DEPARTMENT OF
ECOLOGY
State of Washington

Quality Assurance Project Plan

Evaluation of PCBs in Spokane River Redband Trout

DRAFT – February 2020

Publication No. xx-03-1xx

Publication Information

Each study conducted by the Washington State Department of Ecology must have an approved Quality Assurance Project Plan (QAPP). The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

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This QAPP was approved to begin work in Month Year. It was finalized and approved for publication in Month Year.

The final QAPP is available on Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/xx031xx.html.

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Data for this project are available in Ecology's EIM Database. Search Study ID: xx.

Commented [PJ(2]: (see the EIM Help Center for how to set up an EIM ID or how to find your EIM Data Coordinator for help.)

The Activity Tracker Code for this study is xxx.

Federal Clean Water Act 1996 303(d) Listings Addressed in this Study. See Section 3.3.

Commented [FR(3]: Delete if no Water Quality Impairment Studies.

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Quality Assurance Project Plan

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by author(s)

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Approved by:

Signature:	Date:
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Signatures are not available on the Internet version.
EAP: Environmental Assessment Program

1.0 Table of Contents

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2.0 Abstract

The Department of Ecology Environmental Assessment Program in coordination with the Washington Department of Fish an Wildlife will conduct a study to quantify concentrations of polychlorinated biphenyls (PCBs) in wild Redband Trout from the Spokane River. The results of this study will be used as a baseline for PCB concentrations in fish tissue and will be used to measure the effectiveness of PCB Control Actions aimed at the reduction of PCBs in the Spokane River. Fish collection will be conducted in the fall of 2020 and will be repeated in five year increments.

3.0 Background

Commented [LJ(4]: Use the Styles under the Home tab to add headings to the navigation page and make other format changes.

This major heading is Heading 2. Don't use Heading 1 in this QAPP..

3.1 Introduction and problem statement

Sections of the Spokane River have been placed on the 303(d) list of impaired waters for PCBs based on concentrations measured in fish tissue that exceed criterion for human consumption. The Spokane River Regional Toxics Task Force (SRRTTF) developed a "Comprehensive Plan" to identify sources of PCBs and implement Control Actions to reduce PCB levels in the Spokane River (LimnoTech 2016). This study provides a standardized sampling framework and analyses to establish a baseline of PCB concentrations in fish tissue and can be used to help assess the Control Actions identified in the Comprehensive Plan to Reduce PCBs in the Spokane River. The study utilizes index reaches that are comparable to past studies while including new reaches with similar hydrology for direct comparison across a geographic range. The study reduces bias by limiting the sampling to a single species with similar residence time in the river. Additionally, fish processing and analysis methods will be standardized to provide directly comparable results over time. The standardization allows the study to be repeated for use as a "yardstick" to monitor PCB concentrations in fish tissue over time. These analyses will provide provide a direct link to the efficacy of Control Actions on the bioaccumulation of PCBs in fish tissue in the Spokane River.

3.2 Study area and surroundings

The Spokane River originates at the outlet of Coeur d'Alene Lake in northern Idaho (rkm 178.8) and flows west 179 km through the City of Spokane to its confluence with Franklin D. Roosevelt Lake, an impoundment of the Columbia River in eastern Washington (**Error! Reference source not found.**). This study is focused on an area of the Spokane River from the Riverside Water Reclamation Facility to the Washington/Idaho border (rkm 108.0-154.5)

Provide a general description of the study area. Include relevant features such as climate, geology, topography, hydrologic regime, unique features of the landscape, ecosystem vegetation and biota, key ecological functions, and human uses. Figure 1 should reflect these descriptions.

xx

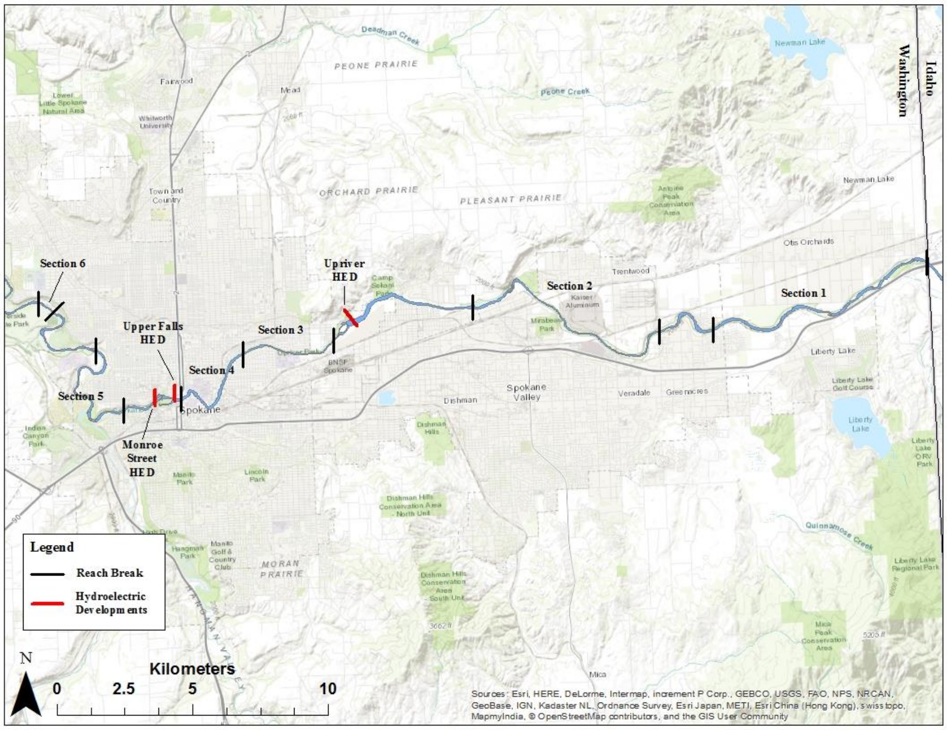

Figure 1. Map of Spokane River Redband Trout PCB study area.

3.2.1 History of study area

Prior to European settlement, the Spokane River free flowing from it's origin at the outlet of Coeur d'Alene Lake to the confluence with the Columbia River. The river supported anadromous salmon and steelehead runs as well as a resident fish assemblage. The river also provided opportunity for urbanization and industry. The first hydroelectric development (HED) on the Spokane River was completed in 1890 and provided electrical power to the developing City of Spokane. Currently, seven HEDs are in operation on the Spokane River, including Post Falls (1906), Upriver (1933), Upper Falls (1922), Monroe Street (1890), Nine Mile (1908), Long Lake (1915), and Little Falls (1910). The construction and operation of the HEDs has changed the hydrodynamics of the river considerably, altering timing and volume of flows throughout its course. A thorough description of the study area was provided in the Comprehensive Plan (LimnoTech 2016).

