Quality Assurance Project Plan

Monitoring of Tributaries to the Yakima River Boundary Waters of the Yakama Nation

August 2022

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Quality Assurance Project Plan

Monitoring of Tributaries to the Yakima River Boundary Waters of the Yakama Nation

by
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and
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August 2022

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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

Previous monitoring within the Yakima River boundary waters of the Yakama Nation Reservation (Union Gap to Mabton) has shown that the Yakima River can have high water temperature and low dissolved oxygen (DO) levels. These levels do not protect fish and other aquatic life that depend on cool, oxygenated water. Previous monitoring of tributaries on this reach of the Yakima River has also shown dangerous high water temperature and low DO levels.

This project involves water quality monitoring of tributaries and discharges to the Yakima River. It outlines a Yakama Nation monitoring program to measure temperature, DO, and other parameters associated with algal growth in the water (primary productivity). This project will collect water quality data in support of United States Geological Survey (USGS) continuous water quality monitoring that is being conducted at several Yakima River locations during 2022.

The United States Bureau of Reclamation (USBR), along with the Yakima Basin Integrated Plan (YBIP) and the Benton Conservation District (BCD), is sponsoring the USGS water quality monitoring gages in order to provide calibration data to develop a water quality model that simulates water temperature and DO, along with other parameters. The calibrated model will be used to assess different water management strategies to improve fish migration in the Yakima River corridor.

By conducting data collection in the tributaries to the Yakima River, the Yakama Nation monitoring will help provide a more complete data set that can be used to calibrate a water quality model for temperature and DO; both of these parameters are important to aquatic life throughout the Yakima River basin. The Washington State Department of Ecology will assist the Yakama Nation in collecting and processing water quality samples.

If possible, sampling will occur from June through November 2022, capturing critical periods during the early irrigation season, as well as some post-irrigation periods. Sampling will take place every two weeks at about 20 locations within the Yakima River boundary waters of the Yakama Nation.

3.0 Background

3.1 Introduction

Previous monitoring by the Yakama Nation of its Yakima River boundary waters between the towns of Union Gap and Mabton has shown that the Yakima River has high water temperature and low dissolved oxygen (DO) levels. These levels do not adequately protect fish and other aquatic life that depend on cool, oxygenated water. In order to preserve, protect, enhance, and restore these culturally important Yakima River fish populations, and to protect the right of the Yakama Nation members to utilize these resources, water temperatures need to be reduced and DO levels increased.

The USBR, in coordination with the Yakima Basin Integrated Plan (YBIP) and the Washington State Department of Ecology (Ecology) is trying to understand the dynamics that cause high water temperatures and low DO. Improving this understanding will assist the ongoing efforts of the Yakama Nation and government agencies to find ways to improve the water quality in the river. This will be in order to improve fish spawning, rearing, and migration throughout the Yakima River corridor in both the near-term and the long-term.

The USBR and the Benton Conservation District (BCD) are sponsoring USGS continuous water quality monitoring at several sites on the mainstem Yakima River to support the development of a water quality model that can simulate water temperature and DO levels. A calibrated model can be used as a tool to simulate different water management scenarios, such as pulse releases of water from reservoirs. The model will predict what changes in temperature and DO levels are expected from the different flow management scenarios (Pickett, 2017).

One of the gaps in water quality monitoring in the Lower Yakima River corridor is in the Yakima River boundary waters of the Yakama Nation from Union Gap (Ahtanum Creek) to the Mabton Bridge. In order to better understand the temperature and DO levels in this reach, the USBR, YBIP, and BCD are sponsoring two continuous water quality monitoring gages in the boundary waters of the Yakima River during 2022:

- Yakima River at the city of Union Gap above Ahtanum Creek.
- Yakima River below the city of Granger near the Satus Wildlife and Recreation Area.

These two gages bracket an important stretch of the Yakima River that is crucial to fish and other aquatic life. These gages also incorporate a reach that is significantly de-watered by the Wapato Irrigation Project and the Sunnyside Valley Irrigation District diversions. While minimum instream flow levels are required to be maintained by the USBR water management, it is unclear how the drop in flow impacts the temperature and DO levels in this reach. A model will help inform how alternative water management decisions will affect water quality.

This project proposal will monitor the tributaries that enter the Yakama Nation boundary waters and is complementary to monitoring efforts in other parts of the Yakima River basin. This Yakama Nation monitoring effort will support the USBR gaging on the Yakima River. By conducting data collection of temperature, DO, and other parameters from the tributaries, the Yakama Nation can assist in providing a more complete data set. This data set can be used to calibrate a water quality model for temperature and DO, both parameters important to aquatic life use throughout the basin. Ecology will assist the Yakama Nation in collecting and processing water quality samples.

3.2 Study area and surroundings

The study area is the Yakama Nation Reservation portion of the Water Resource Inventory Area (WRIA) 37, the Lower Yakima River (Figure 1). About 1390 square miles, or 42%, of the Lower Yakima River basin lies within the Yakama Reservation.

The Yakama Nation does not recognize state authority to regulate water quality on the mainstem Yakima River where it borders the reservation (i.e. from Ahtanum Creek at RM 107.5 to the Mabton-Sunnyside Bridge at RM 59.8).

The focus area of this study is the western portion of WRIA 37 that consists primarily of irrigated agriculture. The urban area of the city of Toppenish is near the center of the study area. The city of Union Gap is near the northern boundary and Mabton nears the southern boundary. Crops are diverse in the study area, and include: hay, asparagus, hops, mint, potatoes, corn, other vegetables, and nursery stock. Livestock (primarily cattle) grazing is a major land use.

Several streams, canals, and drains transect the study area, carrying water to (or from) Toppenish Creek, Satus Creek, and Ahtanum Creek into (or out of) the Yakima River. The water quality characteristics of the streams, canals, and drains are influenced by the various uses of the water, along with wastewater additions and runoff from adjacent land. The wastewater and runoff loads can add excessive fecal coliform bacteria, nutrients, oxygen-demanding substances, pesticides, and/or suspended sediment to the Yakima River.

