QUALITY ASSURANCE PROJECT PLAN ADDENDUM

COLUMBIA SLOPE 2022–2024 WATER QUALITY MONITORING

Prepared for
City of Vancouver

Prepared by
Herrera Environmental Consultants, Inc.

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Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will print correctly when duplexed.

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COLUMBIA SLOPE 2022–2024 WATER QUALITY MONITORING

Prepared for
City of Vancouver
Surface Water management
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December 2, 2022

PROJECT TEAM SIGNATURE PAGE

Approval signatures indicate that members of the project team have reviewed this Quality Assurance Project Plan (QAPP) addendum and agree to follow the methods and quality assurance (QA) procedures contained herein.

Team Member	Organization/Title	Signature	Date
Kris Olinger	City of Vancouver, City EPA Coordinator	Kris Olinger	12/6/2022
Dorie Sutton	City of Vancouver, City Project Manager	Dorie Sutton	12/5/2022
Nicole Taylor	US EPA, Grant Project Officer	NICOLE TAYLOR Digitally signed by NICOLE TAYLOR Date: 2022.12.06 13:46:07 -08'00'	12/6/2022
Meghan Dunn	US EPA, Regional Sample Control Coordinator	MEGHAN DUNN Digitally signed by MEGHAN DUNN Date: 2022.12.06 13:52:05 -08'00'	
Jess Brown	Herrera, Project Manager and Quality Assurance Officer		12/2/2022
Rob Zisette	Herrera, Principal Investigator		12/2/2022
Sam Nilsson	Herrera, Field Lead		12/2/2022
Mary Larkin	Northwest Watersheds, Field Support		12/2/2022
Howard Holmes	ALS Environmental, Laboratory Project Manager		12/2/2022
Elizabeth Bunger	BSK Associates, Laboratory Director		12/5/22

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INTRODUCTION

The purpose of this document is to amend the quality assurance project plan (QAPP; Herrera 2021) developed for 2021–2022 Columbia Slope Water Quality Monitoring Project. The monitoring program has been extended to 2024 to allow the City of Vancouver (City) to better assess pollutant loading to the Columbia River, prioritize basins for stormwater treatment, and identify areas for protection. To meet these goals, the following objectives have been defined:

- Identify where stormwater contaminants are being carried to the Columbia River
- Prioritize basins where stormwater treatment retrofits could effectively remove pollutants
- Identify outfalls where stormwater treatment activities can be monitored for effectiveness over the long-term
- Accurately characterize specific water quality parameters within the watershed
- Provide high quality data for the City and other users
- Collect baseline data to determine whether trends or correlations are evident
- Provide feedback for adaptive strategies in stormwater management programs

This 2022 QAPP addendum documents project modifications to the original QAPP including an updated set of monitoring stations, parameters, monitoring frequency details, project schedule, and deliverables. Documents prepared for the 2021-2022 monitoring program are referred to through this document and include:

- The original QAPP for the 2021–2022 Columbia Slope Water Quality Monitoring Project (Herrera 2021a), which defined the monitoring, reporting, and quality assurance procedures for the project.
- The 2021 QAPP Addendum Herrera 2021b), which modified the QAPP by adding three monitoring stations that primarily receive runoff from Washington State Department of Transportation (WSDOT) highways to the monitoring regime.
- The 2021–2022 Water Quality Summary Report (Herrera 2022) which outlined the monitoring activities performed for the 2021-2022 Columbia Slope Water Quality Monitoring Project, characterized water quality results throughout the watershed, and provided an evaluation of basins for stormwater treatment retrofitting based on an assessment of pollutants of interest in each basin.

PROJECT ORGANIZATION AND SCHEDULE

Key personnel involved in this effort are identified below, and their respective roles are provided in Table 1.

Table 1. Project Team and Roles.

Personnel	Organization	Phone	Role
Kris Olinger	City of Vancouver	360-487-7188	City EPA coordinator
Dorie Sutton	City of Vancouver	360-487-7184	City Project Manager
Jess Brown	Herrera	971-200-8872	Herrera Project Manager Quality Assurance Officer
Rob Zisette	Herrera	206-787-8262	Principal Investigator
Brian Busiek	Herrera	971-200-8879	Technical Review
Tim Clark	Herrera	971-361-2238	Technical Review Data Management/Analysis Lead Field Support
Sam Nilsson	Herrera	971-200-8871	Field Lead
Katie Sweeney	Herrera	971-200-8877	Field Support Data Management/Analysis Support
Jennifer Schmidt	Herrera	206-787-8233	GIS Support
Mary Larkin	Northwest Watersheds	503-781-2799	Field Support
Howard Holmes	ALS Environmental	360-577-7222	Laboratory Chemist
Elizabeth Bunger	BSK Associates	360-750-0055 x403	Laboratory Director

The project schedule is summarized in Table 2. The schedule may be revised over the course of the project as needed and approved by the City.

