
2011 Monitoring Report for King County Stormwater Monitoring Under S8.D of the NPDES Phase 1 Municipal Permit WAR04-4501 (Issued February 2007)

March 2012



King County

Department of Natural Resources and Parks
Water and Land Resources Division

Science Section

King Street Center, KSC-NR-0600
201 South Jackson Street, Suite 600
Seattle, WA 98104
dnr.metrokc.gov/wlr

Alternate Formats Available

206-296-7380 TTY Relay: 711

Prepared by



2011 Monitoring Report for King County Stormwater Monitoring Under S8.D the NPDES Municipal Phase 1 Municipal Permit WAR04-4501(Issued February 2007)

Submitted by:

King County
Water and Land Resources Division
Department of Natural Resources and Parks



King County

Department of
Natural Resources and Parks

Water and Land Resources Division

Table of Contents

1.0.	Introduction.....	5
2.0.	Summary of Monitoring Stations.....	6
2.1	Site Descriptions	6
2.1.1	Commercial Site (COM).....	7
2.1.2	High Density Residential (HDR)	10
2.1.3	Low Density Residential (LDR)	12
3.1	Summary of Storm Events	15
3.2	Characteristics of Individual Sampled Events	16
3.2.1	Sampled Events at Commercial (COM) Site	17
3.2.2	Sampled Events at High Density Residential (HDR) Site	22
3.2.3	Sampled Events at Low Density Residential (LDR) Site	27
3.3	Sediment Sampling	33
4.0.	QA/QC Report	34
5.0.	Discussion of Results.....	35
5.1	Composite Sample Results.....	35
5.1.1	Commercial (COM) Site.....	35
5.1.2	High Density Residential (HDR) Site.....	39
5.1.3	Low Density Residential (LDR) Site.....	41
5.2	Stormwater Grab Sample Results	45
5.3	Annual Sediment Sample	47
5.4	Stormwater Management Program Activities within Monitoring Drainage Areas.....	50
6.0.	Pollutant Loading Calculations.....	51
7.0.	Other Stormwater Monitoring.....	67
8.0.	References.....	68

APPENDIX A: KING COUNTY STORMWATER MONITORING S8.D QAPP

APPENDIX B: TARGETED AND SAMPLED STORM EVENTS FOR COM, HDR, AND LDR

APPENDIX C: STORM EVENT FILES

APPENDIX D: QA/QC REPORTS

APPENDIX E: ANALYTICAL LABORATORY REPORTS

APPENDIX F: TOXICITY SAMPLE REPORTS

Figures

Figure 1. Drainage area and drainage system for the Fall City Commercial Monitoring Site.	8
Figure 2. Catch basin monitoring site and sampler housing at COM site.	9
Figure 3. Drainage area and drainage system for the Fall City High Density Residential Monitoring Site.	11
Figure 4. Automated sampler and downstream vault at HDR monitoring site.....	12
Figure 5. Drainage area and Drainage system for the Low Density Residential Monitoring Site.	13
Figure 6. Flume and autosampler suction line at LDR monitoring site.....	14
Figure 7. Grain size distribution for sediment samples collected at COM, HDR, and LDR.....	47

Tables

Table 1. Monitoring Site Characteristics	6
Table 2. NPDES S8.D Storm Criteria for Stormwater Sampling	15
Table 3. Number of targeted and sampled storm events at COM, HDR and LDR.	16
Table 4. Details of sampling attempts for qualifying storms at COM monitoring site.	17
Table 5. Characteristics of sampled storms at COM.	18
Table 6. Parameters analyzed in composite stormwater samples at COM monitoring site.....	19
Table 7. Parameters analyzed in grab stormwater samples at COM monitoring site.	21
Table 8. Details of sampling attempts for qualifying storms at HDR monitoring site.	22
Table 9. Characteristics of sampled storms at HDR.	23
Table 10. Parameters analyzed in composite stormwater samples at HDR monitoring site.	24
Table 11. Parameters analyzed in grab stormwater samples at HDR monitoring site.....	26
Table 12. Details of sampling attempts for qualifying storms at LDR monitoring site.....	27
Table 13. Characteristics of sampled storms at LDR.	29
Table 14. Parameters analyzed in composite stormwater and base flow samples at LDR monitoring site.	30
Table 15. Parameters analyzed in grab stormwater samples at LDR monitoring site.	32
Table 16. Concentration data for target analytes in stormwater samples collected at COM.....	36
Table 17. Concentration data for target analytes in stormwater samples collected at HDR	39
Table 18. Concentration data for target analytes in stormwater samples collected at LDR.....	42
Table 19. Concentration data for target analytes in stormwater grab samples collected at the COM monitoring site.	46
Table 20. Concentration data for target analytes in stormwater grab samples collected at the HDR monitoring site.....	46
Table 21. Concentration data for target analytes in stormwater grab samples collected at the LDR monitoring site.	47
Table 21. Concentration data for target analytes in annual sediment samples collected at COM, HDR and LDR (wet weight basis)	48
Table 22. Pollutant load (pounds) for individual sampled storm events at COM.	53
Table 23. Pollutant load (pounds) for individual sampled storm events at HDR.	55
Table 24. Pollutant load (pounds) for individual sampled storm events at LDR.	57
Table 25. Pollutant loads (pounds) by period for COM.	59
Table 26. Pollutant loads (pounds) by period for HDR.	61
Table 27. Storm and base flow pollutant loads (pounds) by period for LDR.....	63
Table 28. Annual pollutant loads (pounds per acre) for WY2011 for all monitoring sites	65

1.0. INTRODUCTION

The Washington State Phase I Municipal Stormwater Permit (Phase I 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 Phase I 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 2011 Stormwater Monitoring Report, and documents the stormwater characterization monitoring conducted under S8.D of the Phase I 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 Phase I 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 February 2010. The updated QAPP is included as Appendix A.

The permit requires each Permittee to monitor stormwater and sediment from three different land use types: commercial (COM), high density residential (HDR), and low density residential (LDR). 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, high density residential, and low density residential 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 Year 2010 Stormwater Monitoring Report.

Table 1. Monitoring Site Characteristics

Site Characteristics	Monitoring Site Name		
	COM	HDR	LDR
Location	Fall City	Fall City	Near Renton
Drainage Area (acres)	5 acres	5.25 acres	42.7 acres
% 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 commercial site (COM) 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 (see 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 both Highway 202 and Preston-Fall City Road consist of a commercial area that includes 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 made up of 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 (noted in 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 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 represents runoff from both the Highway 202 and the Preston-Fall City Road systems.

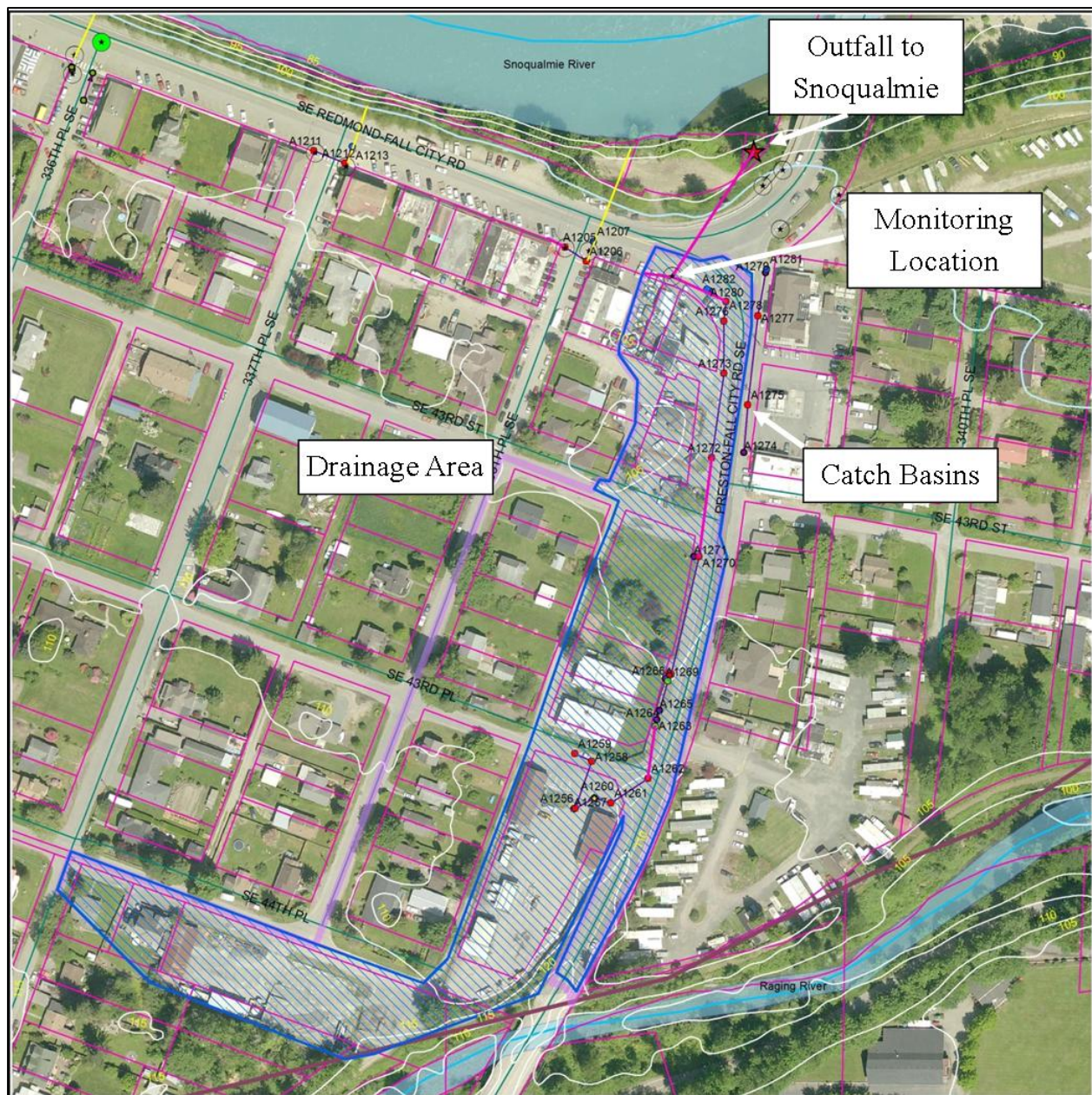


Figure 1. Drainage area and drainage system for the Fall City Commercial Monitoring Site.



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

2.1.2 High Density Residential (HDR)

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

The HDR drainage basin is approximately 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, shown in Figure 4, is set up to collect stormwater immediately prior to flowing into the infiltration vault.



Figure 3. Drainage area and drainage system for the Fall City High Density Residential Monitoring Site.



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

2.1.3 Low Density Residential (LDR)

The Low Density Residential (LDR) site selected and monitored by King County is located in a neighborhood near Renton (see Figure 5). For this study low density is defined as one house per 1 to 5 acres. 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 consist predominantly of lawns and forested areas.

Drainage within the basin consists of an open ditch which 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 predominantly from the rural residential properties on the east side of 148th Ave SE, in addition to 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.

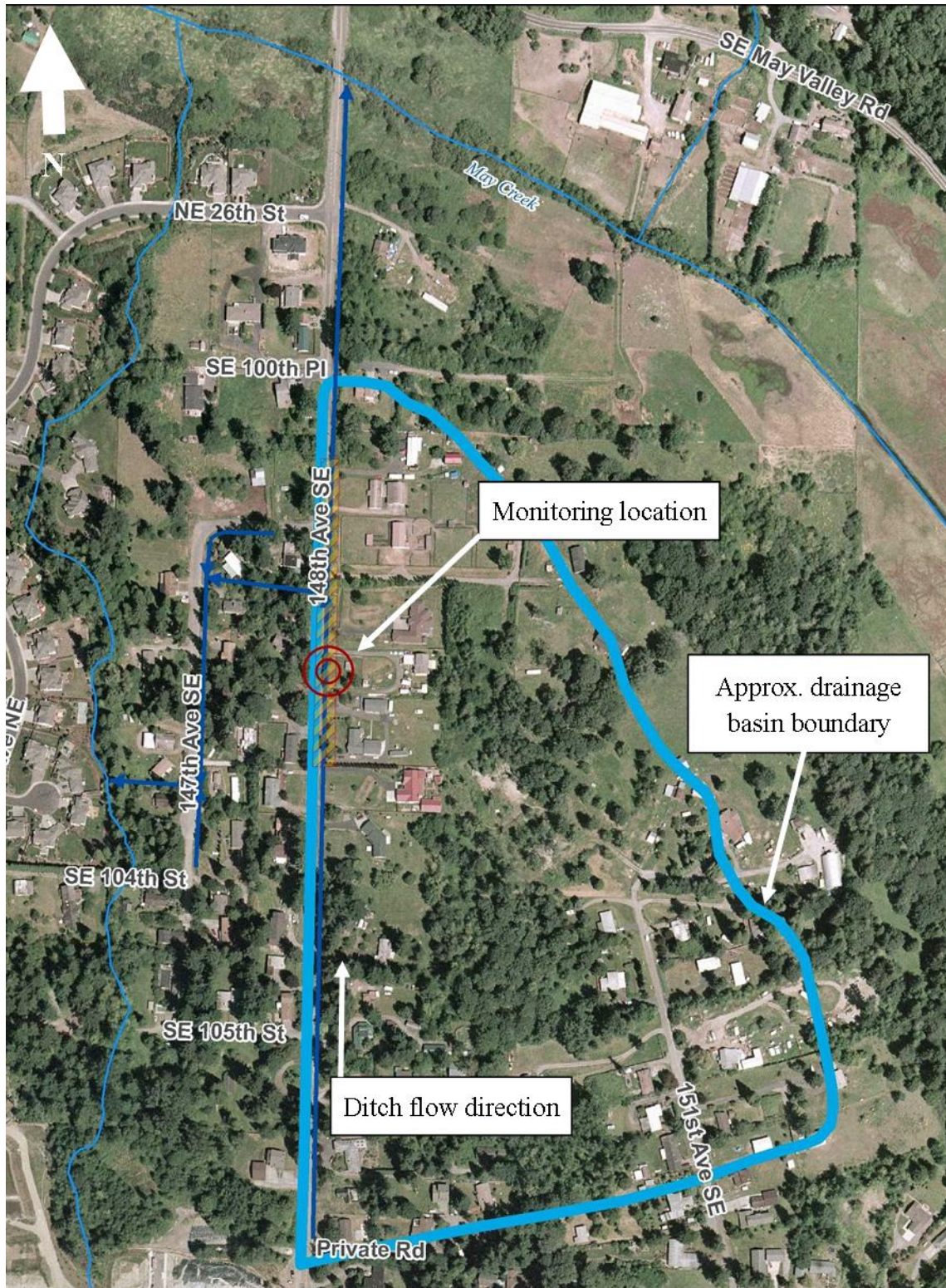


Figure 5. Drainage area and Drainage system for the Low Density Residential Monitoring Site.



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

3.0. COMPREHENSIVE DATA REPORT

This section presents information about the storm, base flow, and sediment events sampled at the COM, HDR, and LDR sites during water year (WY) 2011. All samples were collected following procedures outlined in the project QAPP.

3.1 Summary of Storm Events

Storms were targeted for sampling between October 1, 2010 and September 30, 2011. For all composite samples collected across the three monitoring sites, the storm event criterion (Table 2) was met. For grab samples, one storm sampled at COM and HDR, and three storms sampled at LDR, did not meet the minimum rainfall depth. These grab samples were collected early in the storm and it was not possible to know if rainfall totals would meet the storm criterion. Therefore, these samples were considered valid since they were collected during active runoff from a storm that met all the other criteria.

Two grab and two composite samples were collected during the dry-season months (May through September) at LDR. All remaining samples from LDR and all samples from COM and HDR were collected during the wet season months (October through April).

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, weather forecasts archived by King County staff show that throughout WY2011 there were 16 forecasted qualifying storms at COM, 16 at HDR, and 19 at LDR. Grab and/or composite samples were targeted for 20 storms at COM, 20 at HDR, and 28 at LDR. Of the storms targeted for sampling, a total of 11 grab and 8 composite samples were collected at COM, 10 grab and 6 composite samples at HDR, and 8 grab and 8 composite samples at LDR. The remaining targeted events either didn't meet the storm size criterion or resulted in false starts due to equipment issues.

Of the sampled storm events, valid composite samples were collected at COM, HDR, and LDR from 7, 3, and 6 storms, respectively. Another composite sample was collected at COM, 3 at

HDR, and 2 at LDR that did not meet one of the sampling criterion listed in permit §S8.D.2.b¹. Valid grab samples were collected from 5 storms at COM, 6 storms at HDR, and 8 storms at LDR. Another 6 grab samples were collected at COM and 4 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 is 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 forecasted qualifying storms	16	16	16	16	19	19
Total # of Storms Targeted	20	19	20	19	22	28
Total # of Samples Collected	11	8	10	6	8	8
Total # of Valid Samples	5	7	6	3	8	6

While the permit criterion of collecting 11 valid 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. King County targeted more storms than total number of forecasted qualifying storms at each site. In addition to the successfully sampled storm events at each site, King County targeted 11 more storms at COM, 13 more storms at HDR, and 20 more storms at LDR (Table 3). A table providing a list of the targeted and sampled storm events for each site is included in Appendix B.

