Quality Assurance Project Plan for Status and Trends Monitoring of Small Streams in the Puget Lowlands Ecoregion

for Monitoring Conducted by Pierce County, WA to Comply with NPDES Stormwater Permit Special Condition S8.B Requirements

September 15, 2014

Publication information

This template Quality Assurance Project Plan is available on the Department of Ecology's Regional Stormwater Monitoring Program (RSMP) website for National Pollutant Discharge Elimination System (NPDES) municipal stormwater permittees at http://www.ecy.wa.gov/programs/wq/stormwater/municipal/status.html.

Data for the RSMP will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search Study ID, RSMP_PLES2015. Data from the City of Bellingham will be under Study ID RSMP_BH_PLES2015. Data from Pierce County will be under Study ID RSMP_PC_PLES2015. Data from City of Redmond will be under Study ID RSMP_RD_PLES2015.

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September 15, 2014

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Introduction

Development of a Stormwater Monitoring Strategy for the Puget Sound Region

The Stormwater Work Group (SWG) is a coalition of federal, tribal, state, and local governments; business, environmental, and agricultural entities; and academic researchers. All SWG members have interests and a stake in the Puget Sound watershed. The SWG was convened by the Puget Sound Partnership (PSP) and the Washington State Department of Ecology (Ecology) in October 2008 to develop a regional stormwater monitoring strategy and to recommend monitoring requirements in National Pollutant Discharge Elimination System (NPDES) stormwater permits issued by Ecology. In 2012, the SWG became the first "topical workgroup" included in the Puget Sound Ecosystem Monitoring Program (PSEMP), an organization designed to coordinate regional monitoring efforts to assist in providing information to support Puget Sound recovery efforts.

An overall strategy for stormwater monitoring and assessment for the Puget Sound region was developed by the SWG in 2010 (SWG, 2010a). This strategy summarized in Appendix A, included recommendations for status and trends monitoring in small streams and in the Puget Sound nearshore, with a focus on an integrated approach to quantify stormwater pollutant impacts in Puget Sound, and providing information to efficiently, effectively, and adaptively manage stormwater to reduce harm to the ecosystem.

The SWG also recommended a specific NPDES municipal permittee-funded plan for monitoring the effects of stormwater under the permits in the Puget Sound region (SWG, 2010b). The resulting program, a subset of the overall strategy, is called the Regional Stormwater Monitoring Program (RSMP). Specifically, the RSMP includes status and trends monitoring of water quality and "watershed health" (physical habitat, sediment chemistry, and biological communities) in small streams in the Puget Sound lowlands; and of sediment quality, bacteria, and mussel contaminants in the marine nearshore of Puget Sound. All the RSMP status and trends monitoring follows a probabilistic design (SWG, 2010a) that is compatible with ongoing status and trends monitoring programs such as Ecology's statewide monitoring program entitled *Status and Trends Monitoring for Watershed Health and Salmon Recovery* (WHSR) (Cusimano et al., 2006). Additional information about the experimental design, the goals, and the objectives for status and trends and other monitoring in the RSMP can be found in Appendix A of this report, in SWG (2010a and 2010b), and at the RSMP website (http://www.ecy.wa.gov/programs/wq/stormwater/municipal/status.html).

Scope of this Quality Assurance Project Plan

Ecology issued NPDES municipal stormwater permits for Phase I and Phase II communities (Ecology, 2012a,b) effective August 2013 through July 2018. All permittees located in Puget Sound were given two options to comply with the permits' Special Condition S8.B for status and trends monitoring requirements.

Option 1: Pay a prescribed amount into a pooled fund to support RSMP Status and Trends monitoring. These permittees' role is limited to providing permit-defined amounts of funding for coordinated implementation of monitoring at sites throughout the Puget Sound region.

Or

Option 2: Conduct their own status and trends monitoring at specific, assigned sites inside their jurisdictional boundaries, following the same protocols as those used for the RSMP.

In fall 2013, the City of Bellingham, Pierce County, and the City of Redmond officially selected the second option. This Quality Assurance Project Plan (QAPP) defines the permit-required small streams status and trends monitoring that will be conducted by these three permittees. This QAPP serves as the Ecology-approved "RSMP QAPP" referenced in the permits. This QAPP defines the site confirmation and sampling protocols that these three permittees will follow while conducting the monitoring as well as the data and reports that they will produce to document their monitoring results. The RSMP Status and Trends monitoring in small streams in the Puget Sound lowlands will follow the same protocols established herein. This QAPP was developed in accordance with Ecology's QAPP guidelines (Lombard and Kirchmer, 2004).

Municipal stormwater permittees' roles

The City of Bellingham, Pierce County, and the City of Redmond will conduct monitoring in assigned sites in small streams in their jurisdictions from October 2014 through September 2015. Permittees must submit their completed version of this QAPP to their Ecology permit manager by July 15, 2014 for approval prior to sampling. The key completion dates for the permittees' required monitoring activities including site confirmation, field and laboratory work, data entry into Ecology's Environmental Information Management (EIM) database, and submission of monitoring summary reports, are summarized in Table 1.

Table 1. Key completion dates for permittees' QAPPs, monitoring activities, and reports for status and trends monitoring in small streams.

Due	Item	Description
June 15, 2014	Site selection and verification	Permittees have confirmed all sites to be monitored, including sufficient additional sites to sample if sampling attempted at any of the original sites is unsuccessful.
July 15, 2014	QAPP revisions due	Revised QAPP completed and submitted to Ecology.
August 15, 2014	Ecology QAPP review complete	QAPP reviewed within 30 days; RSMP Coordinator approves or provides comments via Permit Manager. Permittees are informed whether an inter-laboratory comparison will be done.
September 15, 2014	Deadline for final QAPPs	Final QAPP submitted to RSMP Coordinator with all comments addressed.
October 2014 - September 2015	Water quality sampling	Permittees conduct water quality sampling at the required number of lowland stream sites.
June - October 2015	Watershed health sampling	Permittees conduct watershed health (physical habitat, sediment chemistry, and biological) sampling at the required number of lowland stream sites.
December 31, 2016	Electronic data submittal due	All QA/QC'ed data submitted to Environmental Information Management (EIM) database.
March 31, 2016 and March 31, 2017	Stream monitoring reports due	Summary reports submitted to permit manager with Annual Report.

Table 2 lists key permittee staff responsible for monitoring activities detailed in this QAPP.

Table 2. Permittee project staff and responsibilities.

Phase I Permittees	Implementation of Stormwater Permit Monitoring	
Name/Contact	**Role**	**Responsibility**
Carla Vincent cvince2@co.piercel.wa.us (253)798-2467	NPDES Stormwater Monitoring Project Manager	Manage overall compliance activities; verify whether QAPP is followed and monitoring data are of known and acceptable quality; ensure adequate training of staff, complies with corrective action requirements;oversees data QA/QC and submission to EIM; oversees annual report preparation
Water Quality Specialist 3 (currently recruiting)	Field Lead	Manage and oversee monitoring activities and sampling decisions; coordinate laboratory selection and delivery, and equipment maintenance; manage internal and external field teams, prepare reports, performs data QA/QC and submission to EIM
Corrie Lee clee@co.pierce.wa.us (253)798-6822	Field Assistant(s)	Assist in site selection and confirmation, collecting and processing field samples; deliver samples, perform equipment maintenance, assist with report preparation and data entry into EIM.
Berl Eldridge beldrid@co.pierce.wa.us (253)798-2248	Field Assistant	Assist in site selection and confirmation, collecting and processing field samples; deliver samples, perform equipment maintenance, assist with report preparation and data entry into EIM.

Ecology's role

Ecology's RSMP Coordinator will either approve or comment on the permittees' completed QAPPs and transmit approval or comments to the permittee via the permittee's Ecology Regional Permit Manager by August 15, 2014. After the sampling is completed and the permittee has completed quality assurance (QA) and quality control (QC) review of the data and submitted it to EIM, Ecology staff will review and notify the permittees with data quality corrections and when the data is ready for final upload to EIM. The RSMP Coordinator will review monitoring reports. Ecology permit managers will review all submittals for compliance purposes. Ecology staff and their responsibilities are listed in Table 3.

Table 3. Ecology project staff and responsibilities

Ecology Staff	Administration of Stormwater Permits	
Name, Program, Location	**Role**	**Responsibility**
Brandi Lubliner - WQP Lacey, WA	RSMP Coordinator	Ongoing implementation and administration of RSMP. Reviews and approves completed QAPPs and project deliverables from permittees' monitoring efforts.
Christina Maginnis - WQP NWRO: Bellingham, WA	Permit Manager	Ecology's contact for stormwater permittees including Bellingham. Reviews QAPP and monitoring reports for permit compliance.
Anne Dettelbach - WQP NWRO: Bellevue, WA	Permit Manager	Ecology's contact for stormwater permittees including Redmond. Reviews QAPP and monitoring reports for permit compliance.
Chris Montague-Breakwell WQP-SWRO: Lacey, WA	Permit Manager	Ecology's contact for stormwater permittees including Pierce County. Reviews QAPP and monitoring reports for permit compliance.
William Kammin Lacey, WA	Ecology Quality Assurance Officer	Draft template QAPP review and approval.
WQP staff, Lacey, WA	EIM Coordinator	Reviews and QAs data submitted by permittees and RSMP contractors.
EAP staff, Lacey, WA	Watershed Health database coordinator	Reviews and QAs data submitted by permittees and RSMP contractors.

NWRO: Northwest Regional Office
SWRO: Southwest Regional Office
EIM: Environmental Information Management database
WQP: Water Quality Program
EAP: Environmental Assessment Program

Coordination and Training

The City of Bellingham, Pierce County, and the City of Redmond will contribute data collection information and results to the RSMP. The City of Bellingham, Pierce County, and the City of Redmond may benefit from organized efforts under the RSMP to purchase equipment and supplies and receive needed training. The City of Bellingham, Pierce County, and the City of

Redmond are required to participate in a one-day RSMP or Ecology sponsored field-based training (to be held in summer 2015) for sediment and habitat sampling prior to conducting that sampling. This program entails sampling jointly at a field monitoring site to ensure comparability of results for both programs.

Sampling Site Selection and Evaluation

The sampling site selection and evaluation process described in this section of the QAPP concerns selecting suitable sites for inclusion in the RSMP based largely on a field visit to candidate sites before the sampling begins in October 2014. Additional site suitability details that are considered on the day of sampling are described in the specific sections of this QAPP detailing the sampling methods.

Site Lists

Sampling sites within the jurisdictions of the City of Bellingham, Pierce County, and City of Redmond will be selected from a list of candidate sites referred to as the Master Sample Site list. Permittees will evaluate and confirm the suitability of sites in numerical order from lowest to highest in the ORDER column. The required numbers of sites to be monitored are stated in permit condition(s) S8.B.1.b.i for Pierce County and S.8.B.2.a for Bellingham and Redmond. Permittees will select from the list the required number of candidate sites located within their jurisdictional boundaries.

The initial 100 RSMP candidate sites (50 for each assessment region) are shown in Figure 1. The remaining candidate sampling sites will serve as replacement sites within each study area. In the event that any of the candidate sites are found to be unsuitable for sampling, and/or in the event that an insufficient number of candidate sites are located in the permittee's jurisdiction, the permittee will sample sites from the remaining master sampling site list.

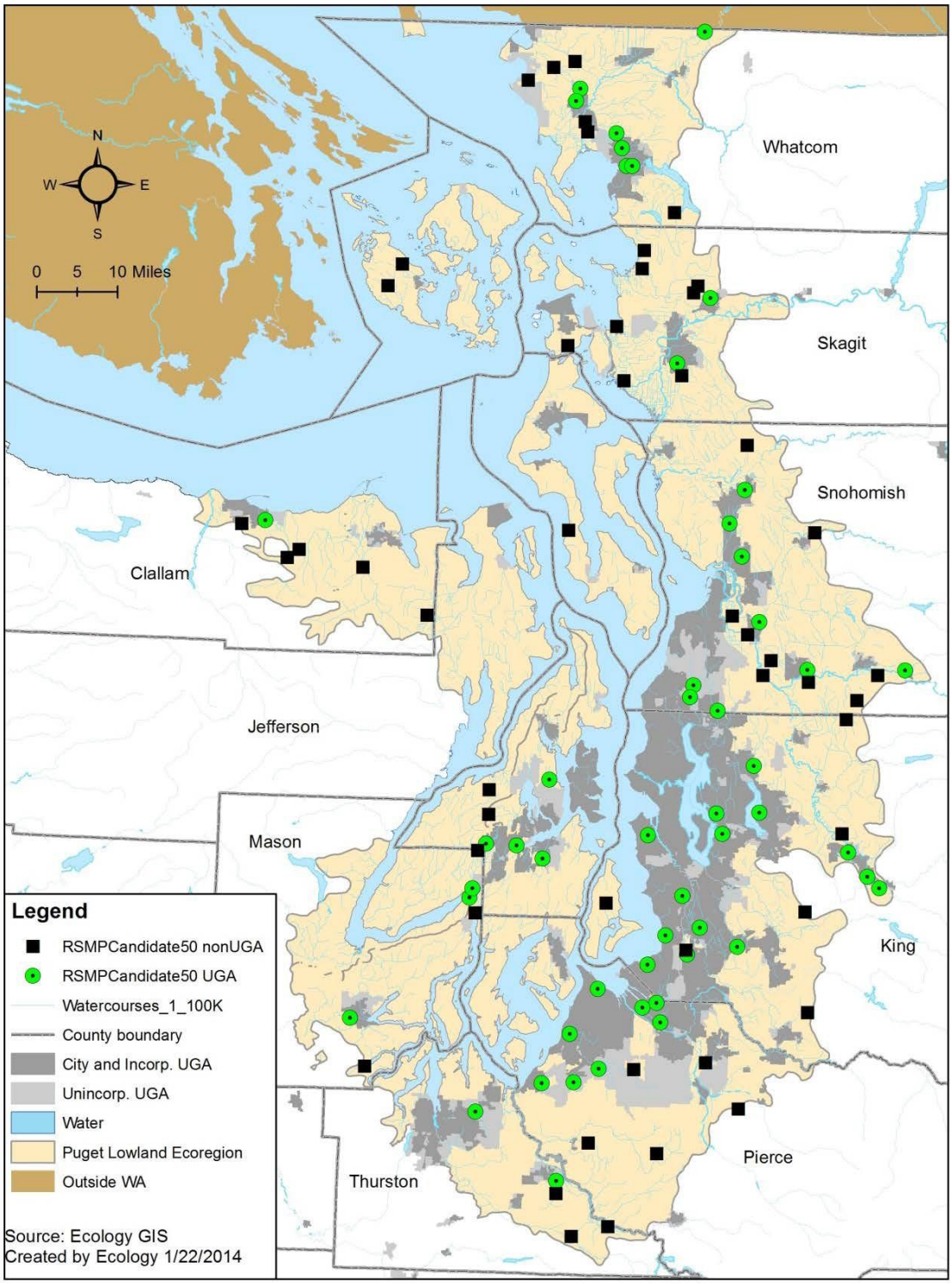

Figure 1. Initial 100 candidate site locations for the UGA and non-UGA assessment areas in the Puget Lowlands Ecoregion for the RSMP.