Table 2. Project Schedule.		
Task	**Activity**	**Proposed Scheduled Date/Duration**
1. Project Management	Project Management	10/11/22-8/31/24
2. Site Selection and QAPP Addendum	Kick Off Meeting	10/31/22
	Desktop Assessment	10/11/22-10/26/22
	Field Investigation	10/10/22-10/26/22
	Draft QAPP Addendum	11/9/22
	Draft Final QAPP	Within 1 weeks of receiving comments
	Final QAPP	Within 1 week of receiving comments
3. Monitoring	Water Quality Sampling	November 2022 – March 2024
	Final Laboratory Reports	Approximately 20 business days after sampling
4. Interim Updates, Progress Update and Data Review	Interim Update Reports	4 weeks after receipt of final laboratory reports
	Progress Update Meeting	August or September 2023
5. Summary Report	Draft Summary Report	6/24/24
	Final Summary Report	Within 2 weeks of receiving comments
	Data Submittal (WQX)[a]	Within 3 weeks of approval of Final Summary Report

a Data will be submitted to Ecology EIM if requested by the City and approved by Ecology.

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EXPERIMENTAL DESIGN

This monitoring program generally follows the experimental design outlined in the QAPP and 2021 QAPP Addendum (Herrera 2021a and 2021b) except where noted below. The experimental design is summarized in Table 3.

The following five types of monitoring stations are proposed:

- Four previously monitored outfalls for comparison to previous monitoring results
- Four new monitored outfalls to evaluate water quality in drainage from new basins
- Two stations located upstream of monitored outfalls to evaluate water quality changes downstream of pollutant sources in the basin
- Two stormwater best management practice (BMP) stations to evaluate pollutant removal of an existing BMP
- Three WSDOT stations to evaluate pollutant concentrations in highway runoff

The following three types of monitoring events are proposed:

- Six storm events in the first wet season from November 2022 through April 2023
- Six base flow events from March 2023 through December 2023
- Six storm events in the second wet season from October 2023 through March 2023

The following three types of parameters will be analyzed:

- Field parameters, conventionals, nutrients, metals, and bacteria for all events at most stations
- Semivolatile organics and organochlorine pesticides at new stations for one season of storm events
- Stream discharge for all events at most stations except previously monitored outfalls

Table 3. Columbia Slope Water Quality Monitoring Design for WY 2023-2024.						
Monitoring Station ID	Drainage Basin	Station Type	Coordinates	Parameters		
				Wet Season 1 Storm Events	Base Flow Events	Wet Season 2 Storm Events
CSE1	E	Previous Outfall	45.607295 N, -122.577057 W	A	A	AB
CSO1	O	Previous Outfall	45.590452 N, -122.507968 W	A	A	A
CSP1	P	Previous Outfall	45.587198 N, -122.504995 W	A	A	A
CSR1	R	Previous Outfall	45.586833 N, -122.493536 W	A	A	A
CSAA1	AA	New Outfall	45.610831 N, -122.604481 W	ABC	AC	AC
CSH1	H	New Outfall	45.601760 N, -122.556469 W	ABC	AC	AC
CSL1	L	New Outfall	45.594178 N, -122.523529 W	ABC	AC	AC
CSQ1	Q	New Outfall	45.590149 N, -122.502950 W	ABC	AC	AC
CSE2	E	Upstream	45.607318 N, -122.577114 W	--	--	ABC
CSE3	E	Upstream	45.609643 N, -122.576251 W	--	AC	ABC
CSBMP1_IN	O	BMP	45.594580 N, -122.511296 W	AC	--	--
CSBMP1_OUT	O	BMP	45.593244 N, -122.510492 W	AC	--	--
CSWSDOT1	I	WSDOT	45.598897 N, -122.551083 W	ABC	--	--
CSWSDOT4	B	WSDOT	45.612863 N, -122.599429 W	ABC	--	ABC
CSWSDOT5	O	WSDOT	45.593207 N, -122.510686 W	--	--	ABC

Group A = Field parameters except stream discharge (temperature, conductivity, dissolved oxygen, pH), turbidity, total suspended solids, hardness, chloride, total phosphorus, total nitrogen, nitrate+nitrite, total metals (copper, lead and zinc), and *E. coli*.

Group B = Semivolatile organic compounds, polycyclic aromatic hydrocarbons, phthalates, chlorinated hydrocarbons, organochlorine pesticides.