Base flow was present at LDR from mid-October 2010 through May 2011. One base flow sample was collected at the LDR site on January 26, 2011. Details on the base flow sampling event are provided in Section 3.2.3. Base flow was not present at COM or HDR during either the wet or dry seasons.

Toxicity testing was required for King County for water year 2011. Toxicity testing was completed at all sites in October 2011. A full report outlining the sampling procedures and results from this toxicity sampling event is included in Appendix F.

3.2 Characteristics of Individual Sampled Events

Continuous precipitation and flow data were collected throughout the water year, and sample event information was documented for all sampled storm and base flow 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 or base flow 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 WY 2011 there were 25 qualifying storm events measured by the Fall City rain gage, which serves as the gage for the COM and HDR sites. Of these 25 qualifying events, 16 were forecasted. Forecasts for the remaining 9 events indicated the antecedent dry period and/or storm size criteria would not be met. The 16 forecasted qualifying events are outlined in Table 4. Details of each successfully sampled event are presented in Table 5. For several sampling events, insufficient volume was collected for biochemical oxygen demand analysis. Table 6 and Table 7 indicate the analyses completed and laboratory methods for the composite and grab samples for COM.

Table 4. Details of sampling attempts for qualifying storms at COM monitoring site.

Event Date	Description of sampling attempts
10/30/10	The event was targeted for sampling at COM. Problems with equipment and the flow pacing caused false starts and therefore the samples were discarded.
11/1/10	A 1.39-inch precipitation event preceded by 26 hours of antecedent dry period. A grab sample and a composite sample were successfully collected. The composite sample was composed of 38 aliquots representing 97 percent of the runoff of the first 24 hours of the event.
11/9/10	A 0.16-inch precipitation event preceded by almost 58 hours of antecedent dry period. The minimum amount of rainfall criterion was not met; however, a grab sample was collected and submitted to the laboratory for analyses. The grab sample was considered valid because it was (1) submitted prior to knowing if the storm would meet the rainfall criterion, and (2) collected early in the event and during active runoff.
11/17/10	Rainfall totaled 0.54-inches with an antecedent dry period of 43 hours. The storm was targeted for both grab and composite samples. Composite sampling efforts were halted when staff expected a 6-hour break in the storm prior to meeting the storm size criterion. The grab samples were submitted to the lab as valid samples.
11/25/10	No details on event or sampling attempts. Event was on Thanksgiving Day.
11/30/10	The rain gage recorded 0.86-inches after a 39 hour antecedent dry period. Successful grab and composite samples were collected, with the composite sample composed of 27 aliquots representing 90 percent of the runoff from the first 24 hours of the event.
12/7/10	A 0.87-inch precipitation event preceded by over 105 hours of antecedent dry period. A grab and composite sample were submitted to the laboratory. The composite sample was composed of 24 aliquots representing 91 percent of the runoff from the first 24 hours of the event.
12/23/10	No details on event or sampling attempts. Event was two days prior to Christmas Day.
1/5/11	A 0.64-inch storm event after a nearly 129 hour antecedent dry period. The event was successfully sampled for a grab and composite sample, with the composite sample composed of 20 aliquots representing 89 percent of the storm runoff from the first 24 hours of the event.
1/12/11	The event produced 2.38-inches with an antecedent dry period of almost 57 hours. The event was targeted for grab and composite samples, however, problems occurred with the flow pacing so the composite sample was discarded.
1/20/11	A 1.39-inch storm event after an antecedent dry period of 43 hours. The event was successfully targeted for grab and composite samples, with the composite sample composed of 35 aliquots representing 75 percent of the runoff from the first 24 hours of the event.
2/4/11	The event was targeted for sampling at COM. Problems with equipment and the flow pacing caused false starts and therefore the samples were discarded.
2/12/11	Rainfall totaled 0.58-inches and was preceded by a 119 hour antecedent dry period. The event was successfully targeted for grab and composite samples. The composite sample was composed of 21 aliquots and represented 74 percent of the runoff from the first 24 hours of the event.
4/10/11	No details on event or sampling attempts.
4/13/11	A successful sample collection of a 0.6-inch storm preceded by almost 60 hours of antecedent dry period. A grab and composite sample were submitted to the laboratory. The composite sample represented 96 percent of the first 24 hours of the storm runoff, and was composed of 37 aliquots.
4/26/11	Event was preceded by 29 hours of antecedent dry period, and totaled 0.65-inches. The event was successfully targeted for grab and composite samples, with the composite sample representing 97 percent of the first 24 hours of the storm runoff and composed of 35 aliquots.

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 submitted?	Composite sample submitted?	Number of aliquots	Average flow rate (cfs)	Runoff volume 1 st 24 hours (gal) ^(e)	Runoff volume sampled (gal)	Percent runoff sampled
Permit Criteria	≥ 0.2 ^(a)	NA	Y	≥ 24 ^(b)	≥ 72 ^(c)	NA	NA	10 ^(d)	NA	NA	NA	≥ 75
11/01/10	1.39	12.1	Y	26	NA	Y	Y	38	182	94,493	91,561	97
11/09/10	0.16	2.0	Y	57.8	NA	Y	n	-	-	-	-	-
11/17/10	0.54	9.8	Y	43	NA	Y	n	-	-	-	-	-
11/30/10	0.86	23.8	Y	39	NA	Y	Y	27	85	109049	97714	90
12/07/10	0.87	21.1	Y	105.5	NA	Y	Y	24	100	102661	93369	91
01/05/11	0.64	36.8	Y	128.7	NA	Y	Y	20	37	75120	66696	89
01/12/11	2.38	63.5	Y	56.9	NA	Y	n	-	-	-	-	-
01/20/11	1.39	20.6	Y	43	NA	Y	Y	35	194	216266	163110	75
02/12/11	0.58	3.6	Y	119	NA	Y	Y	21	385	48466	35921	74, j
04/13/11	0.6	32.1	Y	59.7	NA	Y	Y	37	24	78923	76052	96
04/26/11	0.65	25.6	Y	29	NA	Y	Y	35	22	64,814	62,987	97

Notes:

(a) grab samples are collected early in the storm, prior to knowing if the rainfall totals meet storm criterion. If rainfall criterion was not met, grab samples were still considered valid as long as samples were collected during active storm flow and the other storm criteria were met.

(b) applies to wet season (October 1 through April 30).

(c) applies to dry season (May 1 through September 30).

(d) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.

(e) if sample duration lasted more than 24 hours, runoff volume was calculated from start of runoff to end of sampling period.

NA - not applicable.

"- " - no data, composite sample not submitted.

j - did not meet permit criterion, conditional use only.

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

		Storm Start Date							
Parameters	Analytical Methods	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
Conventionals									
Total Suspended Solids	SM2540D	x	x	x	x	x	x	x	x
Turbidity	SM2130B	x	x	x	x	x	x	x	x
Conductivity	SM2510B	x	x	x	x	x	x	x	x
Chloride	SM4110B	x	x	x	x	x	x	x	x
BOD	SM5210B	x	x	x	--	x	--	x	x
Hardness as CaCO ₃	EPA 200.8/ SM2340B.ED19	x	x	x	x	x	x	x	x
Methylene Blue Act. Substance	SM5540C	x	x	x	x	x	x	x	x
Nutrients									
Nitrite + Nitrate Nitrogen	SM4500-NO3-F	x	x	x	x	x	x	x	x
Total Kjeldahl Nitrogen	EPA 351.2	x	x	x	x	x	x	x	x
Total Phosphorus	SM4500-P-B,F	x	x	x	x	x	x	x	x
Orthophosphate Phosphorus	SM4500-P-F	x	x	x	x	x	x	x	x
Metals									
Cadmium, Dissolved	EPA 200.8	x	x	x	x	x	x	x	x
Cadmium, Total		x	x	x	x	x	x	x	x
Calcium, Total		x	x	x	x	x	x	x	x
Copper, Dissolved		x	x	x	x	x	x	x	x
Copper, Total		x	x	x	x	x	x	x	x
Lead, Dissolved		x	x	x	x	x	x	x	x
Lead, Total		x	x	x	x	x	x	x	x
Magnesium, Total		x	x	x	x	x	x	x	x
Mercury, Dissolved	EPA 245.1	x	x	x	x	x	x	x	x
Mercury, Total		x	x	x	x	x	x	x	x
Zinc, Dissolved	EPA 200.8	x	x	x	x	x	x	x	x
Zinc, Total		x	x	x	x	x	x	x	x

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

		Storm Start Date							
Parameters	Analytical Methods	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
Organics									
Polycyclic aromatic hydrocarbons (PAHs)									
Acenaphthene	SW846-8270D	X	X	X	X	X	X	X	X
Acenaphthylene		X	X	X	X	X	X	X	X
Anthracene		X	X	X	X	X	X	X	X
Benzo(a)anthracene		X	X	X	X	X	X	X	X
Benzo(a)pyrene		X	X	X	X	X	X	X	X
Benzo(b)fluoranthene		X	X	X	X	X	X	X	X
Benzo(g,h,i)perylene		X	X	X	X	X	X	X	X
Benzo(k)fluoranthene		X	X	X	X	X	X	X	X
Chrysene		X	X	X	X	X	X	X	X
Dibenzo(a,h)anthracene		X	X	X	X	X	X	X	X
Fluoranthene		X	X	X	X	X	X	X	X
Fluorene		X	X	X	X	X	X	X	X
Indeno(1,2,3-Cd)Pyrene		X	X	X	X	X	X	X	X
2-Methylnaphthalene		X	X	X	X	X	X	X	X
Naphthalene		X	X	X	X	X	X	X	X
Phenanthrene		X	X	X	X	X	X	X	X
Pyrene	X	X	X	X	X	X	X	X	
Phthalates									
Benzyl Butyl Phthalate	SW846-8270D	X	X	X	X	X	X	X	X
Bis(2-Ethylhexyl)Phthalate		X	X	X	X	X	X	X	X
Diethyl Phthalate		X	X	X	X	X	X	X	X
Dimethyl Phthalate		X	X	X	X	X	X	X	X
Di-N-Butyl Phthalate		X	X	X	X	X	X	X	X
Di-N-Octyl Phthalate		X	X	X	X	X	X	X	X
Pesticides									
2,4-D	SW846-8270D-SIM	X	X	X	X	X	X	X	X
Chlorpyrifos		X	X	X	X	X	X	X	X
Diazinon		X	X	X	X	X	X	X	X
Dichlobenil		X	X	X	X	X	X	X	X

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

Parameters	Analytical Methods	Storm Start Date							
		11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
Pesticides (cont.)									
Malathion	SW846-8270D-SIM	x	x	x	x	x	x	x	x
MCPP		x	x	x	x	x	x	x	x
Pentachlorophenol		x	x	x	x	x	x	x	x
Prometon		x	x	x	x	x	x	x	x
Triclopyr		x	x	x	x	x	x	x	x

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

Parameters	Analytical Methods	Storm Start Date											
		11/1/10	11/9/10	11/17/10	11/30/10	12/7/10	1/5/11	1/12/11	1/20/11	2/12/11	4/13/11	4/26/11	
Bacteria													
Fecal Coliform	SM9222D	x	x	x	x	x	x	x	x	x	x	x	
Organics													
TPH													
Diesel Range (>C12-C24)	NWTPH-Dx	x	x	x	x	x	x	x	x	x	x	x	
Lube Oil Range (>C24)		x	x	x	x	x	x	x	x	x	x	x	
Gasoline Range (C7-C12)	NWTPH-GX	x	x	x	x	x	x	x	x	x	x	x	

3.2.2 Sampled Events at High Density Residential (HDR) Site

During WY 2011 there were 25 qualifying storm events measured by the Fall City rain gage. Of these 25 qualifying events, 16 were forecasted. Forecasts for the remaining 9 events indicated the antecedent dry period and/or storm size criteria would not be met. The 16 forecasted qualifying events are outlined in Table 8. Details of each successfully sampled event are presented in Table 9. For each sample event sufficient volume was collected for complete laboratory analysis. Total and dissolved mercury analysis is not required at the HDR site, and was only completed for the first sample event. Table 10 and Table 11 indicate the analyses completed and laboratory methods for the composite and grab samples for HDR.

Table 8. Details of sampling attempts for qualifying storms at HDR monitoring site.

Event Date	Description of sampling attempts
10/30/10	The event was targeted for sampling at HDR. Problems with equipment and the flow pacing caused false starts and therefore the samples were discarded.
11/1/10	A 1.26-inch precipitation event preceded by a 26 hour antecedent dry period. Grab sample and a composite sample composed of 35 aliquots were successfully collected to represent 91 percent of the runoff of the first 24 hours of the event.
11/9/10	A 0.16-inch event preceded by almost 58 hours of antecedent dry period. The minimum amount of rainfall criterion was not met; however, a grab sample was collected and submitted to the laboratory for analyses. The grab sample was considered valid because it was (1) submitted prior to knowing if storm would meet the rainfall criterion, and (2) collected early in the event and during active runoff.
11/17/10	The event totaled 0.54-inches with an antecedent dry period of 43 hours. The storm was targeted for grab and composite samples. Composite sampling was halted when a 6-hour break in the storm was expected prior to meeting the storm size criterion. The grab sample was submitted to the lab.
11/25/10	No details on event or sampling attempts. Event was on Thanksgiving Day.
11/30/10	The project rain gage recorded 0.81-inches after a 39 hour antecedent dry period. Successful grab and composite samples were collected, with the composite sample composed of 26 aliquots representing 99 percent of the runoff from the first 24 hours of the event.
12/7/10	The event was targeted for both a grab and composite sample. Rainfall totaled 0.87-inches and was preceded by over 105 hours of antecedent dry period. The grab sample was successful, however, the composite sample did not collect enough sample volume for analysis. The composite sample was discarded and considered a false start.
12/23/10	No details on event or sampling attempts. Event was two days prior to Christmas Day.
1/5/11	The event resulted in 0.64-inches after a nearly 129 hour antecedent dry period. The event was targeted for a composite sample, however, the sampler did not collect enough sample volume for analysis. The sample was discarded and considered a false start.
1/12/11	A 2.38-inch event with an antecedent dry period of almost 57 hours. The event was targeted for grab and composite samples, however, problems occurred with the flow pacing so the composite sample was discarded. The grab sample was submitted to the laboratory as a valid sample.
1/20/11	The project rain gage recorded 1.24-inches after an antecedent dry period of 43 hours. The event was successfully targeted for grab and composite samples, with the composite sample composed of 38 aliquots representing 20 percent of the runoff from the first 24 hours of the event.
2/4/11	The event totaled 0.26-inches with a dry antecedent period of 112 hours. The event was successfully sampled for both grab and composite samples. The composite sample was composed of 35 aliquots and represented 96 percent of the first 24 hours of runoff from the storm event.
2/12/11	The event totaled 0.58-inches and was preceded by a 119 hour antecedent dry period. The event was successfully targeted for grab and composite samples. The composite sample was composed of 35 aliquots and represented 47 percent of the runoff from the first 24 hours of the event.
4/10/11	No details on event or sampling attempts.
4/13/11	The event was targeted for sampling at HDR. Problems with equipment and the flow pacing caused false starts and therefore the samples were discarded.
4/26/11	The event was preceded by 29 hours of antecedent dry period, and totaled 0.63-inches. The event was successfully targeted for grab and composite samples, with the composite sample representing 54 percent of the first 24 hours of the storm runoff and composed of 34 aliquots.

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 submitted?	Composite sample submitted?	Number of aliquots	Average flow rate (gpm)	Runoff volume 1 st 24 hours (gal) ^(e)	Runoff volume sampled (gal)	Percent runoff sampled
Permit Criteria	≥ 0.2 ^(a)	NA	Y	≥ 24 ^(b)	≥ 72 ^(c)	NA	NA	10 ^(d)	NA	NA	NA	≥ 75
11/01/10	1.26	9.0	Y	26	NA	Y	Y	35	70	25,211	23,064	91
11/09/10	0.16	2.0	Y	57.8	NA	Y	n	-	-	-	-	-
11/17/10	0.54	9.8	Y	43	NA	Y	n	-	-	-	-	-
11/30/10	0.81	21.6	Y	39	NA	Y	Y	37	26	26325	26161	99
12/07/10	0.87	21.1	Y	105.5	NA	Y	n	-	-	-	-	-
01/12/11	2.38	63.5	Y	56.9	NA	Y	n	-	-	-	-	-
01/20/11	1.24	24.0	Y	43	NA	Y	Y	38	12	41,859	8,534	20, j
02/04/11	0.26	2.3	Y	112	NA	Y	Y	35	181	7,644	7,352	96
02/12/11	0.58	2.6	Y	119	NA	Y	Y	35	171	22646	10623	47, j
04/26/11	0.63	24	Y	29	NA	Y	Y	34	12	21,510	11,672	54, j

Notes:

(a) grab samples are collected early in the storm, prior to knowing if the rainfall totals meet storm criterion. If rainfall criterion was not met, grab samples were still considered valid as long as samples were collected during active storm flow and the other storm criteria were met.

(b) applies to wet season (October 1 through April 30).

(c) applies to dry season (May 1 through September 30).

(d) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.

(e) if sample duration lasted more than 24 hours, runoff volume was calculated from start of runoff to end of sampling period.

NA - not applicable.

“-“ – no data, composite sample not submitted.

j - did not meet permit criterion, conditional use only.

