled events. Detection frequencies for PAHs ranged from 0 percent for six different compounds to 100 percent for fluoranthene, phenanthrene, and pyrene (Table 17). All phthalates compounds were detected in both the samples with the exception of benzyl butyl phthalate (detected in one sample) and dimethyl phthalate (not detected in either sample). Pesticides were not detected in either sample at HDR.

Table 17. Concentration data for target analytes in stormwater composite samples collected at HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date	
			11/16/11	6/22/12
COMPOSITE SAMPLE PARAMETERS				
Conventionals				
Total Suspended Solids	mg/L	SM2540D	59.4	15.3
Turbidity	NTU	SM2130B	21.6	8.21
Conductivity	µmhos/cm	SM2510B	14.5	16
Chloride	mg/L	SM4110B	0.308	0.206
Biochemical Oxygen Demand	mg/L	SM5210B	9.3	2.39, TA
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	7.22	5.89
Methylene Blue Act. Substance	mg/L	SM5540C	<0.025	<0.025
Nutrients				
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	0.022, <RDL	0.0819
Total Kjeldahl Nitrogen		EPA 351.2	1.13, SH	0.407, SH
Total Phosphorus		SM4500-P-B,F	0.16	0.0794
Orthophosphate Phosphorus		SM4500-P-F	0.0314, H	0.0356, H
Metals				
Cadmium, Dissolved	µg/L	EPA 200.8	<0.05, H	<0.05, H
Cadmium, Total			0.11, <RDL	<0.05
Calcium, Total			2070	1960
Copper, Dissolved			1.2, <RDL, H	4.41, H
Copper, Total			9.98	6.68
Lead, Dissolved			0.18, <RDL, H	0.94, H
Lead, Total			13.4	3.36
Magnesium, Total			499	242
Zinc, Dissolved		EPA 200.8	2.3, <RDL, H	2.59, H
Zinc, Total			28.3	6.89
Organics				
PAHs				
Acenaphthene	µg/L	SW846-8270D	<0.0094	<0.0094
Acenaphthylene			<0.0094	<0.0094
Anthracene			<0.0094	<0.0094
Benzo(a)anthracene			0.0603	<0.0094
Benzo(a)pyrene			0.148	<0.0094
Benzo(b,j,k)fluoranthene			0.169	<0.094
Benzo(g,h,i)perylene			0.128	<0.047
Chrysene			0.0964	<0.0094
Dibenzo(a,h)anthracene			<0.0094	<0.047
Fluoranthene			0.184	0.0366
Fluorene			<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene			0.136	<0.047
2-Methylnaphthalene			<0.0094	<0.0094
Naphthalene			0.017, <RDL	<0.0094
Phenanthrene			0.0987	0.0268
Pyrene			0.16	0.201

Table 17. Concentration data for target analytes in stormwater composite samples collected at HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date	
			11/16/11	6/22/12
Phthalates				
Benzyl Butyl Phthalate	µg/L	SW846-8270D	<0.047	0.163
Bis(2-Ethylhexyl)Phthalate			1.55, B	4.43
Diethyl Phthalate			0.251	0.141
Dimethyl Phthalate			<0.024	<0.024
Di-N-Butyl Phthalate			0.0706, B	0.0494
Di-N-Octyl Phthalate			2.77	0.386
Pesticides				
2,4-D	µg/L	SW846-8270D-SIM	<0.5	<0.5
Chlorpyrifos			<0.032	<0.032
Diazinon			<0.041	<0.041
Dichlobenil			<0.047	<0.047
Malathion			<0.045	<0.045
MCPP			<0.5	<0.5
Pentachlorophenol			<0.094	<0.12
Prometon			<0.047	<0.047, JG
Triclopyr			<0.5	<0.5, JG

Notes:

Values reported with "<" indicate the target analyte was below the MDL.
Values reported with "<RDL" indicate the target analyte was above the MDL but below RDL.
Values reported with "SH" indicate sample handling criterion was not met.
Values reported with "H" indicate the holding time was exceeded for that analyte.
Values reported with "B", "B2" or "B3" indicate method blank contamination was observed.
Values reported with "JG" indicate estimated value with a low bias.
Values reported with "TA" indicate additional text information is available in the lab report (see enclosed CD)

5.1.3 Low Density Residential (LDR) Site

At LDR, conventional and nutrient parameters were detected in all stormwater composite samples (Table 18), with the exception of MBAs, which were detected in two of the three samples. Metals were detected in all composite samples with the following exceptions:

- total and dissolved cadmium were not detected in any sample
- dissolved lead was detected in one of the three samples

Measured concentrations for PAHs varied across the 3 sampled events. Detection frequencies for PAHs ranged from 0 percent (not detected) for 5 separate compounds to 100 percent for six separate PAH compounds (Table 18). Three of the phthalate compounds were detected in all samples while the remaining three phthalate compounds were not detected in any of the samples. For pesticides pentachlorophenol was detected in two samples. No other pesticides were detected in the 3 storm samples collected at LDR in WY12.