Group C = Stream discharge field measurement.

MONITORING STATIONS

Monitoring will be conducted at 15 stations in the Columbia Slope watershed (Figure 1), composed of stations primarily receiving runoff from City roadways (referred to herein as "City stations") and stations primarily receiving runoff from WSDOT highways (referred to herein as "WSDOT stations"). Monitoring stations are listed below by station type. The rationale for station selection is presented in the following section.

Previously Monitored Outfalls

The following four previously monitored City outfall stations are proposed:

- Basin E outfall (CSE1) – Upstream culvert along Southeast Evergreen Highway approximately 250 feet east of Southeast Image Road.
- Basin O outfall (CSO1) – Upstream culvert along Southeast Evergreen Highway approximately 100 feet east of Southeast 158th Avenue.
- Basin P outfall (CSP1) – Outfall accessible at the beach access approximately 50 feet south of the southern extent of Southeast 164th Avenue.
- Basin R outfall (Fisher's Creek; CSR1) – Exposed artificial channel on unnamed gravel road south of the railroad tracks adjacent to 17403 Southeast Evergreen Highway.

New Priority Outfalls

Four new City outfall stations are proposed and listed below:

- Basin AA outfall (CSAA1) – Outfall located approximately 120 feet south of the restroom structure to the east of the Wintler Park parking lot.
- Basin H outfall (CSH1) – Upstream culvert along Southeast Evergreen Highway approximately 150 feet east of Southeast 112th Avenue.
- Basin L outfall (CSL1) – Upstream culvert along Southeast Evergreen Highway approximately 100 feet east of Southeast 144th Court.

Basin Q outfall (CSQ1) – Upstream culvert along Southeast 164th Avenue approximately 200 feet northwest of the intersection with Southeast Evergreen Highway.

Upstream Stations

Two upstream City monitoring stations in Basin E are proposed and listed below:

- Basin E Evergreen Highway ditch (CSE2) – Ditch-fed side channel connected directly to monitoring station CSE1 from the west.

- Basin E north of SR 14 (CSE3) – Downstream culvert and exposed flow-control manhole along Southeast French Road at the intersection with Southeast 95th Avenue.

Best Management Practice Stations

Monitoring of the inflow and outflow of one stormwater BMP is proposed at the following City stations:

- Basin O stormwater pond influent (CSBMP1_IN) – Stream channel below pond outfalls off Southeast Cascade Park Drive approximately 1,000 feet west of the C-Tran Fisher's Landing Transit Center.

- Basin O stormwater pond effluent (CSBMP1_OUT) – Downstream culvert of SR 14 near the eastbound shoulder pullout at exit 8. Culvert is approximately 325 feet north of the north end of Southeast 158th Court and only accessible by walking east along the south side of the highway sound barriers.

WSDOT Stations

One previously monitored WSDOT station and two new WSDOT stations are proposed:

- I-205 outfall (CSWSDOT1) – Outfall located approximately 50 feet from the bank of the Columbia River directly beneath the western edge of the southbound I-205 bridge. This station was monitored previously.

- Basin B untreated SR 14 runoff (CSWSDOT4) – Exposed channel off the south side of eastbound SR 14 approximately 300 feet east of Southeast Chelsea Avenue. Channel drains into a small private pond near 7100 Southeast Evergreen Highway.

- Basin O treated SR 14 runoff (CSWSDOT5) – Outfall discharging 10 feet downstream of monitoring station CSBMP1_OUT near the eastbound SR 14 shoulder pullout at exit 8. Outfall drains the nearby highway stormwater treatment facility and connects to the south bank of the stream.