All drains have seasonal hydrologic characteristics and stream networks that are typical of agricultural irrigation or drainage operations; that is, high summer irrigation flows and low winter natural baseflows. Satus, Toppenish, and Ahtanum Creeks experience winter spikes in the flow hydrograph from snowmelt or rainfall in the contributing area, with the highest sustained flows during springtime. Marion Drain and Satus South Drain sometimes experience spikes in flow during snowmelt and rainfall, as well, because of their connection to the natural runoff network.

Each of the drainage watersheds deliver more water than the watersheds generate naturally. During the irrigation season (typically Apr-Oct), the creeks carry inter-basin return flow transferred through the irrigation network. These return flows can be highly variable because they depend on water availability, the water needs of specific crops, and operational management of the irrigation network.

Return flows from agricultural returns contribute as much as 90% of the total flow in the Lower Yakima River during the irrigation season (Morace et al. 1999). Suspended sediment concentrations and turbidity generally increase in a downstream direction, coinciding with increased runoff from agricultural areas (Morace et al. 1999). Peak suspended sediment concentrations in the Lower Yakima River occur in April through June when stream flows are high, snowmelt occurs, and irrigation of freshly tilled fields commences (Joy and Patterson 1997).

The Satus Creek and Toppenish Creek watersheds have historically been an important area for steelhead, salmon, and resident salmonids. Over one-half the Yakima River steelhead return to Satus and Toppenish Creeks in some years (Yakama Nation, 2000). Fish numbers have declined in the watersheds because of degraded channel conditions, reduced water quality, reduced stream flows, and fish passage blockages. One fish species in the watersheds is currently listed as threatened under the federal Endangered Species Act (ESA): the Middle Columbia River steelhead.

3.2.1 History of study area

The Yakima River basin is one of the most irrigated areas in Washington. The United States Department of the Interior's Bureau of Reclamation (USBR) operates the Yakima Project, which greatly influences stream discharge volumes into the Yakima River and some of its tributaries. The USBR delivers water to meet downstream demands, such as irrigation, power production, and instream flow for fish protection. To meet these demands, the USBR releases water from five storage reservoirs in the Upper Yakima River watershed (basin). Although these five reservoirs are all outside the study area, they are the dominant drivers of flow entering the Lower Yakima River.

Management of water volumes for human uses has changed the distribution of water throughout the year in the Yakima River from natural and historical conditions. Original conditions flowed highest during the spring snowmelt and lowest during summer. Because irrigation water delivery has been mandated by Congress and court adjudications, water volumes now flow high during summer in the Yakima River.

In the latter decades of the 20th century, Congress and the courts mandated that fishery concerns be addressed, including defining minimum flows levels in the Lower Yakima River. Driven by these fishery mandates and agricultural losses during drought years, more than 35 government and stakeholder groups met for 12 years, culminating in 2010 with the Yakima Basin Integrated Plan (YBIP). The YBIP focuses on large-scale projects designed to ensure additional flow volumes to support fish and increase water supply during drought years. The YBIP also has a component for restoration of the watershed, riparian areas, and fish habitat.