3.2.2 Summary of previous studies and existing data

Summarize when and how the focus of the study was first identified as an issue. List previous investigations and summarize the findings for each.

Elevated levels of PCBs have been identified in the Spokane River by previous studies. Maret and Dutton (1999) reported PCB concentrations in Spokane River sediments which exceeded guidelines for Washington State freshwater sediment screening (0.021 ppm total PCBs). Initial studies conducted prior to the implementation of the Comprehensive Plan detected concentrations of PCBs in sportfish fillets and whole fish exceeded the human consumption criteria for edible fish (0.0053 ppm) and criterion for fish-eating wildlife (0.11 ppm) (MacCoy 2001; USEPA 1999; WDOE 1994; Newall et al. 1987). A subsequent report indicated that PCB concentrations in fish tissue decreased in some areas of the Spokane River, while results in other areas were variable but suggested no strong evidence of improving conditions (Serdar and Johnson 2006).

3.2.3 Parameters of interest and potential sources

List environmental pollutants or contaminants of interest. Identify concerns related to each (e.g., potential toxicity, bioaccumulation of PCBs, endangered species / human health effects) along with known and possible sources. If the project doesn't involve pollutants or contaminants, summarize the other environmental parameters of interest (e.g., streambank width, flow, shade).

xx

3.2.4 Regulatory criteria or standards

If study objectives include assessing regulatory compliance status, identify all applicable governing regulations, list the relevant standards or criteria, and define how compliance will be determined. Assessing compliance status may indicate a need to set decision quality criteria for the data to be obtained (see section 6.1).

xx

3.3 Water quality impairment studies

If this QAPP does not describe some type of WQ impairment study, delete this section.

If this is a WQ impairment study, import relevant boilerplate language from an active web link.

Refer readers to Figure 2 or insert another figure to help readers visualize the study area.

Insert figure here and modify caption below as needed.

Figure 2. Study area for the water body parameter Water Quality Impairment Study.

xx

3.4 Effectiveness monitoring studies

If this is not an Effectiveness Monitoring (EM) study, delete this section.

If this is an EM study, insert Effectiveness Monitoring Standard Language.

Refer readers to Figure 3 or insert another figure to help readers visualize the study area.

Insert figure here and modify caption below as needed.

Figure 3. Study area for the Effectiveness Monitoring study.

xx

4.0 Project Description

Fish Sampling

WDFW will conduct boat electrofishing to capture Redband Trout in six reaches in three sections of the Spokane River in Washington state between the Washington/Idaho border to the Nine Mile HED. The three sections from upstream to downstream are the Upper Spokane River (Post Falls HED to Upriver HED), the Middle Spokane River (Upriver HED to Upper Falls HED), and the Lower Spokane River (Monroe Street HED to Nine Mile HED). The sections from upstream to downstream will be defined as: Reach 1 (WA/ID State Line to McMillan Road; rkm 154.5-146.1), Reach 2 (Flora Road to Donkey Island; rkm 143.1-134.8) Reach 3 (Upriver Dam to Crestline Street; rkm 129.0-120.2), Reach 4 (Crestline Street to Division Street; rkm 124.1-120.2), Reach 5 (Water Street to and T.J. Meenach Bridge; rkm 117.9-112.3) and Section 6 (Riverside Water Reclamation Facility to the kayak takeout site approximately 650 m below the effluent pipe rkm 108.7-108.0). Sampling will occur during the month of October when river discharge increases from summer low flows.

A crew of three individuals, one boat captain/rower and two netters, will conduct the surveys. A maximum of two sampling events will be conducted at each of the five reaches. A subsample of wild unmarked Rainbow Trout will be euthanized and preserved consistent with the procedures described by Serdar and Johnson (2006). Biological data collection will include total length (TL; mm), weight (WT; g), sample number and GPS coordinates of capture locations. WDFW will attempt to collect up to 25 sub-adult Redband Trout 150-300 mm TL within each sampling section.

Analysis

4.1 Project goals

State the major reasons for conducting the project. Examples include to:

- Develop a standardized sampling and analysis protocol for evaluating PCB concentrations in Redband Trout collected from six reaches of the Spokane River.
- Determine PCB concentrations in sub-adult Redband Trout in six reaches of the Spokane River from the Washington/Idaho border to Riverside Water Reclamation Facility to provide a baseline for future comparisons. to evaluate the efficacy of Control Actions to reduce PCBs in the Spokane River.
- Compare PCB concentrations in Redband Trout to previous studies to evaluate the efficacy of Control Actions implemented through the 2016 Comprehensive Plan.

xx

4.2 Project objectives

Describe specific activities you want to accomplish. Examples include to:

- Collect 25 sub-adult Redband Trout in each of six reaches from three section of the Spokane River from the Washington/Idaho border to Riverside Water Reclamation Facility.
- Analyze PCBs concentration of 30 composite samples of five sub-adult Redband Trout collected from each of six reaches of the Spokane River as described above.
- Analyze composite samples utilizing the 1668 analysis methodology

xx

4.3 Information needed and sources

Summarize the types and sources of existing data to be assembled, and all new data to be collected, that will address project objectives. Projects that involve analysis of existing environmental information, including many GIS layers, should summarize the data needed. For environmental modeling projects, data need can be described in overview here, with details provided in Section 7.3.

xx

4.4 Tasks required

List tasks, the specific activities planned to address each objective or obtain the needed information. For example, if one objective is to measure summer dissolved oxygen in Smith Creek, then a corresponding task might be to deploy continuous DO monitoring instrumentation at one site in Reach X and collect weekly grab samples from multiple depths at the same location.

xx

4.5 Systematic planning process

Preparing the QAPP is adequate systematic planning for most projects. However, for very complex or specialized projects, consider including description of a formalized systematic planning process.

xx

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1 shows the responsibilities of those who will be involved in this project.

Table 1. Organization of project staff and responsibilities.