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

		Storm Start Date					
Parameters	Analytical Methods	11/1/10	11/30/10	1/20/11	2/4/11	2/12	4/26
Conventionals							
Total Suspended Solids	SM2540D	x	x	x	x	x	x
Turbidity	SM2130B	x	x	x	x	x	x
Conductivity	SM2510B	x	x	x	x	x	x
Chloride	SM4110B	x	x	x	x	x	x
BOD	SM5210B	x	x	x	x	x	x
Hardness as CaCO ₃	EPA 200.8/ SM2340B.ED19	x	x	x	x	x	x
Methylene Blue Act. Substance	SM5540C	x	x	x	x	x	x
Nutrients							
Nitrite + Nitrate Nitrogen	SM4500-NO3-F	x	x	x	x	x	x
Total Kjeldahl Nitrogen	EPA 351.2	x	x	x	x	x	x
Total Phosphorus	SM4500-P-B,F	x	x	x	x	x	x
Orthophosphate Phosphorus	SM4500-P-F	x	x	x	x	x	x
Metals							
Cadmium, Dissolved	EPA 200.8	x	x	x	x	x	x
Cadmium, Total		x	x	x	x	x	x
Calcium, Total		x	x	x	x	x	x
Copper, Dissolved		x	x	x	x	x	x
Copper, Total		x	x	x	x	x	x
Lead, Dissolved		x	x	x	x	x	x
Lead, Total		x	x	x	x	x	x
Magnesium, Total		x	x	x	x	x	x
Mercury, Dissolved	EPA 245.1	x	--	--	--	--	--
Mercury, Total		x	--	--	--	--	--
Zinc, Dissolved	EPA 200.8	x	x	x	x	x	x
Zinc, Total		x	x	x	x	x	x

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

Parameters	Analytical Methods	Storm Start Date					
		11/1/10	11/30/10	1/20/11	2/4/11	2/12	4/26
Organics							
PAHs							
Acenaphthene	SW846-8270D	X	X	X	X	X	X
Acenaphthylene		X	X	X	X	X	X
Anthracene		X	X	X	X	X	X
Benzo(a)anthracene		X	X	X	X	X	X
Benzo(a)pyrene		X	X	X	X	X	X
Benzo(b)fluoranthene		X	X	X	X	X	X
Benzo(g,h,i)perylene		X	X	X	X	X	X
Benzo(k)fluoranthene		X	X	X	X	X	X
Chrysene		X	X	X	X	X	X
Dibenzo(a,h)anthracene		X	X	X	X	X	X
Fluoranthene		X	X	X	X	X	X
Fluorene		X	X	X	X	X	X
Indeno(1,2,3-Cd)Pyrene		X	X	X	X	X	X
2-Methylnaphthalene		X	X	X	X	X	X
Naphthalene		X	X	X	X	X	X
Phenanthrene		X	X	X	X	X	X
Pyrene		X	X	X	X	X	X
Phthalates							
Benzyl Butyl Phthalate	SW846-8270D	X	X	X	X	X	X
Bis(2-Ethylhexyl)Phthalate		X	X	X	X	X	X
Diethyl Phthalate		X	X	X	X	X	X
Dimethyl Phthalate		X	X	X	X	X	X
Di-N-Butyl Phthalate		X	X	X	X	X	X
Di-N-Octyl Phthalate		X	X	X	X	X	X
Pesticides							
2,4-D	SW846-8270D-SIM	X	X	X	X	X	X
Chlorpyrifos		X	X	X	X	X	X
Diazinon		X	X	X	X	X	X
Dichlobenil		X	X	X	X	X	X

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

Parameters	Analytical Methods	Storm Start Date					
		11/1/10	11/30/10	1/20/11	2/4/11	2/12	4/26
Pesticides (cont.)							
Malathion	SW846-8270D-SIM	x	x	x	x	x	x
MCPP		x	x	x	x	x	x
Pentachlorophenol		x	x	x	x	x	x
Prometon		x	x	x	x	x	x
Triclopyr		x	x	x	x	x	x

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

Parameters	Analytical Methods	Storm Start Date									
		11/1/10	11/9/10	11/17/10	11/30/10	12/7/10	1/12/11	1/20/11	2/4/11	2/12/11	4/26/11
Bacteria											
Fecal Coliform	SM9222D	x	x	x	x	x	x	x	x	x	x
Organics											
TPH											
Diesel Range (>C12-C24)	NWTPH-Dx	x	x	x	x	x	x	x	x	x	x
Lube Oil Range (>C24)		x	x	x	x	x	x	x	x	x	x
Gasoline Range (C7-C12)	NWTPH-GX	x	x	x	x	x	x	x	x	x	x

3.2.3 Sampled Events at Low Density Residential (LDR) Site

During WY 2011 there were 26 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 26 qualifying events, 19 were forecasted. Forecasts for the remaining 7 events indicated the antecedent dry period and/or storm size criteria would not be met, or forecasted a rain on snow event which is not representative of stormwater and was therefore not targeted. The 19 forecasted qualifying events, as well as the single base flow event, are outlined in Table 12. Details of each successfully sampled event are presented in Table 13. For each sample event sufficient volume was collected for complete laboratory analysis. Total and dissolved mercury analysis is not required at the LDR site, and was only completed for the first sample event. Table 14 and Table 15 indicate the analyses completed and laboratory methods for the composite and grab samples for LDR.

Table 12. Details of sampling attempts for qualifying storms at LDR monitoring site.

Event Date	Description of sampling attempts
10/8/10	The event was targeted for sampling at LDR. Problems with equipment and the flow pacing caused false starts and therefore the samples were discarded.
10/23/10	The 2.34-inch precipitation event was preceded by 31 hours of antecedent dry period. A grab sample was not collected. The composite sample was composed of 30 aliquots representing 100 percent of the runoff of the first 24 hours of the event.
11/5/10	The storm resulted in a 1.24-inch precipitation event preceded by 70 hours of antecedent dry period. A grab sample was successfully collected. The event was not targeted for a composite sample.
11/17/10	The event totaled 0.29-inches with an antecedent dry period of 37 hours. The storm was targeted for both grab and composite samples. Composite samples were discarded because there was a 6-hour break in the storm prior meeting the storm size criterion. The grab sample was submitted to the lab as a valid sample.
11/29/10	The rain gage recorded 0.56-inches after a 36 hour antecedent dry period. The event was not targeted for a grab sample. The composite sampler enabled early and four aliquots were collected prior to the onset of storm runoff. These aliquots represented less than ten percent of the overall storm flow so the composite sample was submitted as a valid sample. The composite included 38 aliquots representing 108 percent of the first 24 hours of runoff. More than 100 percent of the storm flow was captured because the sampler enabled early and sampled some base flow.
12/7/10	The event was targeted for a composite sample only. Rainfall totaled 0.83-inches and was preceded by 142 hours of antecedent dry period. The composite sample was composed as 37 aliquots representing 80 percent of the runoff from the first 24 hours of the event.
12/11/10	No details on event or sampling attempts.
12/23/10	No details on event or sampling attempts. Event was two days prior to Christmas Day.
1/4/11	The event resulted in 0.15-inches after a 140 hour antecedent dry period. The event was targeted for a grab and composite sample, however, the composite sample was discarded since the event did not meet the storm size criterion. The grab sample was submitted to the laboratory for analyses. The grab sample was considered valid because it was (1) submitted prior to knowing if the storm would meet the rainfall criterion, and (2) collected early in the event and during active runoff.
1/20/11	The event produced 1.16-inches with an antecedent dry period of 50 hours. The event was targeted for composite samples only. The composite sample was composed of 50 aliquots representing 62 percent of the runoff from the first 24 hours of the event.
1/26/11	The LDR site had base flow between December and May. The base flow composite sample collected on January 26 was flow weighted and collected 50 aliquots over 15 hours. The event was preceded by a 43 hour dry antecedent period.
2/12/11	No details on event or sampling attempts.
3/7/11	The project rain gage recorded 0.11-inches after an antecedent dry period of 75 hours. The event was targeted for a grab and composite sample, however, the composite sample was discarded since the event didn't meet the storm size criterion. The grab sample was submitted to the laboratory for analyses. The grab sample was considered valid because it was (1) submitted prior to knowing if storm would meet the rainfall criterion, and (2) collected early in the event and during active runoff.

Event Date	Description of sampling attempts
3/24/11	The event totaled 0.25-inches with a dry antecedent period of 142 hours. The event was targeted for composite samples only. The composite sample was composed of 21 aliquots and represented 57 percent of the first 24 hours of runoff for the storm event.
4/13/11	The event resulted in 0.11-inches after a 59 hour antecedent dry period. The event was targeted for a grab and composite sample, however, the composite sample was discarded because the event did not meet the storm size criterion. The grab sample was submitted to the laboratory for analyses. The grab sample was considered valid because it was (1) submitted prior to knowing if storm would meet the rainfall criterion, and (2) collected early in the event and during active runoff.
4/26/11	The event totaled 0.58-inches and was preceded by a 33 hour antecedent dry period. The event was successfully targeted for grab and composite samples. The composite sample was composed of 50 aliquots and represented 56 percent of the runoff from the first 24 hours of the event.
5/25/11	The event was preceded by 85 hours of antecedent dry period, and totaled 0.61-inches. The event was successfully targeted for grab and composite samples, with the composite sample composed of 31 aliquots and representing 100 percent of the first 24 hours of the storm runoff.
5/31/11	The event totaled 0.27-inches with an antecedent dry period of 96 hours. The storm was targeted for both grab and composite samples. Composite samples were discarded because there was a 6-hour break in the storm prior meeting the storm size criterion. The grab sample was submitted to the lab as valid samples.
7/12/11	The event totaled 0.3-inches with a dry antecedent period of 152 hours. The event was targeted for composite samples only. The composite sample was composed of 26 aliquots and represented 99 percent of the first 24 hours of runoff from the storm event.
8/22/11	The event totaled 0.21-inches with a dry antecedent period of 671 hours. The event was targeted for composite samples, however, the storm did not produce any storm flow at the site and the sampler never enabled.

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 submitted?	Composite sample submitted?	Base flow rate (gpm)	Number of aliquots	Average flow rate (gpm)	Runoff volume 1 st 24 hours (gal) ^(e)	Runoff volume sampled (gal)	Percent runoff sampled
Permit Criteria	≥ 0.2 ^(a)	NA	Y	≥ 24 ^(b)	≥ 72 ^(c)	NA	NA	NA	10 ^(d)	NA	NA	NA	≥ 75
10/23/10	2.34	54.5	Y	31	NA	n	Y	0	30	5	10,553	10,553	100
11/05/10	1.24	46	Y	70	NA	Y	n	-	-	-	-	-	-
11/17/10	0.29	18	N	37	NA	Y	n	-	-	-	-	-	-
11/29/10	0.56	14	Y	36	NA	n	Y	8	38	18	43,299	46,877	108
12/07/10	0.83	16	Y	142	NA	n	Y	2	37	24	33,745	26,982	80
01/04/11	0.15	13	Y	140	NA	Y	n	-	-	-	-	-	-
01/20/11	1.16	22	Y	50	NA	n	Y	11	50	82	119,956	74,386	62, j
03/07/11	0.11	3.5	Y	75	NA	Y	n	-	-	-	-	-	-
03/24/11	0.25	9	Y	142	NA	n	Y	3	21	6	7,317	6,394	87
04/13/11	0.11	7	Y	59	NA	Y	n	-	-	-	-	-	-
04/26/11	0.58	32	Y	33	NA	Y	Y	4	50	9	17,213	9,669	56, j
05/25/11	0.61	7	Y	NA	85	Y	Y	0	31	12	11,975	11,975	100
05/31/11	0.27	14	N	NA	96	Y	n	-	-	-	-	-	-
07/12/11	0.3	5.8	Y	NA	152	n	Y	0	26	12	789	782	99

Notes:

(a) grab samples are collected early in the storm, prior to knowing if the rainfall totals meet storm criterion. If rainfall criterion was not met, grab samples were still considered valid as long as samples were collected during active storm flow and the other storm criteria were met.

(b) applies to wet season (October 1 through April 30).

(c) applies to dry season (May 1 through September 30).

(d) 10 aliquots is the goal, but 7 to 9 aliquots are acceptable if other sampling criteria are met.

(e) if sample duration lasted more than 24 hours, runoff volume was calculated from start of runoff to end of sampling period.

NA - not applicable.

" - no data, composite sample not submitted.

j - did not meet permit criterion, conditional use only.

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

Table 1W Parameters Analyzed in Composite Stormwater and Base flow Samples at EDR Monitoring Site.										
Parameters	Analytical Methods	Storm Start Date								Base flow
		10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
Conventionals										
Total Suspended Solids	SM2540D	x	x	x	x	x	x	x	x	x
Turbidity	SM2130B	x	x	x	x	x	x	x	x	x
Conductivity	SM2510B	x	x	x	x	x	x	x	x	x
Chloride	SM4110B	x	x	x	x	x	x	x	x	x
BOD	SM5210B	--	x	--	x	--	--	--	--	x
Hardness as CaCO ₃	EPA 200.8/ SM2340B.ED19	x	x	x	x	x	x	x	x	x
Methylene Blue Act. Substance	SM5540C	x	x	x	x	x	x	x	x	x
Nutrients										
Nitrite + Nitrate Nitrogen	SM4500-NO3-F	x	x	x	x	x	x	x	x	x
Total Kjeldahl Nitrogen	EPA 351.2	x	x	x	x	x	x	x	x	x
Total Phosphorus	SM4500-P-B,F	x	x	x	x	x	x	x	x	x
Orthophosphate Phosphorus	SM4500-P-F	x	x	x	x	x	x	x	x	x
Metals										
Cadmium, Dissolved	EPA 200.8	x	x	x	x	x	x	x	x	x
Cadmium, Total		x	x	x	x	x	x	x	x	x
Calcium, Total		x	x	x	x	x	x	x	x	x
Copper, Dissolved		x	x	x	x	x	x	x	x	x
Copper, Total		x	x	x	x	x	x	x	x	x
Lead, Dissolved		x	x	x	x	x	x	x	x	x
Lead, Total		x	x	x	x	x	x	x	x	x
Magnesium, Total		x	x	x	x	x	x	x	x	x
Mercury, Dissolved	EPA 245.1	x	--	--	--	--	--	--	--	--
Mercury, Total		x	--	--	--	--	--	--	--	--
Zinc, Dissolved	EPA 200.8	x	x	x	x	x	x	x	x	x
Zinc, Total		x	x	x	x	x	x	x	x	x

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

Parameters	Analytical Methods	Storm Start Date								Base flow
		10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
Organics										
PAHs										
Acenaphthene	SW846-8270D	X	X	X	X	X	X	X	X	X
Acenaphthylene		X	X	X	X	X	X	X	X	X
Anthracene		X	X	X	X	X	X	X	X	X
Benzo(a)anthracene		X	X	X	X	X	X	X	X	X
Benzo(a)pyrene		X	X	X	X	X	X	X	X	X
Benzo(b)fluoranthene		X	X	X	X	X	X	X	X	X
Benzo(g,h,i)perylene		X	X	X	X	X	X	X	X	X
Benzo(k)fluoranthene		X	X	X	X	X	X	X	X	X
Chrysene		X	X	X	X	X	X	X	X	X
Dibenzo(a,h)anthracene		X	X	X	X	X	X	X	X	X
Fluoranthene		X	X	X	X	X	X	X	X	X
Fluorene		X	X	X	X	X	X	X	X	X
Indeno(1,2,3-Cd)Pyrene		X	X	X	X	X	X	X	X	X
2-Methylnaphthalene		X	X	X	X	X	X	X	X	X
Naphthalene		X	X	X	X	X	X	X	X	X
Phenanthrene		X	X	X	X	X	X	X	X	X
Pyrene	X	X	X	X	X	X	X	X	X	
Phthalates										
Benzyl Butyl Phthalate	SW846-8270D	X	X	X	X	X	X	X	X	X
Bis(2-Ethylhexyl)Phthalate		X	X	X	X	X	X	X	X	X
Diethyl Phthalate		X	X	X	X	X	X	X	X	X
Dimethyl Phthalate		X	X	X	X	X	X	X	X	X
Di-N-Butyl Phthalate		X	X	X	X	X	X	X	X	X
Di-N-Octyl Phthalate		X	X	X	X	X	X	X	X	X
Pesticides										
2,4-D	SW846-8270D-SIM	X	X	X	X	X	X	X	X	X
Chlorpyrifos		X	X	X	X	X	X	X	X	X
Diazinon		X	X	X	X	X	X	X	X	X
Dichlobenil		X	X	X	X	X	X	X	X	X

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

		Storm Start Date								Base flow
Parameters	Analytical Methods	10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
Pesticides (cont.)										
Malathion	SW846-8270D-SIM	x	x	x	x	x	x	x	x	x
MCPP		x	x	x	x	x	x	x	x	x
Pentachlorophenol		x	x	x	x	x	x	x	x	x
Prometon		x	x	x	x	x	x	x	x	x
Triclopyr		x	x	x	x	x	x	x	x	x

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

Parameters	Analytical Methods	Storm Start Date							
		11/5/10	11/17/10	1/4/11	3/7/11	4/13/11	4/26/11	5/25/11	5/31/11
Bacteria									
Fecal Coliform	SM9222D	x	x	x	x	x	x	x	x
Organics									
TPH									
Diesel Range (>C12-C24)	NWTPH-Dx	x	x	x	x	x	x	x	x
Lube Oil Range (>C24)		x	x	x	x	x	x	x	x
Gasoline Range (C7-C12)	NWTPH-GX	x	x	x	x	x	x	x	x

3.3 Sediment Sampling

The WY2011 annual sediment samples were collected at each stormwater monitoring site. Samples were collected at HDR and COM on July 20, 2011 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 a 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.