Candidate Sites

Candidate and alternative small stream sites for the three "Option 2" permittees Bellingham, Redmond, and Pierce County are listed in Tables 4-7 and shown in Figures 2-4. RSMP site lists are also available on Ecology's RSMP website at www.ecy.wa.gov/programs/wq/stormwater/municipal/status.html.

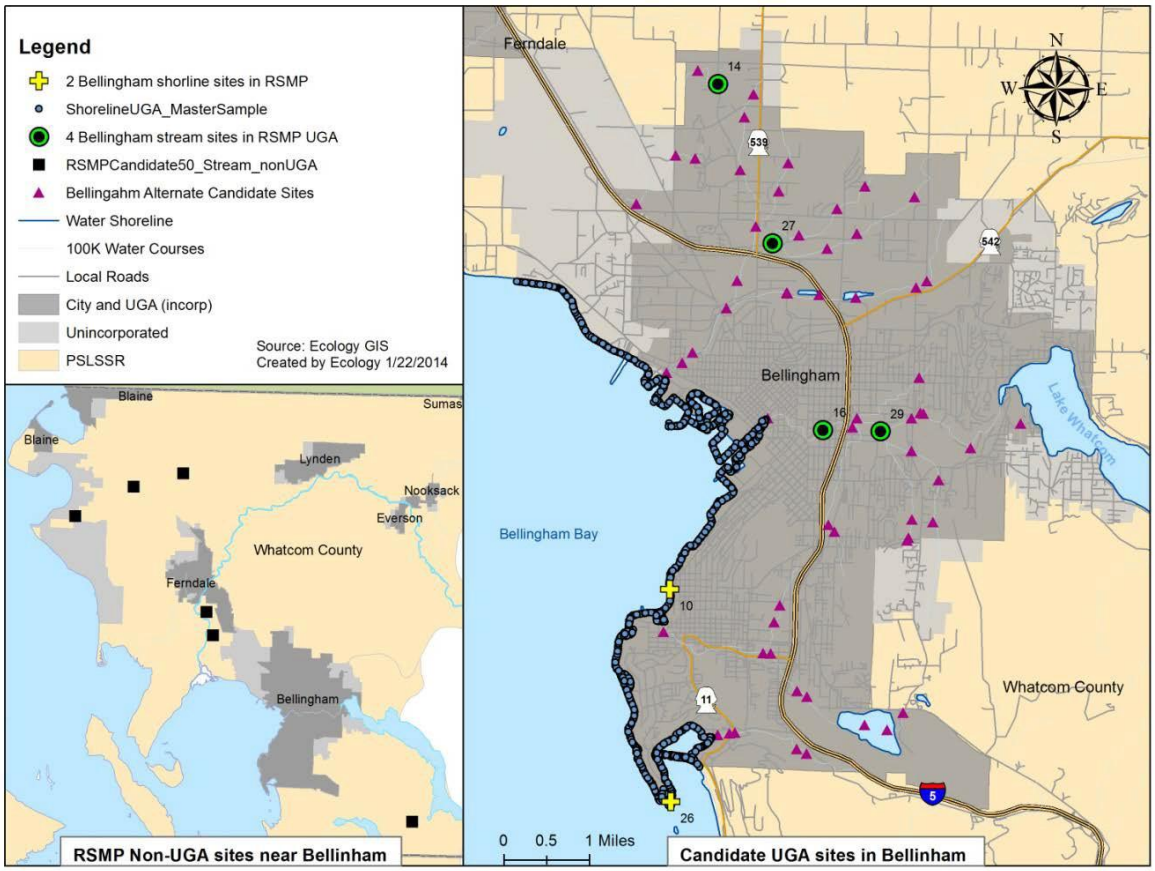

Figure 2. City of Bellingham small stream candidate UGA sites.

Table 4. Bellingham - Incorporated UGA Small Stream Sites

ORDER	LON_DD	LAT_DD	County	WRIA	Subwatershed Name	NHD GNIS	Land Manager	Land Type
14	-122.49704	48.811437	Whatcom	1	Silver Creek			
16	-122.467873	48.753304	Whatcom	1	Lower Whatcom Creek	Whatcom Creek		
27	-122.481984	48.784703	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay			
29	-122.453101	48.753318	Whatcom	1	Lower Whatcom Creek		City of Bellingham	Park/Non Wilderness
69	-122.429786	48.750858	Whatcom	1	Lower Whatcom Creek	Whatcom Creek	City of Bellingham	Park/Non Wilderness
71	-122.465551	48.790801	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay			
72	-122.455278	48.703538	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay	Padden Creek	City of Bellingham	Park/Non Wilderness
102	-122.481712	48.715267	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay	Padden Creek	City of Bellingham	Park/Non Wilderness
148	-122.477667	48.723416	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay		City of Bellingham	Unknown
154	-122.449493	48.702788	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay	Padden Creek	City of Bellingham	Park/Non Wilderness
167	-122.490768	48.778176	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay			
189	-122.445461	48.705757	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay	Padden Creek	City of Bellingham	Park/Non Wilderness
214	-122.504275	48.764077	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay	Squalicum Creek		
233	-122.444964	48.750078	Whatcom	1	Lower Whatcom Creek			
248	-122.479011	48.720555	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay		City of Bellingham	Unknown
257	-122.442114	48.756492	Whatcom	1	Lower Whatcom Creek	Whatcom Creek	City of Bellingham	Park/Non Wilderness
292	-122.472757	48.709037	Whatcom	1	Chuckanut Creek-Frontal Bellingham Bay	Padden Creek		
302	-122.475197	48.786151	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay			
308	-122.443506	48.762577	Whatcom	1	Lower Whatcom Creek			
329	-122.477755	48.776265	Whatcom	1	Squalicum Creek-Frontal Bellingham Bay	Squalicum Creek		
346	-122.459188	48.755466	Whatcom	1	Lower Whatcom Creek			

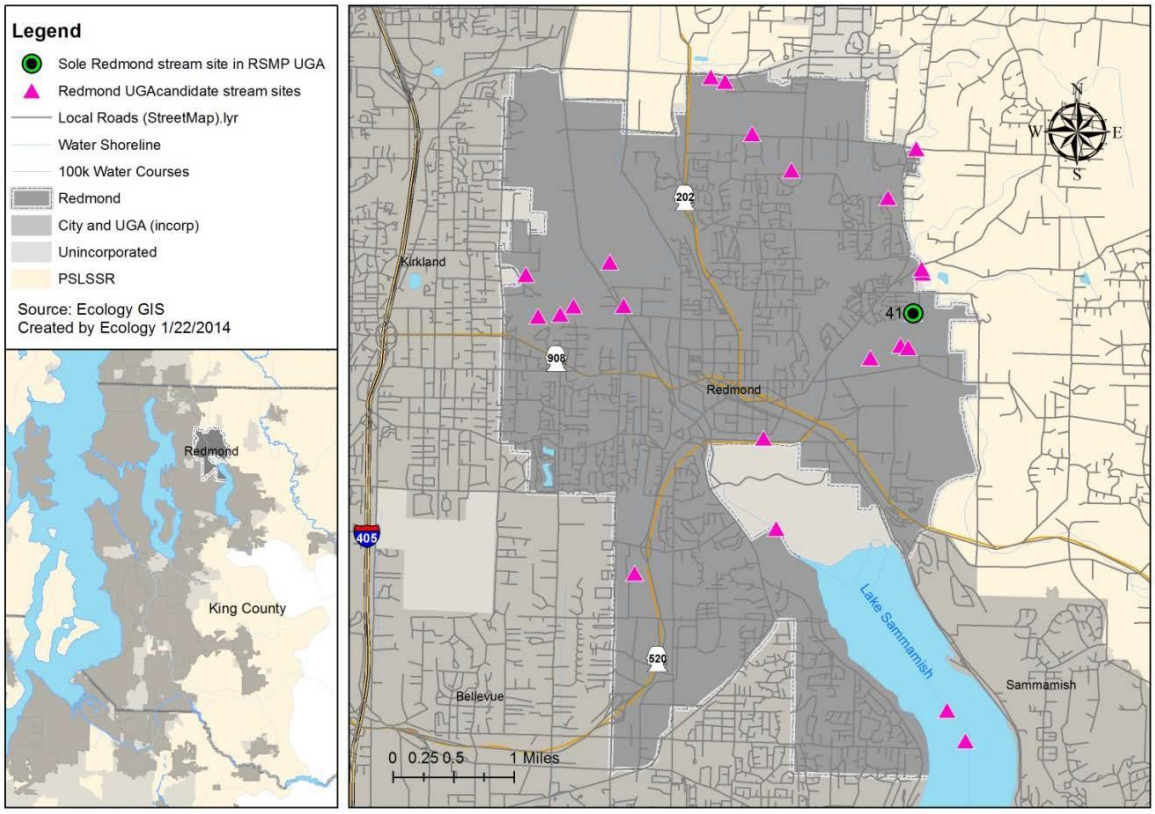

Figure 3. City of Redmond candidate small stream UGA sites.

Table 5. Redmond - Incorporated UGA Small Stream Sites

ORDER	LON_DD	LAT_DD	County	WRIA	Subwatershed Name	NHD GNIS	Land Manager	Land Type
41	-122.091069	47.68306	King	8	Bear Creek	Bear Creek		
58	-122.089474	47.687881	King	8	Bear Creek	Bear Creek		
158	-122.142431	47.683244	King	8	Bear Creek-Sammamish River			
221	-122.093184	47.679188	King	8	Bear Creek	Bear Creek		
419	-122.091832	47.678924	King	8	Bear Creek	Evans Creek		
459	-122.113141	47.6999	King	8	Bear Creek-Sammamish River			
512	-122.117131	47.667758	King	8	Bear Creek	Bear Creek		
626	-122.098486	47.677608	King	8	Bear Creek	Bear Creek		
656	-122.125271	47.710295	King	8	Bear Creek-Sammamish River			
657	-122.091099	47.702746	King	8	Bear Creek	Bear Creek		
736	-122.145028	47.688406	King	8	Bear Creek-Sammamish River			
753	-122.151274	47.683061	King	8	Bear Creek-Sammamish River			
784	-122.089709	47.688351	King	8	Bear Creek	Bear Creek		
798	-122.114555	47.65697	King	8	Bear Creek-Sammamish River	Sammamish River	County Government	Park/Non Wilderness
814	-122.159812	47.686714	King	8	Bear Creek-Sammamish River			
874	-122.139456	47.651246	King	8	Bear Creek-Sammamish River			
885	-122.157503	47.681774	King	8	Bear Creek-Sammamish River			
886	-122.12775	47.710834	King	8	Bear Creek-Sammamish River			
900	-122.083631	47.635625	King	8	Lake Sammamish-Sammamish River			
977	-122.080264	47.632008	King	8	Lake Sammamish-Sammamish River			

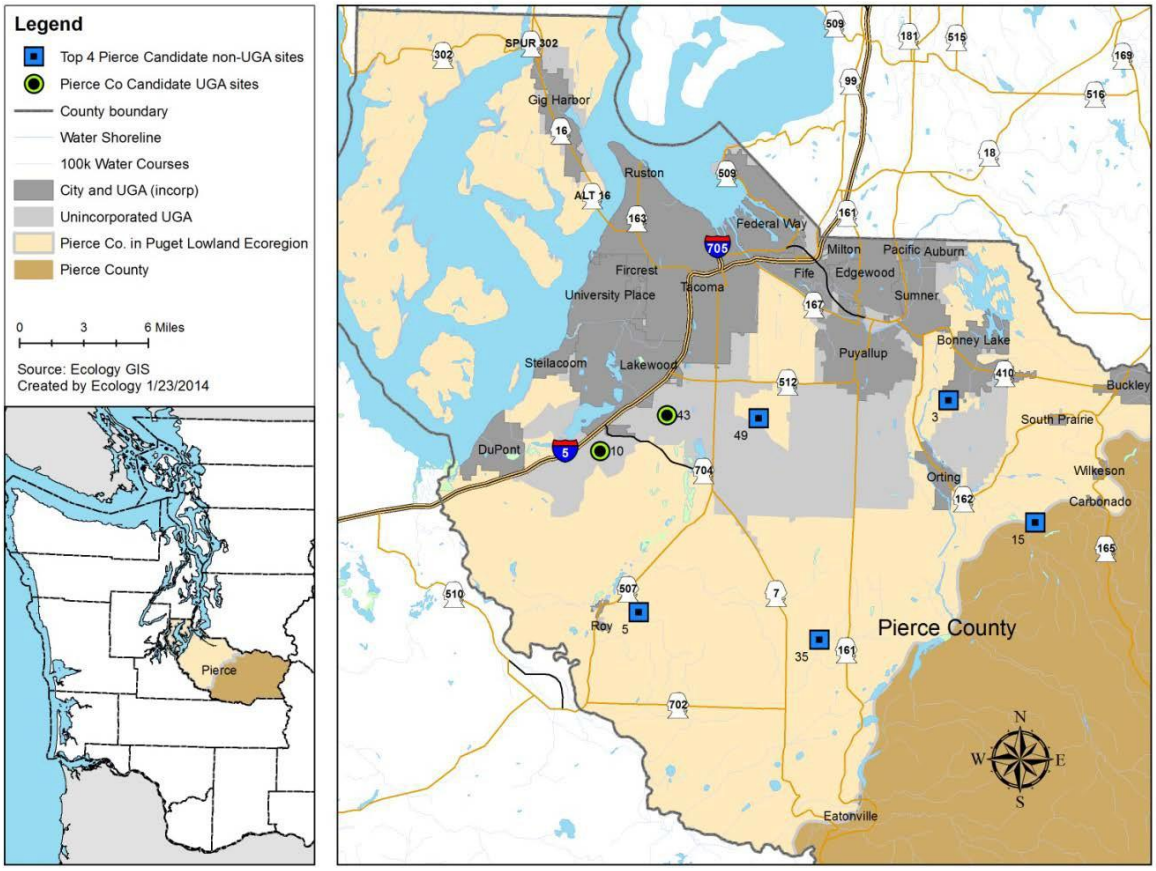

Figure 4. Pierce County UGA and non-UGA candidate small stream sites.

