Lower Duwamish Waterway Group

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Baseline Surface Water Collection and Chemical Analyses Data Report

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

April 2, 2019

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Acronyms

ALS	ALS-Environmental-Kelso (ALS)
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate
ARI	Analytical Resources, Inc.
Axys	SGS Axys Analytical Services, Ltd.
BEHP	bis(2-ethylhexyl)phthalate
Brooks	Brooks Applied Labs
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CSM	conceptual site model
CV-AFS	cold vapor-atomic fluorescence spectrometry
DCM	dichloromethane
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
DOC	dissolved organic carbon
DQO	data quality objective
ECD	electron capture detector
EPA	US Environmental Protection Agency
GC	gas chromatography
HG	hydride generation
HPLC	high-performance liquid chromatography
HRGC	high-resolution gas chromatography
HRMS	high-resolution mass spectrometry
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran

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ICP	inductively coupled plasma
ID	identification
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
MS	mass spectrometry
NOAA	National Oceanic and Atmospheric Administration
NPD	nitrogen-phosphorus detector
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
ppt	parts per thousand
PRC	performance reference compound
QAPP	quality assurance project plan
RL	reporting limit
RM	river mile
SIM	select ion monitoring
SM	Standard Method
SVOC	semivolatile organic compound
TBT	tributyltin
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TOC	total organic carbon
TS	thermospray
TSS	total suspended solids
USGS	US Geological Survey

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1   Introduction

This data report presents the results of the baseline chemical analyses of surface water samples and passive samplers collected from the Lower Duwamish Waterway (LDW) from August 2017 to August 2018. These data were collected as required by the third amendment to the Administrative Order on Consent (AOC), (EPA 2016) (EPA 2016) (EPA 2016) (EPA 2016) (EPA 2016) as outlined in the *Pre-Design Studies Work Plan* (Windward and Integral 2017) (hereafter referred to as the Work Plan).

Data quality objectives (DQOs) for the collection of these samples were presented in the Work Plan and in the surface water quality assurance project plan (QAPP) (Windward 2017). The objective of the surface water study, per the third amendment to the AOC (EPA 2016), was to collect and analyze surface water samples to assess progress toward applicable or relevant and appropriate requirements (ARARs) for water quality and establish baseline concentrations to be used to assess trends in polychlorinated biphenyl (PCB) concentrations as sediment remediation and source control continue.

The collection and analysis of surface water samples was conducted in accordance with the QAPP, which included details regarding project organization, sampling design, analytical methods, and data validation (Windward 2017). The QAPP was approved by the US Environmental Protection Agency (EPA) on August 2, 2017, and an addendum to the QAPP describing changes to the analyte list and criteria for one of the sampling events was approved by EPA on March 2, 2108 (Windward 2018a). In addition to presenting the data collected as part of this effort, this surface water data report discusses any deviations from the QAPP.

The remainder of this data report is organized into the following sections:

- Section 2 – Field Collection Methods and Sampling Conditions
- Section 3 – Analytical Methods
- Section 4 – Results of Chemical Analyses
- Section 5 – References

The main text is supported by the following appendices:

- Appendix A – Field Notes and COCs
- Appendix B – *In Situ* Water Quality Profiles
- Appendix C – Sampling Condition Summaries
- Appendix D – Data Tables (complete results for all samples in Excel)
- Appendix E – Laboratory Reports and Data Validation Report
- Appendix F – Surface Water Analyte Memorandum
- Appendix G – Passive Sampler Calculations

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2 Field Collection Methods and Sampling Conditions

The field methods used during the surface water composite-grab[1] and passive sampling efforts are summarized in the following sections. Section 2.1 presents the sampling locations and describes the methods used in the field to collect samples, Section 2.2 describes field sampling conditions, Section 2.3 describes sample identification, and Section 2.4 describes field deviations from the QAPP. All notes were recorded in field notebooks, which are provided in Appendix A, along with chain of custody forms.

2.1 SAMPLING LOCATIONS AND METHODS

Using a Niskin bottle sampler, composite-grab samples in the LDW were collected from two locations in the center of the navigation channel (i.e., midway between the banks) and from one location midway between the banks in the Green River. In addition, freely dissolved PCB concentrations were determined at two locations in the LDW using polyethylene passive samplers; further details are presented in Table 2-1 and Map 2-1. Methods used are summarized in the following sections, and additional details are described in the QAPP (Windward 2017, 2018a).

Table 2-1. Sampling locations

Sampling Location ID	Sample Type	Location Name	RM	Coordinates[a] Easting (X)	Coordinates[a] Northing (Y)	Sample Depth(s)
SW1	composite-grabs	Kellogg Island	0.75	1267254	207589	1 near-surface and 1 near-bottom per event[b]
SW2	composite-grabs	South Park Bridge	3.3	1274597	196624	1 near-surface and 1 near-bottom per event[b]
SW3	composite-grabs	Green River	10[c]	1287985	177867	1 mid-depth per event[b]
PS1	passive samplers	South Park Bridge	3.3[d]	1274652	196653	near-bottom (15 per event)
PS2	passive samplers	Linear Logistics	1.9[e]	1269066	201789	near-bottom (15 per event)

[a]   North American Datum 1983. Easting/Northing in US Survey feet.

[b]   For the LDW locations (i.e., SW1 and SW2), near-surface samples were collected 1 m below water surface from the center of the navigation channel; near-bottom samples were collected 1 m above sediment surface from the center of the navigation channel. For the Green River location (i.e., SW3), mid-depth samples were collected from midway between the banks.

[c]   The SW3 sampling location is in the Green River upstream of the LDW CERCLA site.

[d]   Passive samplers were deployed along the northern wing wall upstream of the base of South Park Bridge.

[e]   Passive samplers were deployed along Lineage Logistics (former Sea-Freeze Cold Storage) pier dock pilings. This location was used because a permit to attach the passive samplers to the originally selected location (i.e., the 1st Ave South Bridge) could not be obtained. As described in the QAPP (Windward 2017), this alternate location (i.e., the Lineage Logistics pier dock pilings) was identified and approved by EPA prior to deployment of the passive samplers.

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[1] The term "composite-grab" as used throughout this report refers to samples created by compositing equal volumes from four separate individual grabs that were collected approximately one hour apart.

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
EPA – US Environmental Protection Agency

LDW – Lower Duwamish Waterway
QAPP – quality assurance project plan
RM – river mile

2.1.1 Composite-grab samples

Surface water composite-grab samples were generally collected using a 5-L Teflon™-coated Niskin bottle sampler,[2] which was set in the open position and lowered on a line to the targeted depth. A messenger was attached to the line and released so that it mechanically triggered the closure of the Niskin bottle sampler once it had reached the targeted depth. Field duplicate samples were collected with a second Niskin bottle sampler that was deployed side-by-side with the original sampler to ensure that the field duplicate samples were captured at the same time and depth. After the end caps of the sampler had been triggered shut, the sampler was retrieved.

For each sample location and depth, four separate individual grab samples were collected, each approximately one hour apart. These four grab samples were combined to create a composite-grab sample. For each individual grab, the Niskin bottle sampler was hand agitated prior to dispensing individual aliquots into sample bottles in order to maintain a well-mixed sample (e.g., suspending solids in the sample), thereby creating a representative composite. Water from the second, third, and fourth individual grabs was dispensed into the sample containers in the reverse order of the previous sample (e.g., bottle No. 1 to bottle No. 10 for individual grab 1, bottle No. 10 to bottle No. 1 for individual grab 2, bottle No. 1 to bottle No. 10 for individual grab 3, and bottle No. 10 to bottle No. 1 for individual grab 4.) This was done to further ensure the creation of well-mixed composite-grab samples (i.e., that the suspended solids were distributed consistently throughout the bottles).

For each sample location and depth, four conventional water quality profiles were completed, each approximately an hour apart; these profiles corresponded to the four water grabs collected for each composite-grab. *In situ* conventional water quality parameters were taken each second using a multi-parameter water quality meter that was lowered slowly through the water column. The meter recorded conductivity, temperature, dissolved oxygen (DO), pH, and turbidity (Appendix B). *In situ* salinity values were calculated based on measurements recorded by the water quality meter as part of the water column profile. Salinity of the composite-grab samples was calculated

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[2] The QAPP specified that a 5-L Niskin bottle sampler would be used because it would contain sufficient volume to create the composite-grab samples. During several events, a larger Niskin sampler was used (i.e., when a 5-L Niskin was not available); this did not impact the collection procedures. During one event (Storm 1), a 2.5-L Niskin bottle sampler was used at river mile (RM) 10, because the 5-L Niskin broke during collection (see discussion of this field deviation in Section 2.4).

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based on conductivity and temperature analyses in the laboratory (results presented in Section 4.1).[3]

2.1.2 Passive samplers

Passive samplers, which consisted of stainless steel mesh envelopes containing low-density polyethylene strips, were deployed at two locations (PS1 and PS2). The near-bottom placement of the passive samplers was determined based on existing whole-water data and the conceptual site model (CSM) presented in the Work Plan (Windward and Integral 2017), which suggested that the highest PCB concentrations would be expected in the near-bottom water layer during the lower water flows encountered in the dry season. Within-season variability was minimized by using the month-long deployment.