Samples were collected at LDR on July 20, 2011 using a stainless-steel spatula. Sediment was collected from the sampling location at the Southwest corner of the lot at 10222 148th Avenue SE. 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 sample 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 of all parameters listed in the project QAPP. There were several parameters at each site that were not detected 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 WY2011. All WY2011 analytical data will be input in the Environmental Information Management database.

5.1 Composite Sample Results

Concentration data for target analytes in the composite samples from commercial, high density residential and low density residential sites are discussed in the following sections and presented in Tables 16, 17, and 18, respectively. Values reported with a “<” indicate the target analyte was below the method detection limit reported by the analytical laboratory. Values reported with a “<RDL” indicate a target analyte was above the method detection limit, but below the reporting detection limit. Additional lab qualifiers listed in the tables are defined as follows:

- H – holding time exceeded
- B, B2 – blank contamination observed
- SH - sample handling criterion not met
- JG - biased data based on low surrogate or matrix spike recoveries.

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

5.1.1 Commercial (COM) Site

At COM, conventional parameters were detected in all composite samples (Table 16), with the exception of anionic surfactants (methylene blue activating substances [MBAs]) which were detected in only three of the eight samples. Nutrient parameters were detected in all composite samples, with the exception of orthophosphate phosphorus, which was not detected in one sample. Metals (dissolved and total recoverable) were detected in all composite samples with the following exceptions:

- dissolved mercury was not detected in any of the samples
- total mercury was detected in one of the eight samples
- dissolved cadmium was detected in two of the eight samples.

Detection levels for polycyclic aromatic hydrocarbons (PAHs) and phthalates ranged across the storm sampling dates (Table 16). Detection frequencies for PAHs ranged from 0 percent (not detected) for acenaphthene, acenaphthylene, anthracene, dibenzo(a,h)anthracene, fluorene, and indeno(1,2,3-Cd)pyrene to 100 percent for fluoranthene and pyrene. Phthalates were detected in all composite samples with the following exceptions:

- diethyl phthalate was detected in one of the eight samples
- dimethyl phthalate was detected in two of the eight samples
- di-n-octyl phthalate was detected in six of the eight samples
- benzyl butyl phthalate was detected in seven of the eight samples.

For pesticides, pentachlorophenol was detected in two of the eight samples. No other pesticides were detected at the COM site during WY2011.

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

Parameters	Storm Start Date							
	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
Conventionals								
Total Suspended Solids (mg/L)	96.1	165	202	225	175	270	90.7	172
Turbidity (NTU)	114	202	196	275	178	244	109	136
Conductivity (umhos/cm)	16.5	93.7	113	667	146	69.2	44.3	40.8
Chloride (mg/L)	0.496	18.7	22.7	176	35.4	9.95	3.64	1.76
BOD (mg/L)	3.67 H	6.7	10.3	--	4.26	--	5.41	6.17
Hardness as CaCO ₃ (mg/L)	18.1	26.3	32.9	67.9	26.2	31.3	20	27.3
Methylene Blue Act. Substance (mg/L)	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	0.16	0.048
Nutrients								
Nitrite + Nitrate Nitrogen (mg/L)	0.051	0.0937	0.105	0.158	0.0743	0.15	0.141	0.1
Total Kjeldahl Nitrogen (mg/L)	0.9, SH	1.18, SH	1.89, SH	2.13, SH	0.817, SH	1.77, SH	1.01, SH	1.03, SH
Total Phosphorus (mg/L)	0.201	0.196	0.381	0.389	0.239	0.356	0.201	0.287
Orthophosphate Phosphorus (mg/L)	0.013, 1 H	0.0204, H	0.0302, H	0.0102, H	0.00918, H	0.00834, H	<0.01, H, TA	0.0134, H
Metals								
Cadmium, Dissolved (ug/L)	<0.05, H	0.063, <RDL, H	<0.05, H	0.16, <RDL, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H
Cadmium, Total (ug/L)	0.12, <RDL	0.348	0.22, <RDL	0.488	0.19, <RDL	0.21, <RDL	0.15, <RDL	0.18, <RDL
Calcium, Total (ug/L)	3500	5650	7750	19200	5560	6660	4560	6010
Copper, Dissolved (ug/L)	2.53, H	3.84, H	3.98, H	4.92, H	2.07, H	2.79, H	4.25, H	5.41, H
Copper, Total (ug/L)	19	23.2	24.4	36.4	21	29.7	19.7	29
Lead, Dissolved (ug/L)	0.12, <RDL, H	0.38, <RDL, H	0.25, <RDL, H	0.13, <RDL, H	0.18, <RDL, H	0.24, <RDL, H	0.36, <RDL, H	0.16, <RDL, H
Lead, Total (ug/L)	14.9	28.2	33.7	40.1	21.9	31.5	15.5	22.9
Magnesium, Total (ug/L)	2270	2960	3300	4840	3000	3560	2080	2990
Mercury, Dissolved (ug/L)	<0.05	<0.05	<0.05	<0.05	<0.05, H	<0.05, H	<0.05, H	<0.05, H
Mercury, Total (ug/L)	<0.05	<0.05	<0.05	<0.05	<0.05	0.06, <RDL	<0.05	<0.05
Zinc, Dissolved (ug/L)	8.76, H	13.4, H	13.9, H	26.1, H	7.37, H	6.67, H	13.7, H	12.2, H

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

Parameters	Storm Start Date							
	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
Metals (cont.)								
Zinc, Total (ug/L)	76.9	102	107	175	82.5	102	82.8	101
Organics								
<i>PAHs</i>								
Acenaphthene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
Acenaphthylene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
Anthracene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
Benzo(a)anthracene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	0.0264	<0.0094	0.0464	<0.0094
Benzo(a)pyrene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	0.105	<0.0094
Benzo(b,j,k)fluoranthene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	0.0708	0.0666
Benzo(g,h,i)perylene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	0.0541, JG	0.0443	<0.0094	<0.0094
Chrysene (ug/L)	0.0749	0.0928	<0.0094	<0.0094	0.0723	0.0649	0.0817	0.106
Dibenzo(a,h)anthracene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
Fluoranthene (ug/L)	0.0723	0.0796	0.091	0.122	0.0761	0.0739	0.0819	0.133
Fluorene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene (ug/L)	<0.0094	<0.0094	<0.0094	<0.0094	<0.0099	<0.0094	<0.0094	<0.0094
2-Methyl-phthalene (ug/L)	0.0358, JG	0.037	<0.0094	<0.0094	0.0982	<0.0094	<0.0094	<0.0094
Naphthalene (ug/L)	0.0606	0.0417	<0.0094	0.0883	0.0714	0.012, <RDL	0.0367	0.0384
Phenanthrene (ug/L)	0.0543	0.0755	0.0683	0.161	0.114	0.0475	<0.0094	0.105
Pyrene (ug/L)	0.11	0.167	0.133	0.253	0.136	0.119	0.127	0.131
<i>Phthalates</i>								
Benzyl Butyl Phthalate (ug/L)	0.269	0.221	0.208	<0.047	0.125	0.152	0.206 B	0.183
Bis(2-Ethylhexyl)Phthalate (ug/L)	1.98	1.96	1.86	2.52	1.55, B	1.81	2.65	1.74
Diethyl Phthalate (ug/L)	0.116	0.153	0.199	0.131	<0.025	0.122	0.111	0.131
Dimethyl Phthalate (ug/L)	0.047, <RDL	<0.024	<0.024	<0.024	<0.025	<0.024	<0.024	0.0497
Di-N-Butyl Phthalate (ug/L)	0.163	0.252, B2	0.242	0.24, B	0.0819	0.149	0.147, B	0.181, B
Di-N-Octyl Phthalate (ug/L)	<0.024	0.341	<0.024	1.74	0.115	0.161	0.57	0.352

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

Parameters	Storm Start Date							
	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	2/12/11	4/13/11	4/26/11
<i>Pesticides</i>								
2,4-D (ug/L)	<0.49	<0.51	<0.49	<0.5	<0.5	<0.5	<0.49	<0.5
Chlorpyrifos (ug/L)	<0.032	<0.033	<0.032	<0.032	<0.033	<0.032	<0.032	<0.032
Diazinon (ug/L)	<0.041	<0.041	<0.041	<0.041	<0.042	<0.041	<0.041	<0.041
Dichlobenil (ug/L)	<0.047	<0.048	<0.047	<0.047	<0.049	<0.047	<0.047	<0.047
Malathion (ug/L)	<0.045	<0.046	<0.045	<0.045	<0.047	<0.045	<0.045	<0.045
MCPP (ug/L)	<0.49	<0.51	<0.49	<0.5	<0.5	<0.5	<0.49	<0.5
Pentachlorophenol (ug/L)	<0.094	0.22	<0.094	<0.094	<0.099	0.469	<0.094	<0.094
Prometon (ug/L)	<0.047	<0.048	<0.047	<0.047	<0.049	<0.047	<0.047	<0.047
Triclopyr (ug/L)	<0.49	<0.51	<0.49	<0.5	<0.5	<0.5	<0.49	<0.5

Notes:

Values reported with “<” indicate the target analyte was below the method detection limit.

Values reported with “<RDL” indicate the target analyte was above the method detection limit but below the reporting detection limit.

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” or “B2” indicate blank contamination was observed.

Values reported with “JG” indicate biased data based on low surrogate or matrix spike recoveries

“—”, no data reported for target analyte

5.1.2 High Density Residential (HDR) Site

At HDR, conventional parameters were detected in all composite samples (Table 17), with the exception of MBAS, which were detected in two of the six samples. Nutrient parameters were detected in all composite samples at HDR. Metals (total and recoverable) were detected in all composite samples with the following exceptions:

- dissolved cadmium, dissolved mercury and total mercury were not detected in any of the composite samples
- total cadmium was not detected in one sample
- dissolved lead was not detected in two of the samples.

Detection levels for PAHs and phthalates varied across the storm sampling dates. Detection frequencies for PAHs ranged from 16 percent for acenaphthene and acenaphthylene to 100 percent for nine separate PAH compounds (Table 17). Detection frequencies for phthalates ranged from 16 percent for dimethyl phthalate to 100% for bis(2-ethylhexyl)phthalate and diethyl phthalate. Pesticides were not detected in any samples at HDR.

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

Parameters	Storm Start Date					
	11/1/10	11/30/10	1/20/11	2/4/11	2/13/11	4/26/11
Conventionals						
Total Suspended Solids (mg/L)	265	284	40.6	126	32.2	304
Turbidity (NTU)	71.1	97.5	12.5	54.3	17.5	134
Conductivity (umhos/cm)	15.6	14.1	19.2	18	14.8	15.8
Chloride (mg/L)	0.172	0.672	0.403	0.514	0.971	0.949
BOD (mg/L)	2.84, H	3.12	3.32	9.45	3.42	6.23
Hardness as CaCO ₃ (mg/L)	17.2	17.4	8.72	16.9	6.16	31.4
Methylene Blue Act. Substance (mg/L)	<0.025	<0.025	0.034	<0.025	<0.025	0.053
Nutrients						
Nitrite + Nitrate Nitrogen (mg/L)	0.021, <RDL	0.025, <RDL	0.087	0.115	0.114	0.0831
Total Kjeldahl Nitrogen (mg/L)	1.36, SH	1.95, SH	0.347, SH	1.62, SH	0.584, SH	2.58, SH
Total Phosphorus (mg/L)	0.408	0.364	0.0646	0.286	0.106	0.633
Orthophosphate Phosphorus (mg/L)	0.0383, H	0.0292, H	0.00626, H	0.0179, H	0.0129, H	0.0118, H
Metals						
Cadmium, Dissolved (ug/L)	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H
Cadmium, Total (ug/L)	0.315	0.324	0.05, <RDL	0.269	<0.05	0.979
Calcium, Total (ug/L)	3440	3470	2790	3940	1670	7030
Copper, Dissolved (ug/L)	1.2, <RDL, H	0.97, <RDL, H	1.1, <RDL, H	1.1, <RDL, H	1.5, <RDL, H	1.9, <RDL, H
Copper, Total (ug/L)	27.2	27.5	4.85	23.6	6.43	48.8
Lead, Dissolved (ug/L)	0.11, <RDL, H	0.21, <RDL, H	<0.1, H	<0.1, H	0.1, <RDL, H	0.28, <RDL, H
Lead, Total (ug/L)	27.2	34.3	3.42	15.5	3.88	89.2

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

Parameters	Storm Start Date					
	11/1/10	11/30/10	1/20/11	2/4/11	2/13/11	4/26/11
Metals (cont.)						
Magnesium, Total (ug/L)	2090	2120	426	1720	483	3350
Mercury, Dissolved (ug/L)	<0.05	--	--	--	--	--
Mercury, Total (ug/L)	<0.05	--	--	--	--	--
Zinc, Dissolved (ug/L)	1.1, <RDL, H	1.5 <RDL, H	2.61, H	3.62, H	3.48, H	2.2 <RDL, H
Zinc, Total (ug/L)	74.4	75.3	14.8	84.8	17.9	159
Organics						
<i>PAHs</i>						
Acenaphthene (ug/L)	<0.0094	<0.0094	<0.01	<0.0094	<0.0094	<0.0094
Acenaphthylene (ug/L)	<0.0094	<0.0094	<0.01	<0.0094	<0.0094	<0.0094
Anthracene (ug/L)	0.011, <RDL	0.0313	<0.01	0.04	0.011, <RDL	0.0577
Benzo(a)anthracene (ug/L)	0.0443	0.158	0.0259	0.126	0.0507	0.397
Benzo(a)pyrene (ug/L)	0.0577	0.201	0.0275	0.163	0.0537	0.586
Benzo(b,j,k)fluoranthene (ug/L)	0.114	0.408	0.0505	0.287	0.1063	1.11
Benzo(g,h,i)perylene (ug/L)	0.0464	0.176	0.0218	0.0875	0.0422	0.407
Chrysene (ug/L)	0.0774	0.214	0.0378	0.173	0.0753	0.697
Dibenzo(a,h)anthracene (ug/L)	0.014, <RDL	<0.0094	<0.01	<0.0094	<0.0094	<0.0094
Fluoranthene (ug/L)	0.156	0.463	0.0807	0.426	0.152	1.18
Fluorene (ug/L)	<0.0094	<0.0094	<0.01	0.0275	<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene (ug/L)	0.0359	0.132	0.018 <RDL	0.0713	0.0319	0.385
2-Methyl-phthalene (ug/L)	<0.0094 , JG	<0.0094	<0.01	0.0279, JG	<0.0094	<0.0094
naphthalene (ug/L)	0.0205	0.0224	<0.01	<0.0094, JG	<0.0094	0.0381
Phenanthrene (ug/L)	0.0676	0.213	0.0427	0.299	0.105	0.493
Pyrene (ug/L)	0.115	0.405	0.0704	0.285	0.139	0.909
<i>Phthalates</i>						
Benzyl Butyl Phthalate (ug/L)	0.104	0.072, <RDL	0.074, <RDL	<0.047	<0.047	<0.047
Bis(2-Ethylhexyl)Phthalate (ug/L)	0.358, B	0.586, B2	1.75, B	2.58	0.547	1.17
Diethyl Phthalate (ug/L)	0.0649	0.106	0.0636	0.0706 B	0.091	0.0704
Dimethyl Phthalate (ug/L)	<0.024	<0.024	<0.025	<0.024	<0.024	0.045, <RDL
Di-N-Butyl Phthalate (ug/L)	0.13	0.083, B	<0.025	0.024, <RDL	<0.024	<0.024
Di-N-Octyl Phthalate (ug/L)	<0.024	0.0861	<0.025	0.0484	<0.024	<0.024
<i>Pesticides</i>						
2,4-D (ug/L)	<0.5	<0.49	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos (ug/L)	<0.032	<0.032	<0.033	<0.032	<0.032	<0.032
Diazinon (ug/L)	<0.041	<0.041	<0.042	<0.041	<0.041	<0.041
Dichlobenil (ug/L)	<0.047	<0.047	<0.049	<0.047	<0.047	<0.047
Malathion (ug/L)	<0.045	<0.045	<0.047	<0.045	<0.045	<0.045

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

Parameters	Storm Start Date					
	11/1/10	11/30/10	1/20/11	2/4/11	2/13/11	4/26/11
<i>Pesticides (cont.)</i>						
MCPP (ug/L)	<0.5	<0.49	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol (ug/L)	<0.094	<0.094	<0.1	<0.094	<0.094	<0.094
Prometon (ug/L)	<0.047	<0.047	<0.049	<0.047	<0.047	<0.047
Triclopyr (ug/L)	<0.5	<0.49	<0.5	<0.5	<0.5	<0.5

Notes:

- Values reported with “<” indicate the target analyte was below the method detection limit.
- Values reported with “<RDL” indicate the target analyte was above the method detection limit but below the reporting detection limit.
- 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” or “B2” indicate blank contamination was observed.
- Values reported with “JG” indicate biased data based on low surrogate or matrix spike recoveries
- “—”, no data reported for target analyte

5.1.3 Low Density Residential (LDR) Site

At LDR, conventional parameters were detected in all stormwater composite samples (Table 18), with the exception of BOD, which was not detected in any sample and MBAS, which were detected in two of the eight samples. Nutrient parameters were detected in all composite samples at LDR. Metals were detected in all composite samples with the following exceptions:

- dissolved cadmium, and dissolved and total mercury were not detected in any sample
- total cadmium was detected in four of the eight samples
- dissolved copper was detected in seven of the eight samples
- dissolved lead was detected in five of the eight samples.