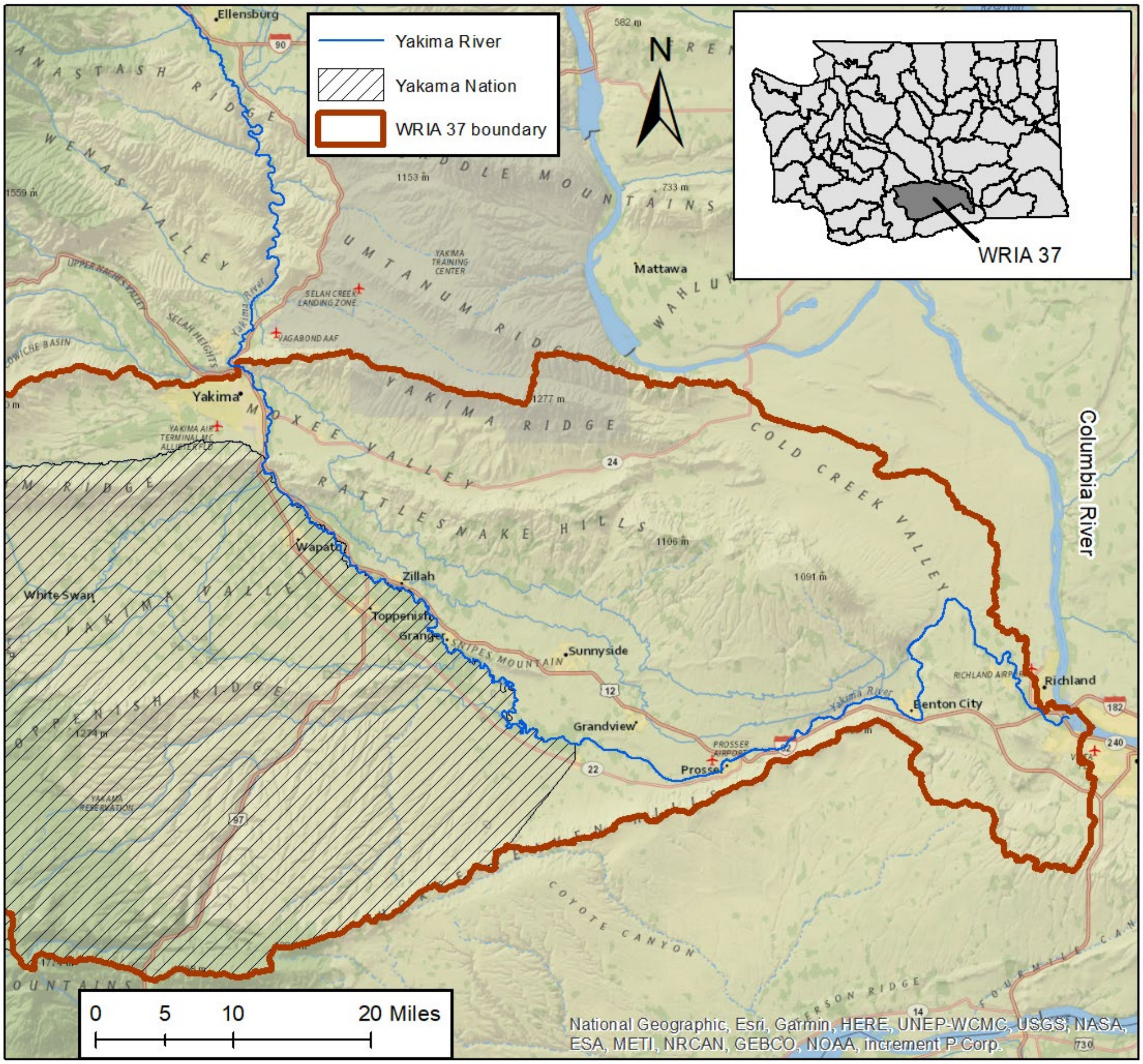


Figure 1. Map of study area, within the Lower Yakima River (WRIA 37) basin.
Monitoring will occur within the Yakima River boundary waters of the Yakama Nation.

3.2.2 Parameters of interest and potential sources

This 2022 monitoring study focuses on water temperature and DO. These parameters play an important role in providing healthy habitat for salmonids and other aquatic life.

Of these two parameters, temperature has received the most attention from the fishery restoration efforts in the Yakima River basin. Temperatures in the Lower Yakima River are known to reach high levels in the summer that create a barrier to migration for salmonids.

Studies have shown that the primary causes of high temperatures in the Lower Yakima River include:

- Summer days in the Yakima River basin are hot, dry, and clear, providing maximum solar radiation to the water.

- The width of the Yakima River surface water does not allow riparian vegetation shade to block the solar radiation.
- The Yakima River has lost floodplain and riparian functions due to channelization, development on the flood plains, disconnection of the floodplain by levees and other structures, and reductions in spring flood flows due to reservoir management.
- Parts of the Yakima River has low flow due to water diversions. Lower flow and shallow depths allow the water to heat up faster than deeper, faster- flowing water.

However, compared to pre-development hydrology, flow is now likely higher in other parts of the river upstream of the study area during the summer due to reservoir releases. Current river operations make an attempt to meet fishery needs by requiring minimum instream flow in critical locations, such as below the city of Parker. As part of Yakima River water management, a volume of reservoir water has been set aside to be released at the call of fishery managers in order to create a cold water pulse during periods of cool summer weather. The sudden and rapid migration of salmon during large pulse flows is well documented.

Low DO and high pH are primarily driven by productivity in the river, as noted in previous studies by the USGS (2009), summarized below. Primary productivity from algal and plant growth requires warm temperature, light, and food (nutrients) to proliferate. The warm temperature of the Yakima River provides ideal water for growth. Clear water provides ample light through the water column for primary productivity. The Yakima River turbidity may create limiting light conditions in some parts of the river where light is blocked from reaching the river bottom where attached algae and plants grow on the substrate. The most limiting nutrients in freshwater rivers like the Yakima River are usually phosphorus and nitrogen. The most likely sources of nutrient loading to the Yakima River are from agriculture return flows and wastewater discharges.

There are many facilities in the Lower Yakima River basin that are covered by a National Pollutant Discharge Elimination System (NPDES) or State Waste Discharge permit. These include individual permits and several general permits. There will be a separate study in 2022 to evaluate the effluent data available for each of these point sources and whether or not additional monitoring will be necessary to include these point sources in the model calibration. NPDES municipal wastewater treatment plants that discharge directly into (or near) the Yakima River boundary waters of the Yakama Nation include:

- Yakima Publicly Owned Treatment Works (POTW)
- Buena (unnamed tributary)
- Zillah POTW
- Toppenish (E. Toppenish Cr.)
- Granger POTW
- Sunnyside POTW (Joint Drain 334, Sulfur Cr.)
- Wapato (Marion Drain)
- Harrah (Marion Drain)
- Mabton POTW

3.2.3 Summary of previous studies and existing data

Pickett (2016) provides a detailed summary of past studies and data. Relevant past studies have included modeling of Yakima River temperatures; modeling of DO and pH in the Lower Yakima River below Prosser; numerous studies of hydrogeology, groundwater, flood plain morphology, and thermal regimes; routine ambient monitoring; and a reconnaissance survey during the summer of 2015. The most relevant studies are described below.

Of particular interest to this study is the United States Geological Survey (USGS) study of eutrophication in the Lower Yakima River (USGS, 2009). Given the central role of the USGS study in identifying eutrophication issues in the Lower Yakima, portions of their abstract are provided here:

- In response to concerns that excessive plant growth in the Lower Yakima River in south-central Washington was degrading water quality and affecting recreational use, the U.S. Geological Survey and the South Yakima Conservation District conducted an assessment of eutrophication in the lower 116 miles of the river during the 2004–07 irrigation seasons (March–October).
- The Zillah reach extended from the upstream edge of the study area at river mile (RM) 116 to RM 72, and had abundant periphyton growth and sparse macrophyte growth, the lowest nutrient concentrations, and moderately severe summer dissolved oxygen and pH conditions in 2005.
- The Mabton reach extended from RM 72 to RM 47, and had sparse periphyton and macrophyte growth, the highest nutrient conditions, but the least severe summer dissolved oxygen and pH conditions in 2005.
- Nutrient concentrations in the Lower Yakima River were high enough at certain times and locations during the 2004-07 irrigation seasons to support the abundant growth of periphytic algae and macrophytes.
- The metabolism associated with this aquatic plant growth caused large daily fluctuations in dissolved oxygen concentrations and pH levels that exceeded the Washington State water-quality standards for these parameters between July and September during all four years, but also during other months when streamflow was unusually low.
- The daily minimum dissolved oxygen concentration was strongly and negatively related to the preceding day’s maximum water temperature—information that could prove useful if a dissolved oxygen predictive model is developed for the Lower Yakima River.