Table 18. Concentration data for target analytes in stormwater composite samples collected at LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
COMPOSITE SAMPLE PARAMETERS					
Conventionals					
Total Suspended Solids	mg/L	SM2540D	9.6	9.58	17.1
Turbidity	NTU	SM2130B	9.12, H	9.41	9.82
Conductivity	µmhos/cm	SM2510B	26	26.5	33.5
Chloride	mg/L	SM4110B	0.658	0.704	0.941
Biochemical Oxygen Demand	mg/L	SM5210B	2.48, H	3.34	3.02
Hardness as $CaCO_3$	mg $CaC0_3$/L	EPA 200.8/ SM2340B.ED19	8.05	7.96	10.6
Methylene Blue Act. Substance	mg/L	SM5540C	<0.025, H	0.025, RDL	0.058
Nutrients					
Nitrite + Nitrate Nitrogen	mg/L	SM4500-NO3-F	0.372	0.344	0.59
Total Kjeldahl Nitrogen		EPA 351.2	0.392, SH	0.399	1.57, SH
Total Phosphorus		SM4500-P-B,F	0.0716, H	0.0868	0.0739
Orthophosphate Phosphorus		SM4500-P-F	0.0302, H	0.0381, H	0.0262, H
Metals					
Cadmium, Dissolved	µg/L	EPA 200.8	<0.05, H	<0.05, H	<0.05, H
Cadmium, Total			<0.05	<0.05	<0.05
Calcium, Total			2310	2200	3010
Copper, Dissolved			2, <RDL, H	1.9, <RDL, H	1.7, <RDL,H
Copper, Total			2.86	2.81	2.91
Lead, Dissolved			0.11, <RDL, H	<0.1, H	<0.1, H
Lead, Total			0.988	0.814	1.29
Magnesium, Total			557	596	740
Zinc, Dissolved		EPA 200.8	3.17, H	3.86, H	4.03, H
Zinc, Total			6.52	6.36	8.3
Organics					
PAHs					
Acenaphthene	µg/L	SW846-8270D	<0.0094	<0.0094	<0.0094
Acenaphthylene			<0.0094	<0.0094	<0.0094
Anthracene			<0.0094	<0.0094	<0.0094
Benzo(a)anthracene			0.0272	0.0882	0.0405
Benzo(a)pyrene			0.122	0.193	0.138
Benzo(b,j,k)fluoranthene			0.122	0.308	0.186
Benzo(g,h,i)perylene			0.0936	0.158	0.118
Chrysene			0.0753	0.194	0.113
Dibenzo(a,h)anthracene			<0.0094	<0.0094	0.0959
Fluoranthene			0.139	0.343	0.215
Fluorene			<0.0094	<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene			0.123	0.172	0.143
2-Methylnaphthalene			<0.0094	<0.0094	<0.0094
Naphthalene			0.014, <RDL	0.034	0.01, <RDL
Phenanthrene			0.0373	0.0891	0.0483
Pyrene			0.114	0.313	0.182

Table 18. Concentration data for target analytes in stormwater composite samples collected at LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			10/28/11	11/2/11	11/16/11
Phthalates					
Benzyl Butyl Phthalate	µg/L	SW846-8270D	<0.047	<0.047	<0.047
Bis(2-Ethylhexyl)Phthalate			0.401, B	0.93, B, JL	0.743, B
Diethyl Phthalate			0.8	0.568	0.659
Dimethyl Phthalate			<0.024	<0.024	<0.024
Di-N-Butyl Phthalate			0.039, <RDL, B	0.0704, B	0.0613, B
Di-N-Octyl Phthalate			<0.024	<0.024	<0.024
Pesticides					
2,4-D	µg/L	SW846-8270D-SIM	<0.51, J	<0.5	<0.51
Chlorpyrifos			<0.032	<0.032	<0.032
Diazinon			<0.041	<0.041	<0.041
Dichlobenil			<0.047	<0.047	<0.047
Malathion			<0.045	<0.045	<0.045
MCPP			<0.51	<0.5	<0.51
Pentachlorophenol			0.521	0.508	<0.094
Prometon			<0.047	<0.047	<0.047
Triclopyr			<0.51	<0.5	<0.51

Notes:

Values reported with "<" indicate the target analyte was below the MDL.
Values reported with "<RDL" indicate the target analyte was above the MDL but below the RDL.
Values reported with "SH" indicate sample handling criterion was not met.
Values reported with "H" indicate the holding time was exceeded for that analyte.
Values reported with "B", "B2" or "B3" indicate method blank contamination was observed.
Values reported with "J" indicate estimated value.
Values reported with "JL" indicate estimated value with a high bias.

5.2 Stormwater Grab Sample Results

Concentration data for target analytes in stormwater grab samples for the COM, HDR, and LDR sites are briefly discussed below and presented in Table 19, Table 20, and Table 21, respectively. Grab samples were analyzed for fecal coliform bacteria along with total petroleum hydrocarbons (TPH). The TPH analysis included diesel and lube oil range organics (using NWTPH-Dx) and gasoline range organics (using NWTPH-Gx).

Fecal coliform was detected in all grab samples from all three sites. The three TPH compounds were not detected in any of the grab samples collected at the HDR and LDR monitoring sites. For COM, diesel was detected in one of the five samples, lube oil was detected in four of the five samples, and gasoline was not detected in any samples.

Table 19. Concentration data for target analytes in stormwater grab samples collected at the COM monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date				
			10/28/11	11/2/11	11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS							
Bacteria							
Fecal Coliform	cfu/100mL	SM9222D	1600	2800	780	1500	800
Organics							
TPH							
Gasoline Range (C7-C12)	µg/L	NWTPH-GX	<250	<250	<250	<100	<100
Diesel Range (>C12-C24)	µg/L	NWTPH-DX	<0.19	<0.19	<0.19	<0.19	.256, TA
Lube Oil Range (>C24)	mg/L		0.379	<0.19	0.197	0.709	0.547

Notes:

Values reported with "<" indicate the target analyte was below the MDL.

Values reported with "TA" indicate text information is available in the laboratory report (see enclosed CD).

Table 20. Concentration data for target analytes in stormwater grab samples collected at the HDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS					
Bacteria					
Fecal Coliform	cfu/100mL	SM9222D	-	1400	33000
Organics					
TPH					
Gasoline Range (C7-C12)	µg/L	NWTPH-GX	<250	<100	<100
Diesel Range (>C12-C24)	µg/L	NWTPH-Dx	<0.19	<0.19	<0.19
Lube Oil Range (>C24)	mg/L		<0.19	<0.19	<0.19

Notes:

Values reported with "<" indicate the target analyte was below the MDL.

"-", no data reported for target analyte.

Table 21. Concentration data for target analytes in stormwater grab samples collected at the LDR monitoring site.

Parameters	Units	Analytical Methods	Storm Start Date		
			11/16/11	6/22/12	7/20/12
GRAB SAMPLE PARAMETERS					
Bacteria					
Fecal Coliform	cfu/100mL	SM9222D	29	830	3400
Organics					
TPH					
Gasoline Range (C7-C12)	µg/L	NWTPH-GX	<250	<100	<100
Diesel Range (>C12-C24)	µg/L	NWTPH-Dx	<0.21	<0.19	<0.19
Lube Oil Range (>C24)	mg/L		<0.21	<0.19	<0.19

Notes:

Values reported with "<" indicate the target analyte was below the MDL.