Staff[1]	Title	Responsibilities
Name Program xx Regional Office Phone: xxx-xxx-xxxx	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Name xx Unit xx Section Phone: xxx-xxx-xxxx	Project Manager	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Name xx Unit xx Section Phone: xxx-xxx-xxxx	Principal Investigator	
Name xx Unit xx Section Phone: xxx-xxx-xxxx	Field Assistant	Helps collect samples and records field information.
Name xx Unit xx Section Phone: xxx-xxx-xxxx	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Name xx Section Phone: xxx-xxx-xxxx	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Name xx Section Phone: xxx-xxx-xxxx	Section Manager for the Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Alan Rue Manchester Environmental Laboratory Phone: 360-871-8801	Manchester Lab Director	Reviews and approves the final QAPP.
Contract Laboratory	Project Manager	Reviews draft QAPP, coordinates with MEL QA Coordinator
Arati Kaza Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

[1]All staff except the client are from EAP.
EAP: Environmental Assessment Program
EIM: Environmental Information Management database
QAPP: Quality Assurance Project Plan

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Commented [FR(6]: (If the Project Manager is also the Principal Investigator, add "Principal Investigator" to title – then delete this row from the table.

Commented [FR(7]: (This may or may not be the author's section manager)

5.2 Special training and certifications

Describe relevant experience, training, and certifications of key project personnel. Examples include: certifications for using field measurement devices and field sampling SOPs, experience collecting specific types of field samples, training related to conducting complex GIS analysis, and experience evaluating and using environmental models.

xx

5.3 Organization chart

Include this if the study involves multiple organizations or many individuals with differing roles. Otherwise, enter "Not Applicable - See Table 1".

xx

5.4 Proposed project schedule

Table 2 lists key activities, due dates, and lead staff for this project.

xx

Table 2. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Work type	Due date	Lead staff
Field and laboratory work		
Field work completed	month year	name
Laboratory analyses completed	month year	name
Environmental Information System (EIM) database		
EIM data loaded [1]	month year	name
EIM data entry review [2]	month year	name
EIM complete [3]	month year	name
Final report		
Draft due to supervisor	month year	name
Draft due to client/peer reviewer	month year	name
Draft due to external reviewer(s)	month year	name
Final (all reviews done) due to publications coordinator	month year	name
Final report due on web	month year	name

[1] All data entered into EIM by the lead person for this task.
[2] Data verified to be entered correctly by a different person; any data entry issues identified. Allow one month.
[3] All data entry issues identified in the previous step are fixed (usually by the original entry person); EIM Data Entry Review Form signed off and submitted to Melissa Peterson (who then enters the "EIM Completed" date into Activity Tracker). Allow one month for this step. Normally the final EIM completion date is no later than the final report publication date.

5.5 Budget and funding

Describe the funding sources for the project. For simpler projects, a short paragraph describing funding sources and budget may be all that is needed. For larger-scale and more complex projects, include a table showing budgets for more specific cost categories (e.g., salary and

Commented [JMP8]: If this won't be an Ecology publication, modify table as needed.

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benefits) or project tasks (e.g., sampling, lab analyses) or contracted services (e.g., aerial surveys, data validation, and other specialized services). Table 3 is an example.

Table 3 shows…

Table 3. Project budget and funding.

Commented [JMP10]: Modify this example table as needed.

xx					**xx**
Salary, benefits, and indirect/overhead					
Equipment					
Travel and other					
Contracts					
Laboratory					
Parameter	**Number of Samples**	**Number of QA Samples**	**Total Number of Samples**	**Cost Per Sample**	**Lab Subtotal**
Screening Samples					
PCB Congeners					
Dieldrin					
TOC					
TSS					
Source Identification Samples					
PCB Aroclors					
Dieldrin					
TOC					
Grain Size					
				Screening Survey Subtotal	
				Source ID Subtotal	
				Lab Grand Total	
				Project Grand Total	

xx

6.0 Quality Objectives

6.1 Data quality objectives [1]

xx

EPA describes a seven-step Data Quality Objectives (DQO) process [EPA, 2006 (EPA QA/G-4, Publication EPA/240/B-06/001)]. Most of the steps are addressed by other sections of this QAPP template (e.g., defining the problem, identifying the type of data needed, describing the analytical approach, and designing data collection efforts). But the sixth step "establishes acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data. These criteria are known as performance or acceptance criteria, or DQOs."

Here is an example of the brief narrative that might appear in this section:

The main data quality objective (DQO) for this project is to collect a minimum of 50 water samples representative of Smith Creek and to have them analyzed. The analysis will use standard methods to obtain total copper concentration data that meet measurement quality objectives (MQOs) that are described below and that are comparable to previous study results.

6.2 Measurement quality objectives

xx

Identify MQOs for the data to be collected. MQOs usually take the form of data quality indicators: precision, bias, sensitivity, representativeness, comparability and completeness. Analytical method descriptions, standard operating procedures (SOPs), and participating laboratories can help fine-tune the target MQOs for these indicators. Projects not involving laboratory analyses, e.g., habitat assessments, will often still benefit from setting MQOs to help ensure that results can be used for their intended purpose. See Ecology QAPP Guidance for more detailed information.

6.2.1 Targets for precision, bias, and sensitivity

xx

For example:

The MQOs for project results, expressed in terms of acceptable precision, bias, and sensitivity, are described in this section and summarized in Table 4 below.

xx

[1] DQO can also refer to ***Decision*** Quality Objectives. The need to identify Decision Quality Objectives during the planning phase of a project is less common. For projects that do lead to important decisions, DQOs are often expressed as tolerable limits on the probability or chance (risk) of the collected data leading to an erroneous decision. And for projects that intend to estimate present or future conditions, DQOs are often expressed in terms of acceptable uncertainty (e.g., width of an uncertainty band or interval) associated with a point estimate at a desired level of statistical confidence.

Table 4. Measurement quality objectives (e.g., for laboratory analyses of water samples).

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MQO →	Precision		Bias			Sensitivity
Parameter	Duplicate Samples	Matrix Spike-Duplicates	Verification Standards (LCS,CRM,CCV)	Matrix Spikes	Surrogate Standards*	MDL or Lowest Conc. of Interest
	Relative Percent Difference (% RPD)		Recovery Limits (%)			Concentration Units

* Surrogate recoveries are compound-specific.
MDL = method detection limit.

6.2.1.1 Precision

xx

Precision is a measure of variability among replicate measurements due to random error. It is usually assessed using duplicate field measurements or laboratory analysis of duplicate samples. In this section, describe how field measurements will be made in duplicate or how duplicate samples will be collected/created for chemical analysis (field duplicates, field splits of a single field sample, laboratory splits, matrix spike duplicates, and/or extract duplicates). List targets for acceptable precision between duplicate results, in terms of relative percent difference (RPD), in Table 4. Express acceptable precision among three or more replicate sample results as relative standard deviation (RSD).

6.2.1.2 Bias

xx

Bias is the difference between the sample mean and the true value. Bias is usually addressed by calibrating field and laboratory instruments, and by analyzing lab control samples, matrix spikes, and/or standard reference materials. List targets for bias in terms of acceptable % recovery of a known quantity, listed in Table 4.