Five passive samplers were attached (approximately 1 ft apart) to each of the three sampling frames at each location to increase the likelihood that nine passive samplers would still be available for analysis at each location at the end of the deployment period.[4] The deployment frames were constructed from PVC pipe and used as the primary structure to suspend the passive samplers in the near-bottom layer of the water column. Two anchor weights were attached across the bottom of each frame to keep the samplers vertical and near the bottom of the water column (Figure 2-1). The loaded frames were deployed from a boat by manually lowering the ropes attached to the frames until the midpoints of the samplers were approximately 1 m above the sediment surface. Once the samplers were at the correct depth, the attached ropes were secured to the fender boards (or pilings) so that the anchor weights did not rest on the sediment surface, thereby minimizing agitation of the sediment (weights were approximately 2 in. above the sediment surface). A multi-parameter data logger was deployed at each location by attaching the data logger to one of the frames at the same depth as the passive samplers to collect *in situ* water quality data (i.e., conductivity, temperature, DO, and pH) for the duration of the sampling period; water quality data measurements were taken every 15 minutes.

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[3] This report does not compare *in situ* salinity to laboratory salinity because of differences in what these measurements represent. The *in situ* salinity data were determined from measurements collected throughout the entire water column, whereas the laboratory salinity analyses were performed on the composite-grab samples, each of which was collected from a single depth.

[4] As described in the QAPP, nine replicate passive samplers per location were targeted for analysis. The six additional passive samplers were deployed in case any samplers were lost during the deployment period.

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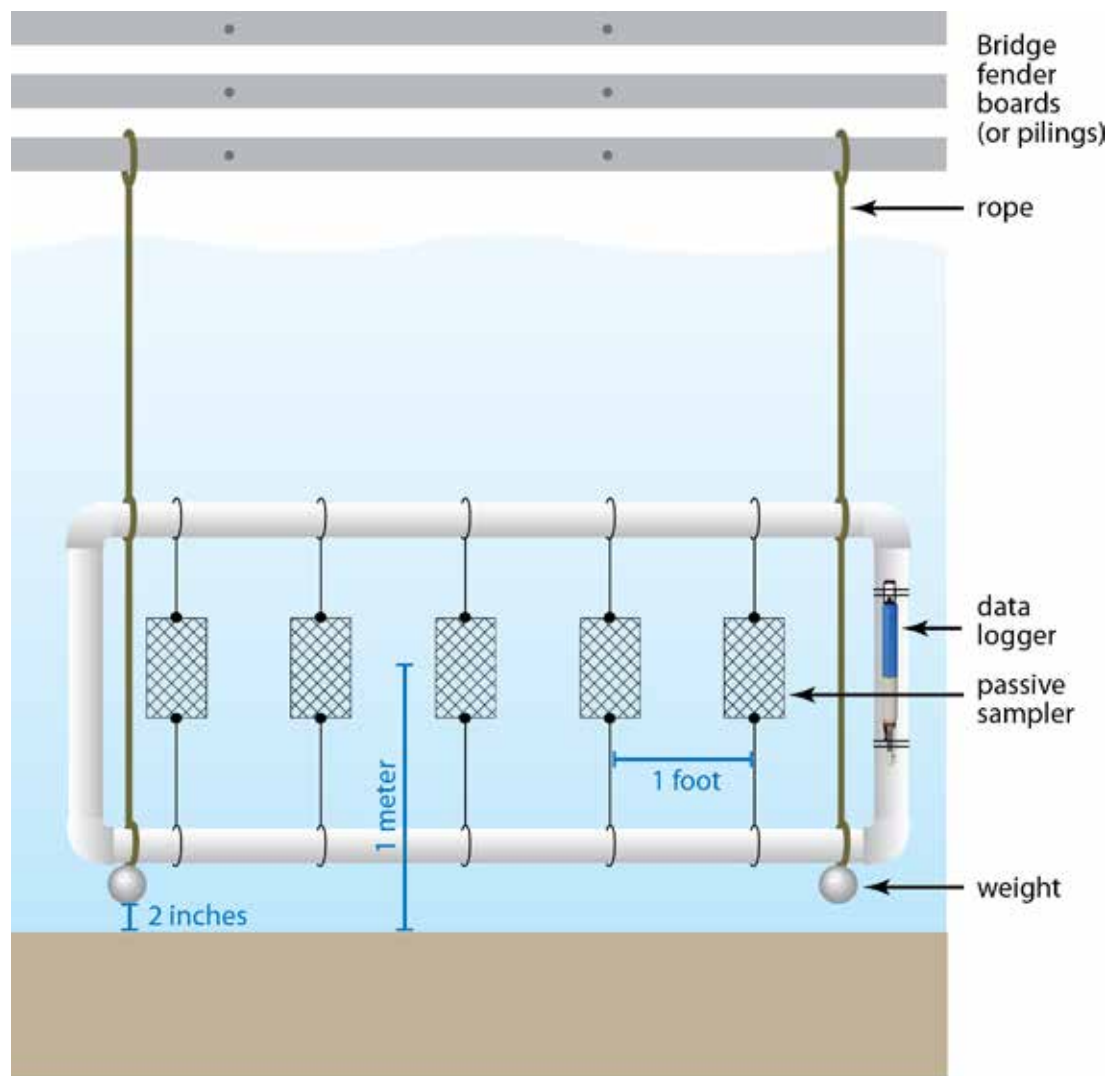
Figure not to scale

Figure 2-1.Design of passive sampler deployment frame

After the one-month deployment period,[5] the passive sampler frames were retrieved from each site. Each passive sampler was detached from the frame but was retained in its mesh envelope. Each mesh envelope containing a passive sampler was wrapped in aluminum foil, double-bagged in resealable plastic bags, and labelled with an appropriate sample identification (ID). The labeled bags containing the passive samplers were placed on ice in a cooler for shipment to SGS Axys Analytical Services, Ltd. (Axys). The multi-parameter data loggers were detached from the frames and water quality data were downloaded off-site; these data are provided in Appendix B.

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[5] Passive sampler frames were deployed for 31 days for the dry baseflow 1 sampling event and 30 days for the dry baseflow 2 sampling event.

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2.2 SAMPLING CONDITIONS

This section describes the sampling conditions for the eight surface water composite-grab sampling events timed to occur during a variety of flow conditions, and the two passive sampler deployments conducted during dry baseflow conditions in August/September 2017 and July/August 2018.

2.2.1 Composite-grab samples

One near-surface composite-grab sample and one near-bottom composite-grab sample were collected from the center of the navigation channel at each LDW location (SW1 at RM 0.75 and SW2 at RM 3.3) during each sampling event. The upstream reference location (SW3 at RM 10) was sampled midway between the banks at the mid-depth of the water column. The exact sample depth varied within and among each sampling event due to tidal fluctuations and flow conditions (total water depths ranged from 3.4 to 7.1 m). A total of 48 composite-grab samples, including the 8 duplicate samples (i.e., 1 per event), were collected over the 8 events.

In order to collect the composite-grab samples as concurrently as possible, three field teams were deployed, each to one of the three sampling locations so that sample collection could occur at approximately the same times. Table 2-2 provides a chronological summary of the sampling conditions for each event.

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Table 2-2. Target and actual composite-grab sampling conditions for surface water sampling events

| Sampling Event | Sampling Date (Time) | Target Conditions Met? | Rainfall[a] | | Dam Release (cfs)[b] | | Tidal Conditions[c] (Type of Tide if Applicable) |
			Target	Actual	Target	Actual	
Dry baseflow 1	08/28/17 (10:29 AM–3:24 PM)	yes	3-day antecedent period without measurable rainfall	*3-day antecedent period:* 0 in.	dry season average (e.g., 200–600 cfs)	325 cfs	high tide of 8.50 ft at 11:12 AM (neap)
Storm 1[d]	09/19/17 (10:08 AM–3:45 PM)	yes	≥ 0.25 in. in 24-hour period with 48-hour antecedent period without heavy rainfall[e]	*48-hour antecedent period:* 0.11 in. from 6:30 PM on September 16 through 6:30 PM on September 18 (i.e., the start of storm)[e] *24-hour rainfall:* 0.35 in. recorded during the 24 hours ending at the completion of sampling (3:45 PM on September 18 to 3:45 PM on September 19)	without significant dam release (< 2,000 cfs)	319 cfs	low tide of 0.18 ft at 11:03 AM
Storm 2[d]	10/19/17 (8:06 AM–12:39 PM)	yes	≥ 0.50 in. in 24-hour period with 48-hour antecedent period without heavy rainfall[e]	*48-hour antecedent period*: 0.06 in. from 10:00 AM on October 16 through 10:00 AM on October 18 (i.e., the start of storm)[e] *24-hour rainfall:* 1.43 in. recorded during the 24 hours ending at the completion of sampling (12:30 PM on October 18 to 12:30 PM on October 19)	without significant dam release (< 2,000 cfs)	726–941 cfs	low tide of 3.06 ft at 11:30 AM
Wet baseflow 1	02/22/18 (8:08 AM–1:10 PM)	yes	3-day antecedent period without measurable rainfall	*3-day antecedent period:* 0.05 in.[f]	wet season average (e.g., 800–1,200 cfs)	1106–1257 cfs	high tide of 11.15 ft at 9:11 AM (neap)
Storm 3[g]	03/08/18 (10:51 AM–2:50 PM)	yes	≥ 0.25 in. in 24-hour period with 48-hour antecedent period (immediately preceding the 24-hour storm period) without heavy rainfall[e]	*48-hour antecedent period*: no measurable rainfall within the 48-hour antecedent period *24-hour rainfall:* 0.50 in. recorded during the 24-hour storm period (10:00 PM on March 7 to 10:00 PM on March 8); of this rainfall, 0.26 in. fell before and during sample collection.	without significant dam release (< 2,000 cfs)	515 cfs	ebbing between high tide of 10.06 ft at 9:09 AM and low tide of 1.50 ft at 4:02 PM
Wet baseflow 2	04/03/18 (6:35 AM–10:18 AM)	yes	3-day antecedent period without measurable rainfall	*3-day antecedent period*: 0 in.	wet season average (e.g., 800–1,200 cfs)	837 cfs	high tide of 10.81 ft at 7:25 AM (spring)