5.3 Annual Sediment Sample

Concentration data for target analytes in accumulated sediment samples collected from COM, HDR, and LDR are presented in Table 22. Analytes include conventionals (solids), metals, and organics.

Analytical results for total solids ranged from 25 percent at HDR to 71 percent at LDR. Results for grain size analysis for all three sites are presented in Figure 7.

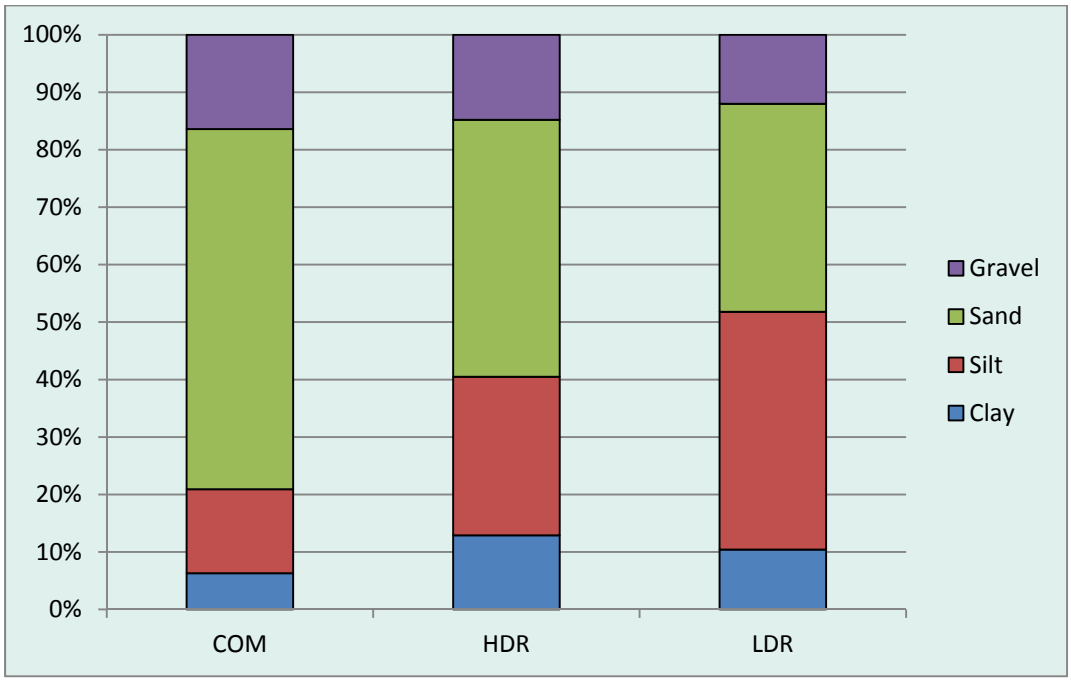

Figure 7. Grain size distribution for sediment samples collected at COM, HDR, and LDR.

Metals were detected in sediment samples collected at all three sites while organics results varied across the sites. For PAHs, 3 out of the 18 compounds were below the MDLs for COM and LDR, while 1 out of the 18 compounds was below the MDLs for HDR. For the phthalate compounds, 4 of the 6 compounds were detected in the COM sample, 3 in the LDR sample, and only 1 compound was detected in the HDR sample. All phenol compounds were below the MDL in the sediment sample from LDR, while 2 of the 4 compounds at COM and 1 of the 4 compounds at HDR were below the MDL. Pesticide compounds were below the MDLs for samples from all 3 sites.

Additional compounds, categorized in Table 22 as “other semivolatile organics” were analyzed in the sediment samples. Benzoic acid and pentachlorophenol were detected in samples from all three sites, dibenzofuran and hexachlorobenznene were detected in the HDR sediment sample, and 1,4-dichlorobenzene was detected in the LDR sample.

The COM sediment sample was the only site analyzed for the PCB Aroclors. All but Aroclor 1254 were below the MDL.

Table 22. Concentration data for target analytes in annual sediment samples collected at COM, HDR, and LDR (wet weight basis).

Parameter	Analytical Methods	Units	Sediment Sample Concentrations		
			COM	HDR	LDR
Conventionals					
Total Solids	SM2540G	%	56.4	25.2	70.8
Total Organic Carbon	EPA9060-PSEP96	mg/Kg	29,500	36,400	55,300
Gravel	ASTM D422	%	15	14.8	12
< -2 Phi Gravel		%	2.5	8.6	4.8
(-1) - (-2) Phi Gravel		%	1.8	0.8, <RDL	1.9
(-1) - 0 Phi Gravel		%	10.7	5.4	5.2
Sand		%	62.3	44.4	36.2
0-1 Phi Sand		%	11.6	8.4	3.1
1-2 Phi Sand		%	11.5	7.2	3
2-3 Phi Sand		%	13	7.7	6.5
3-4 Phi Sand		%	15.8	9.1	10.4
4-5 Phi Sand		%	10.5	12	13.2
Silt		%	13.4	27.2	41.8
5-6 Phi Silt		%	5	14.5	18.1
6-7 Phi Silt		%	2.5	3.6, RDL	13.2
7-8 Phi Silt		%	3.3	7.2	7
8-9 Phi Silt		%	2.5	1.8, <RDL	3.5
Clay		%	5.9	12.7	10.4
9-10 Phi Clay		%	0.8, <RDL	1.8, <RDL	3.5
>10 Phi Clay		%	5	10.9	7
Fines		%	19.3	39.9	52.2
Metals					
Cadmium, Total, ICP	EPA3050B/ 6020A	mg/Kg	0.2, <RDL	0.25, <RDL	0.37, <RDL
Copper, Total, ICP		mg/Kg	27.7	15.3	21.4
Lead, Total, ICP		mg/Kg	31.7	90.8	19.2
Mercury, Total, CVAA		mg/Kg	0.024, <RDL	-	-
Zinc, Total, ICP		mg/Kg	129	46.7	82
Organics					
PAHs					
Benzo(a)anthracene	SW846-8270D	ug/Kg	57.6	279	3080
Benzo(a)pyrene		ug/Kg	178	384	3920
Benzo(b,j,k)fluoranthene		ug/Kg	99.7	772	9970
Benzo(g,h,i)perylene		ug/Kg	97.5	247	1990
Chrysene		ug/Kg	49.6	415	5280
Dibenzo(a,h)anthracene		ug/Kg	52, <RDL, B3	73.4	474
Fluoranthene		ug/Kg	90.4	646	9660
Indeno(1,2,3-Cd)Pyrene		ug/Kg	41, <RDL	218	1910
Pyrene		ug/Kg	232	795	9700
Total HPAHS		ug/Kg	897.8	3829.4	45984
Acenaphthene		ug/Kg	<5.3	9.42	23.9
Acenaphthylene		ug/Kg	<5.3	<3.2	<5.3
Anthracene		ug/Kg	9.8	32.9	129
Fluorene		ug/Kg	<5.3	13.2	28.9
2-Methylnaphthalene		ug/Kg	24.1	4.7, <RDL	<5.3
Naphthalene		ug/Kg	9.7, <RDL	6.2, <RDL	<5.3
Phenanthrene		ug/Kg	70.3	325	1810
Total LPAHs		ug/Kg	89.8	386.72	1991.8
Phthalates					
Benzyl Butyl Phthalate	SW846-8270D	ug/Kg	264	<4.8	88.5
Bis(2-Ethylhexyl)Phthalate		ug/Kg	6520, J	1610	345
Diethyl Phthalate		ug/Kg	<11	<6.4	<11
Dimethyl Phthalate		ug/Kg	<10.7	<6.4	<10.7