Detection levels for PAHs and phthalates varied across the storm sampling dates. Detection frequencies for PAHs ranged from 0 percent (not detected) for acenaphthene, acenaphthylene, and 2-methyl-phthalene to 100 percent for nine separate PAH compounds (Table 18). For phthalates, detection frequencies ranged from 0 percent for di-n-octyl phthalate to 100 percent for bis (2-ethylhexyl) phthalate and diethyl phthalate. Pesticides were not detected in any of the storm samples with the exception of prometon and pentachlorophenol, which were detected in one sample each.

For the base flow sample collected on January 26, 2011, all conventional and nutrient parameters were detected with the following exceptions:

- total suspended solids, BOD, and MBAs for conventional parameters
- total kjeldahl nitrogen for nutrient parameters.

All metals parameters were detected in the base flow sample with the exception of total and dissolved cadmium and dissolved lead. Fluoranthene, naphthalene, and pyrene were detected in the base flow sample, while all other PAHs were not detected. Only one phthalate was detected in the sample, diethyl phthalate, and no pesticides were detected.

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

Parameters	Storm Start Date								Base flow
	10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
Conventionals									
Total Suspended Solids (mg/L)	9.4	6.9	31.8	26	15.6	20.5	62.8	12.4	<1
Turbidity (NTU)	7.11	4.55	24.6	19	14.8	15.2	49.1	8.19	1.64
Conductivity (umhos/cm)	48.9	99.2	74.9	57	56.4	53	55	62	65.6
Chloride (mg/L)	2.04	6.13	4.18	1.87	1.89	2.26	1.45	5.3	2.46
BOD (mg/L)	--	<2	--	<2	--	--	--	--	<2
Hardness as CaCO ₃ (mg/L)	16.8	27.4	20.2	20.8	17.4	17.2	22.2	16.4	19.2
Methylene Blue Act. Substance (mg/L)	<0.025	<0.025	<0.025	0.043	<0.025	<0.025	<0.025	0.23, H	<0.025
Nutrients									
Nitrite + Nitrate Nitrogen (mg/L)	0.917	2.05	1.3	0.951	0.345	0.288	0.459	1.73	0.714
Total Kjeldahl Nitrogen (mg/L)	0.345, SH	0.429, SH	0.838, SH	0.447, SH	0.434, SH	0.526, SH	1.28, SH	1.61, SH	<0.1, SH
Total Phosphorus (mg/L)	0.0602	0.0542	0.16	0.153	0.0572	0.111	0.234	0.224	0.0092, <RDL
Orthophosphate Phosphorus (mg/L)	0.0271, H	0.0307, H	0.0813, H	0.0501, H	0.0164, H	0.0404, H	0.0605, H	0.115, H	0.00916, H
Metals									
Cadmium, Dissolved (ug/L)	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H	<0.05, H
Cadmium, Total (ug/L)	<0.05	<0.05	0.054, <RDL	0.14, <RDL	<0.05	<0.05	0.11, <RDL	0.053, <RDL	<0.05
Calcium, Total (ug/L)	4940	7300	5480	5230	4620	4740	5710	4560	5240
Copper, Dissolved (ug/L)	1.8, <RDL, H	1.4, <RDL, H	2.35, H	<0.4, H	1.3, <RDL, H	1.3, <RDL, H	2.16, H	5.02, H	1, <RDL, H
Copper, Total (ug/L)	2.71	2.04	4.34	5.91	2.58	2.96	7.54	6.53	1.2, <RDL
Lead, Dissolved (ug/L)	<0.1, H	0.1, <RDL, H	0.19, <RDL, H	<0.1, H	0.1, <RDL, H	<0.1, H	0.19, <RDL, H	0.18, <RDL, H	<0.1, H
Lead, Total (ug/L)	0.776	0.776	4.91	2.96	1.98	2.58	9	1.34	0.14, <RDL
Magnesium, Total (ug/L)	1090	2230	1590	1880	1420	1300	1940	1210	1480
Mercury, Dissolved (ug/L)	<0.05	--	--	--	--	--	--	--	--

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

Parameters	Storm Start Date								Base flow
	10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
Metals (cont.)									
Mercury, Total (ug/L)	<0.05	--	--	--	--	--	--	--	--
Zinc, Dissolved (ug/L)	5.5, H	7.36, H	10.3, H	<0.5, H	3.17, H	59.8, H	18.4, H	8.67, H	2.73, H
Zinc, Total (ug/L)	8.43	11.2	18.3	27.4	9.17	74.1	44.9	11.6	5.59
Organics									
<i>PAHs</i>									
Acenaphthene (ug/L)	<0.0095	<0.0095	<0.01	<0.0098	<0.0095	<0.01	<0.01	<0.0094	<0.0094
Acenaphthylene (ug/L)	<0.0095	<0.0095	<0.01	<0.0098	<0.0095	<0.01	<0.01	<0.0094	<0.0094
Anthracene (ug/L)	<0.0095	<0.0095	<0.01	<0.0098	0.013, <RDL	<0.01	0.019, <RDL	<0.0094	<0.0094
Benzo(a)anthracene (ug/L)	0.0223	0.136	0.131	0.0448	0.143	0.0856	0.364	0.0204	<0.0094
Benzo(a)pyrene (ug/L)	0.0399	0.156	0.181	0.0512	0.195	0.165	0.533	0.0383	<0.0094
Benzo(b,j,k)fluoranthene (ug/L)	0.0694	0.303	0.406	0.1085	0.419	0.354	1.16	0.0993	<0.0094
Benzo(g,h,i)perylene (ug/L)	0.0289	0.115	0.169	0.0404	0.175	0.133	0.445	0.0416	<0.0094
Chrysene (ug/L)	0.0474	0.179	0.287	0.0831	0.253	0.283	0.637	0.0641	<0.0094
Dibenzo(a,h)anthracene (ug/L)	<0.0095	<0.0095	<0.01	0.015, <RDL	0.0233	<0.01	0.119	<0.0094	<0.0094
Fluoranthene (ug/L)	0.111	0.417	0.683	0.207	0.536	0.425	1.33	0.151	0.016 <RDL
Fluorene (ug/L)	<0.0095	<0.0095	<0.01	<0.0098	0.011, <RDL	<0.01	<0.01	<0.0094	<0.0094
Indeno(1,2,3-Cd)Pyrene (ug/L)	0.0235	0.106	0.139	0.0366	0.138	0.11	0.364	0.0326	<0.0094
2-Methyl-phthalene (ug/L)	<0.0095, JG	<0.0095	<0.01	<0.0098	<0.0095	<0.01	<0.01	<0.0094	<0.0094
naphthalene (ug/L)	<0.0095, JG	0.013, <RDL	0.0201	0.017, <RDL	<0.0095	<0.01	<0.01	<0.0094	0.018 <RDL
Phenanthrene (ug/L)	0.0229	0.0743	0.152	0.0452	0.194	0.112	0.275	0.0619	<0.0094
Pyrene (ug/L)	0.074	0.329	0.509	0.152	0.455	0.32	1.15	0.0919	0.012 <RDL

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

Parameters	Storm Start Date								Base flow
	10/23/10	11/29/10	12/7/10	1/20/11	3/24/11	4/26/11	5/25/11	7/12/11	1/26/11
<i>Phthalates</i>									
Benzyl Butyl Phthalate (ug/L)	0.125	<0.048	0.144	0.058, <RDL	<0.048	<0.05	<0.05	0.169	<0.047
Bis(2-Ethylhexyl)Phthalate (ug/L)	0.25 B	0.153, B	0.362	0.352, B	0.21, B	0.218, B	0.219, B	0.495, B	<0.024
Diethyl Phthalate (ug/L)	0.0767	0.177	0.177	0.194	0.337	0.357	0.296	0.438	0.479 B
Dimethyl Phthalate (ug/L)	<0.024	<0.024	<0.025	<0.025	0.029, <RDL	<0.025	<0.025	<0.024	<0.024
Di-N-Butyl Phthalate (ug/L)	0.132 B	0.034, <RDL, B	0.156	<0.025	0.0814	<0.025	0.0598, B	0.0847, B	<0.024
Di-N-Octyl Phthalate (ug/L)	<0.024	<0.024	<0.025	<0.025	<0.024	<0.025	<0.025	<0.024	<0.024
<i>Pesticides</i>									
2,4-D (ug/L)	<0.5	<0.49	<0.49	<0.5	<0.5	<0.5	<0.5	<0.49	<0.5
Chlorpyrifos (ug/L)	<0.032	<0.032	<0.033	<0.034	<0.032	<0.033	<0.034	<0.032	<0.032
Diazinon (ug/L)	<0.041	<0.041	<0.042	<0.043	<0.041	<0.042	<0.043	<0.041	<0.041
Dichlobenil (ug/L)	<0.047	<0.048	<0.049	<0.05	<0.048	<0.049	<0.05	<0.047	<0.047
Malathion (ug/L)	<0.045	<0.046	<0.047	<0.048	<0.046	<0.047	<0.048	<0.045	<0.045
MCPD (ug/L)	<0.5	<0.49	<0.49	<0.5	<0.5	<0.5	<0.5	<0.49	<0.5
Pentachlorophenol (ug/L)	<0.095	<0.095	<0.1	<0.098	<0.095	<0.1	<0.1	0.394	<0.094
Prometon (ug/L)	<0.047	<0.048	<0.049	0.05,5 <RDL	<0.048	<0.049	<0.05	<0.047	<0.047
Triclopyr (ug/L)	<0.5	<0.49	<0.49	<0.5	<0.5	<0.5	<0.5	<0.49	<0.5

Notes:

Values reported with “<” indicate the target analyte was below the method detection limit.

Values reported with “<RDL” indicate the target analyte was above the method detection limit but below the reporting detection limit.

Values reported with “H” indicate the holding time was exceeded for that analyte.

Values reported with “B” indicate blank contamination was observed.

Values reported with “JG” indicate biased data based on low surrogate or matrix spike recoveries.

“–”, no data reported for target analyte

5.2 Stormwater Grab Sample Results

Concentration data for target analytes in stormwater grab samples for the commercial, high density residential, and low density residential sites are briefly discussed below and presented in Table 16, Table 17, and Table 18, 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).

The grab sampling results across all three sites was very similar for fecal coliform, while varied across the sites for TPH. For COM, HDR and LDR, fecal coliform was detected in all but one of the grab samples collected at each site (Tables 19, 20 and 21, respectively). For COM, diesel was detected in six of the eleven samples, lube oil was detected in all eleven samples, and gasoline was not detected in any samples. At HDR, lube oil was detected in three of the ten samples, and diesel and gasoline were not detected in any samples. For LDR, diesel, gasoline, and lube oil were not detected in any samples.

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

Parameters	Storm Start Date										
	11/1/10	11/9/10	11/17/10	11/30/10	12/7/10	1/5/11	1/12/11	1/20/11	2/12/11	4/13/11	4/26/11
Bacteria											
Fecal Coliform	290	300	2600	880	530	230	36	250	49	<1	24000
Organics											
<i>TPH</i>											
Diesel Range (>C12-C24)	.192, TA	<.19	.223, TA	.204, TA	<.19	.375	<.19	1.04	<.19	.287	<.19
Lube Oil Range (>C24)	.822	.599	1.08	.869	.383	.998	.769	.46	.433	.554	.628
Gasoline Range (C7-C12)	<250	<250, H	<250	<250	<250	<250	<250	<250, H	<250	<250	<250

Notes:

Values reported with "<" indicate the target analyte was below the method detection limit.

Values reported with "TA" indicate text information is available in the laboratory report.

Values reported with "H" indicate the holding time was exceeded for that analyte.

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

Parameters	Storm Start Date									
	11/1/10	11/9/10	11/17/10	11/30/10	12/7/10	1/12/11	1/20/11	2/4/11	2/12/11	4/26/11
Bacteria										
Fecal Coliform	350	360	200	1900	3300	38	43	4700	<1	9
Organics										
<i>TPH</i>										
Diesel Range (>C12-C24)	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19
Lube Oil Range (>C24)	<.19	<.19	<.19	.218	<.19	<.19	<.19	<.19	.257	.243
Gasoline Range (C7-C12)	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250

Notes:

Values reported with "<" indicate the target analyte was below the method detection limit.

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

Parameters	Storm Start Date							
	11/4/10	11/16/10	1/4/11	3/7/11	4/13/11	4/26/11	5/24/11	5/31/11
Bacteria								
Fecal Coliform	360	110	47	<1	1	89	88	620
Organics								
<i>TPH</i>								
Diesel Range (>C12-C24)	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19
Lube Oil Range (>C24)	<.19	<.19	<.19	<.19	<.19	<.19	<.19	<.19
Gasoline Range (C7-C12)	<250	<250	<250	<250	<250	<250	<250	<250

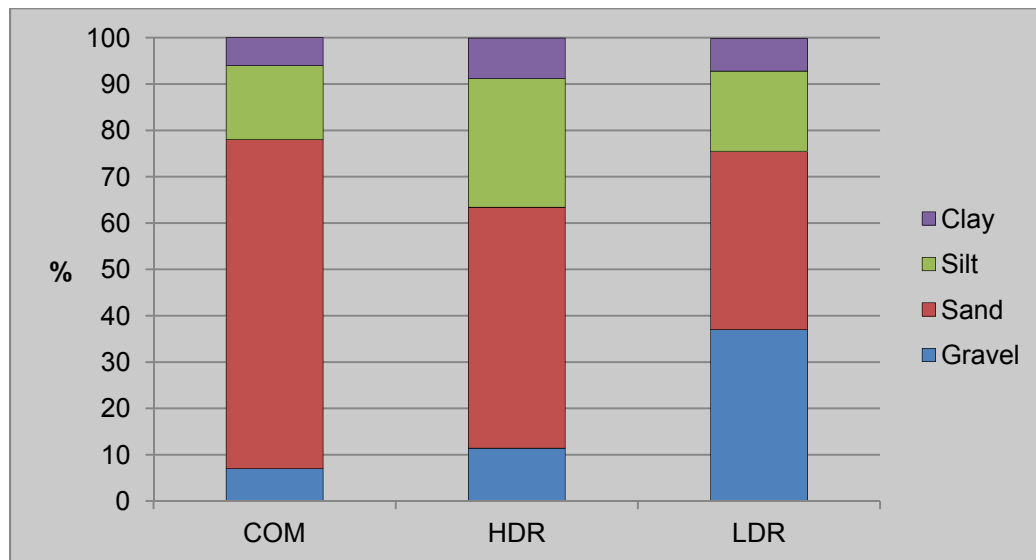
Notes:

Values reported with “<” indicate the target analyte was below the method detection limit.

5.3 Annual Sediment Sample

Concentration data for target analytes in accumulated sediment samples collected from COM, HDR, and LDR are presented in Table 21. Analytes include conventionals (solids), metals, and organics.

Analytical results for total solids ranged from 36.1 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.**

Across all three sites, metals were detected in each of the sediment samples collected while organics results varied across the sites. For PAHs, five out of the 16 compounds were below the method detection limits for COM, four out of the 16 for HDR, and three out of the 16 for LDR. All phenols compounds were below the method detection limits in the sediment sample from

LDR, and all but one compound, 3-,4-methylphenol, were below the detection limit for COM and HDR. For the phthalate compounds, benzyl butyl phthalate and di-n-butyl phthalate was detected in the COM and LDR sediment samples, bis(2-ethylhexyl)phthalate was detected in samples from all three sites, and di-n-butyl phthalate was detected in the HDR sediment sample. All other phthalate compounds were below the method detection limits. In addition, all pesticide compounds were below the method detection limits for samples from all three sites.