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Sampling Event	Sampling Date (Time)	Target Conditions Met?	Rainfall[a]		Dam Release (cfs)[b]		Tidal Conditions[c] (Type of Tide if Applicable)
			Target	Actual	Target	Actual	
Storm 4 [d]	04/07/18 (12:10 PM–3:50 PM)	yes	≥ 0.50 in. in 24-hour period (no antecedent condition requirements)	*24-hour rainfall:* 0.95 in. recorded during the 24-hour storm period (from 2:00 AM on April 7 to 2:00 AM on April 8); of this rainfall, 0.76 in. fell before and during sample collection.	with significant dam release (> 2,000 cfs)	1930 cfs[h]	ebbing between high tide 8.39 ft at 10:07 AM and low tide of 1.17 ft at 5:00 PM
Dry baseflow 2	07/30/18 (5:42 AM–9:05 AM)	yes	3-day antecedent period without measurable rainfall	*3-day antecedent period:* 0 in.	dry season average (e.g., 200–600 cfs)	260–270 cfs	high tide of 9.09 ft at 6:43 AM (spring)

[a] Forecasted rainfall was based on local rainfall projections from the NOAA weather website. Rainfall prior to sampling (i.e., the antecedent period) was based on measurements taken at the Hamm Creek gauge (HAU2).

[b] Dam releases were measured at the USGS gauge just below the Howard Hanson Dam (Gauge 12105900). A range of actual dam release rates is presented if the release rate changed over the course of the sampling event.

[c] For baseflow sampling events, the goal was to collect the samples at approximately high tide (at RM 0.75 and RM 3.3) and during an ebbing tide (at RM 10). For the storm sampling events, specific tidal cycles were not targeted because of the need to capture specific rainfall levels and dam release conditions.

[d] Samples were generally collected within 12 hours of the period during a storm that was predicted to have the greatest amount of rainfall.

[e] During the antecedent 48-hour period, up to approximately 0.2 in. of rainfall was considered acceptable per the QAPP.

[f] A total of 0.05 in. of precipitation was recorded from 8:45 to 9:15 AM at the Hamm Creek gauge (HAU2) on February 22 as a result of approximately 0.5 in. of snow that fell the night of February 21 and melted in early morning of February 22 .

[g] The target sampling criteria for Storm 3 presented in the QAPP (Windward 2017) were changed in March 2018. The revised sampling criteria specified that sampling would start and be completed during the targeted 24-hour storm and during the forecasted 12-hour window that included the predicted period of peak rainfall intensity (Windward 2018a). To capture initial runoff, sample collection overlapped with or encompassed the forecasted period of peak rainfall intensity, rather than starting after it had passed.

[h] Although the release rate during the sampling period (1,930 cfs) was slightly below the threshold of > 2,000 cfs specified in the QAPP, this rate was sufficiently close to the targeted rate to represent a significant dam release. The possibility of a slight difference from this threshold was discussed with EPA prior to sampling.

cfs – cubic feet per second
EPA – US Environmental Protection Agency
NOAA – National Oceanic and Atmospheric Administration
QAPP – quality assurance project plan
RM – river mile
USGS – US Geological Survey

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The schedule for the eight surface water composite-grab sampling events was designed to meet specific criteria regarding targeted rainfall and dam releases: two dry baseflow conditions, two wet baseflow conditions, and four storms were targeted (Table 2-2). Tidal conditions were also prescribed for the four baseflow sampling events. Prior to each sampling event, a summary of the forecast and anticipated sampling conditions was sent to EPA for approval. Additional details for the schedule and timing of each sampling event are described in the QAPP (Windward 2017, 2018a). Rainfall and dam release target sampling criteria were met during all eight surface water composite-grab sampling events (Table 2-2). Summaries of actual sampling conditions for each surface water composite-grab sampling event were sent to EPA upon completion of each event; finalized condition summaries are presented in Appendix C.

2.2.2 Passive samplers

Passive samplers were deployed for 1 month at two near-bottom locations during dry baseflow conditions in 2017 and 2018. The following describes the two passive sampler deployment periods:

- **Dry baseflow 1** – During the first deployment period (2017), 15 passive sampler replicates were deployed for 31 days at each location on August 25, 2017, and retrieved on September 25, 2017. At the South Park Bridge location, 11 passive sampler replicates were recovered; all 15 replicates were recovered at the Lineage Logistics location.

- **Dry baseflow 2** – During the second deployment period (2018), passive sampler replicates were deployed for 30 days on July 30, 2018, and retrieved on August 29, 2018. All 15 replicates were recovered at each location.

Table 2-3 presents a summary of the rainfall and dam release rate conditions during the passive sampler deployment periods.

Table 2-3. Conditions during passive sampler deployments

Sampling Event	Deployment Period	Total Rainfall During Deployment Period (in.)[a]	Average (Range) of Dam Release Rates (cfs)[b]
Dry baseflow 1	31 days (August 25 to September 25, 2017)	0.92 (the majority of this rain [0.68 in.] fell during a 27-hour period from September 18 to 19, 2017)	299 (242 to 328)
Dry baseflow 2	30 days (July 30 to August 29, 2018)	0.14	264 (244 to 287)

[a]   Total rainfall was based on measurements taken at the Hamm Creek gauge (HAU2).
[b]   Dam releases were measured at the USGS gauge just below the Howard Hanson Dam (Gauge 12105900).
cfs – cubic feet per second
USGS – US Geological Survey

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2.3 SAMPLE IDENTIFICATION

Unique alphanumeric IDs were assigned to each surface water sample (i.e., both composite-grab samples and passive samplers). The sample IDs for the composite-grab samples included the following:

- Project area ID (i.e., LDW or Green River) and two-digit year
- Sample location ID (Table 2-1)
- Sampling event ID (i.e., ST [storm], DB [dry baseflow], or WB [wet baseflow] and a one-digit number)
- Depth horizon identifier (i.e., S [near-surface], M [mid-depth], or B [near-bottom])

For example, the near-surface composite-grab sample collected from RM 0.75 during the first dry baseflow sampling event was identified as LDW17-SW1-DB1-S.

For the passive samplers, the sample ID included the following:

- Project area ID (i.e., LDW) and two-digit year
- Passive sampler location ID (i.e., PS1 or PS2)
- Sampling event ID (i.e., DB1 [dry baseflow 1] or DB2 [dry baseflow 2])
- Two-digit sequential replicate number

For example, the ninth passive sampler replicate collected from the South Park Bridge location in 2017 during dry baseflow was identified as LDW17-PS1-DB1-09.

2.4 FIELD DEVIATIONS FROM THE QAPP

This section presents a summary of field deviations from the QAPP (Windward 2017, 2018a). Deviations are organized by type: those related to the collection of *in situ* conventional water quality data, those related to composite-grab sample collection, those related to filling sample bottles, those related to changes in decontamination procedures, and those related to the passive samplers.

- **Deviations related to the collection of *in situ* conventional water quality data during composite-grab sampling**
  - Dry baseflow 1 – Due to an oversight by the field crew, *in situ* conventional water quality data measurements were collected four times at SW3 (RM 10) at only mid-depth, rather than throughout the entire water column.
  - Wet baseflow 1 – *In situ* conventional water quality data were not collected during collection of the first individual grab at SW3 (RM 10), because the water quality probe was not included in the equipment case provided for the location. A meter was obtained in time for the three remaining individual grabs.

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These minor deviations do not impact the quality of the analytical data because the analytical results are independent of conventional water quality parameters.

- **Deviations related to composite-grab sample collection**
  - Dry baseflow 1 – Eight individual grabs were collected 30 minutes apart (instead of four individual grabs collected 1 hour apart) for the field and duplicate near-bottom composite-grab samples at SW2 (RM 3.3). There was only one 5-L Niskin bottle sampler available, instead of the two planned, so it was necessary to double the number of individual grabs collected to obtain sufficient volume to dispense the aliquots equally between the field and duplicate composite-grab samples.
  - Storm 1 – The 5-L Niskin bottle sampler broke during the collection of the first individual grab. Each of the remaining three individual grabs collected at SW3 (RM 10) were collected using two individual grabs from a 2.5-L Niskin bottle sampler. The two smaller individual grab collections were necessary to meet the target volumes for each remaining individual grab sample.

These minor deviations do not impact the quality of the analytical data because each composite-grab was created from equal volumes.