Table 6. Pierce County – UGA Stream Candidate Sites

ORDER	LON_DD	LAT_DD	County	WRIA	Subwatershed Name	NHD GNIS	Land Manager	Land Type
10	-122.547296	47.108694	Pierce	12	Sequalitchew Creek-Frontal Cormorant Passage	Murray Creek	US Dept. of Defense	Reservation
43	-122.481901	47.134146	Pierce	12	Chambers Creek	Clover Creek	US Dept. of Defense	Reservation
106	-122.405498	47.126288	Pierce	12	Clover Creek	Clover Creek		
150	-122.408676	47.133438	Pierce	12	Clover Creek	North Fork Clover Creek		
191	-122.45756	47.130201	Pierce	12	Clover Creek			
245	-122.5518	47.115374	Pierce	12	Sequalitchew Creek-Frontal Cormorant Passage	Murray Creek	US Dept. of Defense	Reservation
246	-122.343633	47.10244	Pierce	12	Clover Creek	Clover Creek		
247	-122.381775	47.114749	Pierce	12	Clover Creek	Clover Creek		
267	-122.195503	47.134771	Pierce	10	Fennel Creek-Puyallup River	Canyonfalls Creek		
294	-122.463671	47.130778	Pierce	12	Clover Creek	Morey Creek		
342	-122.446697	47.110045	Pierce	12	Clover Creek			
367	-122.426427	47.131428	Pierce	12	Clover Creek	Clover Creek		
412	-122.172671	47.090573	Pierce	10	Lower Carbon River			
415	-122.623671	47.381205	Pierce	15	Burley Creek-Frontal Carr Inlet	Goodnough Creek		
423	-122.452441	47.145762	Pierce	12	Clover Creek	Clover Creek		
430	-122.453775	47.099123	Pierce	12	Clover Creek			
432	-122.24726	47.083627	Pierce	10	Fiske Creek-Puyallup River			
484	-122.373516	47.103457	Pierce	12	Clover Creek	Clover Creek		
509	-122.608381	47.368334	Pierce	15	Burley Creek-Frontal Carr Inlet			
565	-122.457745	47.13305	Pierce	12	Clover Creek			

Table 7. Pierce County – Non-UGA Stream Sites

ORDER	LON_DD	LAT_DD	County	WRIA	Subwatershed Name	NHD GNIS	Land Manager	Land Name
3	-122.202609	47.148726	Pierce	10	Fennel Creek-Puyallup River	Fennel Creek		
5	-122.504983	47.000015	Pierce	11	Lacamas Creek	Lacamas Creek	US Dept. of Defense	Fort Lewis Military Reservation
15	-122.114008	47.066981	Pierce	10	Voight Creek	Voight Creek		
35	-122.325508	46.984332	Pierce	11	South Creek			
49	-122.390976	47.133516	Pierce	12	Clover Creek	North Fork Clover Crk		
73	-122.386121	46.995298	Pierce	11	South Creek	South Creek		
104	-122.682119	47.389415	Pierce	15	Key Peninsula-Frontal Carr Inlet			
109	-122.470062	47.03093	Pierce	11	Muck Creek	Muck Creek	US Dept. of Defense	Fort Lewis Military Reservation
130	-122.713058	47.216683	Pierce	15	Anderson Island		WA State Dept. Fish and Wildlife	McNeil Island Wildlife Area
149	-122.474985	46.908395	Pierce	11	Murray Creek-Nisqually River	Horn Creek		
155	-122.296259	46.993503	Pierce	11	South Creek			
210	-122.436656	47.014458	Pierce	11	South Creek	South Creek	US Dept. of Defense	Fort Lewis Military Reservation
244	-122.439264	46.92716	Pierce	11	Murray Creek-Nisqually River	Horn Creek		
245	-122.170574	47.080004	Pierce	10	Voight Creek	Coplar Creek		
256	-122.164833	47.070719	Pierce	10	Voight Creek	Coplar Creek		
275	-122.613191	47.31156	Pierce	15	Burley Creek-Frontal Carr Inlet			
294	-122.167177	47.214758	Pierce	10	White River			
306	-122.379091	46.901616	Pierce	11	Tanwax Creek	Tanwax Creek		
341	-122.688203	47.386512	Pierce	15	Key Peninsula-Frontal Carr Inlet			
376	-122.581865	47.286847	Pierce	15	Burley Creek-Frontal Carr Inlet			
381	-122.706203	47.213126	Pierce	15	Anderson Island		WA State Dept. Fish and Wildlife	McNeil Island Wildlife Area
396	-122.612194	47.320911	Pierce	15	Burley Creek-Frontal Carr Inlet			

Site Evaluation

Site evaluations, which must include a field visit to a candidate site, will determine the suitability of each site for monitoring to meet the RSMP goals. Site suitability is determined by selection criteria related to accessibility, hydrologic and geomorphic characteristics (flow, physical features, and salinity), and location relative to a candidate sites' original coordinates.

Candidate sites for evaluation are from the Master Sample Site list that was generated for Puget Lowland Ecoregion streams that drain to Puget Sound. Within that area, candidate sites are specified within each of the assessment regions: inside the Urban Growth Area (UGA) boundaries, and outside the UGA boundaries. Site evaluations will begin with the priority list of the initial 100 RSMP candidate sites, with 50 for each assessment region shown in the following "Site Lists" section. If any of those initial candidate sites are deemed unsuitable for monitoring, additional candidate sites for the relevant assessment region will be evaluated in the numerical order listed in the Master Sample Site list (from lowest to highest in the ORDER column).

The site evaluation procedure will start well in advance of the sampling season, ideally in March through May 2014, and will continue through the sampling season as necessitated by potential changes in site conditions that affect suitability for sampling. Desktop evaluation of candidate sites will be performed in advance of the initial site evaluation visit, and will include comparing candidate site coordinates to existing information on such items as surficial geology, parcel/property ownership, NHD waterbody type, historical streamflow and /or water quality data, and aerial photographs.

Criteria for Selecting a Suitable Sampling Site

Selection criteria for determining the suitability of a candidate site for monitoring to meet the RSMP goals are described below.

Accessibility Criteria

These criteria concern whether access to a site is permitted by the land owners, and if the site can be safely accessed and sampled throughout the year. A site may also be deemed unsuitable, or impracticable, for sampling certain if more than one hour is required to access the site from the nearest parking location.

Permission

If a candidate site is not obviously accessible through public property, property owners and/or tenants whose property will need to be accessed will, if feasible, be contacted prior to site evaluation. Parcel information gained from the desktop evaluation will be researched and a good faith effort to contact owners or tenants will be made. A site will be deemed unsuitable for sampling if permission has been denied by all land owners, tenants, or resource managers along the entire hydrologic reach (see *Location Criteria*, below). The Washington State Department of Natural Resources (WDNR, 2010) describes how to discern public and state-owned waters.

Safety

Overall safety conditions for access and sampling will be assessed prior to sampling, based on state and federal law and organizational policy. But it is ultimately the responsibility of the field crew at each time of arrival to decide if it is safe to enter the stream to conduct the sampling. Appropriate reasons for disqualifying a site from sampling may include:

- flow is too swift or too deep;
- route of entry is unstable;
- hostile people or animals are present.

Flow, Physical, and Salinity Criteria

These criteria concern the conditions of the stream and streambed with regard to the specific types of data desired for the RSMP. To be considered a suitable sampling site, the waterbody at the candidate site coordinates must be on a stream or small wadeable river, and not on a lake, pond, wetland, or estuary. Specifically, the waterbody must have:

- a net flow of water that is unidirectional;
- defined left and right banks readily discernible from mid-stream;
- uninterrupted surface-water flow for more than half the length of approximately 20 bankfull widths or a minimum of 150 meters surrounding the candidate site coordinates;
- perennial flow (as best as can be determined at the time of the site visit);
- flow in a natural channel that might have been highly modified, but was not constructed (such as canals, ditches, or pipelines);
- natural substrate on the channel bottom;
- freshwater, as defined by a water column with more than 95 percent of its depth with less than 1 part per thousand salinity at any time during the year. Multiple lines of evidence may be used to make this estimation (*e.g.*, vegetation, proximity to a known estuary, or salinity measurement).

Location Criteria

The following location rules apply such that the site reflects the intended probabilistic stream characteristics. During the site evaluation field visit, the field crew will attempt to access the site at the given coordinates or as nearby as possible, with recognition of the challenges of sampling in urban areas, particularly in gaining access to discretely defined locations. Ideally, a suitable sampling location will be located within 250 meters of the given candidate site coordinates.

However, if access, flow, physical, and chemical criteria are not met within this distance, the field crew may continue to investigate locations upstream and downstream of the initial reach with the objective finding a suitable site that maintains the original candidate site characteristics. More specifically, suitable sampling sites upstream and downstream of the candidate site coordinates must fall within these constraints:

- the final site is the same size class of the original candidate site; and
- there are no continuous surface-water inflows in excess of approximately 25 percent of the flow already in the reach[1]; and

[1] During the site confirmation process, questions about a how specific reach is defined should be directed to RSMP Coordinator Brandi Lubliner at 360-407-7140.

- either :
    - there is no substantial, abrupt change in adjacent land use such as from residential to industrial, or from native vegetation to developed conditions; or
    - the final site is less than 500m from the original candidate site coordinates.

The RSMP will determine how to interpret (*i.e.*, statistically weight) the data from all of the sites sampled by permittees who have chosen to conduct their own monitoring.

Documentation of Site Evaluations

The Cities of Bellingham and Redmond, and Pierce County must verify all sites given the suitability criteria above. Documentation of observations from both the desktop and field visits will be recorded and provided to the RSMP upon request. Permittees will provide a table listing the decisions and reasons for site selection or disqualification resulting from the site evaluations to the RSMP Coordinator by June 15, 2014.

As of the September 1, 2014, twelve sampling locations were confirmed. Table 8 includes the original candidate center point coordinates, and the shifted center point coordinates where applicable. Table 9 includes sites that were inspected but deemed to be unsuitable for sampling.

Table 8 - Confirmed Sampling Sites - Pierce County

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
			Inside UGA		
43	-122.481901, 47.134146	TBD at October 2014 sampling	Clover Creek @ JBLM	Inspected site with assigned JBLM escort. Good stretch, although candidate point is located immediately adjacent to paved runway. Will need to shift center point west. Need sponsored monthly pass to conduct sampling, so candidate point will be GPSd in October 2014.	7/10/14
106	-122.405498, 47.126288	-122.406853, 47.126061	Clover Creek @ Brookdale Golf Course.	Good site, accessed by ~10 min walk through golf course. Confirmed year-round flow with owner. As of 7/31/14, do not have permission to access parcel to east of candidate point. May have to shift center point west to keep all sampling on Brookdale Golf Course property. Stream is suitable throughout golf course property.	12/11/2013 7/18/14
294	-122.463671, 47.130778	-122.46555, 47.13894	Morey Creek @ Wetland	Suitable. Coordinates of candidate point are slightly south of actual creek bed on pasture area, but will be shifted north to creek. The substrate on the channel bottom is natural; but portions are 90% sediment with very few rocks. As of 7/31/14, have not obtained permission to access parcel to east of candidate point. Will need to shift center point west for study.	4/18/2014
367	-122.426427447.131428,	-122.425953, 47.130168	Clover Creek @ South of 138th St. E.	Good flow; easy access. Candidate point falls on 138th St East ROW; near where three forks converge. Based on lack of defined channel in immediate vicinity of candidate point, will need to shift center point SE.	4/18/2014
			Outside UGA		
104	-122.682119447.389415,	-122.681373, 47.389609	Little Minter Creek @ SR302 and 144th St. NW.	Good site with easy access, though substrate is silty. Intend to shift center point slightly to NE so that all sampling can be conducted on Key Peninsula Metropolitan Parks District parcels.	12/18/2013
149	-122.474985, 46.908395	-122.474773, 47.908618	Horn Creek @Rural subdivision	Easy access to creek. Possibly deep with low velocity flow. Will probably not need to significantly shift candidate point.	12/3/2013

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
245	-122.170574, 47.080004	-122.169768, 47.078095	Coplar Creek @ Buttes subdivision.	Great access, substrate, depth and flow. As of 7/31/14, do not have permission to access parcel defining north end of sampling reach. Shifted point slightly south.	12/18/2013
275	-122.613191, 47.31156	-122.616033, 47.314628	Wollochet Creek	Reasonable access, perennial flow. Area near candidate point choked with cattails. Will need to move center point upstream about 500 meters in order to get benthic samples.	12/18/2013
341	-122.688203, 47.386512	-122.687814, 47.38647	Little Minter Creek @ Upstream of PC WQI Stn	Suitable perennial creek. Will probably not need to significantly shift candidate point.	12/18/2013
376	-122.581865, 47.286847	-122.581472, 47.285675	Sullivan Gulch Creek	Good creek with difficult access though forests (no trail). Will need to shift candidate point about 150 meters south to avoid thick brush overhanging creek.	12/18/2013
396	-122.612194447.320911,	-122612467, 47.320673	Wollochet Creek	Easy access with low flow during summer months. Will probably not need to significantly shift candidate point.	12/18/2013
465	-122.394102, 47.224004	-122.39403, 47.224014	Upper Swan Creek @ Park.	Good creek and ease of access. Will not need to significantly shift candidate point	1/23/2014

Table 9 - Rejected Sampling Sites – Pierce County

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
Inside UGA					
10	-122.547296	47.108694	Murray Creek @JBLM	Inspected with assigned JBLM escort. Index Station coordinates located off busy intersection by Madigan Hospital with lack of safe parking. Creek has unsafe depth and very low flow. According to JBLM likely caused by beaver dams (recurrent problem); and clogged culvert about 300 feet upstream.	6/10/14.
150	-122.408676	47.133438	North Fork Clover Creek @ Brookdale Golf Course.	North fork goes dry during summer months.	12/11/2013
191	-122.45756	47.130201	Spanaway Creek @ Wetland	Emergent/scrub-shrub wetland area >500m in both directions from coordinate point. Channel not clearly defined. Very Low flow.	4/18/2014
245	-122.5518	47.115374	Murray Creek @ JBLM	Inspected with assigned JBLM escort. Brushy wetland conditions in both directions. Lacks defined left and right banks readily discernible from mid-stream	Attempted 7/3/2013 6/10/14
247	-122.381775	47.114749	Clover Creek @ Wetland area	Channelized with deep silt; contiguous area wetland. Not safely wadeable.	1/27/2014
267	-122.195503	47.134771	Canyon Falls @ Headwaters	Creek incorrectly mapped - most of canyon dry - no surface water or hydrophytic veg. within 500 meters of this index station.	3/12/2014
342	-122.446697	47.110045	Spanaway Creek @ Lake	Index Station located in the middle of Spanaway Lake.	4/16/2014
412	-122.172671	47.090573	Carbon River	River is too deep, fast, and wide to safely sample.	1/27/2014
423	-122.452441	47.145762	Clover Creek @ Headwaters	No water observed within 500m of coordinates.	4/18/2014