Table 22. Concentration data for target analytes in annual sediment samples collected at COM, HDR, and LDR (wet weight basis).

Parameter	Analytical Methods	Units	Sediment Sample Concentrations		
			COM	HDR	LDR
Di-N-Butyl Phthalate		ug/Kg	25.2	<6.4	11, <RDL
Di-N-Octyl Phthalate		ug/Kg	816	<32	<10.7
Phenols					
2,4-Dimethylphenol	SW846-8270D	ug/Kg	<5.3	<3.2	<5.3
2-Methylphenol		ug/Kg	11.6	14.7	<5.3
3-,4-Methylphenol		ug/Kg	341	6070	<27
Phenol		ug/Kg	<27	114	<27
PCB Arocolors					
Aroclor 1016	SW846-8082A	ug/Kg	<2	-	-
Aroclor 1221		ug/Kg	<4	-	-
Aroclor 1232		ug/Kg	<4	-	-
Aroclor 1242		ug/Kg	<2	-	-
Aroclor 1248		ug/Kg	<2	-	-
Aroclor 1254		ug/Kg	5.4, <RDL	-	-
Aroclor 1260		ug/Kg	<2	-	-
Total Aroclors		ug/Kg	5.4, <RDL	-	-
Pesticides					
Chlorpyrifos	SW846-8270DSIM	ug/Kg	<16	<16	<16
Diazinon		ug/Kg	<9.6	<9.6	<9.6
Malathion		ug/Kg	<26	<26	<26
Other Semivolatile Organics					
Benzoic Acid	SW846-8270D	ug/Kg	64, <RDL	99.4, <RDL	58.9, <RDL
Benzyl Alcohol		ug/Kg	<13.3	<8	<13.3
Dibenzofuran		ug/Kg	<5.3	5.4, <RDL	<5.33
1,2-Dichlorobenzene		ug/Kg	<5.33	<3.2	<8
1,4-Dichlorobenzene		ug/Kg	<8	<4.8	11.7
Hexachlorobenzene		ug/Kg	<0.53	8.95	<0.53
Hexachlorobutadiene		ug/Kg	<2.7	<1.6	<2.7
N-Nitrosodiphenylamine		ug/Kg	<13.3	<8	<13.3
Pentachlorophenol		ug/Kg	209	104	183
1,2,4-Trichlorobenzene		ug/Kg	<0.53	<0.32	<0.53

Notes:

Values reported with "<" indicate the target analyte was below the MDL.
Values reported with "<RDL" indicate the target analyte was above the MDL but below the RDL.
Values reported with "J" indicate result is an estimate.
"–", no data reported for target analyte.

5.4 Stormwater Management Program Activities within Monitoring Drainage Areas

The County's stormwater management program activities that occurred during WY12 within the monitoring sites' drainage basins are described below.

- Within the Fall City basins, King County inspected stormwater catch basins within the road right-of-way using a circuit basis methodology as allowed by the Phase I NPDES Municipal Stormwater Permit.
- King County cleaned stormwater catch basins within the inspected circuits that were found to be in exceedance of sediment maintenance standards for catch basins. This was

completed as defined by the methodology allowed by the Phase I NPDES Municipal Stormwater Permit.

- Within the Fall City basins, King County inspected the stormwater treatment and flow control facilities it owns and operates, as required by the Phase I NPDES Municipal Stormwater Permit.
- Within the S8.D monitoring basins, King County performed maintenance on the stormwater treatment and flow control facilities it owns and operates which were found to be in exceedance of function critical maintenance standards for stormwater treatment and flow control facilities.
- King County provided stormwater drainage related technical assistance to rural and agricultural properties near the Fall City Basin.
- King County water quality staff conducted water quality audits of numerous businesses along Redmond Fall City Road in Fall City.
- King County conducted stormwater conveyance system maintenance in both the Renton and Fall City basins. Maintenance included street sweeping along 148th Ave within the Renton basin.

6.0. POLLUTANT LOADING CALCULATIONS

Pollutant loads were calculated following procedures outlined in Ecology's Standard Operating Procedures (SOP) (Ecology, 2009). The pollutant loading calculation procedures included in the project QAPP were different from the Ecology SOP because the Ecology SOP was created six months after King County's QAPP was approved. In November 2010, King County submitted a modified QAPP, which updated the pollutant loading calculations contained in the QAPP to those outlined in the Ecology SOP.

The loading results are based on the parameters analyzed for qualifying[3] composite stormwater samples collected from the HDR and LDR monitoring sites. No pollutant loading calculations were completed for the COM monitoring site since the samples did not meet the criterion stating samples must represent at least 75 percent of the hydrograph of the first 24-hours of the storm event. Base flow was not observed at any of the sites during the abbreviated WY12, therefore no base flow analysis or calculation was needed for the pollutant loading at either HDR or LDR.