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

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	%	49.3	36.1	71
Total Organic Carbon	EPA9060-PSEP96	mg/Kg	27,700	38,600	25,900
Gravel	ASTM D422	%	6.8	11.4	35.9
< -2 Phi Gravel		%	1.9, <RDL	5.9	23.3
(-1) - (-2) Phi Gravel		%	<0.22	0.5, <RDL	3.3
(-1) - 0 Phi Gravel		%	5	5.1	9.3
Sand		%	72.1	52	38.5
0-1 Phi Sand		%	12.6	6.9	3.2
1-2 Phi Sand		%	16.3	8.8	2.7
2-3 Phi Sand		%	14.6	8.8	8.4
3-4 Phi Sand		%	17.5	13.7	11.9
4-5 Phi Sand		%	11.1	13.8	12.4
Silt		%	15.6	27.8	17.3
5-6 Phi Silt		%	6.7	13.9	7.8
6-7 Phi Silt		%	2.2, <RDL	5.2	3.9
7-8 Phi Silt		%	4.5	7	3.1
8-9 Phi Silt		%	2.2, <RDL	1.7, <RDL	2.4
Clay		%	6.7	8.7	6.3
9-10 Phi Clay		%	2.2, <RDL	3.5, <RDL	2.4
>10 Phi Clay		%	4.5	5.2	3.9
Fines		%	22.3	36.5	23.5
Metals					
Cadmium, Total, ICP	EPA3050B/6020A	mg/Kg	0.16, <RDL	0.26, <RDL	0.28, <RDL
Copper, Total, ICP		mg/Kg	24.5	20.2	17
Lead, Total, ICP		mg/Kg	21.9	67	16.6
Mercury, Total, CVAA		mg/Kg	0.016, <RDL	-	-
Zinc, Total, ICP		mg/Kg	87.2	67.7	79.2
Organics					
PAHs					
Acenaphthene	SW846-8270D	ug/Kg	<27	<20	14.2
Acenaphthylene		ug/Kg	<27	<20	<5.3
Anthracene		ug/Kg	42, <RDL	54.6	85.8
Benzo(a)anthracene		ug/Kg	95.3	297	1470
Benzo(a)pyrene		ug/Kg	110	364	2010

Parameter	Analytical Methods	Units	Sediment Sample Concentrations		
			COM	HDR	LDR
PAHs (cont'd)					
Benzo(b,j,k)fluoranthene	SW846-8270D	ug/Kg	159	746	4010
Benzo(g,h,i)perylene		ug/Kg	146	337	1590
Chrysene		ug/Kg	195	425	2300
Dibenzo(a,h)anthracene		ug/Kg	46, <RDL	99.9	558
Fluoranthene		ug/Kg	225	832	4840
Fluorene		ug/Kg	<27	25, <RDL	19.1
Indeno(1,2,3-Cd)Pyrene		ug/Kg	72.3	257	1410
2-Methylnaphthalene		ug/Kg	<27	<20	<5.3
Naphthalene		ug/Kg	<27	<20	<5.3
Phenanthrene		ug/Kg	169	400	840
Pyrene		ug/Kg	265	732	4080
Phthalates					
Benzyl Butyl Phthalate	SW846-8270D	ug/Kg	1310	<29.3	34.8
Bis(2-Ethylhexyl)Phthalate		ug/Kg	5020	2090	113
Diethyl Phthalate		ug/Kg	<53	<39	<11
Dimethyl Phthalate		ug/Kg	<53.3	<39	<10.7
Di-N-Butyl Phthalate		ug/Kg	<53	120, J	<11
Di-N-Octyl Phthalate		ug/Kg	<53.3	<39	<10.7
Phenols					
2,4-Dimethylphenol	SW846-8270D	ug/Kg	<27	<20	<5.3
2-Methylphenol		ug/Kg	<27	<20	<5.3
3-,4-Methyl phenol		ug/Kg	337	110, <RDL	<27
Phenol		ug/Kg	<130	<98	<27
PCB Aroclors					
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	4.18	--	--
Aroclor 1260		ug/Kg	<2	--	--
Total Aroclors		ug/Kg	4.18	--	--
Pesticides					
Chlorpyrifos	SW846-8270DSIM	ug/Kg	<8	<8	<8
Diazinon		ug/Kg	<4.8	<4.8	<4.8
Malathion		ug/Kg	<13	<13	<13
Pentachlorophenol		ug/Kg	<400	<293	<80

Notes:

Values reported with "<" indicate the target analyte was not detected at the reported value.

Values reported with "<RDL" indicate the target analyte was above the method detection limit but below the reporting detection limit.

"--", no data reported for target analyte

5.4 Stormwater Management Program Activities within Monitoring Drainage Areas

- 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 those stormwater catch basins within the inspected circuits, as defined by the methodology allowed by the Phase I NPDES Municipal Stormwater Permit, which were found to be in exceedance of sediment maintenance standards for catch basins
- King County inspected the stormwater treatment and flow control facilities it owns and operates within the basins in question as required by the Phase I NPDES Municipal Stormwater Permit
- King County performed maintenance on the stormwater treatment and flow control facilities it owns and operates within the basins in question which were found to be in exceedance of function critical maintenance standards for stormwater treatment and flow control facilities.
- King County recently conducted Natural Yard Care trainings in the Renton Basin area, and provided stormwater drainage related technical assistance to rural and agricultural properties near the Fall City Basin.

6.0. POLLUTANT LOADING CALCULATIONS

Pollutant loads were calculated following procedures outlined in Ecology's Standard Operating Procedures (SOP) (Ecology, 2009). The loading results are based on the parameters analyzed for valid² composite stormwater samples collected from each of the three (COM, HDR, LDR) monitoring sites. The pollutant loading calculation procedure included in the project QAPP was 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 first step to calculate the pollutant loading was to determine an event mean concentration value (EMC) for each parameter from composite samples that met all of the Phase I Permit criteria. This was done for each qualifying sampled storm from COM, HDR and LDR and from the base flow event for LDR. For all valid samples at COM and HDR, and for valid samples at LDR when there was no base flow, results that were below the method detection limit were assigned an EMC equal to 1/2 of the method detection limit. For results that were above the method detection limit the value used for the EMC was the value reported by the analytical laboratory.

Because LDR had base flow for a portion of the year, an additional step was needed to calculate the EMC for any qualifying sampled storm events with base flow. To calculate the EMC for the storm flow concentration (EMC_s), the base flow volume had to be "unmixed" from the reported EMC (EMC_{tot}) using the following equation:

$$EMC_s = [EMC_{tot} - (C_b \times f_b)] / f_s$$

Where:

- C_b = analyte concentration from base flow sample
- f_b = fraction of base flow volume from storm event
- f_s = fraction of storm flow volume from storm event

Individual storm pollutant loads were calculated for all analytes for all valid samples at each site. The base flow pollutant load was calculated using results from the wet season base flow sample collected at LDR. For each sampled event at each site, the pollutant load was calculated as the product of the EMC and the runoff volume for that event.

$$Pollutant\ Load = EMC_i \times V_i$$

Where:

- EMC_i = EMC from event i in pounds per liter

² 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 criterion were not included in the calculations.

V_i = runoff volume from event i in liters

Pollutant loads, reported as pounds, for the sampled storm events for the COM and HDR sites are presented in Table 23 and Table 24, respectively. Pollutant loads for the sampled storm and base flow events for the LDR site is presented in Table 25.

Wet season, dry season and annual storm and base flow (for LDR) pollutant loads for WY2011, reported in pounds, were calculated for each monitoring site and are presented in Table 26 (COM), Table 27 (HDR), and Table 28 (LDR). Annual pollutant loads calculated as pounds per acre are presented for each site in Table 29. Flow data needed for these calculations included:

- Average flow rates of the qualifying sampled events, which are provided in Table 4 for COM, Table 8 for HDR, and Table 12 for LDR.
- The WY2011 storm flow volume for COM and HDR on a wet season, dry season, and annual basis.
- The WY2011 storm and base flow volume for LDR, on a wet season, dry season, and annual basis.

The wet season, dry season, and annual storm flow volumes for each site were:

- COM – wet = 6,223,599 gallons, dry = 1,143,901 gallons, annual = 7,367,607 gallons
- HDR – wet = 2,048,682 gallons, dry = 297,285 gallons, annual = 2,345,967 gallons
- LDR – wet = 4,033,230 gallons, dry = 312,642 gallons, annual = 4,345,872 gallons.

The wet season, dry season, and annual base flow volumes for LDR were wet = 747,360 gallons, dry = 129,600 gallons, annual = 876,960 gallons. The continuous flow record from each site 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) as reported in Table 1 were used.

Table 23. Pollutant load (pounds) for qualifying sampled storm events at COM.

Parameter	Storm Event Pollutant Loads (pounds)						
	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	4/13/11	4/26/11
Conventionals							
Total Suspended Solids	7.34E+01	1.35E+02	1.57E+02	1.25E+02	2.38E+02	5.76E+01	9.04E+01
Turbidity	nc	nc	nc	nc	nc	nc	nc
Conductivity	nc	nc	nc	nc	nc	nc	nc
Chloride	3.79E-04	1.52E-02	1.77E-02	9.80E-02	4.82E-02	2.31E-03	9.25E-04
Biochemical Oxygen Demand	2.80E+00	5.46E+00	8.03E+00	--	--	3.43E+00	3.24E+00
Hardness, Calc	1.38E+01	2.14E+01	2.56E+01	3.78E+01	3.57E+01	1.27E+01	1.44E+01
Methylene Blue Act. Substance	9.55E-03	1.02E-02	9.74E-03	6.96E-03	4.08E-02	1.02E-01	2.52E-02
Nutrients							
Nitrite + Nitrate Nitrogen	3.90E-02	7.64E-02	8.18E-02	8.79E-02	1.01E-01	8.95E-02	5.26E-02
Total Kjeldahl Nitrogen	6.88E-01	9.62E-01	1.47E+00	1.19E+00	1.11E+00	6.41E-01	5.41E-01
Total Phosphorus	1.54E-01	1.60E-01	2.97E-01	2.17E-01	3.25E-01	1.28E-01	1.51E-01
Orthophosphate Phosphorus	1.00E-02	1.66E-02	2.35E-02	5.68E-03	1.25E-02	3.17E-03	7.04E-03
Metals							
Cadmium, Dissolved	1.91E-05	5.14E-05	1.95E-05	8.91E-05	3.40E-05	1.59E-05	1.31E-05
Cadmium, Total	9.17E-05	2.84E-04	1.71E-04	2.72E-04	2.59E-04	9.52E-05	9.46E-05
Calcium, Total	2.67E+00	4.61E+00	6.04E+00	1.07E+01	7.57E+00	2.89E+00	3.16E+00
Copper, Dissolved	1.93E-03	3.13E-03	3.10E-03	2.74E-03	2.82E-03	2.70E-03	2.84E-03
Copper, Total	1.45E-02	1.89E-02	1.90E-02	2.03E-02	2.86E-02	1.25E-02	1.52E-02
Lead, Dissolved	9.17E-05	3.10E-04	1.95E-04	7.24E-05	2.45E-04	2.28E-04	8.41E-05
Lead, Total	1.14E-02	2.30E-02	2.63E-02	2.23E-02	2.98E-02	9.84E-03	1.20E-02
Magnesium, Total	1.73E+00	2.41E+00	2.57E+00	2.69E+00	4.08E+00	1.32E+00	1.57E+00
Mercury, Dissolved, CVAA	1.91E-05	2.04E-05	1.95E-05	1.39E-05	3.40E-05	1.59E-05	1.31E-05
Mercury, Total,	1.91E-05	2.04E-05	1.95E-05	1.39E-05	3.40E-05	1.59E-05	1.31E-05
Zinc, Dissolved	6.69E-03	1.09E-02	1.08E-02	1.45E-02	1.00E-02	8.70E-03	6.41E-03
Zinc, Total	5.88E-02	8.32E-02	8.34E-02	9.74E-02	1.12E-01	5.26E-02	5.31E-02
Organics							
<i>PAHs</i>							
Acenaphthene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
Acenaphthylene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
Anthracene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
Benzo(a)anthracene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	3.59E-05	2.94E-05	2.47E-06
Benzo(a)pyrene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	6.66E-05	2.47E-06
Benzo(b,j,k)fluoranthene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	4.49E-05	3.50E-05
Benzo(g,h,i)perylene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	7.36E-05	2.98E-06	2.47E-06

Table 23. Pollutant load (pounds) for qualifying sampled storm events at COM.

Parameter	Storm Event Pollutant Loads (pounds)						
	11/1/10	11/30/10	12/7/10	1/5/11	1/20/11	4/13/11	4/26/11
<i>PAHs (cont.)</i>							
Chrysene	5.72E-05	7.57E-05	3.66E-06	2.62E-06	9.84E-05	5.19E-05	5.57E-05
Dibenzo(a,h)anthracene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
Fluoranthene	5.52E-05	6.49E-05	7.09E-05	6.79E-05	1.04E-04	5.20E-05	6.99E-05
Fluorene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
Indeno(1,2,3-Cd)Pyrene	3.59E-06	3.83E-06	3.66E-06	2.62E-06	6.74E-06	2.98E-06	2.47E-06
2-Methylnaphthalene	2.74E-05	3.02E-05	3.66E-06	2.62E-06	1.34E-04	2.98E-06	2.47E-06
Naphthalene	4.63E-05	3.40E-05	3.66E-06	4.91E-05	9.72E-05	2.33E-05	2.02E-05
Phenanthrene	4.15E-05	6.16E-05	5.32E-05	8.96E-05	1.55E-04	2.98E-06	5.52E-05
Pyrene	8.41E-05	1.36E-04	1.04E-04	1.41E-04	1.85E-04	8.06E-05	6.89E-05
<i>Phthalates</i>							
Benzyl Butyl Phthalate	2.06E-04	1.80E-04	1.62E-04	1.31E-05	1.70E-04	1.31E-04	9.62E-05
Bis(2-Ethylhexyl)Phthalate	1.51E-03	1.60E-03	1.45E-03	1.40E-03	2.11E-03	1.68E-03	9.15E-04
Diethyl Phthalate	8.86E-05	1.25E-04	1.55E-04	7.29E-05	1.70E-05	7.05E-05	6.89E-05
Dimethyl Phthalate	3.59E-05	9.79E-06	9.35E-06	6.68E-06	1.70E-05	7.62E-06	2.61E-05
Di-N-Butyl Phthalate	1.25E-04	2.05E-04	1.89E-04	1.34E-04	1.11E-04	9.33E-05	9.51E-05
Di-N-Octyl Phthalate	9.17E-06	2.78E-04	9.35E-06	9.68E-04	1.57E-04	3.62E-04	1.85E-04
<i>Pesticides</i>							
2,4-D	1.87E-04	2.08E-04	1.91E-04	1.39E-04	3.40E-04	1.55E-04	1.31E-04
Chlorpyrifos	1.22E-05	1.35E-05	1.25E-05	8.91E-06	2.25E-05	1.02E-05	8.41E-06
Diazinon	1.57E-05	1.67E-05	1.60E-05	1.14E-05	2.86E-05	1.30E-05	1.08E-05
Dichlobenil	1.80E-05	1.96E-05	1.83E-05	1.31E-05	3.33E-05	1.49E-05	1.24E-05
Malathion	1.72E-05	1.88E-05	1.75E-05	1.25E-05	3.20E-05	1.43E-05	1.18E-05
MCPP	1.87E-04	2.08E-04	1.91E-04	1.39E-04	3.40E-04	1.55E-04	1.31E-04
Pentachlorophenol	3.59E-05	1.79E-04	3.66E-05	2.62E-05	6.74E-05	2.98E-05	2.47E-05
Prometon	1.80E-05	1.96E-05	1.83E-05	1.31E-05	3.33E-05	1.49E-05	1.24E-05
Triclopyr	1.87E-04	2.08E-04	1.91E-04	1.39E-04	3.40E-04	1.55E-04	1.31E-04

Notes:

nc – not computed

“–”, no data reported for target analyte

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 HDR.

Parameter	Storm Event Pollutant Loads (pounds)		
	11/1/10	11/30/10	2/4/11
Conventionals			
Total Suspended Solids	5.10E+01	6.20E+01	7.73E+00
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	3.31E-05	1.47E-04	3.15E-05
Biochemical Oxygen Demand	5.47E-01	6.81E-01	5.80E-01
Hardness, Calc	3.31E+00	0.00E+00	1.04E+00
Methylene Blue Act. Substance	2.41E-03	2.73E-03	7.67E-04
Nutrients			
Nitrite + Nitrate Nitrogen	4.04E-03	5.46E-03	7.06E-03
Total Kjeldahl Nitrogen	2.62E-01	4.26E-01	9.94E-02
Total Phosphorus	7.85E-02	7.95E-02	1.75E-02
Orthophosphate Phosphorus	7.37E-03	6.38E-03	1.10E-03
Metals			
Cadmium, Dissolved	4.81E-06	5.46E-06	1.53E-06
Cadmium, Total	6.06E-05	7.07E-05	1.65E-05
Calcium, Total	6.62E-01	7.58E-01	2.42E-01
Copper, Dissolved	2.31E-04	2.12E-04	6.75E-05
Copper, Total	5.24E-03	6.00E-03	1.45E-03
Lead, Dissolved	2.12E-05	4.58E-05	3.07E-06
Lead, Total	5.24E-03	7.49E-03	9.51E-04
Magnesium, Total	4.02E-01	4.63E-01	1.06E-01
Mercury, Dissolved, CVAA	4.81E-06	--	--
Mercury, Total,	4.81E-06	--	--
Zinc, Dissolved	2.12E-04	3.27E-04	2.22E-04
Zinc, Total	1.43E-02	1.64E-02	5.20E-03
Organics			
PAHs			
Acenaphthene	9.05E-07	1.03E-06	2.88E-07
Acenaphthylene	9.05E-07	1.03E-06	2.88E-07
Anthracene	2.12E-06	6.83E-06	2.45E-06
Benzo(a)anthracene	8.53E-06	3.45E-05	7.73E-06
Benzo(a)pyrene	1.11E-05	4.39E-05	1.00E-05
Benzo(b,j,k)fluoranthene	2.19E-05	8.91E-05	1.76E-05
Benzo(g,h,i)perylene	8.93E-06	3.84E-05	5.37E-06
Chrysene	1.49E-05	4.67E-05	1.06E-05
Dibenzo(a,h)anthracene	2.69E-06	1.03E-06	2.88E-07
Fluoranthene	3.00E-05	1.01E-04	2.61E-05
Fluorene	9.05E-07	1.03E-06	1.69E-06
Indeno(1,2,3-Cd)Pyrene	6.91E-06	2.88E-05	4.37E-06
2-Methylnaphthalene	9.05E-07	1.03E-06	1.71E-06
Naphthalene	3.95E-06	4.89E-06	2.88E-07
Phenanthrene	1.30E-05	4.65E-05	1.83E-05
Pyrene	2.21E-05	8.84E-05	1.75E-05
Phthalates			
Benzyl Butyl Phthalate	2.00E-05	1.57E-05	1.44E-06
Bis(2-Ethylhexyl)Phthalate	6.89E-05	1.28E-04	1.58E-04
Diethyl Phthalate	1.25E-05	2.31E-05	4.33E-06
Dimethyl Phthalate	2.31E-06	2.62E-06	7.36E-07

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

Parameter	Storm Event Pollutant Loads (pounds)		
	11/1/10	11/30/10	2/4/11
Phthalates (cont.)			
Di-N-Butyl Phthalate	2.50E-05	1.81E-05	1.47E-06
Di-N-Octyl Phthalate	2.31E-06	1.88E-05	2.97E-06
Pesticides			
2,4-D	4.81E-05	5.35E-05	1.53E-05
Chlorpyrifos	3.08E-06	3.49E-06	9.82E-07
Diazinon	3.95E-06	4.48E-06	1.26E-06
Dichlobenil	4.52E-06	5.13E-06	1.44E-06
Malathion	4.33E-06	4.91E-06	1.38E-06
MCP	4.81E-05	5.35E-05	1.53E-05
Pentachlorophenol	9.05E-06	1.03E-05	2.88E-06
Prometon	4.52E-06	5.13E-06	1.44E-06
Triclopyr	4.81E-05	5.35E-05	1.53E-05

Notes:

nc – not computed

“–”, no data reported for target analyte

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

Table 25. Pollutant load (pounds) for qualifying sampled storm events at LDR.