- **Deviations related to filling sample bottles**
  - Dry baseflow 1 – During sampling, it was discovered that the total suspended solids (TSS) bottles provided by the laboratory were slightly too small to contain the total volume (i.e., 2 L per composite-sample) of water targeted for laboratory analysis. The result was that the fourth aliquot for dry baseflow 1 was slightly smaller than the first three aliquots for samples collected at all three locations. Subsequently, TSS samples collected during the remaining seven surface water sampling events were composited from four 475-mL (instead of four 500-mL) aliquots from each individual grab, for a total volume of 1.9 L.
  - Storm 1 – A dispensing error occurred during collection of the third individual grab for the organochlorine pesticide bottle at SW3 (RM 10). To avoid impacting data quality, the laboratory did not analyze the contents of the organochlorine pesticide bottle.
  - Storm 4 – The aliquot for dissolved metals from the first near-surface individual grab at SW2 (RM 3.3) was inadvertently not dispensed into the bottle. To compensate for the volume shortage, the aliquot for dissolved metals from the second near-surface individual grab was doubled.

These minor deviations do not impact the quality of the analytical data. The dry baseflow 1 TSS data were not impacted because the percent differences among the aliquot volumes were relatively low. The TSS samples from the next event were not impacted because each composite-grab was created from equal

volumes. The storm 1 results were not affected because the semivolatile organic compounds (SVOCs) bottle contained sufficient volume for the analysis of both organochlorine pesticides and SVOCs. The storm 4 sample was not impacted because short-term temporal variability was still represented over a three-hour period.

⌐ **Deviation regarding Niskin bottle sampler decontamination procedures** – Because the rinsate blank sample collected during the dry baseflow 1 sampling event had elevated total organic carbon (TOC) and dissolved organic carbon (DOC) concentrations,[6] a distilled water rinse was added to the Niskin bottle sampler decontamination procedure during each subsequent sampling event (i.e., all events other than dry baseflow 1). This additional rinse ensured that the methanol used to clean the Niskin bottle sampler was fully flushed out prior to collecting rinsate blanks for future events. This change in procedure eliminated the high TOC/DOC concentrations in rinsate blank samples for all subsequent sampling events by reducing the potential high bias of TOC/DOC data due to residual methanol (which contains carbon) in the Niskin bottle sampler. This did not impact the data quality for any of the LDW samples.

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[6] TOC/DOC concentrations in the rinsate blank sample for dry baseflow 1 were elevated (both DOC and TOC were equal to 502 mg/L). Following the change in procedure, subsequent rinsate blank concentrations ranged from non-detect to approximately 4 mg/L.

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3   Analytical Methods

The methods and procedures used to prepare and chemically analyze surface water composite-grab samples and passive samplers are described briefly in this section and in detail in the QAPP (Windward 2017). This section also discusses laboratory deviations from the QAPP.

3.1   ANALYTICAL METHODS

Surface water samples and passive samplers were analyzed by the laboratories according to the methods presented in Table 3-1.

Table 3-1. Analytical methods for surface water and passive sampler analyses

Analyte	Method	Reference	Extraction Solvent	Laboratory
Surface water				
TSS	gravimetric	SM 2540 D-97	na	ARI
TOC	high-temperature combustion	SM 5310 B-00	na	ARI
DOC	high-temperature combustion	SM 5310 B-00	na	ARI
Salinity	ion-selective electrode	SM 2520 B-00	na	ARI
Total and dissolved metals	ICP-MS	EPA 1638	na	Brooks
Inorganic arsenic	HG-AFS	EPA 1632	na	Brooks
Mercury	CV-AFS	EPA 1631E	na	Brooks
TBT	GC/MS	EPA 3510C/ EPA 8270-SIM	0.10% tropolone/DCM (EPA 3660B) hexyl magnesium bromide in diethyl ether derivitization (Krone)	ARI
PAHs	GC/MS	EPA 3510C/ EPA 8270D-SIM	DCM	ARI
Phthalates	GC/MS	EPA 3510C/ EPA 8270D	DCM	ARI
Other SVOCs	GC/MS	EPA 3510C/ EPA 8270D	DCM	ARI
PCB congeners	HRGC/HRMS	EPA 1668c	DCM	Axys
Dioxins/furans	HRGC/HRMS	EPA 1613B	DCM/hexane	Axys
Organochlorine pesticides	GC/ECD dual column	EPA3510C/ EPA 8081B	DCM	ARI
Organophosphorus pesticides	GC/NPD	EPA3510C/ EPA 8141B	DCM	ALS
Carbamate pesticides (Carbaryl)	HPLC/ TS/MS	EPA 3535/ EPA 8321	methanol	ALS

Table 3-1. Analytical methods for surface water and passive sampler analyses

Analyte	Method	Reference	Extraction Solvent	Laboratory
Passive sampler				
PCB congeners	HRGC/ HRMS	EPA 1668c	DCM	Axys

ARI – Analytical Resources, Inc.
Axys – SGS Axys Analytical Services Ltd.
Brooks – Brooks Analytical Labs
CV-AFS – cold vapor-atomic fluorescence spectrometry
DCM – dichloromethane
DOC – dissolved organic carbon
ECD – electron capture data
EPA – US Environmental Protection Agency
GC – gas chromatography
HG – hydride generation
HPLC – high-performance liquid chromatography
HRGC – high-resolution gas chromatography
HRMS –high-resolution mass spectrometry

ICP – inductively coupled plasma
MS – mass spectrometry
na – not applicable
NPD – nitrogen-phosphorus detector
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SIM – select ion monitoring
SM – Standard Method
SVOC – semivolatile organic compound
TBT – tributyltin
TOC – total organic carbon
TS – thermospray
TSS – total suspended solids

Per the QAPP, after the dry baseflow 1, storm 1, and storm 2 sampling events, the analyte list was re-evaluated based on the data from these events in a memorandum to EPA (Appendix F; Windward 2018c). An analyte was considered for deletion if its concentrations in the three 2017 events were below water quality ARARs or it was not detected. Based on these criteria, the analyte list was reduced for the remaining surface water sampling events (i.e., storm 3, storm 4, wet baseflow 1, wet baseflow 2, and dry baseflow 2), as chronologically summarized in Table 3-2. The updates to the analyte list were approved by EPA and documented in an addendum to the QAPP (Windward 2018a). EPA requested that storm 3 and storm 4 samples be analyzed for the full metals list in order to assess metals during dam releases. The wet baseflow 1, wet baseflow 2, and dry baseflow 2 events were analyzed for copper and inorganic arsenic, as described in the QAPP addendum.

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Table 3-2. Summary of analytes and sample counts for surface water sampling events

Analyte	Sample Counts for Baseline Surface Water Sampling Events (in Chronological Order)								
	Dry Baseflow 1	Storm 1	Storm 2	Wet Baseflow 1	Storm 3	Wet Baseflow 2	Storm 4	Dry Baseflow 2	Total Sample Count
	8/28/17	9/19/17	10/19/17	2/22/18	3/8/18	4/3/18	4/7/18	7/30/18	
Metals and organometals (excluding copper and inorganic arsenic)[a]	6	6	6	-	6	-	6	-	30
Copper and inorganic arsenic only	6	6	6	6	6	6	6	6	48
TBT	6	6	6	-	-	-	-	-	18
PAHs[b]	6	6	6	6	6	6	6	6	48
Phthalates (excluding BEHP)[c]	6	6	6	-	-	-	-	-	18
BEHP only	6	6	6	6	6	6	6	6	48
Other SVOCs[d]	6	6	6	-	-	-	-	-	18
PCB congeners[e]	6	6	6	6	6	6	6	6	48
Organochlorine pesticides[f]	6	6	6	-	-	-	-	-	18
Dioxins/furans[g]	6	6	6	-	-	-	-	-	18
Organophosphate pesticides[h] and carbaryl	-	6	-	-	-	-	-	-	6
Conventionals[i]	6	6	6	6	6	6	6	6	48

Note: Sample counts include field duplicates.

[a] Metals and organometals include total metals (antimony, mercury, and thallium) and dissolved metals (arsenic, cadmium, chromium, lead, nickel, selenium, silver, and zinc).

[b] PAHs include acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, and pyrene.

[c] Phthalates include butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, and di-n-butyl phthalate.

[d] SVOCs include 1,2,4,5-tetrachloro-benzene, 1,2-diphenylhydrazine, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 2,4-dinitrophenol, 2,4-dinitrotoluene, 2-chloronaphthalene, 2-chlorophenol, 3,3'-dichlorobenzidine, 4,6-dinitro-o-cresol, 4-chloro-3-methylphenol, benzidine, bis(2-chloroethyl) ether, bis(2-chloroisopropyl) ether, bis(chloromethyl) ether, hexachlorobenzene, hexachloroethane, hexachlorocyclopentadiene, isophorone, n-Nitrosodiethylamine, n-Nitrosodimethylamine, n-Nitroso-di-n-butylamine, n-Nitroso-di-n-propylamine, n-Nitrosodiphenylamine, n-Nitrosopyrrolidine, nitrobenzene, nonylphenol (mixed isomers), pentachlorobenzene, pentachlorophenol, phenol, total dinitrophenols, and total nitrosamines.

[e] PCB congeners include all 209 congeners listed in Appendix C of the surface water QAPP (Windward 2017).

[f] Organochlorine pesticides include 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, dieldrin, alpha-BHC, beta-BHC, gamma-BHC, total chlordane, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, hexachlorocyclohexane-G, methoxychlor, mirex, and toxaphene.

[g] Dioxins/furans include 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF.

[h] Organophosphate pesticides include chlorpyrifos, diazinon, and malathion.

[i] Conventional parameters analyzed by ARI include TSS, DOC, TOC, and salinity. Water quality profile data collected in the field included conductivity, temperature, dissolved oxygen, pH, and turbidity. Water quality profile data are provided in Appendix B.