The first step in calculating the pollutant loading was to determine an event mean concentration value (EMC) for each parameter from composite samples that met all of the Permit criteria. This was done for each qualifying sampled storm for HDR and LDR. For all qualifying samples at these sites, results below the MDL were assigned an EMC equal to ½ of the MDL. For results that were above the MDL the value reported by the analytical laboratory was used as the EMC.

Individual storm pollutant loads were calculated for each analyte for all qualifying samples at HDR and LDR site. The pollutant load was calculated as the product of the EMC and the runoff volume for that event.

$$Pollutant\ Load = EMC_i\ x\ V_i$$

Where:

EMC_i = EMC from event *i* in pounds per liter
V_i = runoff volume from event *i* in liters

Pollutant loads, reported as pounds, for the qualifying sampled storm events for the HDR and LDR monitoring sites are presented in Table 23 and Table 24, respectively. Wet season, dry season, and annual storm pollutant loads for WY12, reported in pounds, were calculated for each monitoring site and are presented in Table 25 (HDR) and Table 26 (LDR). Annual pollutant loads calculated as pounds per acre are presented for each site in Table 27. Flow data needed for these calculations included:

- Average flow rates of the qualifying sampled events, which are provided in Table 9 for HDR and Table 13 for LDR.
- The WY12 storm flow volume for HDR and LDR for the abbreviated sampling period on a wet season, dry season, and annual basis.

[3] Analytical results used in pollutant loading calculations were from samples that met all storm and sampling criteria outlined in the Permit §S8.D.2.a.i., §S8.D.2.a.ii, and §S8.D.2.b. Samples that did not meet one or more of the criteria were not included in the calculations.

Because the monitoring year was abbreviated (as outlined in Section 3.1) the pollutant loads represent the periods of active monitoring: October 1 through December 31, 2011 for the wet season and June 15 through September 30, 2012 for the dry season. The abbreviated wet season, dry season, and annual storm flow volumes for HDR and LDR were:

- HDR – wet = 537,571 gallons, dry = 22,360 gallons, annual = 560,031 gallons
- LDR – wet = 353,710 gallons, dry = 18,391 gallons, annual = 372,101 gallons.

The continuous flow record from each site for the period of active monitoring was used to determine the annual flow volume. The flow data was reviewed and corrected as needed by King County staff. For the pollutant loads in pounds per acre, the size of the drainage areas (in acres) reported in Table 1 were used.

Table 23. Pollutant load (pounds) for qualifying sampled storm event at HDR for WY12.

Parameter	Storm Event Pollutant Loads (pounds) 11/16/11
Conventionals	
Total Suspended Solids	1.38E+01
Turbidity	nc
Conductivity	nc
Chloride	7.15E-05
Biochemical Oxygen Demand	2.16E+00
Hardness, Calc	1.67E+00
Methylene Blue Act. Substance	2.90E-03
Nutrients	
Nitrite + Nitrate Nitrogen	5.10E-03
Total Kjeldahl Nitrogen	2.62E-01
Total Phosphorus	3.71E-02
Orthophosphate Phosphorus	7.28E-03
Metals	
Cadmium, Dissolved	5.80E-06
Cadmium, Total	2.55E-05
Calcium, Total	4.80E-01
Copper, Dissolved	2.78E-04
Copper, Total	2.32E-03
Lead, Dissolved	4.18E-05
Lead, Total	3.11E-03
Magnesium, Total	1.16E-01
Zinc, Dissolved	5.34E-04
Zinc, Total	6.57E-03
Organics	
PAHs	
Acenaphthene	1.09E-06
Acenaphthylene	1.09E-06
Anthracene	1.09E-06
Benzo(a)anthracene	1.40E-05
Benzo(a)pyrene	3.43E-05
Benzo(b,j,k)fluoranthene	3.92E-05
Benzo(g,h,i)perylene	2.97E-05
Chrysene	2.24E-05
Dibenzo(a,h)anthracene	1.09E-06
Fluoranthene	4.27E-05
Fluorene	1.09E-06
Indeno(1,2,3-Cd)Pyrene	3.15E-05
2-Methylnaphthalene	1.09E-06
Naphthalene	3.94E-06
Phenanthrene	2.29E-05
Pyrene	3.71E-05
Phthalates	
Benzyl Butyl Phthalate	5.45E-06
Bis(2-Ethylhexyl)Phthalate	3.60E-04
Diethyl Phthalate	5.82E-05
Dimethyl Phthalate	2.78E-06
Di-N-Butyl Phthalate	1.64E-05

Table 23. Pollutant load (pounds) for qualifying sampled storm event at HDR for WY12.

Parameter	Storm Event Pollutant Loads (pounds) 11/16/11
Di-N-Octyl Phthalate	6.43E-04
Pesticides	
2,4-D	5.80E-05
Chlorpyrifos	3.71E-06
Diazinon	4.76E-06
Dichlobenil	5.45E-06
Malathion	5.22E-06
MCPP	5.80E-05
Pentachlorophenol	1.09E-05
Prometon	5.45E-06
Triclopyr	5.80E-05

Notes:

nc – Load not calculated. Turbidity and conductivity are not measured in terms of concentration and cannot be directly converted into loadings.

Pollutant loading calculations based on Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1 (Ecology, 2009).

Table 24. Pollutant load (pounds) for qualifying sampled storm events at LDR for WY12.