6.2.1.3 Sensitivity

xx

Sensitivity is a measure of the capability of a method to detect a substance. It is commonly described as a detection limit. In a regulatory setting, the method detection limit (MDL) [2] is often used to describe sensitivity. List targets for acceptable sensitivity of all field and lab measurements in Table 4. Studies not involving environmental pollutants or contaminants may

[2] The lowest quantity of a physical or chemical parameter that is detectable (above background noise) by each field instrument or laboratory method.

still benefit from setting MQOs for sensitivity. Examples include minimum stream depth / minimum measurable flow, minimum area of specific habitat definable using new aerial photographic survey images.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

xx

List the standard operating procedures (SOPs) that will be followed for sampling, analysis, and data reduction and to ensure comparability between projects. Also, list standardized sampling techniques and methods to be used to ensure comparability. Project results may need to be comparable to those generated by other projects that took place in the same study area. The QAPP might need to provide detailed procedures for analyzing existing environmental data or for modeling environmental conditions that are comparable to other existing studies.

6.2.2.2 Representativeness

xx

Describe how environmental samples to be collected are representative of existing conditions. If they are not, the resulting data gathered will either be rejected or of limited use. Show how the sampling strategy and number of collected samples also contribute to representativeness. Show representativeness through consideration of factors such as seasonality, time of day, flow conditions, sampling location(s), and weather. Representativeness also influences the data used in environmental models.

6.2.2.3 Completeness

xx

Propose a percentage of observations, measurements, and samples (taken and analyzed acceptably) for your study to be a success. 95% is often used as a measure for this plan element.

6.3 Acceptance criteria for quality of existing data

xx

If known, describe the quality of existing data available for the study area. If not known, describe the criteria that will be used to assess quality and usability of the existing data, whether the project will also collect new environmental data, analyze the data (only), or use the data for modeling. It may be possible to cite a programmatic QAPP or other document that already contains this information.

Identify data gaps and describe how the study may fill those gaps and improve the quality of available information.

6.4 Model quality objectives

xx

If the project does not involve environmental modeling, then Enter “NA”. Otherwise, describe the quality of modeling results desired to meet the objectives of the project. Quality objectives for modeling results may be a combination of quantitative and qualitative.

Define the quantitative objectives needed for the project. Examples include target values for bias, error, goodness-of-fit, and other measures of uncertainty, that are comparable to ones achieved by similar modeling studies. For some projects, it may be critical to meet firm quantitative objectives. For other projects, quantitative objectives may be used as initial benchmarks in a broader evaluation of model quality. Ecology has summarized quantitative model quality results from various water quality modeling projects (Ecology, 2014). The process of evaluating whether these quality objectives are met, and the consequences of not meeting them, should be described in Section 13.1.

Managers of modeling projects may also set qualitative or narrative quality objectives. Examples include:

- Peak flows should match the timing and magnitude of those observed from 2010 to 2015.
- Model outputs are not overly sensitive to uncertainty associated with input parameters or values.

Past modeling project plans also offer examples of narrative quality objectives.

7.0 Study Design

7.1 Study boundaries

xx

Define the specific area of focus when the project involves measuring parameters in the field, collecting samples for analysis by a laboratory, or other field activities. This might be something as simple as "WRIA 1" or a very complex area designated using a GPS coordinate system and GIS [3]. Consider showing the study area in a figure that is more specific than what is presented in Figure 1a, or refer to Figures 1 – 3, as appropriate.

Insert figure here and modify caption below as needed.

Figure 4. Map showing boundary of project study area.

xx

For projects involving analysis of historic data, GIS analysis, or modeling environmental conditions, descriptions of study design will be different. For these types of projects, describe study design including topics such as: how existing data will be chosen for analysis and the proposed statistical approach; how GIS data layers will be analyzed; the process for choosing the final model(s) from existing alternatives and examples of the model simulations that will be conducted.

7.2 Field data collection

Show the proposed and perhaps alternate measurement and sampling locations.

7.2.1 Sampling locations and frequency

xx

Describe all sampling strategies chosen for the project and explain why they will be appropriate. Examples of sampling strategies include random, stratified random, subjective, before-after-control-impact (BACI), nested paired. List all target sampling locations and potential alternate locations as accurately as possible. If locations cannot be identified in advance of sampling, then describe the factors that will be used to choose locations when in the field. Also describe as accurately as possible how often and when samples will be collected, or how the timing of sample collection will be determined (e.g., within 4 hours of storm > 0.1" of precipitation).

7.2.2 Field parameters and laboratory analytes to be measured

xx

List all environmental parameters to be observed/counted, measured, or analyzed.

---

[3] Water Resource Inventory Areas (WRIAs) for the study area can be found at: [WDFW link to WRIAs]

7.3 Modeling and analysis design

xx

Enter "N/A" if the project does not involve these activities.

7.3.1 Analytical framework

xx

Describe the conceptual framework of the model and the type of model needed. Examples include empirical vs. mechanistic, static vs. dynamic, simulation vs. optimization, deterministic vs. stochastic, and lumped vs. distributed. Project managers analyzing existing environmental data should describe the analytical tools they will use, such as GIS, statistics, and computational models, and how these tools support the project objectives.

If developing a new model, describe key elements of its design. If the project will use a specific model or modeling software package that has already been chosen, briefly justify the choice. If an existing model will be used but has yet to be chosen, describe the criteria that will be used to choose from among the established alternatives.

Describe in detail the hardware and software needed for the planned modeling.

7.3.2 Model setup and data needs

xx

Describe the temporal and geographic scale of the study. Include an initial estimate of the spatial and temporal resolution (geographic features that affect model reach/grid size and design of the data collection network; temporal features or needs affecting model output time-step) that supports project objectives at an appropriate level of certainty.

Describe the level of model process complexity appropriate to meet project objectives. Identify, to the extent possible, the various simulations that will be run or the specific scenarios that will be tested using the model. Specify state variables required by the model framework that are significant and will require data. List the data and parameters needed as model inputs and the data needed for model quality assessment or refer to a previous section (Section 4.3 or 6.3).

7.4 Assumptions underlying design

xx

Discuss any assumptions that affect your study design. This is important for projects generating new environmental data, for projects analyzing existing data, and for environmental modeling.

7.5 Possible challenges and contingencies

xx

Ensure that the study design supports the objectives of the project. Assess the proposed design in light of any challenges the study location may present in terms of access, physical hazards, chemical hazards, and other environmental factors.