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
430	-122.453775	47.099123	Spanaway Ck near inlet to Spanaway Lake (west of confluence with Coffee Creek)	Point is in palustrine forested wetland near confluence of Spanaway Creek and Coffee Creek. Lacks defined left and right banks readily discernible from mid-stream.Similar conditions >500m either direction from candidate point.	4/18/2014
432	-122.24726	47.083627	Large wetland area draining east to Puyallup valley.	Areas within 500m of index station are ponds; with no clearly defined channel. Access from Sunrise PDD is barricaded; dirt roads to site steep (can not access with vehicle). Over an hour walk to site; evidence of homeless camp & beaver activity	4/11/2014
484	-122.373516	47.103457	Clover Creek @ Pierce County property.	Palustrine scrub-shrub wetland with dense cover of reed canarygrass within 500 m of Index Station coordinates. Lacks defined left and right banks readily discernible from mid-stream.	1/28/2014
509	-122.608381	47.368334	Canterwood Country Club	Index station coordinates located along the edge of a water hazard on the golf course, with no visible creek or inflow.	5/1/2014
565	-122.457745	47.13305	Near PLU	No water feature evident near Index Station coordinates.	4/16/2014
Outside UGA					
3	-122.202609	47.148726	Fennel Creek @ Private development	Creek in steep & deep ravine. Access from NE is gated.	Attempted 7/3/13
5	-122.504983	47.000015	Lacamas Creek @ JBLM	Inspected with assigned JBLM escort. Lacks defined left and right banks readily discernible from mid-stream	Attempted 7/3/13 6/10/14
15	-122.114008	47.066981	Voights Creek	Creek in steep ravine no walkable access. Deep and fast current.	7/3/2013

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
35	-122.325508	46.984332	South Creek tributary.	Private parcel gated, so viewed from 304th Street to south. No surface water observed in channel (channel completely dry).	Attempted 7/3/13
49	-122.390976	47.133516	North Fork Clover Creek.	Spoke to parcel owner, who said it goes completely dry during the summer. Also, PC-SWM takes monthly water quality samples at point about 3 km downstream, which consistently goes completely dry during summer months..	12/3/2013
73	-122.386121	46.995298	South Creek @ Bonneville powerline	Unsafe, brushy access. Creek is wide with swift flow.	4/28/2014
109	-122.470062	47.03093	Muck Creek @ JBLM	Creek bed dry (no surface water observed)	6/10/14
130	-122.713058	47.216683	McNeil Island	Coordinates located at a hillside seep. General area is swampy with very low flow. Lacks defined left and right banks readily discernible from mid-stream	3/27/2014
155	-122.296259	46.993503	Pond @ private property.	Pond location, very deep and wide with no flow.	12/3/2013
210	-122.436656	47.014458	South Creek @ JBLM	Inspected with assigned JBLM escort. Observed low surface flow. JBLM biologist who did field visit with us said it goes completely dry in summer months.	Attempted 7/3/2013, 6/10/14
244	-122.439264	46.92716	Horn Creek @ Marshy channel	Currently being short-platted (potentially multiple owners in next few years). This may negate any right of entry we establish now. Also, buffer may be susceptible to logging/disturbance., Very brushy. Point is in stagnant stretch of forested/shrub wetland about 40 feet wide –lacks defined channel. Evidence of beaver activity in area (chewed trees)	12/3/2013
246	-122.343633	47.10244	Clover Creek @ Tacoma Sportsman's Club	Relatively easy access to creek, though brushy and safety concerns due to parking area and trails to creek being in a shooting range. Substrate on parts of stretch waist-deep silt and are unsafe to sample	1/28/2014
256	-122.164833	47.070719	Coplar Creek	Coordinates inaccessible in steep canyon with fast flow and no apparent trails.	12/18/2013
294	-122.167177	47.214758	Lake Tapps wetland	No creek found at or near coordinates.	12/18/2013

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
306	-122.379091	46.901616	Tanwax Creek @ Private timberland property.	Gated community -no way to access parcels without private code.	Attempted 12/3/13
381	-122.706203	47.213126	McNeil Island	Coordinates located along an upland utility corridor. No surface water observed.	3/27/2014
410	-122.035309	47.145161	Spiketon Ditch @ Buckley	No access, dense and brushy. Multiple no trespassing signs	Attempted 12/18/13
424	-122.393276	47.164263	Swan Creek @ Irrigation channel.	Very low flow and, dry during summer. Lots of grasses and trash.	1/23/2014
436	-122.478304	46.930292	Murray Creek	Index Station coordinates located in a scrub-shrub area with "Wetland Buffer" signs posted. No defined channel.	1/23/2014
445	-122.546219	47.010146	Muck Creek @ tributary	Difficult access and dry during summer.	Attempted 1/23/14
449	-122.113955	47.100507	Carbon River	River is too deep, fast, and wide.	1/27/2014
460	-122.366351	46.910661	Tanwax Creek @ Private timberland property.	Same area where access was attempted for site 306. No Access	Attempted 1/23/14
2734	-122.724434	47.203836	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014
5387	-122.705143	47.22417	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014

Mid-Study Changes Affecting Site Suitability

Pierce County will make a good faith effort to sample at the selected sites per QAPP requirements. If a site becomes unsuitable for sampling during the course of the study, the RSMP Coordinator will be notified. Reasons a site may be come unsuitable include, but are not limited to: a stream goes dry; the adjacent parcel(s) change ownership, and the new owner does not grant permission; or natural causes such as mudslides or animals make the site not longer safe to access.

If suitability conditions change prior to sampling a site for watershed health and sediment chemistry and the site is no longer suitable, then a new RSMP site needs to be identified from the list in order. If suitability conditions change after sampling the site for watershed health and sediment chemistry and the site is no longer suitable, sampling will simply discontinue for this round of RSMP sampling and conditions noted on the site lists."

Measurement Quality Objectives

Measurement quality objectives for small stream monitoring described here are to obtain and analyze sufficient numbers of high quality samples to meet the goals and objectives of this program. Data quality indicators include precision, bias, sensitivity, representativeness, comparability, and completeness (Appendix B). The biological and habitat indicators adopted for this program come from Ecology's Watershed Health Monitoring Program for small streams (Adams, 2010a). The adopted water chemistry indicators come from Ecology's Water Quality monitoring program (Hallock, 2012), and the adopted sediment chemistry indicators come from multiple monitoring efforts within Ecology (Dutch et al., 2010; Johnson, A., 2010; and Meredith and Furl, 2008).

Field measurements

Measurements of water quality, sediment size estimation, and stream habitat variables are taken by field staff during a sample collection event. The City of Bellingham, Pierce County, and the City of Redmond must follow the collection methods, reporting requirements, and quality control (QC) procedures summarized in the *Field Operations* sections of this report. This approach will provide field measurement data that meet measurement quality objectives (MQOs) for status and trends monitoring for small streams under the RSMP, listed in Tables 24 and 25.

Pierce County will make a good faith effort to collect monitoring data described per QAPP requirements. If a water quality sample or measurement is missed on occasion, a second effort will be made to collect the sample within the same month. If a second attempt is also unsuccessful, then the RSMP Coordinator will be notified, and a third attempt is not required.

Reasons a sample or measurement may not be made include, but are not limited to: a stream goes dry, the stream site cannot be accessed due to high flow conditions, vandalism, extreme climatic conditions, or monitoring equipment has a sudden failure. Flow measurements may need to be estimated using high water mark, staff gages, or other estimation techniques during the winter

months to minimize exposure to hazardous conditions for staff. Water quality samples and measurements made during very high flows may be made from anywhere within the site reach.

Laboratory measurements

Sediment and water quality analyses will be conducted at Ecology-accredited laboratories, except those noted in Table 10. Ecology's Laboratory Accreditation Program maintains a searchable database that may be accessed from this website: www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html. (Laboratory methods and reporting limits are listed in the *Quality Control* section). Unless alternative methods are approved by Ecology in writing, the analytical methods listed per this QAPP shall be used by Permittees when monitoring as required by section S8B.2 of this permit. Any alternative method proposed by the Permittee must have a similar reporting limit, or must be justified as adequate for the likely range of concentrations. Permittees are not guaranteed approval of their alternative methods or reporting limits.

Taxonomic identification will be conducted by a lab that employs taxonomists certified by the Society for Freshwater Science at the genus level. The taxonomist should have experience with the freshwater macroinvertebrates of the Pacific Northwest.

Work performed by the City of Bellingham, Pierce County, and the City of Redmond is expected to meet the quality control requirements of the analytical methods stated in this QAPP. These requirements are summarized in the *Quality Control* section of this document.

Laboratory selection

Multiple laboratories will be needed to ensure sample completeness. Contracting for laboratories is a responsibility of the permittee. Permittees may consider their own or other permittee's laboratories, commercial laboratories, or Ecology's Manchester Environmental Laboratory (MEL). Laboratories for water and sediment parameters will be selected based on their current accreditation status with Ecology (www.ecy.wa.gov/programs/eap/labs/search.html) and their ability to achieve acceptable limits of detection for the parameters measured as part of this project. Where feasible, laboratories on the list may subcontract with each other to achieve the required analyses.

Table 10. Selected laboratories for sample processing.

Laboratory Name	Analytical Purpose	Address	Phone
Manchester Environmental Laboratory (MEL)	Primary: water quality (except for bacteria) and sediment; Inter-laboratory comparison sediment samples, [3]	7411 Beach Drive East Port Orchard, WA 98366	(360) 871-8800

Laboratory Name	Analytical Purpose	Address	Phone
Spectra Laboratories	Primary: monthly bacterial samples	2221 Ross Way, Tacoma, WA 98421	(253) 272-4850
AmTest Laboratory	Secondary: monthly bacteria samples	13600 NE 126th PL, Suite C Kirkland, WA 98034	(425) 885-1664
Rhithron Associates, Inc.[1]	Stream benthos and periphyton	33 Fort Missoula Road Missoula, Montana 59804	(406) 721-1977
AXYSAnalytical Services Ltd.[2]	Pharmaceuticals and personal care products (PPCPs) and hormones/steroids (H/S).	2045 Mills Road W. Sidney BC Canada V8L 5X2	+1 (250) 655-5800

[1] Chlorophyll a may be done either at Rhithron or MEL or another Ecology approved laboratory. Rhithron must be used for benthos and periphyton to remain consistent with the RSMP.

[2] Axys Analytical is required for PPCP and H/S analysis.

[3] There will be a inter-laboratory comparison element for sediment chemistry samples if different laboratories are used between the Option 2 permittees and the RSMP. One set of samples for the inter-laboratory comparison must be sent to MEL.

General Field Sampling Procedures

This section describes field sampling procedures. This QAPP's appendices C through F provide detailed procedures for watershed health, water quality monitoring and quality control. Appendix G provides field forms that may be used in the field for data collection.

Scientific collection permit

Permittees are responsible for obtaining the necessary permits for sampling macroinvertebrates. The scientific collection permit is required by the Washington Department of Fish and Wildlife (http://wdfw.wa.gov/licensing/scp). Permittees are advised that it may take several months to process and acquire these permits.

Safety

The City of Bellingham, Pierce County, and the City of Redmond should develop a site-specific safety plan including at a minimum the following elements.

Sampling

Field activities should be conducted by at least two people. Activities can be parsed into tasks to be accomplished by one or more persons at a given time. A contact person will be designated at the office to which field personnel report at the end of each day at pre-designated times. Staff must carefully plan field activities and obtain permission to access private land. Staff may also notify the land owner which day they will be sampling.

Field and laboratory preservatives

Biological samples collected from streams must be preserved immediately following storage in containers. Inadequate preservation often results in (1) loss of prey organisms through consumption by predators, (2) eventual deterioration of the macroinvertebrate specimens, and/or (3) deformation of macroinvertebrate tissue and body structures, making taxonomic identification difficult or impossible.

The field preservative used for biological samples is 85% denatured ethanol. The preservative is typically prepared from a stock standard of 95% denatured ethanol. Flammability, health risks, protective equipment, and containment information are listed on warning labels supplied with the preservative container. Detailed information can be found with the Materials Safety Data Sheets (MSDS). Minimal contact with the 95% denatured ethanol solution is recommended.

For the water samples, several of the nutrient parameters require field preservation using hydrochloric acid (HCL) or sulfuric acid (H_2SO_4) (see Table 21). These jars can be ordered with preservative in them, and they must be handled carefully.

Equipment and maintenance

A list of equipment necessary to complete both watershed health and water quality monitoring field activities is presented in Appendix H of this QAPP.

Servicing of scientific instrumentation will follow manufacturers' methods and will be conducted as needed. General maintenance will consist of equipment inventories, inspections, testing, and replacement of worn, torn, or missing components.

Equipment decontamination and prevention of spread of aquatic invasive species

Field work will be conducted and equipment cleaned to prevent the spread of invasive species. Staff practices and equipment that contact multiple surface waters will, at a minimum, be cleaned according to Ecology's standard operating procedure (SOP) EAP070, *Minimizing the Spread of Aquatic Invasive Species* (Parsons et al., 2012). These procedures will be followed at the end of each work day or upon leaving a water body before entering another. Some areas are designated to be of "Extreme Concern"; these areas are shown in several maps at the following link: www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html

All sediment material not retained for analyses or archiving will be rinsed near the sampling location with stream water. Also, the sediment scoop and bowl will be rinsed on-site. Used equipment will not be used at another site on the day of sampling, unless completely cleaned.

Any portion of the sampling equipment (nets, sample container holders, scoops, bowls), filters, or other materials coming into contact with the sample will be decontaminated prior to use or will be certified as pre-cleaned from the equipment source. Sampling equipment and containers will be prepared prior to the sampling event. Otherwise, cleaning will match the purpose of sampling. For example, the kick nets only need to be free of benthic macroinvertebrates, leaves, and sticks and air dried. Nets, buckets, funnels, and other general sampling equipment may be washed or rinsed with tap water and air dried.