Parameter	Storm Event Pollutant Loads (pounds)		
	10/28/11	11/2/11	11/16/11
Conventionals			
Total Suspended Solids	1.43E+00	1.06E+00	2.94E+00
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	9.82E-05	7.74E-05	1.62E-04
Biochemical Oxygen Demand	3.70E-01	3.67E-01	5.18E-01
Hardness, Calc	1.20E+00	8.76E-01	1.82E+00
Methylene Blue Act. Substance	1.86E-03	1.38E-03	9.96E-03
Nutrients			
Nitrite + Nitrate Nitrogen	5.55E-02	4.09E-02	1.01E-01
Total Kjeldahl Nitrogen	5.85E-02	4.31E-02	2.70E-01
Total Phosphorus	1.07E-02	7.88E-03	1.27E-02
Orthophosphate Phosphorus	4.51E-03	3.32E-03	4.50E-03
Metals			
Cadmium, Dissolved	3.73E-06	2.75E-06	4.29E-06
Cadmium, Total	3.73E-06	2.75E-06	4.29E-06
Calcium, Total	3.45E-01	2.42E-01	5.17E-01
Copper, Dissolved	2.98E-04	2.09E-04	2.92E-04
Copper, Total	4.27E-04	3.09E-04	5.00E-04
Lead, Dissolved	1.64E-05	5.50E-06	8.58E-06
Lead, Total	1.47E-04	8.95E-05	2.21E-04
Magnesium, Total	8.31E-02	6.56E-02	1.27E-01
Zinc, Dissolved	4.73E-04	3.49E-04	6.92E-04
Zinc, Total	9.73E-04	7.17E-04	1.42E-03
Organics			
PAHs			
Acenaphthene	7.01E-07	5.17E-07	8.07E-07
Acenaphthylene	7.01E-07	5.17E-07	8.07E-07
Anthracene	7.01E-07	5.17E-07	8.07E-07
Benzo(a)anthracene	4.06E-06	9.70E-06	6.95E-06
Benzo(a)pyrene	1.82E-05	2.12E-05	2.37E-05
Benzo(b,j,k)fluoranthene	1.82E-05	3.39E-05	3.19E-05
Benzo(g,h,i)perylene	1.40E-05	1.74E-05	2.03E-05
Chrysene	1.12E-05	2.13E-05	1.94E-05
Dibenzo(a,h)anthracene	7.01E-07	5.17E-07	1.65E-05
Fluoranthene	2.07E-05	3.77E-05	3.69E-05
Fluorene	7.01E-07	5.17E-07	8.07E-07
Indeno(1,2,3-Cd)Pyrene	1.84E-05	1.89E-05	2.45E-05
2-Methylnaphthalene	7.01E-07	5.17E-07	8.07E-07
Naphthalene	2.09E-06	1.54E-06	1.72E-06
Phenanthrene	5.57E-06	4.10E-06	8.29E-06
Pyrene	1.70E-05	1.25E-05	3.12E-05
Phthalates			
Benzyl Butyl Phthalate	3.51E-06	2.59E-06	4.03E-06
Bis(2-Ethylhexyl)Phthalate	5.98E-05	1.02E-04	1.28E-04
Diethyl Phthalate	1.19E-04	6.25E-05	1.13E-04
Dimethyl Phthalate	1.79E-06	1.32E-06	2.06E-06
Di-N-Butyl Phthalate	5.82E-06	7.74E-06	1.05E-05
Di-N-Octyl Phthalate	1.79E-06	1.32E-06	2.06E-06

Table 24. Pollutant load (pounds) for qualifying sampled storm events at LDR for WY12.

Parameter	Storm Event Pollutant Loads (pounds)		
	10/28/11	11/2/11	11/16/11
Pesticides			
2,4-D	3.80E-05	2.75E-05	4.38E-05
Chlorpyrifos	2.39E-06	1.76E-06	2.75E-06
Diazinon	3.06E-06	2.26E-06	3.52E-06
Dichlobenil	3.51E-06	2.59E-06	4.03E-06
Malathion	3.36E-06	2.48E-06	3.86E-06
MCPP	3.80E-05	2.75E-05	4.38E-05
Pentachlorophenol	7.77E-05	5.73E-05	8.07E-06
Prometon	3.51E-06	2.59E-06	4.03E-06
Triclopyr	3.80E-05	2.81E-05	4.38E-05

Notes:

nc – Load not calculated. Turbidity and conductivity are not measured in terms of concentration and cannot be directly converted into loadings.

Pollutant loading calculations based on Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1 (Ecology, 2009).

Table 25. Pollutant loads (pounds) by period for HDR for WY12.

Parameter	Seasonal and Annual Pollutant Loads (pounds)[1]		
	Wet Season (Oct – Dec)	Dry Season (June 15 – Sept)	Annual
Conventionals			
Total Suspended Solids	2.78E+02	2.67E+02	1.11E+01
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	1.44E-03	1.38E-03	5.75E-05
Biochemical Oxygen Demand	4.35E+01	4.17E+01	1.74E+00
Hardness, Calc	3.37E+01	3.24E+01	1.35E+00
Methylene Blue Act. Substance	5.84E-02	5.61E-02	2.33E-03
Nutrients			
Nitrite + Nitrate Nitrogen	1.03E-01	9.87E-02	4.11E-03
Total Kjeldahl Nitrogen	5.28E+00	5.07E+00	2.11E-01
Total Phosphorus	7.48E-01	7.18E-01	2.99E-02
Orthophosphate Phosphorus	1.47E-01	1.41E-01	5.86E-03
Metals			
Cadmium, Dissolved	1.17E-04	1.12E-04	4.67E-06
Cadmium, Total	5.14E-04	4.94E-04	2.05E-05
Calcium, Total	9.67E+00	9.29E+00	3.86E-01
Copper, Dissolved	5.61E-03	5.38E-03	2.24E-04
Copper, Total	4.66E-02	4.48E-02	1.86E-03
Lead, Dissolved	8.41E-04	8.08E-04	3.36E-05
Lead, Total	6.26E-02	6.01E-02	2.50E-03
Magnesium, Total	2.33E+00	2.24E+00	9.31E-02
Zinc, Dissolved	1.07E-02	1.03E-02	4.29E-04
Zinc, Total	1.32E-01	1.27E-01	5.28E-03
Organics			
PAHs			
Acenaphthene	2.20E-05	2.11E-05	8.77E-07
Acenaphthylene	2.20E-05	2.11E-05	8.77E-07
Anthracene	2.20E-05	2.11E-05	8.77E-07
Benzo(a)anthracene	2.82E-04	2.71E-04	1.13E-05
Benzo(a)pyrene	6.92E-04	6.64E-04	2.76E-05
Benzo(b,j,k)fluoranthene	7.90E-04	7.58E-04	3.15E-05
Benzo(g,h,i)perylene	5.98E-04	5.74E-04	2.39E-05
Chrysene	4.51E-04	4.33E-04	1.80E-05
Dibenzo(a,h)anthracene	2.20E-05	2.11E-05	8.77E-07
Fluoranthene	8.60E-04	8.26E-04	3.43E-05
Fluorene	2.20E-05	2.11E-05	8.77E-07
Indeno(1,2,3-Cd)Pyrene	6.36E-04	6.10E-04	2.54E-05
2-Methylnaphthalene	2.20E-05	2.11E-05	8.77E-07
Naphthalene	7.95E-05	7.63E-05	3.17E-06
Phenanthrene	4.61E-04	4.43E-04	1.84E-05
Pyrene	7.48E-04	7.18E-04	2.99E-05
Phthalates			
Benzyl Butyl Phthalate	1.10E-04	1.05E-04	4.39E-06
Bis(2-Ethylhexyl)Phthalate	7.24E-03	6.95E-03	2.89E-04
Diethyl Phthalate	1.17E-03	1.13E-03	4.68E-05
Dimethyl Phthalate	5.61E-05	5.38E-05	2.24E-06