The Zillah and Mabton reaches partially encompass the study area for this Quality Assurance Project Plan (QAPP). The final USGS reach, referred to as the Kiona reach, was downstream of the study area and had the most abundant macrophyte growth and very high nutrient levels. Nutrient loading within the study area has the potential to impact nutrient growth in the downstream Kiona reach.

Other studies provide useful information that could support model development and quality assessment:

- USGS developed a basin-wide groundwater model (USGS, 2011) that is based on the MODFLOW modeling framework. The model includes tributaries, agricultural drains, recharge, and pumpage. The model was calibrated to conditions for October 1959 to September 2001, providing a 42-year record of monthly water budgets.

- Ecology is currently conducting a monitoring study (Carroll, 2022) to build and calibrate a water quality model for temperature and DO in the Lower Yakima River based on available data (Pickett, 2017). The Picket (2017) project called for using existing data, some over 20 years old to calibrate the model. However, the new data collected during the 2022 monitoring will supersede any historical data and will allow for a more current and robust model calibration.
- Longitudinal thermal profiles of nine reaches in the Lower Yakima River were surveyed at ambient river velocity during summer 2018 when surface-water temperatures were near their annual maximum (Gendaszek and Appel, 2021).

3.2.4 Regulatory criteria or standards

Yakama Nation (YN) water quality standards

This QAPP proposes monitoring reaches of the Yakima River that flow through YN lands. The YN has established water quality standards for the waters within their reservation boundaries. However, at this time EPA has not granted YN "Treatment as a State" authority for purposes of approving water quality standards for waters within the YN reservation. The EPA does use YN water quality standards in making Clean Water Act (CWA) regulatory and certification decisions for reservation waters.

This 2022 project does not attempt to make policy calls or interpret treaties, laws, or regulation regarding the shared waters. YN Committee Action numbers 165-2022-2 and 38-2022-5 provide approval for water quality sampling to occur at the locations identified in this document.

Yakama Nation Beneficial Uses

Yakama Nation Water Code (Title 60) establishes beneficial uses for waters (60.01.13):

1. Religious and cultural uses including, but not limited to, instream flow and habitat fisheries and wildlife conservation, and reservation of habitat for berries, roots, medicines, and other vegetation significant to the values of the Yakama People.
2. Domestic and municipal uses, for personal household and garden purposes.
3. Stock watering.
4. Agricultural uses, provided that agricultural practices which do not make reasonably efficient use of water, or which waste water shall not be considered a beneficial use.
5. Aquifer and groundwater recharge, provided that unreasonable capture of water to create an artificial aquifer for private use shall not be considered a beneficial use.
6. Economic development uses, including timber, industrial, and power needs.

Washington State designated and beneficial uses

Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A-200) establish beneficial uses of waters and incorporate specific numeric and narrative criteria for parameters such as turbidity. The criteria are intended to define the level of protection necessary to support the beneficial uses. Washington Administrative Code (WAC) 173-201A-600 and WAC 173-201A 602 list the use designations for specific areas (WAC 173-201A-600 and WAC 173-201A-602).

For the Lower Yakima River, the designated uses of the waters in this specific area are:

Aquatic Life Uses

- *Salmonid Spawning, Rearing, and Migration*: Yakima River and its tributaries, downstream from the Cle Elum River, except for Ahtanum Creek (*Core and Char Spawning/Rearing*) and Sulphur Creek (*Rearing and Migration only*).

Recreation (Primary Contact)

- Fishing
- Swimming

Water Supply (Municipal, Industrial, and Agricultural Water Supply and Stock Watering)

- Agricultural enterprises extract water for irrigation and livestock watering.
- Other industries use Yakima River water for their operations.

Miscellaneous Uses (Wildlife Habitat, Harvesting, Commerce, Boating, and Aesthetics)

- Riparian areas are used by a variety of wildlife species that are dependent on the habitat.

Criteria for designated aquatic life uses

The criteria used to protect the aquatic life uses are outlined in Table 1. The water quality standards also have the following special water temperature criteria for the Lower Yakima River:

- Water temperature shall not exceed a 1-DMax (1-day daily maximum) of 21.0°C (69.8°F) due to human activities. When natural conditions exceed 21.0°C (69.8°F), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C (0.54°F); nor shall such temperature increases, at any time, exceed t=34/(T + 9).

Also, a complete list of additional supplemental criteria can be found in the Water Quality Standards for Surface Waters of the State of Washington (Ecology, 2019).

Table 1. Washington State water quality criteria for temperature and DO in the Lower Yakima River and tributaries (WRIA 37), except Ahtanum Creek.

Parameter	Criteria
Water Temperature	Water temperature shall not exceed a 1-DMax (1-day daily maximum) 21.0°C (69.8°F) due to human activities. When natural conditions exceed 21.0°C (69.8°F), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C (0.54°F); nor shall such temperature increases, at any time, exceed t=34/(T + 9).
Dissolved Oxygen*	To protect the designated aquatic life use of "Salmonid Spawning, Rearing, and Migration," the lowest 1-day minimum oxygen level must not fall below 8.0 mg/L more than once every ten years on average.

*Ecology is currently drafting a new rule for dissolved oxygen for percent saturation criteria (in process)

Current impairments for temperature and dissolved oxygen

Table 2 shows current listings on the 303(d) list (category 5) for water temperature, DO, and pH in the Lower Yakima River (WRIA 37).

Table 2. Current category 5 listings for temperature, DO, and pH on the Lower Yakima River.

Listing ID	Assessment Unit ID	Parameter	Location description
11199	17030003000240	pH	Yakima River at Terrace Heights
11195	17030003000236	pH	Yakima River at Nob Hill Blvd.
8309	17030003000143	Dissolved Oxygen	Yakima River below Prosser
11177	17030003000102	Dissolved Oxygen	Yakima River at Kiona
6734	17030003000102	pH	Yakima River at Kiona
8311	17030003000102	Temperature	Yakima River at Kiona
15008	17030003000038	Dissolved Oxygen	Yakima River at Van Giesen St.
15018	17030003000038	pH	Yakima River at Van Giesen St.