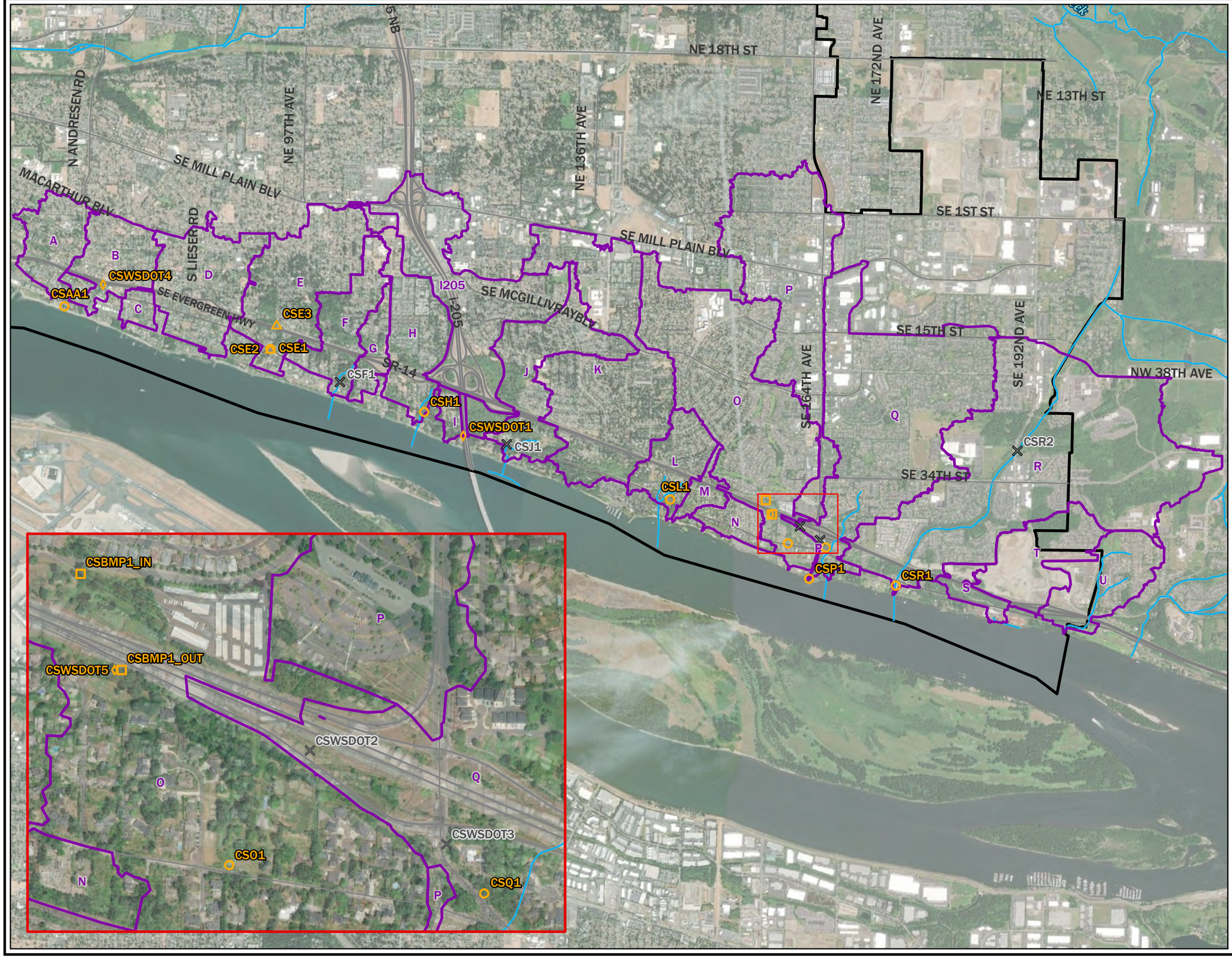

Figure 1.
Columbia Slope 2022-2024
Monitoring Stations

Legend

Monitoring Stations

- Outfall
- Upstream
- BMP
- WSDOT
- Discontinued
- Columbia Slope Basin
- Streams
- Major Roads
- Vancouver City Limits

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Monitoring Station Selection and Alternatives

Monitoring stations were identified and selected through desktop analysis and field reconnaissance using the same procedures and considerations as described in the QAPP (Herrera 2021a). The 2022 desktop assessment used findings of the 2021 desktop assessment in conjunction with monitoring recommendations from the 2021-2022 Summary Report (Herrera 2022) to identify potential monitoring stations for field reconnaissance. Logistics such as proximity and travel times between monitoring stations were considered to allow the field team sufficient time to sample all stations within one day. Field reconnaissance was performed to evaluate feasibility for each potential station, including safety considerations and access constraints. Potential stations were categorized by station type including previously monitored outfalls, new basin outfalls, upstream characterization or pollutant tracking, WSDOT characterization, and stormwater BMP effectiveness stations. Three of the proposed monitoring stations are located at two proposed stormwater retrofit projects whose concept designs are being developed under the City's Columbia Slope Stormwater Retrofit Evaluation Study funded by the Washington State Department of Ecology (Ecology). Monitoring at these stations will help to inform project benefits in terms of water quality and provide baseline data.

Monitoring stations deemed feasible in the desktop assessment and field reconnaissance but not selected for monitoring are also described below. If selected monitoring stations identified above cannot be safely monitored due to unanticipated conditions, these additional stations may be used as replacements pending an approved QAPP Addendum.