ARI – Analytical Resources, Inc.	HpCDF – heptachlorodibenzofuran	PeCDF – pentachlorodibenzofuran
BEHP – bis(2-ethylhexyl)phthalate	HxCDD – hexachlorodibenzo-*p*-dioxin	QAPP – quality assurance project plan
BHC – benzene hexachloride	HxCDF – hexachlorodibenzofuran	SVOC – semivolatile organic compound
DDD – dichlorodiphenyldichloroethane	OCDD – octachlorodibenzo-*p*-dioxin	TBT – tributyltin
DDE – dichlorodiphenyldichloroethylene	OCDF – octachlorodibenzofuran	TCDD – tetrachlorodibenzo-p-dioxin
DDT – dichlorodiphenyltrichloroethane	PAH – polycyclic aromatic hydrocarbon	TCDF – tetrachlorodibenzofuran
DOC – dissolved organic carbon	PCB – polychlorinated biphenyl	TOC – total organic carbon
HpCDD – heptachlorodibenzo-*p*-dioxin	PeCDD – pentachlorodibenzo-*p*-dioxin	TSS – total suspended solids

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3.2 LABORATORY DEVIATIONS FROM THE QAPP

Two laboratory deviations occurred relative to the methods outlined in the QAPP (Windward 2017). The first was that a matrix spike/matrix spike duplicate for dry baseflow 1 was not analyzed for SVOCs, polycyclic aromatic hydrocarbons (PAHs), tributyltin (TBT), or organochlorine pesticides. Laboratory control samples (LCSs) were used to assess accuracy for these methods instead. All recoveries were within laboratory control limits. Precision was assessed for SVOCs using an LCS duplicate. No LCS duplicate was analyzed for PAHs, TBT, or organochlorine pesticides due to a laboratory oversight. This deviation did not impact data quality.

The second laboratory deviation occurred during analysis of the dry baseflow 2 passive samplers. One of the passive samplers (LDW18-PS1-DB2-02) was incorrectly loaded onto the instrument, meaning that no results could be reported for this sample. One of the archived passive sampler replicates (LDW18-PS1-DB2-12) was analyzed in its place. The total number of passive samplers analyzed was not impacted.

4   Results of Chemical Analyses

This section summarizes the results of the chemical analyses and data validation of surface water composite-grab samples (Section 4.1) and passive samplers (Section 4.2). The complete chemistry dataset is presented in Appendix D (in Excel).

4.1   CHEMISTRY RESULTS FOR SURFACE WATER COMPOSITE-GRAB SAMPLES

Table 4-1 presents a summary of the surface water composite-grab sample results, including detection frequencies, mean detected concentrations, ranges of detected concentrations, and ranges of reporting limits (RLs) for the non-detected results. In addition, results by sampling event and location are presented in Tables 4-2 through 4-4 for total PCBs, three metals (inorganic arsenic, copper, and mercury), and three PAHs (acenaphthene, fluoranthene, and fluorene) that were detected in the majority of the samples and were not eliminated from the surface water sample analyte list (Table 3-2 and Appendix F). Results for each sampling event and location are also presented for the four conventional parameters analyzed by ARI. (Tables 4-5). Full results are presented in Appendix D.

Table 4-1. Summary of chemistry and conventional parameter results in surface water composite-grab samples for all sampling locations and events

Chemical	Fraction[a]	Unit	Detection Frequency		Detected Results			Calculated Mean[b]	RL or Range of RLs
			Ratio	%	Minimum	Maximum	Mean		
Metals									
Antimony	T	µg/L	12/30	40	0.032	0.273 J	0.18	0.30	0.306–1.02
Arsenic	D	µg/L	30/30	100	0.453	2.10	1.23	1.23	na
Arsenic (inorganic)	T	µg/L	48/48	100	0.451	1.72	1.07	1.07	na
Cadmium	D	µg/L	4/30	13	0.023 J	0.123 J	0.068	0.20	0.003–1.02
Chromium	D	µg/L	6/30	20	0.120	1.22 J	0.503	0.806	0.138–1.91
Copper	D	µg/L	44/48	92	0.279	2.32	0.878	0.875	1.68
Lead	D	µg/L	5/30	17	0.0450	0.121	0.0786	0.173	0.383
Mercury	T	ng/L	21/30	70	0.76	4.17	1.9	1.5	0.85–1.37
Nickel	D	µg/L	23/30	77	0.165	3.24	0.839	0.849	1.76
Selenium	D	µg/L	5/30	17	0.023 J	0.554 J	0.14	0.60	0.028–1.43
Silver	D	µg/L	0/30	0	nd	nd	nd	0.23	0.021–0.536
Thallium	T	µg/L	0/30	0	nd	nd	nd	0.35	0.004–1.02
Zinc	D	µg/L	23/30	77	1.66	14.5	4.38	4.11	3.36–10.2
Organometals									
TBT as ion	T	µg/L	0/18	0	nd	nd	nd	0.0026	0.0052
PAHs									
Acenaphthene	T	µg/L	29/48	60	0.0030 J	0.0090 J	0.0050	0.0050	0.010
Anthracene	T	µg/L	10/48	21	0.0010 J	0.0050 J	0.0021	0.0041	0.0010–0.010
Benzo(a)anthracene	T	µg/L	4/48	8	0.00080 J	0.012	0.0037	0.0049	0.010
Benzo(a)pyrene	T	µg/L	1/48	2	0.0070 J	0.0070 J	na	0.0050	0.010
Benzo(b)fluoranthene	T	µg/L	6/48	13	0.00060 J	0.011	0.0026	0.0047	0.010
Benzo(k)fluoranthene	T	µg/L	1/48	2	0.0050 J	0.0050 J	na	0.0050	0.010
Chrysene	T	µg/L	10/48	21	0.0010 J	0.0070 J	0.0017	0.0043	0.010
Dibenzo(a,h)anthracene	T	µg/L	1/48	2	0.0020 J	0.0020 J	na	0.0049	0.010
Fluoranthene	T	µg/L	33/48	69	0.0020 J	0.010 J	0.0043	0.0043	0.0030–0.010

Chemical	Fraction[a]	Unit	Detection Frequency		Detected Results			Calculated Mean[b]	RL or Range of RLs
			Ratio	%	Minimum	Maximum	Mean		
Fluorene	T	µg/L	25/48	52	0.0020 J	0.0060 J	0.0030	0.0036	0.0020–0.010
Indeno(1,2,3-cd)pyrene	T	µg/L	2/48	4	0.0020 J	0.0020 J	0.0020	0.0049	0.010
Pyrene	T	µg/L	22/48	46	0.0010 J	0.010 J	0.0037	0.0030	0.0010–0.010
cPAHs – mammal[c]	T	µg/L	11/48	23	0.00670 J	0.0121 J	0.00885	0.00554	0.00910
Phthalates									
Bis(2-ethylhexyl)phthalate	T	µg/L	3/48	6	0.5 J	2.0 J	1.2	1.5	3.0
Butyl benzyl phthalate	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Diethyl phthalate	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Dimethyl phthalate	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Di-n-butyl phthalate	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Other SVOCs									
1,2,4,5-Tetrachloro-benzene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
2,2'-oxybis(1-chloro)propane	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
2,4,5-Trichlorophenol	T	µg/L	0/18	0	nd	nd	nd	2.5	5.0
2,4,6-Trichlorophenol	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
2,4-Dichlorophenol	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
2,4-Dimethylphenol	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
2,4-Dinitrophenol	T	µg/L	0/18	0	nd	nd	nd	10.0	20.0
2,4-Dinitrotoluene	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
2,5-Dinitrophenol	T	µg/L	0/18	0	nd	nd	nd	12.5	25.0
2-Chloronaphthalene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
2-Chlorophenol	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
3,3'-Dichlorobenzidine	T	µg/L	0/18	0	nd	nd	nd	2.5	5.0
4,6-Dinitro-o-cresol	T	µg/L	0/18	0	nd	nd	nd	5.00	10.0
4-Chloro-3-methylphenol	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
Azobenzene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Benzidine[d]	T	µg/L	0/13	0	nd	nd	nd	5.00	10.0
bis(2-chloroethyl)ether	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0

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Chemical	Fraction[a]	Unit	Detection Frequency		Detected Results			Calculated Mean[b]	RL or Range of RLs
			Ratio	%	Minimum	Maximum	Mean		
Hexachlorobenzene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Hexachlorocyclopentadiene	T	µg/L	0/18	0	nd	nd	nd	2.5	5.0
Hexachloroethane	T	µg/L	0/18	0	nd	nd	nd	1.0	2.0
Isophorone	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
N-Nitrosodiethylamine	T	µg/L	0/18	0	nd	nd	nd	1.0	2.0
n-Nitrosodimethylamine	T	µg/L	0/18	0	nd	nd	nd	1.5	3.0
N-Nitroso-di-n-butylamine	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
n-Nitroso-di-n-propylamine	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
n-Nitrosodiphenylamine	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
N-Nitrosopyrrolidine	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Nitrobenzene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Nonylphenol (mixed isomers)	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Pentachlorobenzene	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
Pentachlorophenol	T	µg/L	0/18	0	nd	nd	nd	5.00	10.0
Phenol	T	µg/L	0/18	0	nd	nd	nd	0.50	1.0
PCBs									
Total PCB Congeners	T	pg/L	48/48	100	10.52 J	5573 J	937	937	na
Pesticides									
4,4'-DDD	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
4,4'-DDE	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
4,4'-DDT	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Aldrin	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
Dieldrin	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
alpha-BHC	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
beta-BHC	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
gamma-BHC	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
delta-BHC	T	µg/L	2/18	11	0.033 JN	0.049 JN	0.041	0.016	0.025
Carbaryl	T	µg/L	0/6	0	nd	nd	nd	0.010	0.020