4.0 Project Description

4.1 Project goals

The goal of this study is to collect a data set of field measurements and water samples from tributaries to the Yakima River boundary waters of the Yakama Nation. The Yakama Nation will collect this data in conjunction with Ecology during 2022 to support the continuous water quality monitoring in the Yakima River by the USGS. The data will be part of a larger data set used to model and simulate water temperature and DO levels in the Lower Yakima River basin.

4.2 Project objectives

Fieldwork is planned from spring 2022 through November 2022.

Specific objectives of the study are to:

- Collect biweekly (every other week) samples of suspended solids, turbidity, nutrients, organic carbon, and alkalinity in the Lower Yakima River mainstem and major tributaries.
- Use dataloggers to monitor on an hourly basis (for the whole study period) continuous stage with pressure transducers (flow), turbidity, DO, and temperature. Measuring continuous time series for these parameters will provide direct data inputs for a seasonal water quality model. Table 8 lists the locations of these monitoring activities.
- Collect streamflow measurements at monitoring stations.
- Submit results of monitoring into Ecology's Environmental Information Management (EIM) database, as appropriate.

4.3 External information needed and sources

Streamflow data may be needed from the Lower Yakima River and its tributaries within the study area. It will be downloaded from online streamflow databases: USBR, USGS, Ecology, and other sources.

4.4 Tasks required

The tasks required to meet project goals are discussed in Section 4.2. More details on field and lab tasks are described in Section 7.

4.5 Systematic planning process

This project-specific QAPP and the Programmatic QAPP (McCarthy and Mathieu, 2017) represent the systematic planning process and include the key elements:

- Description of the project, goals, and objectives (Section 3 and 4).
- Project organization, responsible personnel, and schedule (Sections 5 and 12).
- Study design to support the project goals/objectives and procurement of data (Sections 7, 8, and 9).
- Specification of quality assurance (QA) and quality control (QC) activities to assess the quality performance criteria (Sections 6, 10, and 11).
- Analysis of acquired data (Sections 13 and 14).

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Key responsibilities of individuals are listed in Table 3.

Table 3. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Chris Perra Yakama Nation 509-830-9136	Yakama Nation Fisheries Project Lead	Writes the QAPP. Conducts QA review of data and analyzes and interprets data. Oversees field sampling and transportation of samples to the lab. Tracks schedule. Assists writing draft and final data summary report.
Scott Ladd Yakama Nation 509-945-4303	Yakama Nation Water Resources Lead	Reviews the project scope and budget, tracks budget and progress, reviews the draft QAPP, and approves the final QAPP.
Joe Blodgett Yakama Nation 509-865-6262 ext. 6372	Yakama Fisheries Manager	Reviews the project scope and budget, tracks budget and progress, reviews the draft QAPP, and approves the final QAPP.
Jim Carroll EAP 509-406-2459	Ecology Project Manager and Field Lead	Writes the QAPP. Conducts QA review of data and analyzes and interprets data. Tracks schedule. Reviews and approves draft and final data summary report.
Evan Newell EAP 509-575-2825	Ecology Field Lead and Data Manager	Manages sample collection, monitoring, and field records information. Conducts QA review of data, analyzes and interprets data. Lead author of the draft and final data summary report.
Rachel Caron EAP 509-504-4056	Ecology CRO Unit Manager	Reviews the project scope and budget, tracks budget and progress, reviews the draft QAPP, and approves the final QAPP.
George Onwumere EAP 509-454-4244	Ecology Section Manager	Reviews the project scope and budget, tracks budget and progress, reviews the draft QAPP, and approves the final QAPP.
Alan Rue MEL, EAP Phone: 360-871-8801	Ecology Laboratory Director	Reviews and approves the final QAPP.
Arati Kaza Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the final QAPP.

CRO: Central Regional Office, Union Gap, WA
EAP: Environmental Assessment Program, Washington State Department of Ecology
EIM: Environmental Information Management database
MEL: Manchester Environmental Laboratory
QAPP: Quality Assurance Project Plan

5.2 Special training and certifications

All field staff involved in this project either already have the relevant experience in the following SOPs or will be trained by more senior field staff who do. Any staff helping in the field who lack sufficient experience will always be paired with someone who does have the necessary training and experience and who will then lead the field data collection and oversee/mentor less experienced staff.

5.3 Organization chart

See Table 3, Section 5.1.

5.4 Project schedule

See Table 4 for project schedule.

Table 4. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work	Due date	Lead staff
Field work completed	November 2022	Evan Newell
Laboratory analyses completed	December 2022	
Environmental Information System (EIM) database		
EIM Study ID	JICA0007	
Product	**Due date**	**Lead staff**
EIM data loaded	February 2023	Evan Newell
EIM data entry review	March 2023	TBD
EIM complete	December 2023	Evan Newell
Final data summary report		
Author lead / Support staff	Yakama Nation, Ecology	
Schedule		
Final data summary report due on web	December 2023	

5.5 Limitations on schedule

Potential field-related constraints are addressed in Section 7.5. Any unforeseen limitations that would affect the project schedule will be discussed with the appropriate supervisor as needed.

5.6 Budget and funding

The budget in Table 5 assumes 13 sampling events.

Table 5. Tentative project budget.