Parameter	Storm Event Pollutant Loads (pounds)						Baseflow Poll. Load (Pounds)
	10/22/10	11/29/10	12/6/10	3/24/11	5/24/11	7/12/11	1/26/11
Conventionals							
Total Suspended Solids	8.28E-01	4.75E+00	7.77E+00	1.55E+00	6.28E+00	8.09E-02	3.14E-02
Turbidity	nc	nc	nc	nc	nc	nc	nc
Conductivity	nc	nc	nc	nc	nc	nc	nc
Chloride	1.80E-04	3.57E-03	9.75E-04	7.39E-05	1.45E-04	3.46E-05	1.55E-04
Biochemical Oxygen Demand	--	3.91E-01	-	-	--	--	6.28E-02
Hardness, Calc	1.48E+00	1.33E+01	4.57E+00	8.43E-01	2.22E+00	1.07E-01	1.21E+00
Methylene Blue Act. Substance	1.10E-03	4.89E-03	2.81E-03	6.67E-04	1.25E-03	1.50E-03	7.85E-04
Nutrients							
Nitrite + Nitrate Nitrogen	8.08E-02	1.23E+00	3.04E-01	9.48E-04	4.59E-02	1.13E-02	4.49E-02
Total Kjeldahl Nitrogen	3.04E-02	2.89E-01	2.04E-01	4.13E-02	1.28E-01	1.05E-02	3.14E-03
Total Phosphorus	5.30E-03	3.56E-02	3.90E-02	5.32E-03	2.34E-02	1.46E-03	5.78E-04
Orthophosphate Phosphorus	2.39E-03	1.89E-02	1.97E-02	1.22E-03	6.05E-03	7.51E-04	5.76E-04
Metals							
Cadmium, Dissolved	2.20E-06	9.78E-06	5.63E-06	1.33E-06	2.50E-06	1.63E-07	1.57E-06
Cadmium, Total	2.20E-06	9.78E-06	1.27E-05	1.33E-06	1.10E-05	3.46E-07	1.57E-06
Calcium, Total	4.35E-01	3.52E+00	1.24E+00	2.17E-01	5.71E-01	2.98E-02	3.28E-01
Copper, Dissolved	1.59E-04	6.76E-04	5.56E-04	8.36E-05	2.16E-04	3.28E-05	6.28E-05
Copper, Total	2.39E-04	1.07E-03	1.04E-03	2.03E-04	7.54E-04	4.26E-05	7.54E-05
Lead, Dissolved	4.40E-06	5.51E-05	4.55E-05	7.70E-06	1.90E-05	1.17E-06	3.14E-06
Lead, Total	6.83E-05	5.07E-04	1.20E-03	1.93E-04	8.99E-04	8.74E-06	8.80E-06
Magnesium, Total	9.60E-02	1.11E+00	3.60E-01	7.29E-02	1.94E-01	7.90E-03	9.30E-02
Mercury, Dissolved, CVAA	2.20E-06	-	-	-	--	--	--
Mercury, Total,	2.20E-06	-	-	-	--	--	--
Zinc, Dissolved	4.84E-04	4.36E-03	2.47E-03	1.90E-04	1.84E-03	5.66E-05	1.72E-04
Zinc, Total	7.42E-04	6.18E-03	4.37E-03	6.59E-04	4.49E-03	7.57E-05	3.51E-04
Organics							
PAHs							
Acenaphthene	4.18E-07	1.87E-06	1.13E-06	2.56E-07	5.00E-07	3.07E-08	2.95E-07
Acenaphthylene	4.18E-07	1.87E-06	1.13E-06	2.56E-07	5.00E-07	3.07E-08	2.95E-07
Anthracene	4.18E-07	1.87E-06	1.13E-06	1.09E-06	1.90E-06	3.07E-08	2.95E-07
Benzo(a)anthracene	1.96E-06	9.52E-05	3.20E-05	1.42E-05	3.64E-05	1.33E-07	2.95E-07
Benzo(a)pyrene	3.51E-06	1.09E-04	4.42E-05	1.94E-05	5.33E-05	2.50E-07	2.95E-07
Benzo(b,j,k)fluoranthene	6.11E-06	2.14E-04	9.93E-05	4.20E-05	1.16E-04	6.48E-07	2.95E-07

Table 25. Pollutant load (pounds) for qualifying sampled storm events at LDR.

Parameter	Storm Event Pollutant Loads (pounds)						Baseflow Poll. Load (Pounds)
	10/22/10	11/29/10	12/6/10	3/24/11	5/24/11	7/12/11	1/26/11
PAHs (cont.)							
Benzo(g,h,i)perylene	2.55E-06	8.03E-05	4.13E-05	1.74E-05	4.45E-05	2.71E-07	2.95E-07
Chrysene	4.17E-06	1.26E-04	7.02E-05	2.52E-05	6.37E-05	4.18E-07	2.95E-07
Dibenzo(a,h)anthracene	4.18E-07	1.87E-06	1.13E-06	2.12E-06	1.19E-05	3.07E-08	2.95E-07
Fluoranthene	9.78E-06	2.91E-04	1.67E-04	5.32E-05	1.33E-04	9.85E-07	1.01E-06
Fluorene	4.18E-07	1.87E-06	1.13E-06	8.85E-07	5.00E-07	3.07E-08	2.95E-07
Indeno(1,2,3-Cd)Pyrene	2.07E-06	7.39E-05	3.39E-05	1.37E-05	3.64E-05	2.13E-07	2.95E-07
2-Methylnaphthalene	4.18E-07	1.87E-06	1.13E-06	2.56E-07	5.00E-07	3.07E-08	2.95E-07
Naphthalene	4.18E-07	3.49E-06	4.57E-06	-3.74E-07 ¹	5.00E-07	3.07E-08	1.13E-06
Phenanthrene	2.02E-06	5.13E-05	3.71E-05	1.93E-05	2.75E-05	4.04E-07	2.95E-07
Pyrene	6.52E-06	2.30E-04	1.24E-04	4.52E-05	1.15E-04	6.00E-07	7.54E-07
Phthalates							
Benzyl Butyl Phthalate	1.10E-05	9.55E-06	3.48E-05	1.30E-06	2.50E-06	1.10E-06	1.48E-06
Bis(2-Ethylhexyl)Phthalate	2.20E-05	1.05E-04	8.84E-05	2.06E-05	2.19E-05	3.23E-06	7.54E-07
Diethyl Phthalate	6.75E-06	-2.74E-05 ¹	3.39E-05	1.13E-05	2.96E-05	2.86E-06	3.01E-05
Dimethyl Phthalate	1.06E-06	4.69E-06	2.82E-06	2.35E-06	1.25E-06	7.83E-08	7.54E-07
Di-N-Butyl Phthalate	1.16E-05	2.03E-05	3.79E-05	7.63E-06	5.98E-06	5.53E-07	7.54E-07
Di-N-Octyl Phthalate	1.06E-06	4.69E-06	2.82E-06	6.40E-07	1.25E-06	7.83E-08	7.54E-07
Pesticides							
2,4-D	2.20E-05	9.42E-05	5.51E-05	1.33E-05	2.50E-05	1.60E-06	1.57E-05
Chlorpyrifos	1.41E-06	6.26E-06	3.73E-06	8.54E-07	1.70E-06	1.04E-07	1.01E-06
Diazinon	1.81E-06	8.02E-06	4.74E-06	1.09E-06	2.15E-06	1.34E-07	1.29E-06
Dichlobenil	2.07E-06	9.55E-06	5.54E-06	1.30E-06	2.50E-06	1.53E-07	1.48E-06
Malathion	1.98E-06	9.16E-06	5.31E-06	1.25E-06	2.40E-06	1.47E-07	1.41E-06
MCP	2.20E-05	9.42E-05	5.51E-05	1.33E-05	2.50E-05	1.60E-06	1.57E-05
Pentachlorophenol	4.18E-06	1.87E-05	1.13E-05	2.56E-06	5.00E-06	2.57E-06	2.95E-06
Prometon	2.07E-06	9.55E-06	5.54E-06	1.30E-06	2.50E-06	1.53E-07	1.48E-06
Triclopyr	2.20E-05	9.42E-05	5.51E-05	1.33E-05	2.50E-05	1.60E-06	1.57E-05

Notes:

nc – not computed

“–”, no data reported for target analyte

¹ Negative pollutant load calculations resulted due to higher pollutant concentrations in the base flow sample than the storm event sample

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 COM.

Parameter	Sampling Period Pollutant Loads (pounds)		
	Wet Season (Oct – Apr)	Dry Season (May – Sept)	Annual
Conventionals			
Total Suspended Solids	8.06E+03	1.48E+03	9.54E+03
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	1.41E+00	2.59E-01	1.67E+00
Biochemical Oxygen Demand	2.71E+02	4.98E+01	3.21E+02
Hardness, Calc	1.41E+03	2.59E+02	1.67E+03
Methylene Blue Act. Substance	1.27E+00	2.34E-01	1.51E+00
Nutrients			
Nitrite + Nitrate Nitrogen	4.32E+00	7.95E-01	5.12E+00
Total Kjeldahl Nitrogen	5.95E+01	1.09E+01	7.04E+01
Total Phosphorus	1.32E+01	2.42E+00	1.56E+01
Orthophosphate Phosphorus	7.83E-01	1.44E-01	9.27E-01
Metals			
Cadmium, Dissolved	1.96E-03	3.61E-04	2.32E-03
Cadmium, Total	1.10E-02	2.01E-03	1.30E-02
Calcium, Total	3.16E+02	5.82E+01	3.75E+02
Copper, Dissolved	1.61E-01	2.95E-02	1.90E-01
Copper, Total	1.16E+00	2.14E-01	1.38E+00
Lead, Dissolved	1.06E-02	1.94E-03	1.25E-02
Lead, Total	1.22E+00	2.24E-01	1.44E+00
Magnesium, Total	1.51E+02	2.77E+01	1.79E+02
Mercury, Dissolved, CVAA	1.30E-03	2.39E-04	1.54E-03
Mercury, Total,	1.30E-03	2.39E-04	1.54E-03
Zinc, Dissolved	5.74E-01	1.06E-01	6.80E-01
Zinc, Total	4.84E+00	8.90E-01	5.73E+00
Organics			
PAHs			
Acenaphthene	2.48E-04	4.56E-05	2.94E-04
Acenaphthylene	2.48E-04	4.56E-05	2.94E-04
Anthracene	2.48E-04	4.56E-05	2.94E-04
Benzo(a)anthracene	6.64E-04	1.22E-04	7.86E-04
Benzo(a)pyrene	4.43E-04	8.14E-05	5.24E-04
Benzo(b,j,k)fluoranthene	4.86E-04	8.94E-05	5.76E-04
Benzo(g,h,i)perylene	1.02E-03	1.87E-04	1.20E-03
Chrysene	3.26E-03	6.00E-04	3.86E-03
Dibenzo(a,h)anthracene	2.48E-04	4.56E-05	2.94E-04
Fluoranthene	4.29E-03	7.89E-04	5.08E-03
Fluorene	2.48E-04	4.56E-05	2.94E-04
Indeno(1,2,3-Cd)Pyrene	2.48E-04	4.56E-05	2.94E-04
2-Methylnaphthalene	2.38E-03	4.38E-04	2.82E-03
Naphthalene	2.73E-03	5.02E-04	3.23E-03
Phenanthrene	4.32E-03	7.95E-04	5.12E-03
Pyrene	7.19E-03	1.32E-03	8.52E-03
Phthalates			
Benzyl Butyl Phthalate	9.89E-03	1.82E-03	1.17E-02
Bis(2-Ethylhexyl)Phthalate	9.75E-02	1.79E-02	1.15E-01
Diethyl Phthalate	5.39E-03	9.91E-04	6.38E-03

Table 26. Pollutant loads (pounds) by period for COM.

Parameter	Sampling Period Pollutant Loads (pounds)		
	Wet Season (Oct – Apr)	Dry Season (May – Sept)	Annual
Phthalates (cont.)			
Dimethyl Phthalate	1.21E-03	2.23E-04	1.43E-03
Di-N-Butyl Phthalate	8.68E-03	1.59E-03	1.03E-02
Di-N-Octyl Phthalate	1.13E-02	2.08E-03	1.34E-02
Pesticides			
2,4-D	1.29E-02	2.37E-03	1.53E-02
Chlorpyrifos	8.42E-04	1.55E-04	9.97E-04
Diazinon	1.07E-03	1.97E-04	1.27E-03
Dichlobenil	1.24E-03	2.28E-04	1.47E-03
Malathion	1.19E-03	2.18E-04	1.41E-03
MCP	1.29E-02	2.37E-03	1.53E-02
Pentachlorophenol	3.67E-03	6.74E-04	4.34E-03
Prometon	1.24E-03	2.28E-04	1.47E-03
Triclopyr	1.29E-02	2.37E-03	1.53E-02

Notes:

nc – not computed

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

Table 27. Pollutant loads (pounds) by period for HDR.

Parameter	Sampling Period Pollutant Loads (pounds)		
	Wet Season (Oct – Apr)	Dry Season (May – Sept)	Annual
Conventionals			
Total Suspended Solids	3.01E+03	4.36E+02	3.44E+03
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	7.57E-03	1.10E-03	8.67E-03
Biochemical Oxygen Demand	1.23E+02	1.78E+01	1.41E+02
Hardness, Calc	2.91E+02	4.22E+01	3.33E+02
Methylene Blue Act. Substance	2.14E-01	3.10E-02	2.45E-01
Nutrients			
Nitrite + Nitrate Nitrogen	1.42E+00	2.06E-01	1.62E+00
Total Kjeldahl Nitrogen	2.71E+01	3.93E+00	3.10E+01
Total Phosphorus	5.54E+00	8.04E-01	6.34E+00
Orthophosphate Phosphorus	4.12E-01	5.98E-02	4.72E-01
Metals			
Cadmium, Dissolved	4.27E-04	6.20E-05	4.89E-04
Cadmium, Total	4.89E-03	7.09E-04	5.59E-03
Calcium, Total	6.45E+01	9.35E+00	7.38E+01
Copper, Dissolved	1.90E-02	2.76E-03	2.18E-02
Copper, Total	4.25E-01	6.17E-02	4.87E-01
Lead, Dissolved	1.37E-03	1.99E-04	1.57E-03
Lead, Total	3.46E-01	5.01E-02	3.96E-01
Magnesium, Total	3.16E+01	4.59E+00	3.62E+01
Mercury, Dissolved, CVAA	4.27E-04	6.20E-05	4.89E-04
Mercury, Total,	4.27E-04	6.20E-05	4.89E-04
Zinc, Dissolved	4.76E-02	6.91E-03	5.46E-02
Zinc, Total	1.39E+00	2.02E-01	1.59E+00
Organics			
PAHs			
Acenaphthene	8.04E-05	1.17E-05	9.20E-05
Acenaphthylene	8.04E-05	1.17E-05	9.20E-05
Anthracene	5.45E-04	7.91E-05	6.24E-04
Benzo(a)anthracene	1.85E-03	2.69E-04	2.12E-03
Benzo(a)pyrene	2.39E-03	3.47E-04	2.74E-03
Benzo(b,j,k)fluoranthene	4.36E-03	6.32E-04	4.99E-03
Benzo(g,h,i)perylene	1.46E-03	2.12E-04	1.67E-03
Chrysene	2.61E-03	3.79E-04	2.99E-03
Dibenzo(a,h)anthracene	1.20E-04	1.75E-05	1.38E-04
Fluoranthene	6.18E-03	8.97E-04	7.08E-03
Fluorene	3.35E-04	4.87E-05	3.84E-04
Indeno(1,2,3-Cd)Pyrene	1.16E-03	1.69E-04	1.33E-03
2-Methylnaphthalene	3.40E-04	4.93E-05	3.89E-04
Naphthalene	1.77E-04	2.57E-05	2.02E-04
Phenanthrene	3.98E-03	5.77E-04	4.55E-03
Pyrene	4.33E-03	6.29E-04	4.96E-03
Phthalates			
Benzyl Butyl Phthalate	8.26E-04	1.20E-04	9.46E-04
Bis(2-Ethylhexyl)Phthalate	3.13E-02	4.55E-03	3.59E-02
Diethyl Phthalate	1.24E-03	1.80E-04	1.42E-03

Table 27. Pollutant loads (pounds) by period for HDR.