7.5.1 Logistical problems

xx

Describe potential problems associated with logistics. Examples might include: access to private property (uncertain access to safe sampling sites); timing field work for optimal tidal conditions; precipitation and high-flow/low-flow sampling issues (adequate flow and water depth, threshold defining storm event), and other seasonal considerations. Also describe contingencies or measures to be taken that may prevent or reduce the likelihood of such problems.

7.5.2 Practical constraints

xx

Describe issues such as availability of resources (human and budgetary), difficulties obtaining historic data for novel analyses, and access to hardware or software required to run preferred models. Also, summarize how investigators will prevent or minimize the impact of such problems.

7.5.3 Schedule limitations

xx

Describe how problems and constraints listed in the previous sections may impact the proposed study schedule. Include discussion of other things that may impact schedule, including the time required for QAPP review and approval and the preparedness of external parties involved in the project.

8.0 Field Procedures

8.1 Invasive species evaluation

Assess the possibility of invasive species contamination of both protective gear and sampling equipment, including boats, rafts, and other water-borne devices. Ecology's SOP EAP070 addresses invasive species transport and contamination. This document is at Ecology's QA website: Published SOPs.

xx

8.2 Measurement and sampling procedures

Standard Operating Procedures (SOPs) are required for field sampling and field analyses. Ecology's QA Website contains over 80 SOPs that address specific sampling and field analytical techniques. Identify and reference SOPs that accurately reflect field, laboratory, and other procedural details of the project. Include relevant SOPs for projects that involve complex data analyses or modeling (to ensure repeatability of project outcomes). Develop a new SOP, if no existing one fits your particular situation.

xx

8.3 Containers, preservation methods, holding times

Refer to the example Table 5 and describe appropriate containers, preservation techniques, and holding times as per 40CFR 136.

xx

Table 5. Sample containers, preservation, and holding times.

Parameter	Matrix	Minimum Quantity Required	Container	Preservative	Holding Time

8.4 Equipment decontamination

Explain your procedure for decontamination that may be necessary when sampling substances that contain high levels of contaminants, bacterial contamination, or organic materials that stick to the sampling devices. Refer to Ecology's SOP EAP090, *Decontamination of Sampling Equipment for Use in Collecting Toxic Chemical Samples*.

xx

8.5 Sample ID

Provide a specific protocol for establishing sample IDs. If such a protocol is lacking, adopt one (e.g., from an analytical laboratory) or develop and describe a new one.

xx

8.6 Chain of custody

Maintaining environmental samples under chain of custody is standard practice. If standard procedures and forms are not available, adopt them, for example, from an analytical laboratory or develop and describe new ones here. More details on chain of custody are available in the Ecology QAPP Guidance.

xx

8.7 Field log requirements

A field log is an important component of many projects. It is used to record irreplaceable information, such as:

- Name and location of project
- Field personnel
- Sequence of events
- Any changes or deviations from the QAPP
- Environmental conditions
- Date, time, location, ID, and description of each sample
- Field instrument calibration procedures
- Field measurement results
- Identity of QC samples collected
- Unusual circumstances that might affect interpretation of results

Use field logs that are bound, waterproof notebooks with pre-numbered pages. Use permanent, waterproof ink for all entries. Make corrections with single line strikethroughs; initial and date corrections. Do not use correction fluid such as Wite-Out. Electronic field logs may be used if they demonstrate equivalent security to a waterproof, bound notebook.

xx

8.8 Other activities

These may include:

- Briefings and trainings for field staff
- Periodic maintenance for field instrumentation
- Procedures and equipment for homogenizing non-aqueous matrices
- Procedure for lab notification regarding sampling and other topics

xxxx

9.0 Laboratory Procedures

9.1 Lab procedures table

Include Table 6 which contains the following information for each analysis to be performed:

- Analyte or parameter name. The element, compound, physical property, chemical property, or organism that is being analyzed or determined. Examples include temperature, pH, sodium, PCBs, or *E. coli*.
- Matrix. The type of substance being analyzed. Typical matrices include water, air, soil and sediment, hazardous waste, and tissues of biota.
- Number of samples. Use a table to list the number of samples, by matrix, that will be analyzed for each parameter.
- Expected range of results. List ranges derived based on results of previous studies, if available and relevant.
- Analytical method. List the analytical method that will be used for each analyte. Generally speaking, these must be EPA-approved methods.
- Sensitivity/Method Detection Limit (MDL). Identify the method that will be used to detect low levels of each analyte. Obtain MDL values from published methods or from the laboratory performing the analysis.

Information required for this table may be provided by the lab that will perform the analyses, and it is available in these publications:

- 40 CFR 136.3, Table II
- SW-846 Methods, Section 6.0
- EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*, August, 1993

Table 6. Measurement methods (laboratory).

Analyte	Sample Matrix	Samples (Number/ Arrival Date)	Expected Range of Results	Detection or Reporting Limit	Sample Prep Method	Analytical (Instrumental) Method

Commented [JMP12]: Modify this example table as needed

A similar table should be constructed for field testing that will occur in support of this project.

xx

9.2 Sample preparation method(s)

It is rare to analyze samples without some form of preparation and extraction. List each preparation and extraction technique. It is especially important to provide details of any unusual or nonstandard technique.

xx

9.3 Special method requirements

Some analytical laboratories have special requirements. Record these in the QAPP to communicate them effectively to the laboratory. Typical causes for special method modifications include: analysis of very low or very high concentrations of analytes, analysis of analytes with high levels of interference, and use of non-standard methods.

xx

9.4 Laboratories accredited for methods

You must use an accredited laboratory to analyze your samples. That laboratory must also be accredited for the specific method that you are using for analysis. Ecology only accredits methods published by EPA, Standard Methods, or ASTM. This is an Ecology legal requirement, and exceptions for it are difficult to obtain. If your technical work involves the use of non-standard methods or analytes, a waiver process is available. Contact the Ecology Lab Accreditation Unit for more information.

xx

10.0 Quality Control Procedures

Describe the quality control procedures that will help identify problems or issues associated with data collection, data analysis, or modeling while the project is underway (e.g., before it is too late to address them). These may include having experts accompany field staff on sampling campaigns, holding weekly staff meetings, or reviewing interim work products or model outputs.

xx

10.1 Table of field and laboratory quality control

Identify the QC samples that will be measured in the field, analyzed in the lab or otherwise evaluated. You may do this with a table similar to Table 7. Ecology's QA Glossary defines various types of QC samples, including:

- Blanks (lab, field, and other)Standard Reference Materials (SRM)
- Duplicates (lab and field) "Blind" SRMs submitted to the laboratory
- Lab Control Samples (LCS) Surrogates
- Matrix Spikes

xx

Table 7. Quality control samples, types, and frequency.