Table 25. Pollutant loads (pounds) by period for HDR for WY12.

Parameter	Seasonal and Annual Pollutant Loads (pounds)[1]		
	Wet Season (Oct – Dec)	Dry Season (June 15 – Sept)	Annual
Di-N-Butyl Phthalate	3.30E-04	3.17E-04	1.32E-05
Di-N-Octyl Phthalate	1.29E-02	1.24E-02	5.17E-04
Pesticides			
2,4-D	1.17E-03	1.12E-03	4.67E-05
Chlorpyrifos	7.48E-05	7.18E-05	2.99E-06
Diazinon	9.58E-05	9.20E-05	3.83E-06
Dichlobenil	1.10E-04	1.05E-04	4.39E-06
Malathion	1.05E-04	1.01E-04	4.20E-06
MCPP	1.17E-03	1.12E-03	4.67E-05
Pentachlorophenol	2.20E-04	2.11E-04	8.77E-06
Prometon	1.10E-04	1.05E-04	4.39E-06
Triclopyr	1.17E-03	1.12E-03	4.67E-05

Notes:

[1] – Pollutant loads calculated using flow volumes from the abbreviated WY12 sampling period. Therefore, wet season represents October 1 through December 31. Dry season represents June 15 through September 30.

nc – Load not calculated. Turbidity and conductivity are not measured in terms of concentration and cannot be directly converted into loadings.

Pollutant loading calculations based on Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1 (Ecology, 2009).

Table 26. Pollutant loads (pounds) by period for LDR for WY12.

Parameter	Seasonal and Annual Pollutant Loads (pounds)[1]		
	Wet Season (Oct – Dec)	Dry Season (June 15 – Sept)	Annual
Conventionals			
Total Suspended Solids	3.30E+01	3.14E+01	1.63E+00
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	2.22E-03	2.11E-03	1.10E-04
Biochemical Oxygen Demand	8.97E+00	8.53E+00	4.43E-01
Hardness, Calc	2.60E+01	2.47E+01	1.28E+00
Methylene Blue Act. Substance	7.35E-02	6.99E-02	3.63E-03
Nutrients			
Nitrite + Nitrate Nitrogen	1.22E+00	1.16E+00	6.01E-02
Total Kjeldahl Nitrogen	1.73E+00	1.65E+00	8.57E-02
Total Phosphorus	2.42E-01	2.30E-01	1.19E-02
Orthophosphate Phosphorus	1.02E-01	9.66E-02	5.02E-03
Metals			
Cadmium, Dissolved	7.76E-05	7.38E-05	3.84E-06
Cadmium, Total	7.76E-05	7.38E-05	3.84E-06
Calcium, Total	7.34E+00	6.98E+00	3.63E-01
Copper, Dissolved	5.96E-03	5.67E-03	2.95E-04
Copper, Total	8.84E-03	8.41E-03	4.37E-04
Lead, Dissolved	2.43E-04	2.31E-04	1.20E-05
Lead, Total	2.99E-03	2.84E-03	1.48E-04
Magnesium, Total	1.86E+00	1.76E+00	9.17E-02
Zinc, Dissolved	1.10E-02	1.05E-02	5.46E-04
Zinc, Total	2.08E-02	1.98E-02	1.03E-03
Organics			
PAHs			
Acenaphthene	1.46E-05	1.39E-05	7.21E-07
Acenaphthylene	1.46E-05	1.39E-05	7.21E-07
Anthracene	1.46E-05	1.39E-05	7.21E-07
Benzo(a)anthracene	1.64E-04	1.56E-04	8.10E-06
Benzo(a)pyrene	4.71E-04	4.48E-04	2.33E-05
Benzo(b,j,k)fluoranthene	6.31E-04	6.00E-04	3.12E-05
Benzo(g,h,i)perylene	3.79E-04	3.60E-04	1.87E-05
Chrysene	3.93E-04	3.74E-04	1.94E-05
Dibenzo(a,h)anthracene	5.39E-05	5.13E-05	2.67E-06
Fluoranthene	7.11E-04	6.76E-04	3.51E-05
Fluorene	1.46E-05	1.39E-05	7.21E-07
Indeno(1,2,3-Cd)Pyrene	4.50E-04	4.28E-04	2.22E-05
2-Methylnaphthalene	1.46E-05	1.39E-05	7.21E-07
Naphthalene	6.59E-05	6.26E-05	3.26E-06
Phenanthrene	1.83E-04	1.74E-04	9.05E-06
Pyrene	6.24E-04	5.93E-04	3.08E-05
Phthalates			
Benzyl Butyl Phthalate	7.30E-05	6.94E-05	3.61E-06
Bis(2-Ethylhexyl)Phthalate	2.03E-03	1.93E-03	1.00E-04
Diethyl Phthalate	2.14E-03	2.04E-03	1.06E-04
Dimethyl Phthalate	3.73E-05	3.54E-05	1.84E-06

Table 26. Pollutant loads (pounds) by period for LDR for WY12.