Parameter	Sampling Period Pollutant Loads (pounds)		
	Wet Season (Oct – Apr)	Dry Season (May – Sept)	Annual
Phthalates (cont.)			
Dimethyl Phthalate	2.05E-04	2.98E-05	2.35E-04
Di-N-Butyl Phthalate	9.61E-04	1.40E-04	1.10E-03
Di-N-Octyl Phthalate	7.31E-04	1.06E-04	8.37E-04
Pesticides			
2,4-D	4.27E-03	6.19E-04	4.89E-03
Chlorpyrifos	2.74E-04	3.97E-05	3.13E-04
Diazinon	3.50E-04	5.09E-05	4.01E-04
Dichlobenil	4.02E-04	5.83E-05	4.60E-04
Malathion	3.85E-04	5.58E-05	4.41E-04
MCP	4.27E-03	6.19E-04	4.89E-03
Pentachlorophenol	8.04E-04	1.17E-04	9.20E-04
Prometon	4.02E-04	5.83E-05	4.60E-04
Triclopyr	4.27E-03	6.19E-04	4.89E-03

Notes:

nc – not computed

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

Table 28. Storm and base flow pollutant loads (pounds) by period for LDR.

Parameter	Sampling Period Pollutant Loads (pounds)								
	Wet Season (Oct – Apr)			Dry Season (May – Sept)			Annual		
	Storm Flow	Base Flow	Total	Storm Flow	Base Flow	Total	Storm Flow	Base Flow	Total
Conventionals									
Total Suspended Solids	9.42E+02	3.12E+00	9.45E+02	7.30E+01	5.41E-01	7.36E+01	1.02E+03	3.66E+00	1.02E+03
Turbidity	nc	nc	nc	nc	nc	nc	nc	nc	nc
Conductivity	nc	nc	nc	nc	nc	nc	nc	nc	nc
Chloride	1.61E-01	1.53E-02	1.77E-01	1.25E-02	2.66E-03	1.52E-02	1.74E-01	1.80E-02	1.92E-01
Biochemical Oxygen Demand	6.05E+00	6.24E+00	1.23E+01	4.69E-01	1.08E+00	1.55E+00	6.52E+00	7.32E+00	1.38E+01
Hardness, Calc	7.61E+02	1.20E+02	8.80E+02	5.90E+01	2.08E+01	7.97E+01	8.19E+02	1.41E+02	9.60E+02
Methylene Blue Act. Substance	1.61E+00	7.80E-02	1.69E+00	1.25E-01	1.35E-02	1.38E-01	1.73E+00	9.15E-02	1.82E+00
Nutrients									
Nitrite + Nitrate Nitrogen	5.25E+01	4.45E+00	5.70E+01	4.07E+00	7.72E-01	4.84E+00	5.66E+01	5.23E+00	6.18E+01
Total Kjeldahl Nitrogen	3.34E+01	3.12E-01	3.37E+01	2.59E+00	5.41E-02	2.64E+00	3.60E+01	3.66E-01	3.64E+01
Total Phosphorus	5.33E+00	5.74E-02	5.39E+00	4.14E-01	9.95E-03	4.23E-01	5.75E+00	6.73E-02	5.82E+00
Orthophosphate Phosphorus	2.35E+00	5.71E-02	2.40E+00	1.82E-01	9.91E-03	1.92E-01	2.53E+00	6.70E-02	2.60E+00
Metals									
Cadmium, Dissolved	8.41E-04	1.56E-04	9.97E-04	6.52E-05	2.70E-05	9.23E-05	9.07E-04	1.83E-04	1.09E-03
Cadmium, Total	1.76E-03	1.56E-04	1.91E-03	1.36E-04	2.70E-05	1.63E-04	1.89E-03	1.83E-04	2.08E-03
Calcium, Total	2.03E+02	3.27E+01	2.36E+02	1.58E+01	5.67E+00	2.14E+01	2.19E+02	3.83E+01	2.58E+02
Copper, Dissolved	8.57E-02	6.24E-03	9.20E-02	6.65E-03	1.08E-03	7.73E-03	9.24E-02	7.32E-03	9.97E-02
Copper, Total	1.60E-01	7.48E-03	1.67E-01	1.24E-02	1.30E-03	1.37E-02	1.72E-01	8.78E-03	1.81E-01
Lead, Dissolved	5.66E-03	3.12E-04	5.97E-03	4.39E-04	5.41E-05	4.93E-04	6.10E-03	3.66E-04	6.47E-03
Lead, Total	1.30E-01	8.73E-04	1.31E-01	1.01E-02	1.51E-04	1.03E-02	1.41E-01	1.02E-03	1.42E-01
Magnesium, Total	6.15E+01	9.23E+00	7.08E+01	4.77E+00	1.60E+00	6.37E+00	6.63E+01	1.08E+01	7.71E+01
Mercury, Dissolved, CVAA	8.41E-04	--	8.41E-04	6.52E-05	--	6.52E-05	9.07E-04	--	9.07E-04
Mercury, Total,	8.41E-04	--	8.41E-04	6.52E-05	--	6.52E-05	9.07E-04	--	9.07E-04
Zinc, Dissolved	3.64E-01	1.70E-02	3.81E-01	2.82E-02	2.95E-03	3.12E-02	3.93E-01	2.00E-02	4.13E-01
Zinc, Total	6.71E-01	3.49E-02	7.05E-01	5.20E-02	6.05E-03	5.80E-02	7.23E-01	4.09E-02	7.63E-01
Organics									
PAHs									
Acenaphthene	1.64E-04	2.93E-05	1.94E-04	1.27E-05	5.08E-06	1.78E-05	1.77E-04	3.44E-05	2.11E-04
Acenaphthylene	1.64E-04	2.93E-05	1.94E-04	1.27E-05	5.08E-06	1.78E-05	1.77E-04	3.44E-05	2.11E-04
Anthracene	2.78E-04	2.93E-05	3.08E-04	2.16E-05	5.08E-06	2.67E-05	3.00E-04	3.44E-05	3.34E-04
Benzo(a)anthracene	6.14E-03	2.93E-05	6.16E-03	4.76E-04	5.08E-06	4.81E-04	6.61E-03	3.44E-05	6.65E-03
Benzo(a)pyrene	8.25E-03	2.93E-05	8.28E-03	6.40E-04	5.08E-06	6.45E-04	8.89E-03	3.44E-05	8.93E-03

Table 28. Storm and base flow pollutant loads (pounds) by period for LDR.

Parameter	Sampling Period Pollutant Loads (pounds)								
	Wet Season (Oct – Apr)			Dry Season (May – Sept)			Annual		
	Storm Flow	Base Flow	Total	Storm Flow	Base Flow	Total	Storm Flow	Base Flow	Total
PAHs (cont.)									
Benzo(b,j,k)fluoranthene	1.77E-02	2.93E-05	1.77E-02	1.37E-03	5.08E-06	1.37E-03	1.90E-02	3.44E-05	1.91E-02
Benzo(g,h,i)perylene	6.97E-03	2.93E-05	7.00E-03	5.41E-04	5.08E-06	5.46E-04	7.51E-03	3.44E-05	7.55E-03
Chrysene	1.08E-02	2.93E-05	1.08E-02	8.35E-04	5.08E-06	8.40E-04	1.16E-02	3.44E-05	1.16E-02
Dibenzo(a,h)anthracene	8.44E-04	2.93E-05	8.73E-04	6.54E-05	5.08E-06	7.05E-05	9.09E-04	3.44E-05	9.44E-04
Fluoranthene	2.41E-02	9.98E-05	2.42E-02	1.87E-03	1.73E-05	1.89E-03	2.60E-02	1.17E-04	2.61E-02
Fluorene	1.96E-04	2.93E-05	2.26E-04	1.52E-05	5.08E-06	2.03E-05	2.11E-04	3.44E-05	2.46E-04
Indeno(1,2,3-Cd)Pyrene	5.84E-03	2.93E-05	5.87E-03	4.53E-04	5.08E-06	4.58E-04	6.29E-03	3.44E-05	6.33E-03
2-Methylnaphthalene	1.64E-04	2.93E-05	1.94E-04	1.27E-05	5.08E-06	1.78E-05	1.77E-04	3.44E-05	2.11E-04
Naphthalene	3.23E-04	1.12E-04	4.35E-04	2.50E-05	1.95E-05	4.45E-05	3.48E-04	1.32E-04	4.80E-04
Phenanthrene	5.52E-03	2.93E-05	5.55E-03	4.28E-04	5.08E-06	4.33E-04	5.95E-03	3.44E-05	5.99E-03
Pyrene	1.92E-02	7.48E-05	1.93E-02	1.49E-03	1.30E-05	1.50E-03	2.07E-02	8.78E-05	2.08E-02
Phthalates									
Benzyl Butyl Phthalate	3.18E-03	1.47E-04	3.32E-03	2.46E-04	2.54E-05	2.72E-04	3.42E-03	1.72E-04	3.60E-03
Bis(2-Ethylhexyl)Phthalate	1.16E-02	7.48E-05	1.17E-02	8.98E-04	1.30E-05	9.11E-04	1.25E-02	8.78E-05	1.26E-02
Diethyl Phthalate	5.66E-03	2.99E-03	8.65E-03	4.39E-04	5.18E-04	9.57E-04	6.10E-03	3.51E-03	9.60E-03
Dimethyl Phthalate	4.99E-04	7.48E-05	5.74E-04	3.87E-05	1.30E-05	5.17E-05	5.38E-04	8.78E-05	6.26E-04
Di-N-Butyl Phthalate	3.59E-03	7.48E-05	3.67E-03	2.79E-04	1.30E-05	2.92E-04	3.87E-03	8.78E-05	3.96E-03
Di-N-Octyl Phthalate	4.12E-04	7.48E-05	4.87E-04	3.19E-05	1.30E-05	4.49E-05	4.44E-04	8.78E-05	5.32E-04
Pesticides									
2,4-D	8.26E-03	1.56E-03	9.82E-03	6.40E-04	2.70E-04	9.11E-04	8.90E-03	1.83E-03	1.07E-02
Chlorpyrifos	5.49E-04	9.98E-05	6.49E-04	4.26E-05	1.73E-05	5.99E-05	5.92E-04	1.17E-04	7.09E-04
Diazinon	7.01E-04	1.28E-04	8.29E-04	5.43E-05	2.22E-05	7.65E-05	7.55E-04	1.50E-04	9.05E-04
Dichlobenil	8.20E-04	1.47E-04	9.66E-04	6.35E-05	2.54E-05	8.90E-05	8.83E-04	1.72E-04	1.06E-03
Malathion	7.86E-04	1.40E-04	9.26E-04	6.09E-05	2.43E-05	8.53E-05	8.47E-04	1.65E-04	1.01E-03
MCPP	8.26E-03	1.56E-03	9.82E-03	6.40E-04	2.70E-04	9.11E-04	8.90E-03	1.83E-03	1.07E-02
Pentachlorophenol	3.54E-03	2.93E-04	3.83E-03	2.74E-04	5.08E-05	3.25E-04	3.81E-03	3.44E-04	4.15E-03
Prometon	8.20E-04	1.47E-04	9.66E-04	6.35E-05	2.54E-05	8.90E-05	8.83E-04	1.72E-04	1.06E-03
Triclopyr	8.26E-03	1.56E-03	9.82E-03	6.40E-04	2.70E-04	9.11E-04	8.90E-03	1.83E-03	1.07E-02

Notes:

nc – not computed

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

“–”, no data reported for target analyte

Table 29. Annual pollutant loads (pounds per acre) for WY2011 for all monitoring sites

Parameter	Annual Pollutant Loads for WY2011 (pounds per acre)		
	COM	HDR	LDR
Conventionals			
Total Suspended Solids	1.91E+03	6.56E+02	2.39E+01
Turbidity	nc	nc	nc
Conductivity	nc	nc	nc
Chloride	3.33E-01	1.65E-03	4.49E-03
Biochemical Oxygen Demand	6.42E+01	2.68E+01	3.24E-01
Hardness, Calc	3.34E+02	6.35E+01	2.25E+01
Methylene Blue Act. Substance	3.01E-01	4.66E-02	4.27E-02
Nutrients			
Nitrite + Nitrate Nitrogen	1.02E+00	3.09E-01	1.45E+00
Total Kjeldahl Nitrogen	1.41E+01	5.91E+00	8.52E-01
Total Phosphorus	3.12E+00	1.21E+00	1.36E-01
Orthophosphate Phosphorus	1.85E-01	8.99E-02	6.08E-02
Metals			
Cadmium, Dissolved, ICP-MS	4.65E-04	9.32E-05	2.55E-05
Cadmium, Total, ICP-MS	2.60E-03	1.07E-03	4.86E-05
Calcium, Total, ICP-MS	7.49E+01	1.41E+01	6.03E+00
Copper, Dissolved, ICP-MS	3.80E-02	4.15E-03	2.33E-03
Copper, Total, ICP-MS	2.75E-01	9.28E-02	4.24E-03
Lead, Dissolved, ICP-MS	2.50E-03	2.99E-04	1.51E-04
Lead, Total, ICP-MS	2.88E-01	7.54E-02	3.32E-03
Magnesium, Total, ICP-MS	3.57E+01	6.90E+00	1.81E+00
Mercury, Dissolved, CVAA	3.07E-04	9.32E-05	2.12E-05
Mercury, Total, CVAA	3.07E-04	9.32E-05	2.12E-05
Zinc, Dissolved, ICP-MS	1.36E-01	1.04E-02	9.66E-03
Zinc, Total, ICP-MS	1.15E+00	3.03E-01	1.79E-02
Organics			
PAHs			
Acenaphthene	5.87E-05	1.75E-05	4.95E-06
Acenaphthylene	5.87E-05	1.75E-05	4.95E-06
Anthracene	5.87E-05	1.19E-04	7.83E-06
Benzo(a)anthracene	1.57E-04	4.04E-04	1.56E-04
Benzo(a)pyrene	1.05E-04	5.22E-04	2.09E-04
Benzo(b,j,k)fluoranthene	1.15E-04	9.50E-04	4.46E-04
Benzo(g,h,i)perylene	2.41E-04	3.19E-04	1.77E-04
Chrysene	7.73E-04	5.70E-04	2.73E-04
Dibenzo(a,h)anthracene	5.87E-05	2.63E-05	2.21E-05
Fluoranthene	1.02E-03	1.35E-03	6.12E-04
Fluorene	5.87E-05	7.32E-05	5.76E-06
Indeno(1,2,3-Cd)Pyrene	5.87E-05	2.54E-04	1.48E-04
2-Methylnaphthalene	5.64E-04	7.41E-05	4.95E-06
Naphthalene	6.47E-04	3.86E-05	1.12E-05
Phenanthrene	1.02E-03	8.68E-04	1.40E-04
Pyrene	1.70E-03	9.45E-04	4.87E-04
Phthalates			
Benzyl Butyl Phthalate	2.34E-03	1.80E-04	8.42E-05
Bis(2-Ethylhexyl)Phthalate	2.31E-02	6.84E-03	2.94E-04

Table 29. Annual pollutant loads (pounds per acre) for WY2011 for all monitoring sites

Parameter	Annual Pollutant Loads for WY2011 (pounds per acre)		
	COM	HDR	LDR
Phthalates (cont.)			
Diethyl Phthalate	1.28E-03	2.70E-04	2.25E-04
Dimethyl Phthalate	2.87E-04	4.47E-05	1.47E-05
Di-N-Butyl Phthalate	2.05E-03	2.10E-04	9.28E-05
Di-N-Octyl Phthalate	2.68E-03	1.59E-04	1.25E-05
Pesticides			
2,4-D	3.05E-03	9.31E-04	2.51E-04
Chlorpyrifos	1.99E-04	5.97E-05	1.66E-05
Diazinon	2.54E-04	7.64E-05	2.12E-05
Dichlobenil	2.93E-04	8.76E-05	2.47E-05
Malathion	2.81E-04	8.39E-05	2.37E-05
MCP	3.05E-03	9.31E-04	2.51E-04
Pentachlorophenol	8.68E-04	1.75E-04	9.73E-05
Prometon	2.93E-04	8.76E-05	2.47E-05
Triclopyr	3.05E-03	9.31E-04	2.51E-04

Notes:

nc – not computed

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. Olympia WA. January 17, 2007

Ecology, 2009. Standard Operating Procedure for Calculating Pollutant Loads for Stormwater Discharges, Version 1

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.