Parameter	Field		Laboratory			
	Blanks	Replicates	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes

Each type of QC sample listed above will have MQOs associated with it (Section 6.2) that will be used to evaluate the quality and usability of the results.

xx

10.2 Corrective action processes

This section should describe actions that will be taken if activities are found to be inconsistent with the QAPP, if analysis or modeling results do not meet MQOs or performance expectations, or if some other unforeseen problem arises. Such actions may include:

- Collecting new samples using the method described in the approved QAPP
- Reanalyzing lab samples that do not meet QC criteria (analytical methods often state what to do when QC criteria are not met)
- Convening project personnel and technical experts to decide on the next steps that need to be taken to improve model performance

xx

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

The Environmental Information System (EIM) Study ID for this project is XXXX.

Commented [PJ(13]: (see the *EIM Help Center* for how to set up EIM ID or how to find your EIM Data Coordinator for help.)

Describe field data that will be transferred to Ecology's EIM database (sometimes EPA's STORET or other acceptable database). Also describe procedures for recording lab results and transferring them to the same database. Summarize how data entry errors will be detected and corrected.

xx

11.2 Laboratory data package requirements

Describe how the analytical lab will provide results. Labs usually provide a cover narrative with attached detailed results presented in a standard package when work has been completed. Labs should be required to provide all relevant quality control data.

xx

11.3 Electronic transfer requirements

Require laboratories to submit data electronically, in a readily-usable format, to minimize data entry problems and facilitate data analysis. Most laboratories will comply, with the data at least available in Microsoft Excel and text formats.

xx

11.4 EIM/STORET data upload procedures

Projects funded by or submitting data to Ecology must submit the data formatted for entry into Ecology's EIM data system. EPA-funded projects usually require data to be entered into that agency's STORET data system. It *may* be possible to do this by transferring the data from EIM.

xx

11.5 Model information management

Describe how modeling information will be managed. This should include: the volume of input and output data expected; input and output data storage needs; version control and; mapping post-processed model outputs to the appropriate version of the model. Enter "NA" if this project does not involve modeling or analysis of existing data.

xx

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

Describe the number, frequency, type, and schedule for any audits that are planned. For projects that have controversial implications, or are large, complex, and costly, the QAPP should describe conducting one or more field, “bench,” or telephone audits before project completion. Audits can also be appropriate for projects that only involve complex data analysis and/or modeling. You may also describe audits in which the analytical laboratory routinely participates. Simpler projects may not warrant audits.

xx

12.2 Responsible personnel

Identify who will conduct the audits and what the auditors will examine.

xx

12.3 Frequency and distribution of reports

Determine and describe report frequencies. For a project extending over a long period of time, it may be useful to generate interim reports or report the data more frequently than just at the end of the project. Often some form of short technical communication is used for this reporting. An e-mail message or technical memo may be adequate to cover the required information transfer. Propose an outline for the final report.

xx

12.4 Responsibility for reports

Identify all authors of the final report.

xx

13.0 Data Verification

EPA defines data verification as "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements."

xx

13.1 Field data verification, requirements, and responsibilities

Describe the process by which field data are verified (e.g., examined in detail to ensure that quality criteria such as MQOs have been met). Data verification should be performed by a qualified person different from the field staff who generated the data.

xx

13.2 Laboratory data verification

Describe the process for verifying quality of lab analytical data (see EPA definition above).

xx

13.3 Validation requirements, if necessary

Data validation defined as "an analyte-specific and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set". Validation requires a qualified individual, independent of the data generation process, to use raw instrument records and bench sheets to assess the quality of the data. For the majority of projects that do not warrant this added difficulty and expense, this section is "Not Applicable".

xx

13.4 Model quality assessment

Enter "NA" if this project does not involve modeling or analysis of existing data.

xx

13.4.1 Calibration and validation

Use subsections below to describe how the model will be calibrated and verified/validated. Detail the procedures that will be used to assess goodness-of-fit between model outputs (predictions) and field data. If an independent data set will be used to corroborate calibrated model results (often called "verification" or "validation"), describe that procedure also. Calibration and validation procedures usually involve estimating precision and bias.

xx

13.4.1.1 Precision

Model precision is usually assessed by comparing the “absolute distance” between modeled results and field measurements representing a similar time and location (positive and negative differences will be treated the same). Examples of metrics for precision include relative percent difference (RPD), relative standard deviation (RSD), and the root mean square error (RMSE) between paired modeled and observed results.

xx

13.4.1.2 Bias

Bias is also usually assessed by comparing modeled results to field measurements from a similar time and location. However, bias is indicated by the average shift between the two (positive and negative differences “cancel out”) which helps determine how much precision deviates from being equally balanced. Metrics for bias include the mean error (average of paired observed-modeled values) or the percent error (average of paired observed-modeled values divided by observed value), using actual values and not absolute values.

xx

13.4.1.3 Representativeness

Describe how model results will be assessed to determine how representative they are of the population of interest and the model-specified population boundaries. Describe how the model approach combined with input and calibration data collection methods contribute to representativeness. Show representativeness through consideration of factors such as seasonality, time of day, flow conditions, and weather.

xx

13.4.1.4 Qualitative assessment

Describe any qualitative methods that will be used for goodness-of-fit, such as graphical evaluation. Include the criteria used, e.g., important patterns such as diurnal variation or daily maximum values.

xx

13.4.2 Analysis of sensitivity and uncertainty

Describe the analytical procedures that will be used to assess sensitivity of the model to input values for different parameters. Also describe how uncertainty associated with the various modeled outputs will be calculated.

xx

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

Describe the process for evaluating whether the project outcomes have met the original objectives. In general, this will be the case if the data were collected consistent with the study design [4], methods, and procedures described in the final approved QAPP, and if enough of the data are deemed usable after verification (e.g., quality objectives detailed in the QAPP have been met). Also describe causes for rejecting data, as well as how data that do not meet MQOs will be qualified.

A similar process should be described for projects involving modeling or analysis of existing data. For example, describe how investigators will evaluate overall model quality, e.g., by comparing RSD, RMSE, other goodness-of-fit statistics, and uncertainty values to the model quality objectives listed in Section 6.4. Also describe how the final assessment of model quality may affect usability or applicability of the model.

xx

14.2 Treatment of non-detects

Describe how non-detect project results will be handled. This is a complex topic. If uncertain about how to address non-detect data, determine whether there is available guidance. If not, consult a statistician.

xx

14.3 Data analysis and presentation methods

Include procedures for compiling and analyzing the data, including any software requirements. Discuss, in general terms, any statistical treatment or specialized statistics you plan to use for interpretation of data or determining trends.