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| Chemical | Fraction[a] | Unit | Detection Frequency | | Detected Results | | | Calculated Mean[b] | RL or Range of RLs |
			Ratio	%	Minimum	Maximum	Mean		
alpha-Chlordane	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
beta-Chlordane	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
Total chlordane	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Chlorpyrifos	T	µg/L	0/6	0	nd	nd	nd	0.10	0.20–0.21
Diazinon	T	µg/L	0/6	0	nd	nd	nd	0.10	0.20–0.21
alpha-Endosulfan	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
beta-Endosulfan	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Endosulfan sulfate	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Endrin	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Endrin aldehyde	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Heptachlor	T	µg/L	0/18	0	nd	nd	nd	0.013	0.025
Heptachlor epoxide	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Malathion	T	µg/L	0/6	0	nd	nd	nd	0.10	0.20–0.21
Methoxychlor	T	µg/L	0/18	0	nd	nd	nd	0.125	0.250
Mirex	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
cis-Nonachlor	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
trans-Nonachlor	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Oxychlordane	T	µg/L	0/18	0	nd	nd	nd	0.025	0.050
Toxaphene	T	µg/L	0/18	0	nd	nd	nd	0.625	1.25
Dioxin/furan									
2,3,7,8-TCDD	T	pg/L	0/18	0	nd	nd	nd	0.216	0.248–0.696
1,2,3,7,8-PeCDD	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,4,7,8-HxCDD	T	pg/L	0/18	0	nd	nd	nd	0.221	0.248–0.827
1,2,3,6,7,8-HxCDD	T	pg/L	0/18	0	nd	nd	nd	0.233	0.248–0.827
1,2,3,7,8,9-HxCDD	T	pg/L	0/18	0	nd	nd	nd	0.221	0.248–0.827
1,2,3,4,6,7,8-HpCDD	T	pg/L	8/18	44	1.80 J	9.78 J	4.28	2.80	0.803–9.08
OCDD	T	pg/L	15/18	83	7.45 J	87.5	31.1	26.8	3.44–13.4
2,3,7,8-TCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,7,8-PeCDF	T	pg/L	0/18	0	nd	nd	nd	0.213	0.248–0.629

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Chemical	Fraction[a]	Unit	Detection Frequency		Detected Results			Calculated Mean[b]	RL or Range of RLs
			Ratio	%	Minimum	Maximum	Mean		
2,3,4,7,8-PeCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,4,7,8-HxCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,6,7,8-HxCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,7,8,9-HxCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
2,3,4,6,7,8-HxCDF	T	pg/L	0/18	0	nd	nd	nd	0.209	0.248–0.514
1,2,3,4,6,7,8-HpCDF	T	pg/L	8/18	44	0.407 J	1.91 J	1.02	0.661	0.345–1.56
1,2,3,4,7,8,9-HpCDF	T	pg/L	0/18	0	nd	nd	nd	0.211	0.248–0.550
OCDF	T	pg/L	9/18	50	0.956 J	5.93 J	2.62	1.67	0.514–2.53
Dioxin/furan TEQ – mammal[c]	T	pg/L	18/18	100	0.410 J	0.931 J	0.711	0.711	na
Conventionals									
DOC	D	mg/L	45/48	94	1.05	26.6	2.59	2.52	1.59–3.91
Salinity	T	ppt	45/48	94	0.10	28.7	17	15	0.10
TOC	T	mg/L	45/48	94	1.15 J	26.3	2.83	2.75	1.77–4.19
Total suspended solids	T	mg/L	48/48	100	2.0	29.0	6.6	6.6	na

[a] The fraction for surface water samples is either D (dissolved), which means that the sample was filtered, or T (total), which means that the sample was not filtered.
[b] Mean was calculated using full detected value or one-half the RL for non-detects.
[c] TEQs were calculated using one-half the non-detected value.
[d] Low QC sample recovery resulted in the rejection of benzidine data for 5 of the 18 samples (see Section 4.3).

BHC – benzene hexachloride	HxCDF – hexachlorodibenzofuran	PeCDF – pentachlorodibenzofuran
cPAH – carcinogenic polycyclic aromatic hydrocarbon	J – estimated concentration	RL – reporting limit
D – dissolved (i.e., filtered)	N – tentatively identified	QC – quality control
DDD – dichlorodiphenyldichloroethane	na – not applicable	SVOC – semivolatile organic compound
DDE – dichlorodiphenyldichloroethylene	nd – not detected	T – total (i.e., not filtered)
DDT – dichlorodiphenyltrichloroethane	OCDD – octachlorodibenzo-p-dioxin	TBT – tributyltin
DL – detection limit	OCDF – octachlorodibenzofuran	TCDD – tetrachlorodibenzo-p-dioxin
DOC – dissolved organic carbon	PAH – polycyclic aromatic hydrocarbon	TCDF – tetrachlorodibenzofuran
HpCDD – heptachlorodibenzo-p-dioxin	PCB – polychlorinated biphenyl	TEQ – toxic equivalent
HpCDF – heptachlorodibenzofuran	PeCDD – pentachlorodibenzo-p-dioxin	TOC – total organic carbon
HxCDD – hexachlorodibenzo-p-dioxin		

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Table 4-2. Composite-grab surface water results for total PCBs by location and sampling event

Event Name	Collection Date	Total PCB Congener Results (pg/L)				Green River
		LDW				SW3
		SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		
		Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
Dry baseflow 1	8/28/2017	808.5 J	977.2 J	565.5 J	1,614.9 J/1,498.7 J[a]	19.08 J
Dry baseflow 2	7/30/2018	602.8 J/617.3 J[a]	539.1 J	562.0 J	1,037.9 J	16.62 J
Wet baseflow 1	2/22/2018	90.2 J	188.1 J	21.72 J/35.72 J[a]	353.5 J	49.2 J
Wet baseflow 2	4/3/2018	270.5 J	697.7 J/459.2 J[a]	38.06 J	1,458.9 J	10.52 J
Storm 1 (storm > 0.25 in.)	9/19/2017	1,205.4 J	2,702 J	907.7 J/893.3 J[a]	4,942 J	107.1 J
Storm 2 (storm > 0.5 in.)	10/19/2017	1,077.6 J	4,484 J/5,573 J[a]	257.4 J	1,650.2 J	102.4 J
Storm 3 (storm > 0.25 in.)	3/8/2018	265.3 J	655.8 J	175.7 J	703.0 J/636.2 J[a]	57.77 J
Storm 4 (storm > 0.5 in.)	4/7/2018	1,001.2 J/684.6 J[a]	2,171 J	569.5 J	1,378.3 J	228.9 J

Note: PCB concentrations represent the total fraction.

[a]   Field duplicate result.

J – estimated concentration   PCB – polychlorinated biphenyl
LDW – Lower Duwamish Waterway   RM – river mile

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Table 4-3. Composite-grab surface water results for select metals by location and sampling event

Chemical	Event	Collection Date	Metals Results				Green River
			LDW				Green River
			SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		SW3
			Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
Inorganic arsenic (µg/L)	dry baseflow 1	8/28/2017	1.07	1.34	1.00	1.47/1.45[a]	0.756
	dry baseflow 2	7/30/2018	1.20/1.25[a]	1.45	0.907	1.37	0.993
	wet baseflow 1	2/22/2018	0.694	1.34	0.498/0.466[a]	1.21	0.451
	wet baseflow 2	4/3/2018	0.832	1.35/1.38[a]	0.566	1.38	0.466
	storm1 (storm > 0.25 in.)	9/19/2017	1.17	1.42	1.02/1.07[a]	1.57	0.709
	storm2 (storm > 0.5 in.)	10/19/2017	1.23	1.67/1.72[a]	0.960	1.54	0.791
	storm 3 (storm > 0.25 in.)	3/8/2018	0.839	1.43	0.705	1.25/1.27[a]	0.528
	storm 4 (storm > 0.5 in.)	4/7/2018	0.788/0.837[a]	1.46	0.597	1.46	0.575
Copper (µg/L)	dry baseflow 1	8/28/2017	2.32	0.836 J	1.07 J	0.806 J/0.926 J[a]	0.308
	dry baseflow 2	7/30/2018	0.942 J/1.17 J[a]	1.01 J	1.73	0.968 J	0.350
	wet baseflow 1	2/22/2018	0.784 J	0.582 J	0.648 J/0.624 J[a]	0.612 J	0.403 J
	wet baseflow 2	4/3/2018	0.954 J	1.68 U/1.68 U [a]	1.68 U	1.68 U	0.279
	storm1 (storm > 0.25 in.)	9/19/2017	1.63 J	1.07 J	0.957 J/1.01 J[a]	0.673 J	1.20
	storm2 (storm > 0.5 in.)	10/19/2017	1.43 J	0.601 J/0.586 J[a]	1.06 J	0.643 J	0.820
	storm 3 (storm > 0.25 in.)	3/8/2018	1.06 J	0.788 J	1.05 J	0.598 J/0.733 J[a]	0.438
	storm 4 (storm > 0.5 in.)	4/7/2018	1.17 J/1.09 J[a]	0.573 J	0.898 J	0.586 J	0.642
Mercury (ng/L)[b]	dry baseflow 1	8/28/2017	0.76	1.21	0.95	1.51/1.53[a]	0.81
	storm1 (storm > 0.25 in.)	9/19/2017	1.19 U	1.78	1.26 U/1.37 U[a]	3.14	1.35 U
	storm2 (storm > 0.5 in.)	10/19/2017	1.24	4.17/4.04[a]	1.62	1.55	2.48
	storm 3 (storm > 0.25 in.)	3/8/2018	1.26 U	1.36	1.25 U	0.85 U/0.95 U[a]	1.22 U
	storm 4 (storm > 0.5 in.)	4/7/2018	1.48/1.41[a]	1.53	2.15	1.53	2.62

[a]   Field duplicate result.