Parameter	Seasonal and Annual Pollutant Loads (pounds)[1]		
	Wet Season (Oct – Dec)	Dry Season (June 15 – Sept)	Annual
Di-N-Butyl Phthalate	1.69E-04	1.60E-04	8.34E-06
Di-N-Octyl Phthalate	3.73E-05	3.54E-05	1.84E-06
Pesticides			
2,4-D	7.86E-04	7.47E-04	3.88E-05
Chlorpyrifos	4.97E-05	4.72E-05	2.46E-06
Diazinon	6.37E-05	6.05E-05	3.15E-06
Dichlobenil	7.30E-05	6.94E-05	3.61E-06
Malathion	6.99E-05	6.64E-05	3.45E-06
MCPP	7.86E-04	7.47E-04	3.88E-05
Pentachlorophenol	1.40E-03	1.33E-03	6.91E-05
Prometon	7.30E-05	6.94E-05	3.61E-06
Triclopyr	7.86E-04	7.47E-04	3.88E-05

Notes:

[1] – Pollutant loads calculated using flow volumes from the abbreviated WY12 sampling period. Therefore, wet season represents October 1 through December 31. Dry season represents June 15 through September 30.

nc – Load not calculated. Turbidity and conductivity are not measured in terms of concentration and cannot be directly converted into loadings.

Pollutant loading calculations based on Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1 (Ecology, 2009).

Table 27. Annual pollutant loads (pounds per acre) for WY12 for HDR and LDR.

Parameter	Annual Pollutant Loads for WY12[1] (pounds per acre)	
	HDR	LDR
Conventionals		
Total Suspended Solids	5.29E+01	6.29E+00
Turbidity	nc	nc
Conductivity	nc	nc
Chloride	2.74E-04	4.23E-04
Biochemical Oxygen Demand	8.28E+00	1.71E+00
Hardness, Calc	6.43E+00	4.95E+00
Methylene Blue Act. Substance	1.11E-02	1.40E-02
Nutrients		
Nitrite + Nitrate Nitrogen	1.96E-02	2.32E-01
Total Kjeldahl Nitrogen	1.01E+00	3.30E-01
Total Phosphorus	1.42E-01	4.60E-02
Orthophosphate Phosphorus	2.80E-02	1.94E-02
Metals		
Cadmium, Dissolved, ICP-MS	2.23E-05	1.48E-05
Cadmium, Total, ICP-MS	9.79E-05	1.48E-05
Calcium, Total, ICP-MS	1.84E+00	1.40E+00
Copper, Dissolved, ICP-MS	1.07E-03	1.14E-03
Copper, Total, ICP-MS	8.88E-03	1.68E-03
Lead, Dissolved, ICP-MS	1.60E-04	4.63E-05
Lead, Total, ICP-MS	1.19E-02	5.69E-04
Magnesium, Total, ICP-MS	4.44E-01	3.53E-01
Mercury, Dissolved, CVAA	2.05E-03	2.10E-03
Mercury, Total, CVAA	2.52E-02	3.97E-03
Zinc, Dissolved, ICP-MS	2.23E-05	1.48E-05
Zinc, Total, ICP-MS	9.79E-05	1.48E-05
Organics		
PAHs		
Acenaphthene	4.18E-06	2.78E-06
Acenaphthylene	4.18E-06	2.78E-06
Anthracene	4.18E-06	2.78E-06
Benzo(a)anthracene	5.37E-05	3.12E-05
Benzo(a)pyrene	1.32E-04	8.98E-05
Benzo(b,j,k)fluoranthene	1.50E-04	1.20E-04
Benzo(g,h,i)perylene	1.14E-04	7.22E-05
Chrysene	8.58E-05	7.49E-05
Dibenzo(a,h)anthracene	4.18E-06	1.03E-05
Fluoranthene	1.64E-04	1.35E-04
Fluorene	4.18E-06	2.78E-06
Indeno(1,2,3-Cd)Pyrene	1.21E-04	8.57E-05
2-Methylnaphthalene	4.18E-06	2.78E-06
Naphthalene	1.51E-05	1.26E-05
Phenanthrene	8.79E-05	3.49E-05
Pyrene	1.42E-04	1.19E-04
Benzyl Butyl Phthalate	2.09E-05	1.39E-05
Bis(2-Ethylhexyl)Phthalate	1.38E-03	3.87E-04

Table 27. Annual pollutant loads (pounds per acre) for WY12 for HDR and LDR.

Parameter	Annual Pollutant Loads for WY12[1] (pounds per acre)	
	HDR	LDR
Diethyl Phthalate	2.23E-04	4.08E-04
Dimethyl Phthalate	1.07E-05	7.10E-06
Di-N-Butyl Phthalate	6.28E-05	3.21E-05
Di-N-Octyl Phthalate	2.47E-03	7.10E-06
Pesticides		
2,4-D	2.23E-04	1.50E-04
Chlorpyrifos	1.42E-05	9.46E-06
Diazinon	1.82E-05	1.21E-05
Dichlobenil	2.09E-05	1.39E-05
Malathion	2.00E-05	1.33E-05
MCPP	2.23E-04	1.50E-04
Pentachlorophenol	4.18E-05	2.66E-04
Prometon	2.09E-05	1.39E-05
Triclopyr	2.23E-04	1.50E-04

Notes:

[1] – Pollutant loads calculated using flow volumes from the abbreviated WY12 sampling period. Therefore, loads represent flow and water quality data collected October 1 through December 31, 2011 and June 15 through September 30, 2012.

nc – Load not calculated. Turbidity and conductivity are not measured in terms of concentration and cannot be directly converted into loadings.

Pollutant loading calculations based on Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1 (Ecology, 2009).

7.0. OTHER STORMWATER MONITORING

Descriptions of stormwater monitoring not included with the annual stormwater monitoring report appear in Section 8.B of King County's annual Stormwater Management Program report.

8.0. REFERENCES

Ecology, 2007. Phase 1 Municipal Stormwater Permit. National Pollutant Discharge Elimination System and State Waste Discharge General Permit for discharges from Large and Medium Municipal Separate Storm Sewer Systems. Olympia WA. January 17, 2007

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Ecology, 2010. Stormwater Monitoring Report Guidance. Phase I Municipal Stormwater Permit Reporting Requirements for Special Condition S8. June 2010.

King County, 2010. Quality Assurance Project Plan for King County Stormwater Monitoring Under the Phase 1 Municipal Stormwater Permit WAR04-4501 (Issued February 2007). Updated November 2010.