An important element of the project might be statistical analysis to detect relationships and trends in the data or to compare results with those of other projects. Use guidance for these techniques in Ecology QAPP Guidance.

xx

14.4 Sampling design evaluation

Evaluate the anticipated effectiveness of the sampling design to be used. For example, does the design yield enough statistical power to draw the desired conclusions? Revise as necessary.

xx

[4] And there is no reason to question the study design assumptions xx

14.5 Documentation of assessment

Describe how the data usability assessment will be documented.

xx

15.0 References

Most QAPPs refer to studies, reports, SOPs, and scientific literature. Include these references in this section. Spell out all journal names for Plain Talk.

Authors, delete all of the following references that aren't cited in this QAPP.

APHA, AWWA, and WEF, 1998. Standard Methods for the Examination of Water and Wastewater 20th Edition. American Public Health Association, Washington, D.C.

Aroner, E.R., 2003. WQHYDRO: Water Quality/Hydrology Graphics/Analysis System. Portland, OR.

Ecology, 2019a. Permits – Point Source Pollution. Water Quality Program, Washington State Department of Ecology, Olympia, WA. https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-quality-permits

Ecology, 2019b. River and Stream Water Quality Monitoring. Environmental Assessment Program, Washington State Department of Ecology, Olympia, WA. River & Stream Monitoring.

Ecology, 2019c. Quality Assurance at Ecology. Environmental Assessment Program, Washington State Department of Ecology, Olympia. https://ecology.wa.gov/About-us/How-we-operate/Scientific-services/Quality-assurance.

Ecology, 2019d. Water Quality Data Quality Assessment. Water Quality Program, Washington State Department of Ecology, Olympia, WA. https://ecology.wa.gov/Research-Data/Monitoring-assessment/River-stream-monitoring/Water-quality-monitoring/River-stream-monitoring-methods

Ecology, 2012. 2012 Washington State Water Quality Assessment. Water Quality Program, Washington State Department of Ecology, Olympia, WA. https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d

Janisch, J., 2006. Standard Operating Procedure for Determining Global Position System Coordinates, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP013. Published SOPs.

Joy, J., 2006. Standard Operating Procedure for Grab sampling – Fresh water, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP015. Published SOPs.

Lombard, S. and C. Kirchmer, 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-030. https://fortress.wa.gov/ecy/publications/SummaryPages/0403030.html

Mathieu, N., 2006. Replicate Precision for 12 Total Maximum Daily Load (TMDL) Studies and Recommendations for Precision Measurement Quality Objectives for Water Quality Parameters. Washington State Department of Ecology, Olympia, WA. Publication No. 06-03-044. https://fortress.wa.gov/ecy/publications/SummaryPages/0603044.html

MEL, 2016a. Manchester Environmental Laboratory *Lab Users Manual*, Ninth Edition. Manchester Environmental Laboratory, Washington State Department of Ecology, Manchester, WA.

MEL, 2016b. Manchester Environmental Laboratory *Quality Assurance Manual*. Manchester Environmental Laboratory, Washington State Department of Ecology, Manchester, WA.

Microsoft, 2007. Microsoft Office XP Professional, Version 10.0. Microsoft Corporation.

Ott, W., 1995. Environmental Statistics and Data Analysis. Lewis Publishers, New York, NY.

Sullivan, L., 2007. Standard Operating Procedure for Estimating Streamflow, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP024. Published SOPs.

Swanson, T., 2007. Standard Operating Procedure for Hydrolab® DataSonde® and MiniSonde® Multiprobes, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP Number EAP033. Published SOPs.

WAC 173-201A. Water Quality Standards for Surface Waters in the State of Washington

Washington State Department of Ecology, Olympia, WA. http://app.leg.wa.gov/WAC/default.aspx?cite=173

Ward, W.J., 2007. Collection, Processing, and Analysis of Stream Samples, Version 1.3. Washington State Department of Ecology, Olympia, WA. SOP Number EAP034. https://www.ecology.wa.gov/About-us/How-we-operate/Scientific-services/Quality-assurance

16.0 Appendices

In addition to Appendix A, appendices might include:

- SOPs
- MSDS and safety information
- Historical data
- Examples of forms to be used in the project

Appendix A. xx Title

In Appendix A, number figures and tables as:

- Figure A-1, Figure A-2, etc.
- Table A-1, Table A-2, etc.

Don't caption figure and table titles in the Appendices.

xx

Make this the _last_ appendix.

Appendix xx. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Author, delete all terms that don't apply to this QAPP.

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Anthropogenic: Human-caused.

Bankfull stage: Formally defined as the stream level that "corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels (Dunne and Leopold, 1978).

Baseflow: The component of total streamflow that originates from direct groundwater discharges to a stream.

Char: Fish of genus *Salvelinus* distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light-colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

Chronic critical effluent concentration: The maximum concentration of effluent during critical conditions at the boundary of the mixing zone assigned in accordance with WAC 173-201A-100. The boundary may be based on distance or a percentage of flow. Where no mixing zone is allowed, the chronic critical effluent concentration shall be 100% effluent.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Critical condition: When the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or designated water uses. For steady-state discharges to riverine systems, the critical condition may be assumed to be equal to the 7Q10 flow event unless determined otherwise by the department.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Diel: Of, or pertaining to, a 24-hour period.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Dilution factor: The relative proportion of effluent to stream (receiving water) flows occurring at the edge of a mixing zone during critical discharge conditions as authorized in accordance with the state's mixing zone regulations at WAC 173-201A-100. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-020

Diurnal: Of, or pertaining to, a day or each day; daily. (1) Occurring during the daytime only, as different from nocturnal or crepuscular, or (2) Daily; related to actions which are completed in the course of a calendar day, and which typically recur every calendar day (e.g., diurnal temperature rises during the day, and falls during the night).

Effective shade: The fraction of incoming solar shortwave radiation that is blocked from reaching the surface of a stream or other defined area.

Effluent: An outflowing of water from a natural body of water or from a human-made structure. For example, the treated outflow from a wastewater treatment plant.

Enterococci: A subgroup of the fecal streptococci that includes *S. faecalis*, *S. faecium*, *S. gallinarum,* and *S. avium*. The enterococci are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at 10 degrees C and 45 degrees C.

Eutrophic: Nutrient rich and high in productivity resulting from human activities such as fertilizer runoff and leaky septic systems.