[b]   Mercury was not analyzed in samples collected during wet baseflow 1, wet baseflow 2, and dry baseflow 2, as discussed in the surface water analyte memorandum (Appendix F; Windward 2018c).

J – estimated concentration   RM – river mile
LDW – Lower Duwamish Waterway   U – not detected at given concentration

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Table 4-4. Composite-grab surface water results for select PAHs by location and sampling event

Chemical	Event	Collection Date	PAH results				Green River
			LDW				Green River
			SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		SW3
			Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
Acenaph-thene (µg/L)	dry baseflow 1	8/28/2017	0.0080 J	0.0030 J	0.0070 J	0.0070 J/0.0060 J[a]	0.0030 J
	dry baseflow 2	7/30/2018	0.0090 J/0.0090 J[a]	0.010 U	0.0080 J	0.0070 J	0.0040 J
	wet baseflow 1	2/22/2018	0.0060 J	0.0050 J	0.010 U/0.010 U[a]	0.0060 J	0.010 U
	wet baseflow 2	4/3/2018	0.0040 J	0.010 U/0.010 J[a]	0.010 U	0.010 U	0.010 U
	storm 1 (storm > 0.25 in.)	9/19/2017	0.010 U	0.0030 J	0.0030 J/0.0030 J[a]	0.0030 J	0.010 U
	storm 2 (storm > 0.5 in.)	10/19/2017	0.0050 J	0.0040 J/0.0030 J[a]	0.0030 J	0.0050 J	0.010 U
	storm 3 (storm > 0.25 in.)	3/8/2018	0.0060 J	0.010 U	0.0030 J	0.0030 J/0.0040 J[a]	0.010 U
	storm 4 (storm > 0.5 in.)	4/7/2018	0.010 U/0.010 J[a]	0.010 U	0.010 U	0.0040 J	0.010 U
Fluoran-thene (µg/L)	dry baseflow 1	8/28/2017	0.010 U	0.0030 U	0.0060 U	0.0060 U/0.0060 U[a]	0.010 U
	dry baseflow 2	7/30/2018	0.0090 J/0.0080 J[a]	0.0020 J	0.0080 J	0.0060 J	0.010 U
	wet baseflow 1	2/22/2018	0.0040 J	0.0050 J	0.010 J/0.010 U[a]	0.0050 J	0.010 U
	wet baseflow 2	4/3/2018	0.0030 J	0.010 U/0.0020 J[a]	0.010 U	0.010 U	0.010 U
	storm 1 (storm > 0.25 in.)	9/19/2017	0.0060 J	0.0040 J	0.0040 J/0.0040 J[a]	0.0060 J	0.0020 J
	storm 2 (storm > 0.5 in.)	10/19/2017	0.0060 J	0.0040 J/0.0050 J[a]	0.0040 J	0.0040 J	0.0020 J
	storm 3 (storm > 0.25 in.)	3/8/2018	0.0030 J	0.0020 J	0.010 U	0.0020 J/0.0030 J[a]	0.010 U
	storm 4 (storm > 0.5 in.)	4/7/2018	0.0040 J/0.0050 J[a]	0.0020 J	0.0030 J	0.0040 J	0.0020 J

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Chemical	Event	Collection Date	PAH results				
			LDW				Green River
			SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		SW3
			Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
Fluorene (µg/L)	dry baseflow 1	8/28/2017	0.0050 J	0.0020 J	0.0040 J	0.0040 J/0.0040 J[a]	0.010 U
	dry baseflow 2	7/30/2018	0.0060 J/0.0050 J[a]	0.0020 J	0.0050 J	0.0050 J	0.0030 J
	wet baseflow 1	2/22/2018	0.010 U	0.010 U	0.010 U/0.010 U[a]	0.010 U	0.010 U
	wet baseflow 2	4/3/2018	0.0020 J	0.010 U/0.010 U[a]	0.010 U	0.010 U	0.010 U
	storm 1 (storm > 0.25 in.)	9/19/2017	0.010 U	0.0020 J	0.0020 J/0.0020 J[a]	0.0020 J	0.0020 J
	storm 2 (storm > 0.5 in.)	10/19/2017	0.0040 U	0.0020 U/0.0020 U[a]	0.0020 U	0.0030 U	0.010 U
	storm 3 (storm > 0.25 in.)	3/8/2018	0.0030 J	0.0020 J	0.0020 J	0.0020 J/0.0020 J[a]	0.010 U
	storm 4 (storm > 0.5 in.)	4/7/2018	0.0020 J/0.0020 J[a]	0.0020 J	0.010 U	0.010 U	0.010 U

[a]   Field duplicate result.

J – estimated concentration   RM – river mile   U – not detected at given concentration

LDW – Lower Duwamish Waterway

Table 4-5. Composite-grab surface water results for select conventional parameters by location and sampling event

Parameter	Event	Collection Date	Conventional Parameter Results				
			LDW				Green River
			SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		SW3
			Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
DOC (mg/L)	dry baseflow 1	8/28/2017	1.61	1.83	1.76	2.19/2.01[a]	1.90
	dry baseflow 2	7/30/2018	1.20/1.23[a]	1.05	1.38	1.19	1.51
	wet baseflow 1	2/22/2018	1.51	1.43	1.72/1.68[a]	1.23	1.56
	wet baseflow 2	4/3/2018	1.43 J	1.12 J/1.07 J[a]	1.42 J	1.12 J	1.45 J
	storm 1 (storm > 0.25 in.)	9/19/2017	1.59 U	25.4	2.33/26.6[a]	3.91 U	3.20 U
	storm 2 (storm > 0.5 in.)	10/19/2017	1.34	1.19/1.07[a]	2.11	1.21	2.07
	storm 3 (storm > 0.25 in.)	3/8/2018	1.40	1.10	1.48	1.09/1.11[a]	1.58
	storm 4 (storm > 0.5 in.)	4/7/2018	1.90/1.93[a]	1.10	2.06	1.21	1.82

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Parameter	Event	Collection Date	Conventional Parameter Results				
			LDW				Green River
			SW1 (RM 0.75, Kellogg Island)		SW2 (RM 3.3, South Park Bridge)		SW3
			Near-surface	Near-bottom	Near-surface	Near-bottom	Mid-depth
Salinity (ppt)	dry baseflow 1	8/28/2017	18.8	26.6	10.5	25.6/25.4[a]	0.10
	dry baseflow 2	7/30/2018	24.9/25.3[a]	28.3	12.0	27.1	0.10
	wet baseflow 1	2/22/2018	8.20	24.0	1.50/1.10[a]	23.3	0.10
	wet baseflow 2	4/3/2018	10.8	28.7/28.7[a]	3.40	28.0	0.10 U
	storm 1 (storm > 0.25 in.)	9/19/2017	18.8	26.1	26.6/8.70[a]	24.1	0.10
	storm 2 (storm > 0.5 in.)	10/19/2017	15.9	25.3/25.2[a]	6.20	22.9	0.10 U
	storm 3 (storm > 0.25 in.)	3/8/2018	9.80	24.5	5.70	23.0/22.9[a]	0.10
	storm 4 (storm > 0.5 in.)	4/7/2018	8.40/8.90[a]	28.7	1.40	27.4	0.10 U
TOC (mg/L)	dry baseflow 1	8/28/2017	1.65	1.85	1.90	2.32/2.25[a]	2.89
	dry baseflow 2	7/30/2018	1.32/1.35[a]	1.19	1.54	1.54	1.63
	wet baseflow 1	2/22/2018	1.69	1.49	1.80/1.76[a]	1.34	1.61
	wet baseflow 2	4/3/2018	1.47 J	1.15 J/1.15 J[a]	1.53 J	1.20 J	1.53 J
	storm 1 (storm > 0.25 in.)	9/19/2017	1.77 U	25.9	2.65/26.3[a]	4.19 U	3.39 U
	storm 2 (storm > 0.5 in.)	10/19/2017	1.80	1.49/1.43[a]	2.30	1.54	2.47
	storm 3 (storm > 0.25 in.)	3/8/2018	1.64	1.30	1.78	1.29/1.30[a]	1.86
	storm 4 (storm > 0.5 in.)	4/7/2018	2.25/2.22[a]	1.22	2.71	1.52	3.02
TSS (mg/L)	dry baseflow 1	8/28/2017	4.4	5.5	5.0	8.5/10.3[a]	3.2
	dry baseflow 2	7/30/2018	5.0/4.0[a]	4.0	3.0	7.0	4.0
	wet baseflow 1	2/22/2018	3.0	5.0	3.0/3.0[a]	7.0	6.0
	wet baseflow 2	4/3/2018	4.0	4.0/4.0[a]	2.0	7.0	3.0
	storm 1 (storm > 0.25 in.)	9/19/2017	8.0	8.6	8.7/8.4[a]	13.4	4.3
	storm 2 (storm > 0.5 in.)	10/19/2017	6.1	13.2/12.7[a]	5.9	11.2	12.4
	storm 3 (storm > 0.25 in.)	3/8/2018	4.5	4.0	4.0	6.0/6.0[a]	6.0
	storm 4 (storm > 0.5 in.)	4/7/2018	4.0/4.0[a]	8.0	7.0	8.0	29.0

[a]   Field duplicate result.