Parameter	Total # of Samples (including QA/QC and blank samples)	MEL Cost Per Sample	MEL Subtotal
Alkalinity (carbonate & bicarbonate)	325	$20.00	$6,500.00
Dissolved organic carbon - DOC	325	$45.00	$14,625.00
Total organic carbon - TOC	325	$35.00	$11,375.00
Ammonia - NH3	325	$15.00	$4,875.00
Orthophosphate - OP	325	$20.00	$6,500.00
Total Phosphorus - TP colorimetric	325	$20.00	$6,500.00
Nitrate/Nitrite - NO2/NO3	325	$15.00	$4,875.00
Total Persulfate Nitrogen	325	$20.00	$6,500.00
TSS/TNVSS	325	$30.00	$9,750.00
		Grand Total =	$73K

MEL: Manchester Environmental Laboratory

6.0 Quality Objectives

Quality objectives are statements of the precision, bias, and lower reporting limits necessary to meet project objectives. Precision and bias together express data accuracy. Other considerations of quality objectives include representativeness and completeness. In 2017, Ecology published a Programmatic QAPP (McCarthy and Mathieu, 2017) that has standard and approved requirements for project quality objectives. This 2022 QAPP will refer to the 2017 Ecology publication for these statements.

6.1 Decision quality objectives

All of the data collected for this project should meet the measurement quality objectives (MQO) to be used for the project goals. Decisions can be made on a case-by-case basis for data that do not meet the MQO as to whether the data can be used for project purposes (e.g., informational, estimated values).

6.2 Measurement quality objectives

Field sampling procedures and laboratory analysis inherently have associated error. MQOs state the allowable error for a project. Precision and bias provide measures of data quality and are used to assess agreement with MQOs.

6.2.1 Targets for precision, bias, and sensitivity

6.2.1.1 Precision

Precision is a measure of the variability in the results of replicate measurements due to random error. Precision is usually assessed by analyzing duplicate field measurements or lab samples. Random error is imparted by the variation in concentrations of samples from the environment as well as other introduced sources of variation (e.g., field and lab procedures). Table 5 of the Programmatic QAPP (McCarthy and Mathieu, 2017) presents field measurement MQOs for precision and bias, as well as the manufacturer's stated accuracy, resolution, and range for the field equipment that will be used in this study. Table 6 below presents the MQOs for additional equipment being used in the project that are not included in the Programmatic QAPP.

Table 6. Manufacturers' specifications for equipment being used in project.

Parameter	Equipment	Precision Field dupes (median)	Accuracy	Resolution	Range	Expected Range
Dissolved Oxygen	miniDOT	5% RSD	± 5% of measurement or ± 0.3 mg/L, whichever is larger	0.01 mg/L	0 to 150% saturation	1 - 15 mg/L
Turbidity	Manta Trimeter	15% RSD	± 2% of reading or ± 0.3 NTU, whichever is larger	0.01 NTU	0 - 1000 NTU	0 - 500 NTU

6.2.1.2 Bias

Bias is the difference between the population mean and the true value of the parameter measured. Bias is usually addressed by calibrating field and laboratory instruments, and by analyzing lab control samples, matrix spikes, and standard reference materials. Lab QC procedures such as blanks, check standards, and spiked samples will provide a measure of any bias affecting sampling and analytical procedures for this project.

The MQOs for water samples taken in the field and associated lab analyses are shown in Table 6 of the Programmatic QAPP (McCarthy and Mathieu, 2017). This table outlines analytical parameters, expected precision of sample duplicates, and method reporting limits. Table 7 below shows the method reporting limits for analyses that differ from the Programmatic QAPP. The target expectations for precision of field duplicates are based on historical performance by Ecology's Manchester Environmental Laboratory (MEL) for environmental samples taken around the state by EAP (Mathieu, 2006). The reporting limits of the methods listed in Table 7 are appropriate for the expected range of results and the required level of sensitivity to meet project objectives.

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a method to detect a substance. It is commonly described as detection limit. In a regulatory sense, the method detection limit (MDL) is usually used to describe sensitivity. The method reporting limit and the reporting limits are the same for the parameters of interest for this project. See Table 6 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for MDLs for this project, as well as Table 7 below for MDLs that differ from the Programmatic QAPP.

Table 7. Measurement reporting limits for analyses.

Analysis	Method	Method Lower Reporting (Detection) Limit
Alkalinity	SM2320B	2.0 mg/L
Nitrate/Nitrite	EPA 353.3	0.10 (0.05) mg/L
Ammonia	SM4500NH3D	0.10 (0.05) mg/L
Dissolved Organic Carbon	SM5310B	0.50 (0.237) mg/L
Total Organic Carbon	SM5310B	0.50 (0.237) mg/L
Total Persulfate Nitrogen	SM4500NC	0.10 (0.05) mg/L
Total Phosphorus	SM4500PH	0.010 (0.0063) mg/L

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

See Section 6.2.2.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

6.2.2.2 Representativeness

See Section 6.2.2.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

6.2.2.3 Completeness

See Section 6.2.2.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

7.0 Study Design

7.1 Study boundaries

The Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) numbers for the study area are:

- WRIA: 37, Lower Yakima River basin
- HUC number: 17030003

Figure 1 shows the boundary of WRIA 37 and highlights the section of the Yakima River that pertains to the project study area.