Water sampling equipment

The containers used to collect nutrient samples should be washed in 10% HCl and triple rinsed in deionized water prior to collecting each sample (Ward, 2007a).

Sediment sampling equipment

The stainless-steel scoops and bowls used to collect sediments for organic analysis need to be properly cleaned using the following procedure. Clean implements will be stored in aluminum foil or polyethylene bags for transport to the field station. Stainless-steel sampling implements, including the spoons, bowls, and stirrers, will be cleaned sequentially:

1. Washing in non-phosphate detergent (Liquinox) and hot tap water.
2. Rinsing with hot tap water.

3. Rinsing with 10% nitric acid (if sampling for metals).
4. Rinsing with deionized water three times.
5. Air drying in clean area free of contaminants.
6. Rinsing with pesticide-grade acetone (if sampling for organics).
7. Air drying in clean area free of contaminants.

After drying, equipment will be wrapped in aluminum foil and stored in polyethylene bags until used in the field. Sampling equipment will be dedicated to a single site. Reuse will require cleaning as outlined in the procedure above, which is based on EPA guidelines (EPA, 1990).

Labeling samples

Labeling is used to identify where and when a sample was collected and the analyte(s) in that sample to be analyzed. Laboratory-prepared bottles will be labeled to identify the cleanliness and/or preservative contents for each bottle. Bottles will be either numbered or pre-labeled to ensure proper handling. Labels will be filled out in pencil or permanent pen, placed on sample containers. Sample labels will contain the following information:

- Site name and SITE_ID
- Analysis to be performed
- Date and time of sampling
- Sample ID or coding information
- Sample numbers (1 of 3, 2 of 3, and so on)
- Name/initials of field tech performing the sampling

This labeling information will be written in the chain-of-custody forms, which are discussed below.

Chain-of-custody procedures for samples

Chain-of-custody (COC) procedures are necessary to ensure thorough documentation of handling for each sample, from field collection to laboratory analysis. The purpose of this procedure is to minimize errors, maintain sample integrity, and protect the quality of data collected. A COC form will accompany each cooler of samples sent to a laboratory. Individuals who manipulate or handle these samples are required to log their activities on the form. When the laboratory receives a cooler of samples, it will assume responsibility for samples and maintenance of the COC forms. The laboratory will then conduct its procedures for sample receipt, storage, holding times, tracking, and submittal of final data to the responsible parties. Example COC forms for benthic and water or sediment chemistry samples are in Appendix L.

Watershed Health Monitoring

This section describes watershed health monitoring which refers to physical habitat, soil chemistry measurements, and biological community characterization. These measurements and samples will be collected once at each site during the period July 1 through October 15, 2015. The biological, physical habitat, and sediment chemistry parameters for watershed health monitoring are presented in Tables 11 and 12.

Analysis for PPCPs and H/S will be conducted on a sub-set of sediment sites, those that number from 0-120 in the "ORDER" column in the site list available at Ecology's RSMP website. Therefore, the cities of Bellingham and Redmond, and Pierce County will monitor only the selected sites with an order number between 0-120 in Tables 4-7 in this QAPP.

Table 11. Biological and habitat parameters for watershed health monitoring

Biological and Habitat Parameters
Aquatic macroinvertebrates (benthos)
Periphyton
Physical habitat (discharge, slope and bearing, wetted width, bankfull width, bar width, substrate size, substrate depth, shade, human influence, riparian vegetation, large woody debris).

Table 12. Sediment chemistry parameters for watershed health monitoring

Sediment Parameters
Grain size estimation
Total organic carbon (TOC)
Percent Solids
Metals (arsenic, copper, lead, and zinc)
Polynuclear aromatic hydrocarbons[1,2]
Pesticides[1,3]
Phthalates[1,4]
Polybrominated diphenyl ethers (PBDEs)[1,5]
Polychlorinated biphenyls (PCBs)[1,6]
Hormone disrupting chemicals: Pharmaceuticals and personal care products (PPCPs) and hormones and steroids (H/S)[1,7]

[1] Additional parameters recommended by the SWG, to the extent that funding becomes available. Permittees selecting Option 2 will monitor for these additional parameters.

[2] PAH compounds include: 1-methylnaphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, acenaphthene anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, dibenzofuran, carbazole, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, retene.

[3] Pesticides include: 2,4-D, triclopyr, carbaryl, and chlorpyrifos.

[4] Phthalates include: bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate.

[5] PBDEs include: 47, 49, 66, 71, 99, 100, 138, 153, 154, 183, 184, 191, 209.

[6] PCBs include: all 209 congeners.

[7] Hormone disrupting chemicals include: pharmaceuticals and personal care products, hormones and steroids per EPA Methods 1694 and 1698, respectively.

Field activities and protocols for watershed health monitoring

The field activities and associated data collection protocols required for watershed health monitoring are described below. For each activity, the reader is also referred to specific appendices in this QAPP. The protocols in this QAPP have been tailored to the RSMP and based on Ecology's ambient biological monitoring program (Adams, 2010a) and Ecology SOPs for measuring physical habitat (Clinton, 2009; Kennedy, 2009; Werner, 2009a,b,c d).

The primary field data and samples collected during watershed health data collection event (DCE) include stream discharge, sediment chemistry, benthic macroinvertebrates, periphyton, and habitat. Water quality may also be monitored (as described in the *Water Quality Monitoring* section of this QAPP) during a watershed health DCE, or it may be completed during a separate site visit.

One site is typically sampled in one workday by a two-person field team (Table 13). The following activities must be completed in the listed order during the day in order to avoid damage to biological specimens while sampling sediment or measuring habitat:

1. Site verification and layout
2. Streamflow measurement
    - Optional: water-quality measurement and sample collection
3. Benthos and periphyton sample collection
4. Sediment chemistry sample collection
5. Habitat measurements

Table 13. Typical daily work flow for a watershed health data collection event.

Activity	# Staff	Time Since Arrival On-site (hours)				
		1	2	3	4	5
Verification & Layout	1	■				
Streamflow measurement	2	■				
Benthos/periphyton sample collection	2		■			
Sediment sample collection	2			■		
Habitat measurements	2				■	■

Watershed health monitoring is conducted according to a reach-wide sampling scheme (Hayslip, 2007) that uses equidistant transects set along a stream reach with a length equal to 20 times the bankfull width at the sample site. However, for any site with bankfull width less than 8 meters, the site length will be extended to 150 meters. Benthos and sediment sampling along the reach are conducted systematically without consideration for habitat type. For example, the sampler might start collecting on the left bank at transect one, move to midstream at transect two and the right bank at transect three, and move back again until 8 square feet have been sampled from

randomly chosen transects. A list of the field activities required for monitoring watershed health and the corresponding appendices of this QAPP that describe the procedures and protocols is given in Table 14.

Table 14. Field activities for watershed health monitoring, QAPP appendices describing the procedures, and where at a site the activities take place.

Activity	Appendix	Where[1]
Site verification and layout	C-1	Entire site
Streamflow measurement	C-3	Near index station
Benthos sample collection	D-1	Major transects
Periphyton sample collection	D-3	Major transects
Sediment chemistry sample collection	C-4	Near index station
Habitat measurements		
Bank measurements	C-5	Major transects
Substrate and depth measurements	C-6	Major transects
Shade measurements	C-7	Major transects
Estimating fish cover	C-8	Major transects
Human influence	C-9	Major transects
Riparian vegetation structure	C-10	Major transects
Measuring thalweg depth	C-11	Thalweg transect
Large woody debris tally	C-12	Major transect
Habitat unit descriptions	C-13	Thalweg transect
Side-channel descriptions	C-14	Thalweg transect
Width and substrate measurements	C-15	Minor transects
Measuring slope and bearing	C-16	All transects

[1] Transects and index stations are described in Appendix C-1.

Table 15 presents the same information according to which activities take place at the different transects and stations that are established during the site layout.

Table 15. Field procedures by station within a site (transects and index stations are described in Appendix C-1).

Major Transect	Minor Transect	Thalweg Transect	Near the Index station (Transect F) [6]
Slope[1]	Slope[1]	Slope[1]	In-situ measures
Bearing[2]	Bearing[2]	Bearing[2]	Sediment sampling
Wetted width	Wetted width	Thalweg depth	Discharge
Bankfull width	Bankfull width	Habitat unit presence	GPS coordinates [5]
Bar width	Bar width	Side channel presence	
Substrate sizes	Substrate sizes	Edge pool presence	
Substrate depths		Bar presence	
Fish cover by class			
Shade			
Human influence			
Riparian vegetation			
Benthos[3]			
Periphyton[3]			
Large woody debris [4]			
GPS coordinates [5]			

[1] Slope can be measured among any combination of convenient contiguous stations, as long as crews determine total elevation gain or average slope across the entire site length.
[2] Bearing: normally 20 measurements per site: one measurement at each major transect and one at each minor transect. Supplemental measurements sometimes are needed from intermediate thalweg transects.
[3] The benthos and periphyton samples are composite samples from eight randomly selected major transects.
[4] Large woody debris is tallied across the full length of the site, but records are kept for counts between major transects, on the *Thalweg Data Form*.
[5] Global Positioning System (GPS) is required at site coordinates (index station) and at two major transects for small streams (top and bottom of site).
[6] Except for GPS coordinates, these measurements can be done anywhere within the site, but near the index station (mid-reach, transect F) is preferred.

Field quality control procedures

To ensure the quality and consistency of sample collections, equipment maintenance and sample collection protocols described in the appendices of this QAPP will be followed.

Sample holding times

Holding times are the maximum allowable length of time between sample collection and laboratory manipulation. Holding times are different for each analyte and are in place to maximize analytical accuracy and representativeness. Each sample collected will be packaged in a container and labeled accordingly. If necessary, the permittee will coordinate with the analytical laboratory to ensure samples can be transported, received, and processed during non-business hours. Sample containers will be transported or sent by the field team to the analytical

laboratory, following established sample handling and chain-of-custody procedures. At the laboratory, samples may be further divided for analysis or storage.

Tables 16 – 17 list sample volumes, holding times, containers, and preservation requirements for sediment and biological samples collected during a watershed health DCE. Appendix D elaborates on the bottles and other equipment needed for biological samples.

Table 16. Sample containers, amounts, holding times, and preservation for sediment samples.

Analysis	Container[1]	Holding Time	Preservative[2]
Percent solids	2 oz glass jar	7 days	Cool to ≤6°C
Total organic carbon (TOC)	2 oz glass jar	14 days/1 year if frozen	Cool to ≤6°C; PSEP standard (1986): may freeze at ≤18°C at lab
Metals (As, Cu, Pb, Zn)	4 oz glass jar[3]	6 months	Cool to ≤6°C
Pesticides – 2,4-D, triclopyr, carbaryl, chlorpyrifos	8 oz glass jar[3,4]	14 days	Cool to ≤6°C
PAHs	8 oz glass jar[3,5]	14 days/1 year if frozen	Cool to ≤6°C; PSEP standard (1986): may freeze at ≤18°C at lab
Phthalates (can be sent in same container as PAHs)	8 oz glass jar[3,5]	14 days/1 year if frozen	Cool to ≤6°C; PSEP standard(1986): may freeze at ≤18°C at lab
PBDEs	8 oz glass jar[3]	14 days/1 year if frozen	Cool to ≤6°C; PSEP standard(1986): may freeze at ≤18°C at lab
PCBs (congeners)	8 oz glass jar[3]	14 days/1 year if frozen	Cool to ≤6°C; PSEP standard(1986): may freeze at ≤18°C at lab
PPCPs and H/S	8 oz HDPE jar[6]	2 day/7 days if frozen	Freeze as soon as possible. Store in dark <10°C until analyzed.

[1] No additional sample volume is needed for analysis and QC samples if the jar is filled, with the exception of PPCPs and H/S, check with laboratory. Some parameters may be sampled from same container, check with laboratory.

[2] Preservation needs to be done in the field, unless otherwise noted. Ice will be used to cool samples to approximately 4-6°C.

[3] Glass containers with Teflon-lined lids, certified clean by manufacturer or laboratory in accordance with OSWER Cleaning Protocol #9240.0-05 (MEL, 2008).

[4] All four pesticides can likely be combined in the same jar; check with laboratory.

[5] PAHs and phthalates can likely be combined in the same jar; check with laboratory.

[6] Certified clean jar; request from laboratory.

Table 17.Sample containers, amounts, holding times, and preservation for biological samples.

Analysis	Container[1]	Holding Time	Preservative[2]
Periphyton - for species analysis	500 mL brown poly bottle	6 months	Lugol's iodine to 1%; Cool to ≤4°C
Periphyton - for chlorophyll *a*[3] analysis	500 mL poly vial	25 day	Field filtered 0.7 micron glass microfiber filter; folded in quarters and wrapped in foil then polyethylene bag; Cool to ≤4°C; freeze at -20°C if necessary and ship frozen.
Macroinvertebrate	3.8 L wide-mouth poly jars	Indefinitely	Field preserved with ethanol

[1] Replicate samples should be collected in additional container.

[2] Preservation should be done in the field, unless otherwise noted. Ice will be used to cool samples.

[3] Chlorophyll a may be sent to the water quality laboratory, as opposed to the benthos laboratory.

Documentation

Field data measurements will be recorded in the field; example field forms are provided in Appendices C, D, and G for biological, habitat, and sediment chemistry monitoring. These forms are used by Ecology, as print documents and taken into the field for recording. At this time, Ecology has developed new electronic field forms and software to improve field documentation for their Watershed Health Monitoring Program with completeness and data entry to the EIM database. The anticipated completion date is spring 2015. Once completed, the software will be freely distributed to the permittees conducting monitoring for the RSMP for use during the 2015 field season for habitat, benthos and sediment sampling. This software and data management are further discussed in the Data Management and Reporting section of this QAPP.

While development and distribution of the field software is intended, as a back-up the field forms provided in the appendices can be printed and used. Paper field forms should be printed on water-resistant paper. When completed, these field sheets will be entered into the above mentioned electronic forms at the office, and paper copies will be stored in an organized central filing location. Forms and documentation will include the station visit/maintenance sheet, meter calibration, and chain-of-custody forms. All entries on field documents will be made in pencil or permanent pen and will list the field technician name(s). Any errors or typos will be crossed out and rewritten by the technician who recorded the data. All corrections will be initialed and dated when made.

If field sampling or procedural errors are discovered, action will be taken to manage and correct those errors. Corrections may occur with corrective editing, relabeling, or, if warranted, flagging, discarding, and re-sampling. If a consistent error persists, an amendment to the sampling procedures may be required.