Previously Monitored Outfalls

Outfall monitoring stations in basins E, O, and P are prioritized for continued monitoring due to elevated pollutant concentrations. Continued monitoring allows for evaluation of long-term trends and patterns in these pollutants.

- Basin E outfall station (CSE1) had the most individual detections of storm-only parameters (semivolatile organic compounds [SVOCs] and organochlorine pesticides) of any City station and had elevated nutrients and bacteria concentrations.

- Basins O and P outfall stations (CSO1 and CSP1) are prioritized due to elevated concentrations of metals and bacteria. Elevated turbidity was also observed at CSP1.

- Basin R outfall station (CSR1; Fisher's Creek) is prioritized for continued monitoring, despite generally exhibiting lower pollutant concentrations than other City stations, due to the ecological function the stream may serve as salmonid spawning habitat.

Feasible Alternatives

- Basin J outfall (Biddle Lake Hatchery; CSJ1) – Downstream culvert along Southeast Evergreen Highway east of the intersection with Schafer Rd. This station is not selected for continued monitoring because pollutant concentrations were generally lower than other outfall stations and staff at the nearby hatchery perform water quality monitoring. However, the hatchery does represent a high priority ecological feature and may benefit from continued monitoring.

New Priority Outfalls

New priority outfalls were evaluated based primarily on monitoring station accessibility with consideration to geographic distribution and diversity in basin characteristics. Access to basin outfalls, particularly in the western portion of the Columbia Slope, are constrained by individual private properties and private, gated communities.

- Basin AA outfall station (CSAA1) is prioritized because (1) it expands the project's geographic coverage, (2) the park is a high use recreation resource, (3) the outfall is accessible with sampleable base flow, (4) it would be the smallest basin area sampled by an order of magnitude, and (5) the station will be used to inform project benefits for the Regional Facility at Wintler Park undergoing concept design for the Columbia Slope Stormwater Retrofit Evaluation Study project. The project may include a constructed wetland and outfall enhancements to improve water quality and provide public education.

- Basins H and L outfall stations (CSH1 and CSL1, respectively) were recommended as backup outfall stations in the QAPP (Herrera 2021a) since they are accessible. The basins draining to these stations are not located next to previously monitored basins and will help fill in gaps in water quality data across the watershed.

- Basin Q outfall station (CSQ1) is prioritized due to its high percentage of impervious area contributing to basin discharge and its proximity to major arterial roads and commercial or industrial properties.

Feasible Alternatives

- Basin A outfall (CSA1) – Outfall located approximately 100 feet southwest of the west end of the Wintler Park parking lot and located beneath the walking path. This station was not selected because base flow was minimal in previous field reconnaissance during dry weather and monitoring in the adjacent basin AA is prioritized to inform future stormwater retrofit projects.

- Basin K outfall (CSK1) – Manhole located in the ditch on the south side of Southeast Evergreen Highway approximately 600 feet east of Southeast Silversprings Drive. This

station was not selected because two channels comingle directly in the manhole making mixed sampling and discharge measurements difficult. The adjacent basins J and L have also either been previously monitored or are prioritized as new monitoring outfalls.

Upstream Stations

Elevated pollutant concentrations at the Basin E outfall (station CSE1) are the primary motivation for focusing upstream monitoring within basin E to better characterize sources of these pollutants discharging to the Columbia River. Herrera evaluated three feasible upstream stations in basin E and selected two. One potential upstream station was ruled out because it is fed primarily from a nearby spring, whereas the other two stations contain a greater proportion of stormwater runoff from residential streets and Southeast Evergreen Highway (CSE2 and CSE3).

There are also two upstream stations located in basin O (CSBMP1_OUT and CSWSDOT5) that will be monitored as BMP effectiveness and WSDOT runoff characterization stations. We will be able to leverage the monitoring stations for upstream source characterization for basin O.

Feasible Alternatives

- Basin E springs north of SR 14 (CSE4) – Downstream culvert along Southeast French Road approximately 225 feet east of Mount McKinley Avenue. This station was not selected because it represents flow primarily from groundwater springs and elevated metal, SVOC, and organochlorine pesticide concentrations at station CSE1 were observed during storm flow events. Monitoring at this station may be useful for evaluating nitrogen and phosphorus sources during base flow events when concentrations were elevated.

- Basin R Fisher's Creek at Southeast 180th Avenue (CSR3) – Downstream culvert at Fisher's Creek and Southeast 180th Avenue approximately 700 feet south of Fisher's Landing Elementary School. This station was not selected for monitoring because outfall station CSR1 had relatively low pollutant concentrations. Monitoring at this station may be useful to better characterize how water quality changes along Fisher's Creek between outfall station CSR1 and upstream station CSR2.