7.2 Field data collection

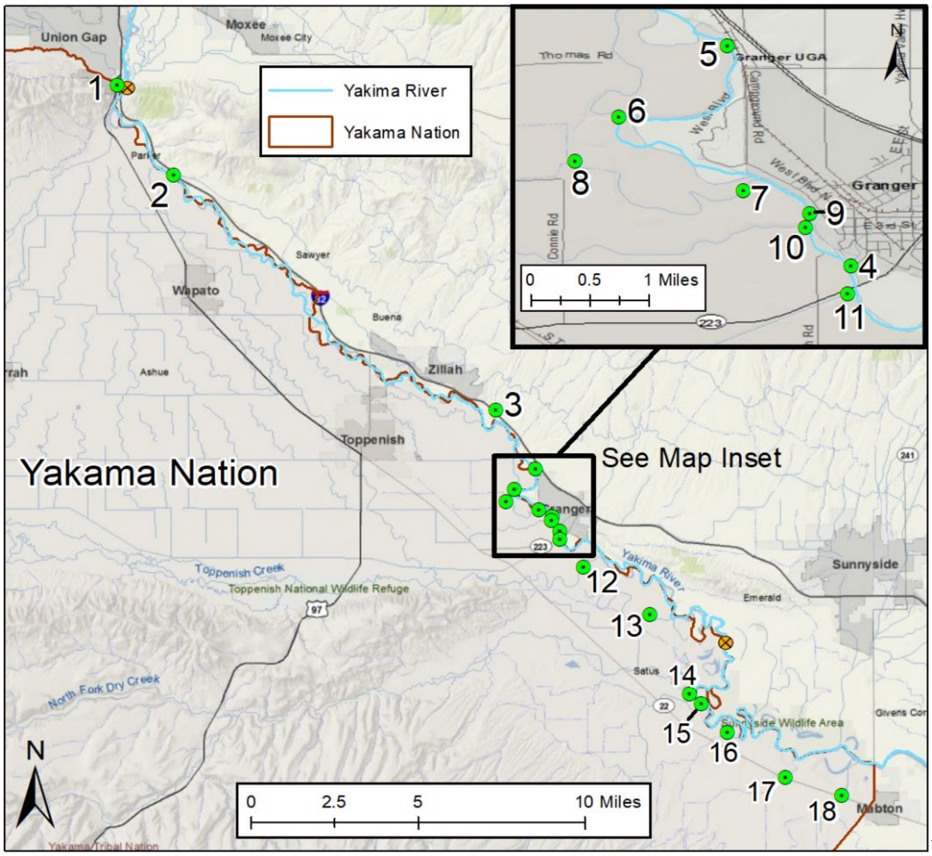
7.2.1 Sampling location and frequency

If possible, water sample collection will be conducted bi-weekly (every other week) from June through November 2022. In that way the first sampling will occur near the beginning of the irrigation season and conclude with samplings after the irrigation season. This will capture conditions as they change and transition out of the irrigation season in the Lower Yakima River basin.

At least 18 monitoring sites are being considered. Alternate or additional sites may be added if found necessary. Figure 2 shows a general map of sites and a list of proposed sites. Site locations may be adjusted based on further reconnaissance.

7.2.2 Field measurements and sample parameters (lab analyses)

The parameters to be measured via field data collection are discussed below and shown in Table 8.



Location Number	Location Name	Latitude	Longitude
1	Ahtanum Creek	46.535348	-120.473276
2	Yakima River at Parker Gage	46.495297	-120.438069
3	Roza Wasteway #4	46.389753	-120.235822
4	Granger Drain near mouth	46.335627	-120.195572
5	Yakima River abv E Toppenish Drain	46.363507	-120.210753
6	E. Toppenish Drain	46.354408	-120.224109
7	Sub-drain 93	46.345130	-120.208807
8	Parton Drain	46.348889	-120.229444
9	15" Pipe LB	46.342234	-120.200626
10	Sub-drain 35	46.340434	-120.201103
11	Marion Drain near mouth	46.332071	-120.195985
12	Toppenish Creek near mouth	46.319631	-120.181142
13	Coulee Drain	46.298333	-120.139722
14	Satus Creek	46.262622	-120.115003
15	Satus South Drain	46.258170	-120.107450
16	Spillway Drain 2 at Mose Bar	46.245556	-120.091389
17	Drain 302 west of Holt Rd on Hwy 22	46.225354	-120.055066
18	Drain 303 west of Boundary Rd on Hwy 22	46.216870	-120.020013
USGS WQ/flow gage	Yakima River @ Union Gap (USGS)	46.534268	-120.467147
USGS WQ/flow gage	Yakima River below Granger	46.285644	-120.092335

Figure 2. Map and table of proposed monitoring sites.

Table 8. List of measurements and parameters to be determined at each site.

Site ID	Monitoring Sites	Inst. flow	Pressure Transducer	Sample team: grab/ composite	Turbidity data logger	DO meter Data logger	Field measurement (temp/DO/pH/ cond/turb)	Sample (nutrients, TOC, DOC, alkalinity, TSS)	Temper-ature tidbit logger
DR303	Wasteway west of Boundary Rd on Hwy 22	YN	ECY PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
DR302	Wasteway west of Holt Rd on Hwy 22	YN	ECY PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
SOUTHDR	South Drain	YN	YN PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
SATCR	Satus Creek	YN	YN PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
COULDR	Coulee Drain	YN	ECY PT	YN/ECY			YN/ECY	YN/ECY	
TOPCR	Toppenish Creek near mouth	YN	YN PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
MARDR	Marion Drain near mouth	AG/YN	AG/YN PT	YN/ECY		DO	YN/ECY	YN/ECY	AG
SUB35	SubDrain 35	YN	YN PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
PARDR	Parton Drain	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
SUB93	SubDrain 93	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
ETOPDR	East Toppenish Drain	YN	ECY PT	YN/ECY		DO	YN/ECY	YN/ECY	ECY
SUCW	Sulphur Creek Wasteway	USBR	USBR PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	AG
GRAD	Granger Drain near mouth	USGS	USGS PT	YN/ECY	TURB	DO	YN/ECY	YN/ECY	ECY
ROZ4	Roza Wasteway #4	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
AHTCR	Ahtanum Creek	USGS	USGS PT	YN/ECY			YN/ECY	YN/ECY	AG
	Special Study								
YKET	Yakima River abv E Toppenish Drain	YN/ECY	ECY PT		TURB	DO			ECY
OCD15	Old County Drain 15" Pipe LB	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
SPILLWL	Spillway drain#2 wetland complex	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
ETOPWL	E. Toppenish Drain wetland complex	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
SATUSWL	Mouth of Satus Wildlife wetland complex	YN/ECY		YN/ECY			YN/ECY	YN/ECY	
SUNNYWL	Sunnyside Recreation wetland complex	YN/ECY		YN/ECY			YN/ECY	YN/ECY	

TSS = total suspended solids
Turb. = turbidity
grab = grab sample
comp. = composite sample
Cont. = continuous
Inst. = instantaneous
Temp. = temperature.
cond. = specific conductivity
TOC = total organic carbon
DOC = dissolved organic carbon
HL = Hydrolab multi-meter datalogger
DO = dissolved oxygen
ECY = Ecology
YN = Yakama Nation
AG = WA State Dept. of Agriculture

Streamflow measurements

Ecology will take streamflow measurements during each survey at tributary locations that do not have continuous streamflow gage stations. Streamflow measurements are made following Ecology protocols (Kardouni, 2019).