Composite/grab field replicate samples

One each of composited benthic macroinvertebrate, periphyton, and sediment field replicate samples will be collected for monitoring under the permit (Table 18). All replicates may be collected at one site, and the site shall be randomly selected from among the twelve sites being

monitored. Field replicates will be collected by splitting composited samples. All field replicates will be labeled similar to other samples, so that the sample has its own unique number. These replicate samples will be submitted blind to the laboratory, with all other field samples.

Field blanks

Field blanks are not required for watershed health monitoring.

Table 18. Field quality control schedule for watershed health samples collected.

Field Sample Collected	Frequency	Control Limit	Corrective Action
Composited benthic macroinvertebrate, periphyton, and sediment field replicate	Once	Qualitative control – Assess representativeness, comparability, and field variability	Review procedures; alter if needed

Water Quality Monitoring

Water quality monitoring consists of monthly year-round (October through September) measurements and collection of water samples at the field sites. Measurements and sample collection may be done from a bridge, by wading, or using a stream-side grab method, depending on the size of the stream and access, provided stream water at the specific monitoring location is well-mixed and representative.

Water quality parameters that are either measured in the field or in a laboratory are listed in Table 19.

Table 19. Water quality parameters to be monitored.

Parameter	Where measured
Ammonia	Laboratory
Chloride	Laboratory
Dissolved oxygen	Field
Hardness	Laboratory
Fecal coliform	Laboratory
Nitrate-Nitrite-N	Laboratory
pH	Field
Orthophosphate	Laboratory
Specific Conductance	Field
Temperature	Field
Total nitrogen	Laboratory
Total phosphorus	Laboratory
Total suspended solids	Laboratory
Turbidity	Laboratory

Field activities and protocols for water quality monitoring

The primary field activities conducted during a water quality data collection event include measuring stream discharge and in-situ (field) water quality parameters, and collecting and processing water-quality samples for laboratory analyses.

Field activities for water quality monitoring and appendices within this QAPP that describe the procedures and protocols are shown in Table 20. Protocols for the RSMP water quality monitoring are adapted from Ecology's Watershed Health and Water Quality Index (WQI) programs are discussed in Appendix D and are based on multiple Ecology SOPs (Ward et al., 2001; Hallock and Ehinger, 2003; Ward, 2007a,b; Hallock, 2012).

Table 20. Field activities for water quality monitoring and the appendices describing the procedures.

Activity	Appendix
Site verification	C-1[1]
Streamflow measurement	C-3
Water-quality measurements and sample collection	E

[1] The site layout part of this appendix is not applicable to a water-quality DCE

Seasonal conditions should be considered during site verification, as the water quality portion of the monitoring program will occur monthly over an entire year and may include sampling during inclement weather or high-flow conditions. Field staff must always survey the sample location on the day of sampling for hazards for staff and equipment.

Field quality control procedures for water quality monitoring

To ensure the quality and consistency of sample collections, equipment maintenance and sample collection protocols described in the appendices of this QAPP will be followed.

Sample holding times

Holding times are the maximum allowable length of time between sample collection and laboratory manipulation. Holding times are different for each analyte and are in place to maximize analytical accuracy and representativeness. Each sample collected will be packaged in a container and labeled accordingly. If necessary, staff will coordinate with the analytical laboratory to ensure samples can be transported, received, and processed during non-business hours. Sample containers will be transported or sent by the field team to the analytical laboratory, following established sample handling and chain-of-custody procedures. At the laboratory, samples may be further divided for analysis or storage. Table 21 lists sample volumes, holding times, containers, and preservation requirements for sediment and biological samples collected for water quality. Appendix D elaborates on the bottles and other equipment needed for biological samples.

Table 21. Sample containers, amounts, holding times, and preservation for water samples.

Analysis	Container[1]	Holding Time	Preservative[2]
Ammonia-N	125 mL poly bottle	28 days	H_2SO_4 to pH<2; cool to ≤4°C
Chloride	500 mL poly bottle	28 days	Cool to ≤4°C
Fecal coliform	250 or 500 mL autoclaved glass/poly bottle	24 hours (Hallock, 2007)	Fill bottle to shoulder, cool to ≤ 4°C
Hardness as $CaCO_3$	125 mL w/m poly bottle	6 months	H_2SO_4 to pH<2; cool to ≤6°C
Nitrate-Nitrite-N	125 mL poly bottle	28 days	H_2SO_4 to pH<2; cool to ≤4°C
Nitrogen, total	125 mL poly bottle	28 days	H_2SO_4 to pH<2; cool to ≤4°C
Orthophosphate	125 mL brown poly	2 days	Filter in field and cool to <4°C
Phosphorus, total	60 mL poly bottle	28 days	H_2SO_4 to pH<2; cool to ≤4°C or HCl to pH<2; cool to <°4
Total suspended solids (TSS)	1000 mL poly bottle	7 days	Cool to ≤4°C
Turbidity	500 mL poly bottle	2 days	Cool to ≤4°C

[1] Replicate samples should be collected in additional containers.

[2] Preservation should be done in the field, unless otherwise noted. Ice will be used to cool samples.

Field instrument quality control

In order to maintain the highest degree of data quality, field equipment will undergo routine cleaning, calibrations, and maintenance at the recommended frequency specified by each manufacturer and described in SOPs. Appendices B and F discuss field meters.

Documentation

Field data measurements will be recorded in the field. The software being developed for Watershed health monitoring will also be able to record any in-situ water quality measurements. As previously mentioned in the Documentation section for watershed health monitoring, staff will need to prepare paper field forms in case the software is not ready in time for the October 2014 start date. Appendix M contains an example field form to record in-situ water quality measurements made at each site. Forms and documentation will include the station visit/maintenance sheet, meter calibration, and chain-of-custody forms.

All entries on field documents will be made in pencil or permanent pen and will list the field technician name(s). Any errors or typos will be crossed out and rewritten by the technician who recorded the data. All corrections will be initialed and dated when made. If field sampling or procedural errors are discovered, action will be taken to manage and correct those errors. Corrections may occur with corrective editing, relabeling, or, if warranted, flagging, discarding,

and re-sampling. If a consistent error persists, an amendment to the sampling procedures may be required.

Grab water field replicate samples

A field quality control schedule is shown in Table 22. Grab field replicate samples will be collected at a rate of 10% of the total samples collected for monitoring under the permit. Field replicates will be collected by filling additional grab sample jars. Parameters measured in the field sample also will be measured in the replicate sample for that particular site.

All field replicates will be labeled similar to other samples, so that the sample has its own unique number. These replicate samples will be submitted blind to the laboratory, with all other field samples.

Field blanks

The term *field blanks* includes equipment rinsate blanks, trip blanks, transfer blanks, or specific equipment blanks. Blanks serve as field audits to ensure procedures to reduce contamination.

For this study, a single transfer blank for water-based parameters will be collected, labeled with unique numbers and will accompany one set of samples to the laboratory. The transfer blank will be collected by pouring lab-provided deionized water into a clean sample bottle to determine whether field contamination (including DI water contamination) is present, unrelated to the equipment.

Other field blank samples may be collected as needed for determining a contamination source. If field blank contamination is discovered, additional field blank samples may be used to determine the source of the contamination. Field blank samples collected to determine the contamination source may include:

- A field equipment blank collected from the filtration apparatus used to filter orthophosphate.
- A field trip blank collected by transporting unopened bottles containing organic and metal-free, certified clean water from the laboratory into the field, and then returned it to the laboratory (bottles are not opened in the field). Trip blanks are used to determine whether any contamination occurs while traveling from field to laboratory.

Any field blank contamination will be reviewed by the field lead to determine if samples associated with the field blanks should be qualified based on the contamination. Sample results will be flagged with a *J* if they are less than, or equal to, 5 times the field blank concentration.

Table 22. Field quality control schedule for water quality samples collected.

Field Sample Collected	Frequency [1]	Control Limit	Corrective Action
Grab water field replicate	10% of total samples[2]	Qualitative control – Assess representativeness, comparability, and field variability	Review procedures; alter if needed
Transfer blank	At least one sample a year	Blank analyte concentration should be below the reporting limit	Compare blanks for analyte to determine whether the sampling process is the source of contamination; re-evaluate decontamination procedures; evaluate results greater than 5x blank concentrations
Other blank samples for determining a contamination source	As needed	Blank analyte concentration should be below the reporting limit	Compare results from separated blanks to isolate the source of contamination; evaluate results greater than 5x blank concentrations

[1] This table is based in part on an EPA QA website accessed August 2013: www.epa.gov/earth1r6/6pd/qa/qadevtools/mod5_sops/sample_handling_preservation/appendix_b3.pdf

[2] Total samples refers to the total number of samples for each permittee who selects Option S8.B.1.b or S8.B.2 in the permit. The number of samples is dependent on the number of sites each permittee monitors.

Laboratory Quality Control Procedures

This section discusses the laboratory QC procedures that will be implemented to provide high quality data. Field QC procedures were previously described as part of the *Field Operations* sections of this QAPP. QC will be monitored throughout the duration of the study. The quality of raw, unprocessed, and processed data is subject to review according to established protocols in the *Measurement Quality Objectives* section of this QAPP.

Biotic samples

QC procedures for biotic samples are currently limited to field replicates precision and laboratory duplicates for accuracy for benthic macroinvertebrates and periphyton. Contract laboratories will make every effort to ensure accurate identification of specimens. More information on laboratory QC procedures is provided in Appendix F-2 and F-3.

Water and sediment samples

This section discusses QC procedures that will be implemented by the contracted analytical laboratory to provide high quality chemical and physical analyses that meet these QAPP requirements. Contract laboratories will make every effort to meet sample holding times and target reporting limits for all parameters. Laboratory QC procedures and results will be closely monitored throughout the duration of the permit-mandated sampling. The quality of laboratory data is subject to review via the established protocols in the *Measurement Quality Objectives* section. A typical schedule for laboratory QC samples is shown in Table 23 and, at a minimum, includes:

- Laboratory duplicates
- Matrix spikes
- Matrix spike duplicates
- Method/instrument blanks
- References (lab standards/surrogate standards/internal standards)

Table 23. Laboratory quality control schedule for monitoring.

Quality Control Sample[1]	Analysis Type	Frequency[2]	Corrective Action
Laboratory Duplicates	inorganic	5% of total samples or 1 per batch (method-specific)	Evaluate procedure; ID contaminant source; reanalyze or qualify affected data
	conventional		
	organics		
Matrix Spikes	inorganic	For metals at least 1 sample per year, otherwise 5% of total samples or 1 per batch	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
	conventional	5% of total samples or 1 per batch	
	organics	5% of total samples or 1 per batch	Evaluate lab duplicates/standards recoveries and assess matrix effects; evaluate or qualify affected data
Matrix Spike Duplicates[3]	inorganic	For metals at least 1 samples per year, otherwise 5% of total samples or 1 per batch	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
	conventional	5% of total samples or 1 per batch	
	organics	5% of total samples or 1 per batch	
Method / Instrument Blanks	inorganic	5% of total samples or 1 per batch (method-specific)	Blank concentration is defined as the new reporting limit. Evaluate procedure; ID contaminant source; reanalyze blanks or qualify sample data (<5-10x blank concentration).
	conventional		
	organics		
References (lab control standard, surrogate, and internal standards)	inorganic	5% of total samples or 1 per batch (method-specific)	Evaluate lab duplicates/matrix spike recoveries; assess efficiency of extraction method; evaluate or qualify affected data
	conventional		
	organics		

[1] Quality control samples may be from different projects for frequencies on a per-batch basis.
[2] Frequencies may be determined from the study number of samples collected by the permittee.
[3] Matrix spike duplicates may be used to satisfy frequencies for laboratory duplicates.

Instrument calibration

The instrumentation used by the chosen laboratories will meet or exceed manufacturers' specifications for use and maintenance. Maintenance of this equipment will be conducted in a manner specified by the manufacturer or by the QA guidelines established by the chosen laboratory.

Duplicate/splits

Laboratory duplicate samples will be analyzed regularly to verify that the laboratory's analytical methods are maintaining their precision. The laboratory should perform "random" duplicate selection on submitted samples that meet volume requirements. After a sample is randomly selected, the laboratory should homogenize the sample and divide it into two identical "split" samples. To verify method precision, identical analyses of these lab splits should be performed and reported. Some parameters may require a double volume for the parameter to be analyzed as the

laboratory duplicate. Matrix spike duplicates may be used to satisfy frequencies for laboratory duplicates.

Matrix spikes and matrix spike duplicates

Matrix spike samples are triple-volume field samples (per parameter tested) to which method-specific target analytes are added or spiked into two of the field samples, and then analyzed under the same conditions as the field sample. A matrix spike provides a measure of the recovery efficiency and accuracy for the analytical methods being used. Matrix spikes are typically analyzed in duplicate (matrix spike/matrix spike duplicate [ms/msd]) to determine method accuracy and precision. Matrix spikes will be prepared and analyzed at a rate of 1 pair/20 (five percent) samples collected or one pair for each analytical batch, whichever is most frequent. Use of ms/msd at the frequency of 5% of the total number of samples is common practice. For the purposes of permit monitoring, these frequencies meet the expectations.

Blanks and standards

Laboratory blanks are useful for instrument calibrations and method verifications, as well as for determining whether any contamination is present in laboratory handling and processing of samples.

Laboratory standards

Laboratory standards (reference standards) are objects or substances that can be used as a measurement base for similar objects or substances. In many instances, laboratories using digital or optical equipment will purchase from an outside accredited source a solid, powdered, or liquid standard to determine high-level or low-level quantities of a specific analyte. These standards are accompanied by acceptance criteria and are used to test the accuracy of the laboratory's methods. Laboratory standards are typically used after calibration of an instrument and prior to sample analysis.

Surrogate and internal standards

Surrogate standards are used to process and analyze extractable organic compounds (PAHs, phthalates, and pesticides). A surrogate standard is added before extraction, and it monitors the efficiency of the extraction methods. Internal standards are added to organic compounds and metal digests to verify instrument operation when using inductively coupled plasma mass spectrometry (ICP-MS) analysis.

Method blanks

Method blanks are designed to determine whether contamination sources may be associated with laboratory processing and analysis. Method blanks are prepared in the laboratory using the same reagents, solvents, glassware, and equipment as the field samples. These method blanks will accompany the field samples through analysis.

Instrument blank

An instrument blank is used to "zero" analytical equipment used in the laboratory's procedures. Instrument blanks usually consist of laboratory-pure water and any other method-appropriate reagents, and they are used to zero instrumentation.