- Basin L western upstream channel (CSL) – Upstream culvert along Southeast Bella Vista Place approximately 200 feet west of Southeast Rivercrest Drive. This station was not selected because water quality in Basin L has not been characterized yet and the usefulness of an upstream pollutant tracking station is unknown. If elevated pollutant concentrations are observed at new outfall station CSL1, this may be a useful upstream station to track pollutant sources in the future.

- Basin K SR 14 culvert discharge (CSK1) – Downstream culvert and exposed channel along Southeast Rivercrest Drive approximately 1,000 feet west of Southeast Silversprings Drive. This station was not selected as an upstream or WSDOT highway station because

water quality at the Basin K outfall has not been previously characterized, and the WSDOT discharge is comingled with a large proportion of residential runoff from north of the highway.

BMP Stations

The basin O BMP monitoring stations have been selected for evaluating BMP effectiveness and providing baseline water quality data to inform concept design for the Pond Retrofit at Southeast Cascade Park Drive under the City's Columbia Slope Stormwater Retrofit Evaluation Study. The BMP is a large detention pond located between SR 14 and Southeast Cascade Park Drive. The pond detains and treats runoff from a large residential subdivision to the north, a golf course, and Southeast Cascade Park Drive. Outflow from the pond is carried via culvert across SR 14 and conveyed by channels and pipes to the basin O outfall. The pond may be enhanced to provide better water quality treatment as part of a retrofit.

Most large BMPs in the watershed have several influent outfalls which are challenging to collect a representative sample of all inputs. This is also the case at the CSBMP1_IN monitoring station, but three of the four main influent locations are located in the northwest corner near the monitoring station where comingled channelized flow can be sampled. Effluent from the BMP will be sampled at station CSBMP1_OUT located at the downstream end of the culvert (south of SR 14) and upstream of other inputs.

Feasible Alternatives

- Basin H City Water Quality Facility #374 (CSBMP2_OUT) – Downstream culvert and exposed channel at the end of Southeast Maxon Road which drains to a City-owned stormwater retention pond. This station was not selected because a consolidated BMP influent station could not be identified, and a similar more feasible BMP has been identified (Basin O Pond). This BMP may be monitored in the future if effluent-only data is considered valuable for BMP effectiveness monitoring.

Water Quality Sampling and Analysis

Herrera will implement the base and storm flow monitoring program from November 2022 through March 2024 as shown in Table 4. The monitoring will be performed in accordance with field measurement, sampling, and quality control procedures in the QAPP and 2021 QAPP addendum (Herrera 2021a, 2021b) and as modified herein.

Sampling and field measurements will be collected at all stations during a single day for each of the 18 monitoring events. The frequency of sampling will be approximately monthly. To ensure a consistent approach, at least one staff member who conducted monitoring in 2021-2022 will conduct the first sampling event. It is anticipated that sampling will begin at 8:00 am and conclude by 4:00 pm. Sampling will progress from downstream to upstream (to prevent

sampling of sediment suspended by samplers at the upstream station) and from east to west where feasible. For quality control, one field duplicate sample will be collected during each sampling event. Including duplicates, a total of 216 samples will be collected over the 18 monitoring events or 10 samples for each of six base flow events and 13 samples for each of 12 storm flow events (Table 5).

Table 4. Columbia Slope Sampling Schedule

Planned Event	Planned Schedule
Storm Event 1	November-December 2022
Storm Event 2	December 2022
Storm Event 3	January 2023
Storm Event 4	February 2023
Storm Event 5	March 2023
Storm Event 6	April 2023
Base Flow Event 1	March–April 2023
Base Flow Event 2	May–June 2023
Base Flow Event 3	July 2023
Base Flow Event 4	August 2023
Base Flow Event 5	October–November 2023
Base Flow Event 6	November–December 2023
Storm Event 7	October 2023
Storm Event 8	November 2023
Storm Event 9	December 2023
Storm Event 10	January 2024
Storm Event 11	February 2024
Storm Event 12	March 2024

Storm event monitoring will occur for the first wet season from November 2022 through April 2023 and resume for the second wet season from October 2023 to March 2024. Storm sampling will occur on days when the following criteria for storm event conditions are met:

- A least 0.30 inches of rain is predicted to occur in daylight hours of the sampling date and at least 0.10 inches of rain occurs before sampling begins.