Existing uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Fish Tissue Equivalent Concentration (FTEC): The FTEC is a tissue contaminant concentration used by Ecology to determine whether the designated uses of fishing and drinking from surface waters are being met. The FTEC is an interpretation of Washington's water quality criterion for a specific chemical for the protection of human health: the National Toxics Rule (40 CFR 131.36). Fish tissue sample concentrations that are lower than the FTEC suggest that the uses of fishing and drinking from surface waters are being met for that specific contaminant. Where an FTEC is not met (i.e., concentration of a chemical in fish tissue is greater than the FTEC), that water body is then placed into Category 5 during Washington's periodic Water Quality Assessment (WQA and 303d List). Category 5 listings become part of Washington's 303(d) list during the assessment process. The FTEC is calculated by multiplying the contaminant-specific Bio-Concentration Factor (BCF) times the contaminant-specific Water Quality Criterion found in the National Toxics Rule.

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

Load allocation: The portion of a receiving water's loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes and (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Near-stream disturbance zone (NSDZ): The active channel area without riparian vegetation that includes features such as gravel bars.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Phase I stormwater permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres.

Phase II stormwater permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point source: Source of pollution that discharges at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites where more than 5 acres of land have been cleared.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Reach: A specific portion or segment of a stream.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Fish that belong to the family *Salmonidae*. Species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Streamflow: Discharge of water in a surface stream (river or creek).

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

Synoptic survey: Data collected simultaneously or over a short period of time.

System potential: The design condition used for TMDL analysis.

System-potential channel morphology: The more stable configuration that would occur with less human disturbance.

S**ystem-potential mature riparian vegetation:** Vegetation which can grow and reproduce on a site, given climate, elevation, soil properties, plant biology, and hydrologic processes.

System-potential riparian microclimate: The best estimate of air temperature reductions that are expected under mature riparian vegetation. System-potential riparian microclimate can also include expected changes to wind speed and relative humidity.

System-potential temperature: An approximation of the temperatures that would occur under natural conditions. System potential is our best understanding of natural conditions that can be supported by available analytical methods. The simulation of the system-potential condition uses best estimates of *mature riparian vegetation, system-potential channel morphology, and system-potential riparian microclimate* that would occur absent any human alteration.

Thalweg: The deepest and fastest moving portion of a stream.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Total suspended solids (TSS): Portion of solids retained by a filter.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

1-DMax or 1-day maximum temperature: The highest water temperature reached on any given day. This measure can be obtained using calibrated maximum/minimum thermometers or continuous monitoring probes having sampling intervals of thirty minutes or less.

303(d) list: Section 303(d) of the federal Clean Water Act, requiring Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

7-DADMax or 7-day average of the daily maximum temperatures: The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days before and the three days after that date.

7Q2 flow: A typical low-flow condition. The 7Q2 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every other year on average. The 7Q2 flow is commonly used to represent the average low-flow condition in a water body and is typically calculated from long-term flow data collected in each basin. For temperature TMDL work, the 7Q2 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

7Q10 flow: A critical low-flow condition. The 7Q10 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every ten years on average. The 7Q10 flow is commonly used to represent the critical flow condition in a water body and is typically calculated from long-term flow data collected in each basin. For temperature TMDL work, the 7Q10 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

90th percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90th percentile value is a statistically derived estimate of the division between 90% of samples, which should be less than the value, and 10% of samples, which are expected to exceed the value.

Acronyms and Abbreviations

Author, delete all of the following that aren't used in this QAPP.

Also, add any acronyms/abbreviations/units used in this QAPP that aren't already on this list.

BMP	Best management practice
DO	(see Glossary above)
DOC	Dissolved organic carbon
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FC	(see Glossary above)
GIS	Geographic Information System software
GPS	Global Positioning System
i.e.	In other words
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
NAF	New Approximation Flow
NPDES	(See Glossary above)
NSDZ	Near-stream disturbance zones
NTR	National Toxics Rule
PBDE	Polybrominated diphenyl ethers
PBT	Persistent, bioaccumulative, and toxic substance
PCB	Polychlorinated biphenyls

QA	Quality assurance
QC	Quality control
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SRM	Standard reference materials
TIR	Thermal infrared radiation
TMDL	(see Glossary above)
TOC	Total organic carbon
TSS	(see Glossary above)
USFS	United States Forest Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQA	Water Quality Assessment
WRIA	Water Resource Inventory Area
WSTMP	Washington State Toxics Monitoring Program
WWTP	Wastewater treatment plant

Units of Measurement

°C	degrees centigrade
Cfs	cubic feet per second
Cfu	colony forming units
Cms	cubic meters per second, a unit of flow
Dw	dry weight
Ft	feet
G	gram, a unit of mass
Kcfs	1000 cubic feet per second
Kg	kilograms, a unit of mass equal to 1,000 grams
kg/d	kilograms per day
km	kilometer, a unit of length equal to 1,000 meters
l/s	liters per second (0.03531 cubic foot per second)
m	meter
mm	millimeter
mg	milligram
mgd	million gallons per day
mg/d	milligrams per day
mg/kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mg/L/hr	milligrams per liter per hour
mL	milliliter
mmol	millimole or one-thousandth of a mole
mole	an International System of Units (IS) unit of matter
ng/g	nanograms per gram (parts per billion)
ng/kg	nanograms per kilogram (parts per trillion)
ng/L	nanograms per liter (parts per trillion)

NTU	nephelometric turbidity units
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
psu	practical salinity units
s.u.	standard units
µg/g	micrograms per gram (parts per million)
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
µm	micrometer
µM	micromolar (a chemistry unit)
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter, a unit of conductivity
ww	wet weight

Quality Assurance Glossary

Don't delete (or add) any terms from the following glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USGS, 1998).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: The difference between the sample mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 1997).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability, and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).

- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier – data are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are rejected, cannot be used for intended purposes.
  (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 1997).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA, 1997).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register, October 26, 1984).

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

%RSD = (100 * s)/x

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

[Abs(a-b)/((a + b)/2)] * 100

where “Abs()” is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1997).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 1997).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 1997).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

References for QA Glossary

Ecology, 2004. Guidance for the Preparation of Quality Assurance Project Plans for Environmental Studies. Washington State Department of Ecology, Olympia, WA. https://fortress.wa.gov/ecy/publications/SummaryPages/0403030.html.

Kammin, B., 2010. Definition developed or extensively edited by William Kammin, 2010. Washington State Department of Ecology, Olympia, WA.

USEPA, 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4. http://www.epa.gov/quality/qs-docs/g4-final.pdf.

USGS, 1998. Principles and Practices for Quality Assurance and Quality Control. Open-File Report 98-636. U.S. Geological Survey. http://ma.water.usgs.gov/fhwa/products/ofr98-636.pdf.