DOC – dissolved organic carbon   ppt – parts per thousand   TSS – total suspended solids

J – estimated concentration   RM – river mile   U – not detected at given concentration

LDW – Lower Duwamish Waterway   TOC – total organic carbon

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4.2 CHEMISTRY RESULTS FOR PASSIVE SAMPLERS

Table 4-6 presents a summary of the total PCBs results for passive samplers, including detection frequencies and minimum, maximum, and mean concentrations. Table 4-7 presents a summary of the conventional parameter data recorded by the data logger. Full results are presented in Appendix D (see passive sampler data tab).

Table 4-6.   Passive sampler results for total PCBs

Sampling Event and Location	Detection Frequency	Total PCB Congener Results (pg/L)		
		Mean	Minimum	Maximum
Passive sampler event 1 (August/September 2017)				
PS1 (South Park Bridge) – RM 3.3	9/9	1,251.4	1,103.6 J	1,415.7 J
PS2 (Linear Logistics) – RM 1.9	9/9	1,264.0	1,049.2 J	1,436.2 J
Passive sampler event 2 (July/August 2018)				
PS1 (South Park Bridge) – RM 3.3	8/8	1,028	876.0 J	1,202.3 J
PS2 (Linear Logistics) – RM 1.9	9/9	956.8	777.4 J	1,065.7 J

Note: Concentrations are dissolved fractions
J – estimated concentration
PCB – polychlorinated biphenyl
RM – river mile

Table 4-7. Summary of *in situ* conventional parameter values recorded during passive sampler deployment

Parameter	Average Parameter Values (Range of 10th to 90th Percentile)[a]			
	Passive Sampler Event 1 (2017)		Passive Sampler Event 2 (2018)	
	PS1 – South Park Bridge (RM 3.3)	PS2 – Linear Logistics (RM 1.9)	PS1 – South Park Bridge (RM 3.3)	PS2 – Linear Logistics (RM 1.9)
DO (mg/L)	5.4 (4.9–5.9)	5.4 (5.1–5.7)	6.2 (4.8–7.4)	6.8 (5.8–7.8)
pH	7.5 (7.4–7.6)	7.7 (7.6–7.7)	7.8 (7.6–7.9)	7.9 (7.8 – 8.0)
Salinity (ppt)	31.4 (28.3–32.7)	31.9 (29.0–33.6)	26.2 (23.9–28.3)	25.5 (21.9–27.5)
Temperature (°C)	13.7 (13.3–14.3)	13.7 (13.2–14.3)	14.1 (13.6–14.9)	14.2 (13.5–15.4)
TDS (mg/L)	31,200 (28,500–32,400)	31,800 (29,100–33,300)	26,600 (24,500–28,500)	25,900 (22,600–27,800)

[a]   Parameter values were recorded by data loggers attached to one of the passive sampler frames at each location every 15 minutes during the passive sampler deployment. The range of the 10th to 90th percentile was used in this table (rather than minimum and maximum values) to avoid the inclusion of data identified as being of questionable quality values.

DO – dissolved oxygen   RM – river mile
ppt – parts per thousand   TDS – total dissolved solids

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Two issues affected the passive sampler results from the 2018 event. The first occurred during analysis/validation of the samplers: As discussed in Section 3.2, it was discovered that one of the passive sampler replicates (LDW18-PS1-DB2-02) had been incorrectly loaded onto the instrument. Thus, this replicate was replaced with an archived passive sampler replicate (LDW18-PS1-DB2-12). Because an archived sample was used, the total number of passive samplers analyzed was not affected.

The second issue was discovered during data assessment. The results for an additional passive sampler replicate from the 2018 event (i.e., sample LDW18-PS1-DB2-08) were rejected because of poor surrogate recovery and poor performance of the performance reference compounds (PRCs). Laboratory review of the sample results revealed that the labeled surrogate compound recoveries were approximately 50% lower than the surrogate recoveries for other samples. The laboratory concluded that data users should consider the results for this sample to be unconfirmed (Brooks 2018). Additionally, the concentrations of three of the six PRCs (i.e., PCB-111, PCB-153, PCB-178) in this passive sampler were greater than the concentrations of these PRCs in the day-zero blank samplers,[7] and the results of two of the six PRCs were outside of the range (15 to 85% equilibration) that could be used in the PRC calculator. The only PRC result that was acceptable for use for the equilibrium correction was PCB-095. Based on these issues, the results for this sample were rejected. The loss of one passive sampler replicate left eight results from this location and sampling event, compared to nine results from all other locations and events. Because this issue was not discovered until after analysis had occurred, the impact of losing this replicate was evaluated. As discussed in Section 3.1.2 of the data evaluation report (Windward 2018b), the low variance among the passive sampler replicates means that the loss of the one replicate in the 2018 dataset does not affect the ability of the baseline passive sampler dataset to meet the DQO (i.e., the analysis of an additional sample would have had minimal impact on the baseline average). Thus, no archived sample was analyzed.

4.3   DATA VALIDATION RESULTS

Independent data validation was performed by EcoChem. Full validation was performed on a minimum of 10% of the data or a single sample delivery group, as specified in the QAPP (Windward 2017). A summary-level validation review was conducted on the remaining data. All data presented in this report were determined to be acceptable for use as qualified, with the exception of five benzidine results that were rejected because benzidine was not recovered in the LCS.

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[7] As described in the QAPP (Windward 2017), day-zero blank samples were stored, frozen, at the laboratory and were analyzed with the passive sampler replicates to measure PRC concentrations. PRC concentrations in the day-zero blanks were used to establish pre-deployment PRC concentrations, which were necessary to determine the fraction of PRC lost from each sampler during deployment. This change in PRC concentration during deployment was used to quantify non-equilibrium conditions.

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The data validation report, which is presented in Appendix E, includes detailed information regarding all data qualifiers. The majority of the data flagged as being estimated (i.e., J-qualified) were qualified because of results that were below the RL, with the exception of dioxin/furan values. For dioxins/furans, the majority of the results flagged as estimated were qualified because the results did not meet compound identification criteria.

In addition, the following two issues resulted in qualified sample results:

- Wet baseflow 2 TOC/DOC results (14 samples) were qualified as estimated with a potential low bias due to a matrix spike recovery below the lower control limit.

- The dry baseflow 1 equipment blank contained detectable concentrations of anthracene, pyrene, fluoranthene, and zinc. Following EPA's national functional guidelines (EPA 2017) for data validation, sample results less than five times the equipment blank concentration were qualified as not detected; analytes qualified as not detected included anthracene (three samples), pyrene (five samples), fluoranthene (five samples), and zinc (six samples).

PCB congener and dioxin/furan samples were co-extracted for the storm 1 samples. The extraction solvent mix led to interferences that limited the quantification of mono- and di-chlorinated PCBs (i.e., the lighter PCB congeners with only one or two chlorine atoms, respectively). Thus, results for PCB 1 (5 samples), PCB 2 (5 samples), PCB 4 (5 samples), and PCB 15 (2 samples) were rejected.

5 References

Brooks G. 2018. Personal communication (email from G. Brooks, Axys, to S. McGroddy, Windward, regarding AOC3 SW passive sampler E2 validated data). SGS Axys Analytical, Sidney, BC. November 12, 2018.

EPA. 2016. Third Amendment to the Administrative Order on Consent for remedial investigation/feasibility study (AOC) for the Lower Duwamish Waterway (LDW), CERCLA-10-2001-0055. US Environmental Protection Agency, Region 10, Olympia, WA.

EPA. 2017. National functional guidelines for organic Superfund methods data review. EPA-540-R-2017-002. US Environmental Protection Agency, Washington, DC.

Windward. 2017. Baseline surface water collection and chemical analyses - quality assurance project plan. Final. Submitted to EPA on August 2, 2017. Lower Duwamish Waterway Pre-Design Studies. Windward Environmental LLC, Seattle, WA.

Windward, Integral. 2017. Pre-design studies work plan. Lower Duwamish Waterway Superfund site. Final. Prepared for the Lower Duwamish Waterway Group for submittal to EPA Region 10 on August 28, 2017. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

Windward. 2018a. Baseline surface water collection and chemical analyses - quality assurance project plan - addendum. Final. Submitted to EPA on March 2, 2018. Lower Duwamish Waterway Pre-Design Studies. Windward Environmental LLC, Seattle, WA.

Windward. 2018b. Lower Duwamish Waterway data evaluation report (Task 6). Draft. Submitted to EPA December 17, 2018. Windward Environmental LLC, Seattle, WA.

Windward. 2018c. Surface water analyte evaluation. Windward Environmental LLC, Seattle, WA.

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