Base flow sampling will be conducted from March 2023 to December 2023 with following criterion for base flow conditions:

- Less than 0.04 inches of rain in the previous 24 hours

Rainfall data from the Post Office Rain Gage (Portland BES 2020) will be checked before monitoring to ensure criteria are met. Monitoring stations with smaller contributing areas and faster stormwater discharge responses to precipitation (CSWSDOT4, CSWSDOT5, and CSE_UP1) may require alternate storm criteria to ensure sufficient storm flow. Storm flow sampling at these stations will be performed with the following storm characteristic goals:

- At least 0.15 inches total storm precipitation
- At least 3 hours total storm duration

Table 5. Number of Samples to be Collected at Each Monitoring Location.

Monitoring Station	Number of Events			Total Number of Samples
	2022-2023 Storm Flow Events	Base Flow Events	2023-2024 Storm Flow Events	
CSE1	6	6	6	18
CSO1	6	6	6	18
CSP1	6	6	6	18
CSR1	6	6	6	18
CSAA1	6	6	6	18
CSH1	6	6	6	18
CSL1	6	6	6	18
CSQ1	6	6	6	18
CSE2	--	--	6	6
CSE3	--	6	6	12
CSBMP1_IN	6	--	--	6
CSBMP1_OUT	6	--	--	6
CSWSDOT1	6	--	--	6
CSWSDOT4	6	--	6	12
CSWSDOT5	--	--	6	6
Duplicate[a]	6	6	6	18
Total samples	**78**	**60**	**78**	**216**
Total stations/event	**12**	**9**	**12**	**--**

[a] One field duplicate will be collected from a random location during each sampling event.

PARAMETERS

Samples collected from all monitoring stations will be analyzed for the same parameters as the Columbia Slope 2021-2022 Monitoring project (Herrera 2021a, Herrera 2021b) to allow for direct comparison where applicable. The parameters monitored at each station vary, as shown in Table 3, to capture seasonal pollutants of concern. Monitoring will be performed in accordance with field measurement, sampling, and quality control procedures provided in the QAPP and 2021 QAPP Addendum, except as specified below.

To characterize discharge at new outfall stations and to inform the Columbia Slope Stormwater Retrofit project, flow measurements will be collected at all new stations (CSAA1, CSH1, CSL1, CSQ1, CSE2, CSE3, CSBMP1_IN, CSBMP1_OUT, CSWSDOT4, and CSWSDOT5) during each monitoring event. Discharge will not be measured at the previously monitored stations (CSE1, CSO1, CSP1, CSR1, CSWSDOT1) due to time constraints, but may performed as time allows or if unusual flow conditions are observed.

It should be noted that some base flow monitoring stations may not have sufficient base flow for sampling during dry summer months. This was considered during station selection and base flow has been observed during late summer at all formerly monitored stations proposed for continued monitoring. Additionally, stations which feature intermittent ("flashy") storm flow may be sampled during one or more separate events if sufficient time or flow is not available during regularly scheduled events.

All sample holding times will be consistent with method recommendations (Table 6). *E. coli* bacteria holding time of 6 hours is specified by the method for compliance or regulatory purposes, but allows for 24 hours for non-compliance water samples. A holding time of 24 hours will be used for this project because these samples are for monitoring purposes only and are not related to regulatory or compliance projects. *E. coli* results will be flagged as estimates (J) if the analytical holding time exceeds 24 hours (but is less than or equal to 48 hours) and will be rejected (R) if the analytical holding time exceeds 48 hours.

Table 6. Sample Bottle, Holding Time, and Preservation Summary				
Parameter	**Container Type**	**Sample Volume (mL)**	**Maximum Holding Time**	**Preservation**
Turbidity	Polyethylene	250[a]	48 hours	Cool to 4°C
Total suspended solids	Polyethylene	1,000	7 days	Cool to 4°C
Nitrate+nitrite nitrogen	Polyethylene	500[b]	28 days	Cool to 4°C Preserve with sulfuric acid
Total nitrogen	Polyethylene	500[b]	28 days	Cool to 4°C Preserve with sulfuric acid
Total phosphorus	Polyethylene	500[b]	28 days	Cool to 4°C Preserve with sulfuric acid
E. coli bacteria	Polyethylene	125	24 hours[c]	Cool to 4°C
Hardness as $CaCO_3$	Polyethylene	125	6 months	Cool to 4°C Preserve with nitric acid
Chloride	Polyethylene	250[a]	28 days	Cool to 4°C
Metals, total	Polyethylene	125	6 months	Cool to 4°C Preserve with nitric acid
SVOCs	Amber glass	1,000	7 days extraction, 40 days analysis	Cool to 4°C
Organochlorine pesticides	Amber glass	1,000	7 days extraction, 40 days analysis	Cool to 4°C

[a] A single 250-mililiter unpreserved sample will be collected for analysis for turbidity and chloride

[b] A single 500-mililiter preserved (sulfuric acid) sample will be collected for analysis of nitrate+nitrite nitrogen, total nitrogen, and total phosphorus

[c] Method holding time for *E. coli* analysis for compliance or regulatory purposes is 6 hours. The method allows for an increased holding time of 24 hours for samples that were not collected for compliance or regulatory purposes.