Inter-laboratory comparison

There is a recognized need to conduct an inter-laboratory comparison study if multiple laboratories are used for the RSMP and permittees conducting monitoring under this QAPP. Permittees will collect replicate samples to support this comparison as follows: Water and sediment replicate samples collected under the RSMP and this QAPP will be sent to two of the participating laboratories. This inter-laboratory comparison does not apply to the fecal coliform samples. Under this QAPP for permittees conducting monitoring, the contracted laboratory will be sent one of the replicates, and the other replicate samples will be sent to the other determined by the RSMP. If the laboratories used by the permittee and the RSMP are the same, then the inter-laboratory comparison requirement is nullified.

Measurement quality objectives (MQOs) for laboratory samples

This section refers to the MQOs, the acceptance thresholds for water data collected under the Water Quality Index monitoring, and sediment data collected under Watershed Health monitoring. MQOs specifically are used to address instrument and analytical performance.

MQOs established for stormwater permit monitoring are based on guidance from multiple sources, including EPA, Ecology, and laboratory experience. Tables 24 and 25 represent how data will be verified prior to reporting results. Failure to meet the MQOs may result in data being qualified or rejected.

Table 24. Measurement quality objectives (MQOs) for water chemistry and chlorophyll *a* for periphyton.

Water Parameters	Methods in Water MQO[3]	Reporting Limit Target	Field/Lab Replicate (RPD) [1]	Matrix Spike[2] (% Recovery)	Lab Duplicate (RPD) [1]	Control Standard/ Surrogate (% Recovery)
		Sensitivity	Bias and Precision	Bias and Accuracy	Bias and Precision	Bias and Accuracy
Ammonia-N	SM 4500-NH_3H	0.01 mg/L	≤10%	75-125	25	80-120
Chloride	EPA 300.0	0.1 mg/L	≤20%	75-125	≤20%	90-100
Dissolved Oxygen*	Electrode meter ±0.2 mg/L	n/a	n/a	n/a	n/a	n/a
Fecal coliform	SM 9222D	1 cfu/100 mL	≤20%	n/a	n/a	n/a
Nitrate+Nitrite-N	SM 4500-NO_3^-I	0.01 mg/L	≤10%	75-125	25%	80-120
Hardness as CaCO3	SM 2430B	1 mg/L	≤10%	n/a	n/a	90-110
pH*	Electrode Meter ± 0.2 std. units	n/a	≤10%	n/a	n/a	n/a
Orthophosphate	SM 4500 PG	0.003 mg/L	≤10%	75-125	≤20%	80-120
Specific conductance* (conductivity)	Electrode meter ±5 us/cm at 100 us/cm	n/a	≤10%	n/a	n/a	90-110
Temperature*	Electrode meter ± 0.2°C	n/a	≤10%	n/a	n/a	n/a
Total nitrogen (TN)	SM 4500-N-B	0.025 mg/L	≤10%	75-125	25	80-120
Total phosphorus (TP)	SM 4500-P H	0.005 mg/L	≤10%	75-125	25%	80-120
Total suspended solids (TSS)	SM 2540D	1 mg/L	≤15%	n/a	n/a	90-110
Turbidity	SM 2130	0.5 NTU	≤15%	n/a	20	90-105
Chlorophyll *a* – in periphyton[4]	SM 10200H(3)	0.01 ug/L	≤50%	n/a	≤20%	n/a

*Field-measured parameters follow manufacturer's website guidelines for meter calibrations.
EPA: Environmental Protection Agency method (http://water.epa.gov/scitech/methods/cwa/methods_index.cfm).
SM: *Standard Methods for the Examination of Water and Wastewater* (www.standardmethods.org).
[1] The relative percent difference (RPD) must be less than or equal to the indicated percentage for values that are greater than 5 times the reporting limit. RPD must be ±2 times the reporting limit for values that are less than or equal to 5 times the reporting limit.
[2] For inorganics, the *Laboratory Program Functional Guidelines* state that the spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of 4 or more (EPA, 2010).
[3] MQOs are based on Hallock (2012) and SOP EAP033 (Swanson, 2007).
[4] MQOs are based on Adams (2010a) and MEL (2008) for chlorophyll *a* content, once field-filtered from a periphyton slurry sample.

Table 25. Measurement quality objectives (MQOs) for chemical analysis of sediments.

Sediment **Parameters for Bioassessment**	**Analysis Methods in Sediment MQO**	**Reporting Limit Target**	**Lab Replicate (RPD)** [1]	**Matrix Spike** [2] **(% Recovery)**	**Matrix Spike Duplicate (RPD)** [1]	**Control Standard/ Surrogate (% Recovery)**
		Sensitivity	**Bias and Precision**	**Bias and Accuracy**	**Bias and Precision**	**Bias and Accuracy**
Percent Solids	SM 2540 G	Sensitivity = 0.1%	≤20%	n/a	n/a	n/a
Total Organic Carbon	PSEP (1986, with 1997a,b updates), combustion/CO^2 (MEL, 2008) or SW 848 9060	Sensitivity = 0.1%	≤20%	n/a	n/a	80-120
Metals (As, Cu, Pb, Zn)	EPA Method 200.8 ICP/MS	(0.1, 0.1, 0.1, 5.0) mg/Kg dw	≤20%	75-125	≤20%	85-115
2,4-D, triclopyr	EPA 8151A GCMS/MS	6.7 ug/Kg dw	n/a	40-130	≤40%	40-130
Chlorpyrifos	EPA 8270D GCMS/MS	6.7 ug/Kg dw	n/a	40-130	≤40%	40-130
Carbaryl	EPA 8321B LCMS/MS	6.7 ug/Kg dw	n/a	30-130	≤40%	40-130
Phthalates	EPA 8270D (GC/MS)	70 ug/Kg dw, except di-n-octylphthalate 250 ug/kg dw	Compound specific ≤40%	40-150	≤40%	40-150[3]
Polybrominated diphenyl ethers (PBDEs) [4]	EPA 1614 HRGC/MS	2 ng/Kg dw[4]	≤20%	50-150	25-150%[5]	50-150
Polycyclic aromatic hydrocarbon (PAH) compounds	EPA 8270D (GC/MS)	70 ug/Kg dw	Compound specific ≤40%	50-150	≤40%	50-150[3]
Polychlorinated biphenyls (PCBs)	EPA Method 1668A	20 ng/Kg dw [4]	≤20%	50-150	≤40%	25-150[6]
Pharmaceuticals and personal care products (PPCPs)	EPA 1694 LC/MS/MS	1- 1000 ug/Kg dw[7]	Compound specific ≤40%	n/a	n/a	Compound specific 5-200[8]
Hormones/Steroids (H/S)	EPA 1698 HRGC/MS	0.1- 100 ug/Kg dw	Compound specific ≤40%	n/a	n/a	Compound specific 5-200[8]

EPA: Environmental Protection Agency Method (http://water.epa.gov/scitech/methods/cwa/methods_index.cfm).
SM: *Standard Methods for the Examination of Water and Wastewater* (www.standardmethods.org).

PAH compounds include: 1-methylnaphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, acenaphthene anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, dibenzofuran, carbazole, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, and retene.

Phthalates include: bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate.
PBDE congeners include: 47, 49, 66, 71, 99, 100, 138, 153, 154, 183, 184, 191, 209.
PCB congeners include: all 209 congeners.
PSEP: Puget Sound Estuary Program (PSEP) Protocols, www.psparchives.com/our_work/science/protocols.htm.

RPD: Relative percent difference.
[1] The relative percent difference (RPD) must be less than or equal to the indicated percentage for values that are greater than 5 times the reporting limit. RPD must be ±2 times the reporting limit for values that are less than or equal to 5 times the reporting limit.
[2] For inorganics, the *Laboratory Program Functional Guidelines* state that the spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of 4 or more (EPA, 2010).
[3] Semivolatile surrogate recoveries are compound specific. MQOs are based on Johnson (2005) and Dutch et al. (2010).
[4] Varies with congener. PBDE and PCB MQOs are based on Johnson (2010) and Dutch et al. (2010).
[5] Except 20-200% for 13C12DeBDE; see EPA Method 1614.
[6] Applies to most congeners; see EPA Method 1668A.
[7] PPCP and H/S MQOs are based on Dutch et al. (2010) and Lubliner et al. (2008).
[8] Labeled compounds are used, not surrogates; see EPA Method 1694 for PPCPs and 1698 for H/S

Data Management

Permittees will be collecting and managing data from field observations/measurements and laboratory analysis of field samples. All data will be managed and stored by the permittees. Post-processed data will be finalized and incorporated into annual reports and electronic reports. Reports and data will be submitted to Ecology in the format required.

Field data

Permittees will need record field water quality and watershed health data using field forms. If necessary, paper field forms should be printed on waterproof paper and kept in a three-ring binder during sampling.

Ecology intends to provide to permittees electronic field data collection software that will assist permittees to assure completeness in the field for benthos and habitat monitoring, and with loading this data to Ecology's Watershed Health database in EIM. Because timing (anticipated completion date of spring 2015) of the software development may not suit monitoring needs under this QAPP, recording on field forms is required.

Laboratory data

Chemical and bacteria laboratory data will be sent to the permittee from each laboratory following analysis. Reporting times may vary depending on holding time but should not exceed six months of the documented sampling date. Laboratory reports will be reviewed by the permittees for errors or missing data; permittees may implement corrective actions. Finalized electronic laboratory data will be loaded to Ecology's EIM database by permittees and saved in the permittee's data file.

Data storage

All field forms, photographs, electronic data, and laboratory electronic or printed data generated for this project will be stored by the permittees in an organized filing system for electronic or paper files. These files may be sought by Ecology within the permit term. Location, measurement, and sample result data will be evaluated through the data verification process, outlined earlier in this QAPP. Acceptable results will be used by scientists to prepare a summary report and entered into Ecology's EIM database.

Benthos data will be loaded into King County's Puget Sound Stream Benthos database (http://www.pugetsoundstreambenthos.org/), as well as the Watershed Health section of Ecology's EIM database. Periphyton data, habitat data, and any field-measured data will be entered into the Watershed Health section of EIM.

Data Verification and Usability

Data verification

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria.

Field staff will verify field results after measuring and before leaving the site. They will keep field notes to meet the requirements for documentation of field measurements. The field lead will ensure that field data entries are complete and error-free. The field lead also will check for consistency within an expected range of values, verify measurements, ensure measurements are made within the acceptable instrumentation error limits, and record anomalous observations. The project manager will verify field data to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results of QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in the Sampling Process Design were obtained.
- Methods and protocols specified in this QAPP were followed.

The project manager at the taxonomic laboratory will verify all taxonomic results, and the laboratory will verify all analytical results prior to reporting.

Corrective actions for inadequate data

If discrepancies in the data are found, there are two options for correction, depending on when the problem is identified.

1. If the problem is identified before the end of the index period (July 1 to October 15), a review of the protocols and SOPs outlined in the appendices of this document is required. After this review, a repeat site visit may be made to re-collect the sample. This may occur if the data set is incomplete or incorrectly collected. Due to the inter-related nature of chemical and biological conditions, problems identified in the chemical or biological data should be addressed by again collecting the entire suite of chemical and biological analyses parameters. Because the habitat is mostly constant within an index period, if the data in question is related to habitat, only the missing habitat information needs to be collected. Before the second sampling, the investigator must review the SOPs and the appendices of this document to understand the protocols. Equipment should be cleaned and recalibrated and checked for proper function.
2. If the problem is identified after the index period, the data should be flagged and the problem explained in a comment in the database. This will allow the Ecology investigator, as well as external users of these data, to know how these data may be used in projects. If the data are

incomplete, or if some data standard was not met, the data will not be used to meet the objectives of the study design.

Data usability assessment

Data usability assessment follows verification. This involves a detailed examination of the data package using professional judgment to determine whether the quality objectives have been met. The project manager examines the complete data package to determine compliance with procedures outlined in the QAPP and SOPs. The project manager also ensures that the MQOs have been met and determines if the quality of the data are usable for the project objectives.

Stream Monitoring Reports

An annual report is required to provide a summary of the previous year's monitoring activities and results. A detailed monitoring report is due to Ecology as an attachment to the permittee's annual report due on March 31 of each year 2016, 2017, and if needed, 2018. Annual reports require a G19 signature.

The stream monitoring report will include a complete discussion of the monitoring effort. The report must include:

- Site selection confirmation documentation,
- Summary of monitoring activities for water quality index, habitat, benthos and sediment chemistry, and
- A cumulative water quality and watershed health results summary for each site.

26 outlines the required monitoring report elements. These monitoring reports shall be submitted electronically, as MS Word documents.

Table 26. Reporting requirements.

Category	Reporting Requirement
Site Confirmation	Documentation of the site confirmation process, including desktop evaluation and field visits for each of the required number of assigned sites.
	List of sites disqualified and specific reasons for disqualification.
	List of final sites. In a table, provide final GPS coordinates for each site and the distances from the initial GPS locations provided in the Master Sample; and indicate the Strahler stream order.
Ancillary Site Information	Description of land use adjacent to the reach sampled.
	Description of the upstream land use of the basin contributed to the site sampled.
	Area (in square miles) of the basin draining to the site.
	Approximate (to the nearest 5%) percentages of industrial, commercial (including multi-family residential), residential (3 categories: 5 or more dwelling units per acre; 3-4 dwelling units per acre; 1-2 dwelling units per acre), agricultural, and forest land uses in the basin area draining to each site.
Water Quality Monitoring	Sample information (dates, times, locations).
	Tabular water quality data. Water Quality Index (WQI) monitoring results shall be provided in an Excel spreadsheet cross-tab format (see Appendix N). This format is designed to facilitate WQI calculations by the permittee or Ecology.
	Summary results for each monitored parameter at each site and for all of the sites.
	Computation of the WQI for each site, if feasible.
Watershed Health Monitoring	Sample information (dates, times, locations).
	Benthos, habitat, periphyton, and sediment monitoring results for each site and for all of the sites.
	B-IBI score for each site, using Puget Sound Stream Benthos tools, and Fore/Wisseman 2012, 0-100 score methodology.
Concerns	Narrative description of any deviations from this QAPP, including any delays, problems, and resolutions in conducting required monitoring activities.

Costs	Estimated monitoring costs for each required monitoring program component.

References

Web links to resources

EPA's aquatic resource monitoring - frequently asked questions

Survey sampling: www.epa.gov/nheerl/arm/sursampfaqs.htm
Survey design: www.epa.gov/nheerl/arm/surdesignfaqs.htm
Data analysis: www.epa.gov/nheerl/arm/dataanalysisfaqs.htm

EPA's data analysis resources and tools for surveys

General statistical books on survey designs:
www.epa.gov/nheerl/arm/bibliography.htm#generalsurveydesignbooks

Monitoring Data Analysis and Reporting:
www.epa.gov/nheerl/arm/analysispages/monitanalysisinfo.htm

Presentations on statistical analysis processes: www.epa.gov/nheerl/arm/presents.htm

Statistical tools for data analysis (Software for R):
www.epa.gov/nheerl/arm/analysispages/software.htm

Example analysis software for EMAP West Wadeable Stream Data
www.epa.gov/nheerl/arm/analysispages/r10_work/r10_intro.htm

Stressor Identification Guidance:
http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/biocriteria/stressors_index.cfm

Biological Indicators of Watershed Health: www.epa.gov/bioindicators

Ecology's relevant resources for biological, habitat, and water quality sampling

Status and Trends Statewide Monitoring:
http://www.ecy.wa.gov/programs/eap/stsmf

Stream Biological Monitoring:
www.ecy.wa.gov/programs/eap/fw_benth

River and Stream Water Quality Monitoring:
www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html

River and Stream Water Quality Index:
www.ecy.wa.gov/programs/eap/fw_riv/docs/WQIOverview.html

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Table 1 - Confirmed Sampling Sites - Pierce County

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
Inside UGA					
43	-122.481901, 47.134146	-122.482770, 47.134433	Clover Creek @ JBLM	Inspected site with assigned JBLM escort. Good stretch, although candidate point is located immediately adjacent to paved runway. Shifted center point west.Need sponsored monthly pass to conduct sampling, Center point was GPSd in October 2014.	7/10/14

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
106	-122.405498, 47.126288	-122.406853, 47.126061	Clover Creek @ Brookdale Golf Course.	Good site, accessed by ~10 min walk through golf course. Confirmed year-round flow with owner. As of 7/31/14, do not have permission to access parcel to east of candidate point. May have to shift center point west to keep all sampling on Brookdale Golf Course property. Stream is suitable throughout golf course property.	12/11/2013 7/18/14

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
294	-122.463671, 47.130778	-122.465536, 47.130890	Morey Creek @ Wetland	Suitable. Coordinates of candidate point are slightly south of actual creek bed on pasture area, but will be shifted north to creek. The substrate on the channel bottom is natural; but portions are 90% sediment with very few rocks. As of 7/31/14, had not obtained permission to access parcel to east of candidate point. Shifted center point further west for study.	4/18/2014

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
367	-122.4264274, 47.131428	-122.425888, 47.130303	Clover Creek @ South of 138th St. E.	Good flow; easy access. Candidate point falls on 138th St East ROW; near where three forks converge. Based on lack of defined channel in immediate vicinity of candidate point, shifted center point SE.	4/18/2014
Outside UGA					
104	-122.6821194, 47.389415,	-122.681373, 47.389609	Little Minter Creek @ SR302 and 144th St. NW.	Good site with easy access, though substrate is silty. Intend to shift center point slightly to NE so that all sampling can be conducted on Key Peninsula Metropolitan Parks District parcels.	12/18/2013

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
149	-122.474985, 46.908395	-122.474773, 47.908618	Horn Creek @Rural subdivision	Easy access to creek. Possibly deep with low velocity flow. Will probably not need to significantly shift candidate point.	12/3/2013
245	-122.170574, 47.080004	-122.169768, 47.078095	Coplar Creek @ Buttes subdivision.	Great access, substrate, depth and flow. As of 7/31/14, do not have permission to access parcel defining north end of sampling reach. Shifted point slightly south.	12/18/2013
275	-122.613191, 47.31156	-122.616033, 47.314628	Wollochet Creek	Reasonable access, perennial flow. Area near candidate point choked with cattails. Will need to move center point upstream about 500 meters in order to get benthic samples.	12/18/2013

ORDER #	Original Longitude, Latitude	Shifted Longitude, Latitude	Pierce County Description	Comments	Field Visit Date
341	-122.688203, 47.386512	-122.687814, 47.38647	Little Minter Creek @ Upstream of PC WQI Stn	Suitable perennial creek. Will probably not need to significantly shift candidate point.	12/18/2013
376	-122.581865, 47.286847	-122.581472, 47.285675	Sullivan Gulch Creek	Good creek with difficult access though forests (no trail). Will need to shift candidate point about 150 meters south to avoid thick brush overhanging creek.	12/18/2013
396	-122.612194447.320911,	-122612467, 47.320673	Wollochet Creek	Easy access with low flow during summer months. Will probably not need to significantly shift candidate point.	12/18/2013
465	-122.394102, 47.224004	-122.39403, 47.224014	Upper Swan Creek @ Park.	Good creek and ease of access. Will not need to significantly shift candidate point	1/23/2014

Table 2 - Rejected Sampling Sites – Pierce County

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
Inside UGA					
10	-122.547296	47.108694	Murray Creek @JBLM	Inspected with assigned JBLM escort. Index Station coordinates located off busy intersection by Madigan Hospital with lack of safe parking. Creek has unsafe depth and very low flow. According to JBLM likely caused by beaver dams (recurrent problem); and clogged culvert about 300 feet upstream.	6/10/14.
150	-122.408676	47.133438	North Fork Clover Creek @ Brookdale Golf Course.	North fork goes dry during summer months.	12/11/2013
191	-122.45756	47.130201	Spanaway Creek @ Wetland	Emergent/scrub-shrub wetland area >500m in both directions from coordinate point. Channel not clearly defined. Very Low flow.	4/18/2014
245	-122.5518	47.115374	Murray Creek @ JBLM	Inspected with assigned JBLM escort. Brushy wetland conditions in both directions. Lacks defined left and right banks readily discernible from mid-stream	Attempted 7/3/2013 6/10/14
247	-122.381775	47.114749	Clover Creek @ Wetland area	Channelized with deep silt; contiguous area wetland. Not safely wadeable.	1/27/2014
267	-122.195503	47.134771	Canyon Falls @ Headwaters	Creek incorrectly mapped - most of canyon dry - no surface water or hydrophytic veg. within 500 meters of this index station.	3/12/2014
342	-122.446697	47.110045	Spanaway Creek @ Lake	Index Station located in the middle of Spanaway Lake.	4/16/2014
412	-122.172671	47.090573	Carbon River	River is too deep, fast, and wide to safely sample.	1/27/2014
423	-122.452441	47.145762	Clover Creek @ Headwaters	No water observed within 500m of coordinates.	4/18/2014

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
430	-122.453775	47.099123	Spanaway Ck near inlet to Spanaway Lake (west of confluence with Coffee Creek)	Point is in palustrine forested wetland near confluence of Spanaway Creek and Coffee Creek. Lacks defined left and right banks readily discernible from mid-stream.Similar conditions >500m either direction from candidate point.	4/18/2014
432	-122.24726	47.083627	Large wetland area draining east to Puyallup valley.	Areas within 500m of index station are ponds; with no clearly defined channel. Access from Sunrise PDD is barricaded; dirt roads to site steep (can not access with vehicle). Over an hour walk to site; evidence of homeless camp & beaver activity	4/11/2014
484	-122.373516	47.103457	Clover Creek @ Pierce County property.	Palustrine scrub-shrub wetland with dense cover of reed canarygrass within 500 m of Index Station coordinates. Lacks defined left and right banks readily discernible from mid-stream.	1/28/2014
509	-122.608381	47.368334	Canterwood Country Club	Index station coordinates located along the edge of a water hazard on the golf course, with no visible creek or inflow.	5/1/2014
565	-122.457745	47.13305	Near PLU	No water feature evident near Index Station coordinates.	4/16/2014
Outside UGA					
3	-122.202609	47.148726	Fennel Creek @ Private development	Creek in steep & deep ravine. Access from NE is gated.	Attempted 7/3/13
5	-122.504983	47.000015	Lacamas Creek @ JBLM	Inspected with assigned JBLM escort. Lacks defined left and right banks readily discernible from mid-stream	Attempted 7/3/13 6/10/14
15	-122.114008	47.066981	Voights Creek	Creek in steep ravine no walkable access. Deep and fast current.	7/3/2013

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
35	-122.325508	46.984332	South Creek tributary.	Private parcel gated, so viewed from 304th Street to south. No surface water observed in channel (channel completely dry).	Attempted 7/3/13
49	-122.390976	47.133516	North Fork Clover Creek.	Spoke to parcel owner, who said it goes completely dry during the summer. Also, PC-SWM takes monthly water quality samples at point about 3 km downstream, which consistently goes completely dry during summer months..	12/3/2013
73	-122.386121	46.995298	South Creek @ Bonneville powerline	Unsafe, brushy access. Creek is wide with swift flow.	4/28/2014
109	-122.470062	47.03093	Muck Creek @ JBLM	Creek bed dry (no surface water observed)	6/10/14
130	-122.713058	47.216683	McNeil Island	Coordinates located at a hillside seep. General area is swampy with very low flow. Lacks defined left and right banks readily discernible from mid-stream	3/27/2014
155	-122.296259	46.993503	Pond @ private property.	Pond location, very deep and wide with no flow.	12/3/2013
210	-122.436656	47.014458	South Creek @ JBLM	Inspected with assigned JBLM escort. Observed low surface flow. JBLM biologist who did field visit with us said it goes completely dry in summer months.	Attempted 7/3/2013, 6/10/14
244	-122.439264	46.92716	Horn Creek @ Marshy channel	Currently being short-platted (potentially multiple owners in next few years). This may negate any right of entry we establish now. Also, buffer may be susceptible to logging/disturbance., Very brushy. Point is in stagnant stretch of forested/shrub wetland about 40 feet wide –lacks defined channel. Evidence of beaver activity in area (chewed trees)	12/3/2013
246	-122.343633	47.10244	Clover Creek @ Tacoma Sportsman's Club	Relatively easy access to creek, though brushy and safety concerns due to parking area and trails to creek being in a shooting range. Substrate on parts of stretch waist-deep silt and are unsafe to sample	1/28/2014
256	-122.164833	47.070719	Coplar Creek	Coordinates inaccessible in steep canyon with fast flow and no apparent trails.	12/18/2013
294	-122.167177	47.214758	Lake Tapps wetland	No creek found at or near coordinates.	12/18/2013

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
306	-122.379091	46.901616	Tanwax Creek @ Private timberland property.	Gated community -no way to access parcels without private code.	Attempted 12/3/13
381	-122.706203	47.213126	McNeil Island	Coordinates located along an upland utility corridor. No surface water observed.	3/27/2014
410	-122.035309	47.145161	Spiketon Ditch @ Buckley	No access, dense and brushy. Multiple no trespassing signs	Attempted 12/18/13
424	-122.393276	47.164263	Swan Creek @ Irrigation channel.	Very low flow and, dry during summer. Lots of grasses and trash.	1/23/2014
436	-122.478304	46.930292	Murray Creek	Index Station coordinates located in a scrub-shrub area with “Wetland Buffer” signs posted. No defined channel.	1/23/2014
445	-122.546219	47.010146	Muck Creek @ tributary	Difficult access and dry during summer.	Attempted 1/23/14
449	-122.113955	47.100507	Carbon River	River is too deep, fast, and wide.	1/27/2014
460	-122.366351	46.910661	Tanwax Creek @ Private timberland property.	Same area where access was attempted for site 306. No Access	Attempted 1/23/14
2734	-122.724434	47.203836	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014
5387	-122.705143	47.22417	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014

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130	-122.713058	47.216683	McNeil Island	Coordinates located at a hillside seep. General area is swampy with very low flow. Lacks defined left and right banks readily discernible from mid-stream	3/27/2014
155	-122.296259	46.993503	Pond @ private property.	Pond location, very deep and wide with no flow.	12/3/2013
210	-122.436656	47.014458	South Creek @ JBLM	Inspected with assigned JBLM escort. Observed low surface flow. JBLM biologist who did field visit with us said it goes completely dry in summer months.	Attempted 7/3/2013, 6/10/14
244	-122.439264	46.92716	Horn Creek @ Marshy channel	Currently being short-platted (potentially multiple owners in next few years). This may negate any right of entry we establish now. Also, buffer may be susceptible to logging/disturbance., Very brushy. Point is in stagnant stretch of forested/shrub wetland about 40 feet wide –lacks defined channel. Evidence of beaver activity in area (chewed trees)	12/3/2013
246	-122.343633	47.10244	Clover Creek @ Tacoma Sportsman's Club	Relatively easy access to creek, though brushy and safety concerns due to parking area and trails to creek being in a shooting range. Substrate on parts of stretch waist-deep silt and are unsafe to sample	1/28/2014
256	-122.164833	47.070719	Coplar Creek	Coordinates inaccessible in steep canyon with fast flow and no apparent trails.	12/18/2013
294	-122.167177	47.214758	Lake Tapps wetland	No creek found at or near coordinates.	12/18/2013

ORDER #	LON_DD	LAT_DD	Pierce County Description	Comments	Field Visit Date
306	-122.379091	46.901616	Tanwax Creek @ Private timberland property.	Gated community -no way to access parcels without private code.	Attempted 12/3/13
381	-122.706203	47.213126	McNeil Island	Coordinates located along an upland utility corridor. No surface water observed.	3/27/2014
410	-122.035309	47.145161	Spiketon Ditch @ Buckley	No access, dense and brushy. Multiple no trespassing signs	Attempted 12/18/13
424	-122.393276	47.164263	Swan Creek @ Irrigation channel.	Very low flow and, dry during summer. Lots of grasses and trash.	1/23/2014
436	-122.478304	46.930292	Murray Creek	Index Station coordinates located in a scrub-shrub area with “Wetland Buffer” signs posted. No defined channel.	1/23/2014
445	-122.546219	47.010146	Muck Creek @ tributary	Difficult access and dry during summer.	Attempted 1/23/14
449	-122.113955	47.100507	Carbon River	River is too deep, fast, and wide.	1/27/2014
460	-122.366351	46.910661	Tanwax Creek @ Private timberland property.	Same area where access was attempted for site 306. No Access	Attempted 1/23/14
2734	-122.724434	47.203836	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014
5387	-122.705143	47.22417	McNeil Island	Note that this site is far down on the candidate list; we were granted access to McNeal Island so decided to look at it while we were there. Access difficult – must be pre-arranged with WA Dept of Corrections, needs special transport on DOC barge, vehicle inspection and escort. Coordinates located in a broad, palustrine scrub shrub wetland with no defined channel or left and right bank. No observed unidirectional flow.	3/27/2014