DATA REVIEW AND REPORTING

DATA REVIEW

All field and laboratory data will be reviewed by the quality assurance officer to ensure that all data meet the objectives for completion, precision, and accuracy in accordance with the QAPP. Any corrective actions will be taken as necessary. Data review and validation results for each monitoring event will be presented in interim updates. Validated project data will be entered into the project database for the project summary report and data submittal.

INTERIM REPORTING

An interim report will be prepared following each monitoring event, within 4 weeks after receipt of final laboratory reports. Each interim report will summarize project activities, progress, and schedule, and discuss any problems and recommend corrective actions, as needed. The reports will present the field forms, laboratory data reports, and chain of custody documentation. Each interim update will include a data quality and usability assessment that identifies any changes or deviations from the QAPP and QAPP addendums for each of the quality control elements outlined in the QAPP (Herrera 2021a).

Herrera will develop a project dashboard to visualize water quality data as it is collected. It is expected that the dashboard will be updated approximately monthly and will include figures and data tables.

MID-PROJECT PROGRESS UPDATE

Herrera will prepare a Progress Update in the form of a presentation to the City near the mid-point of sampling activities to share key findings. The purpose of the update is to review project performance to ensure overall goals are being met and present recommendations for improvement, such as changes to monitoring stations or frequency, if appropriate. This update will report progress to date, discuss any significant deviations from the QAPP or QAPP addendums, and present water quality results in tables and figures. Herrera will present these findings to the City for discussion during one meeting in August or September 2023.

SUMMARY REPORT

Upon completion of all monitoring activities, Herrera will prepare a final monitoring report for the project. This report will identify the specific goals of the monitoring project, then describe

the monitoring procedures that were implemented to achieve those goals. Monitoring quality assurance objectives and review findings will be summarized. The report will include discussion of data collected during the 2021-2022 monitoring program.

Data analysis methods will include:

- **Summary statistics and graphics:** A table of summary statistics and graphics such as line and box and whisker plots.
- **Water Quality Criteria:** Comparison of observed values to relevant water quality criteria.
- **Difference Between Stations**: Statistical comparison of observed values between monitored stations using a repeated measures ANOVA or a Friedman test and a post-hoc Tukey or paired Wilcoxon test.
- **Base flow vs. Storm flow**: Statistical comparison of observed values within monitored stations during base flow and storm flow using a Wilcoxon Signed Rank test.
- **Upstream Stations**: Compare discharge (quantitative or qualitative) and water quality within a drainage area. Use this information to make recommendations for further source evaluation.
- **BMP Stations:** Compare water quality concentrations and instantaneous loadings (concentration multiplied by discharge) above and below the BMP, and statistical analysis of differences using a paired t test or a paired Wilcoxon Signed Rank test.

Given the complexity of the phased monitoring approach (e.g., differing schedule and parameter list for each station type), some statistical data analysis methods may only apply to some groups of data to preserve statistical power and meaningfulness.

Results of the monitoring program will be presented and evaluated using supporting graphical and/or tabular representations of the data as necessary. Findings from statistical analyses performed on the data will be presented, discussed in detail, and compared to applicable water quality criteria. Major conclusions and recommendations will be presented at the end of the report. An executive summary at the beginning of the report will summarize key results, conclusions and recommendations.

A draft summary report will be submitted to the City for review and comment. Herrera will address all comments and submit a final draft report for approval by the City. Once the final monitoring report has been approved by the City, Herrera will make all the project data available to the City in an electronic format (i.e., excel spreadsheet) that is compatible with the City's geographic information system (GIS).

Validated field and laboratory data in the project database will be put in electronic formats that conform to the submittal requirements for the federal Water Quality Portal WQX system and

included with all interim reports as appendices to the summary report. Herrera will submit the WQX data to the federal Water Quality Portal within 3 weeks of completing the project summary report. The data will be added to dataset collected under the Columbia Slope 2021-2022 Water Quality Monitoring project. Herrera's quality assurance officer will perform an independent review of all data entry to ensure individual sample values were entered without error.

Upon completion of all monitoring activities, Herrera will prepare a technical memorandum presenting key results, conclusions and recommendations pertaining to the WSDOT stations in addition to the main summary monitoring report described above.

REFERENCES

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