Streamflow data for the Lower Yakima River and its tributaries will be acquired from USBR, USGS, Ecology, and others. Streamflow will also be measured in the field. Several entities already measure continuous streamflow at several sites on the Yakima River as well as some tributaries. Table 9 shows the location and station names of the gages that this project will use to determine streamflow. Ecology will take periodic streamflow measurements at locations measured by other agencies to conduct QC checks.

Table 9. List of continuous streamflow gages.

Agency	Agency Site ID	Gage Site Location
USGS	12484500	Yakima River @ Umtanum
USBR	RBDW	Yakima River below Roza Dam
Ecology	YKSM	Yakima River at Selah Moxee diversion
USBR	TEAW	Naches River near 16th Ave
USGS	12500450	Yakima River at Union Gap above Ahtanum Creek
USGS	12502500	Ahtanum Creek
USBR	RSCW	New Reservation Canal
USBR	SNCW	Sunnyside Canal
USBR	PARW	Yakima River below Parker (doesn’t catch fish screen return)
USGS	12505450	Granger Drain
WSDA	Marion Drain	Marion Drain
USGS	12507573 (new)	Yakima River below Granger (new Emerald gage)
USBR	SUCW	Sulphur Creek Wasteway
USGS	12508990	Yakima River near Mabton
USBR	CHCW	Chandler Canal diversion
USGS/PNNL	12509489	Yakima River below Prosser (above WWTP - WQ only)
USBR	YRPW	Yakima River below Prosser
USGS	12510500	Yakima River at Kiona
USGS	12511800	Yakima River at Van Giesen Bridge (WQ only)

Continuous water quality monitoring

USGS is conducting continuous water quality monitoring for parameters such as temperature, turbidity, specific conductivity, DO, pH, and nitrate at several Yakima River sites for the 2022 irrigation season (Table 10). Two of the sites (Union Gap and Emerald) bracket the majority of the tributary inflows into the Yakima River boundary waters.

Table 8 lists sites where the Yakama Nation and Ecology will use dataloggers to monitor on an hourly basis (June-Nov 2022) continuous stage with pressure transducers, turbidity, DO, and temperature. Measuring continuous time series for these parameters will provide direct data inputs to the seasonal water quality model and also improve the understanding of data variability compared to bi-weekly sampling.

Table 10. List of USGS continuous water quality gages.

Agency	Agency Site ID	Gage Site Location	Parameters
USGS	12500450	Yakima River at Union Gap above Ahtanum Creek	DO, Temp, SpCond, Turb, Nitrate
USGS	12507573	Yakima River below Granger (new Emerald gage)	DO, Temp, SpCond, Turb, Nitrate
USGS	12509489	Yakima River below Prosser (above WWTP)	DO, Temp, SpCond, pH, Turb, Nitrate
USGS	12510500	Yakima River at Kiona	DO, Temp, SpCond, pH
USGS	12511800	Yakima River at Van Giesen Bridge	DO, Temp, SpCond, pH

Special studies

Some sites in Table 8 are labeled for special study status and will not be sampled regularly. Some of the drains and tributaries discharge into backwater areas (old meander channels) that form wetland complexes. Most of the wetland complexes have distinct outlets. Accessing the outlets of the wetland complexes will typically need to be done by boat, because there is no road access. Quarterly sampling at these sites will be attempted, depending on safe access and appropriate river conditions.

7.3 Maps or diagram

A map of proposed monitoring sites can be found in Figure 2.

7.4 Assumptions underlying design

In conjunction with USGS and USBR continuous water quality gages, this 2022 field study is specifically designed to generate a data set that will allow calibration of a water quality model that can simulate water temperature and DO in the Lower Yakima River. The 2022 data collection will also rely on the successful data collection from the mainstem of the Lower Yakima River that will concurrently be completed by Ecology and the USBR (Carroll, 2022).

This 2022 data collection is specifically designed to generate a complete data set for the tributaries and drains that discharge to the Lower Yakima River, in order to represent these tributaries and drains in the water quality model. The data collection is intended to provide enough detail to construct a time series for each tributary and drain. The assumption is that these monitored tributaries and drains represent the bulk of the mass balance terms in the model domain in order to successfully simulate water temperature and DO in the Lower Yakima River.

7.5 Possible challenges and contingencies

See Section 7.5 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of potential logistical problems, practical constraints, and schedule limitations.

8.0 Field Sampling Procedures

8.1 Invasive species evaluation

See Section 8.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.2 Measurement and sampling procedures

See Section 8.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017). Table 9 in the Programmatic QAPP lists the field activities and their associated Standard Operating Procedures (SOPs) used to collect different types of data.

Additional Ecology SOPs can be found on Ecology's website[1].

8.3 Containers, preservation methods, holding times

See Section 8.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.4 Equipment decontamination

See Section 8.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.5 Sample ID

See Section 8.5 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.6 Chain of custody, if required

See Section 8.6 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.7 Field log requirements

See Section 8.7 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.8 Other activities

See Section 8.8 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

[1] https://www.ecology.wa.gov/quality

9.0 Laboratory Procedures

9.1 Lab procedures table

See Table 11 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for lab methods, including sample matrix, expected range of results, and method detection limits.

9.2 Sample preparation method(s)

See Section 9.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

9.3 Special method requirements

No special methods will be used for this study.

9.4 Labs accredited for methods

All chemical analysis will be performed at MEL, which is accredited for all methods.

10.0 Quality Control Procedures

See Section 10.0 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of field and lab QC procedures.

10.1 Table of field and laboratory quality control

See Section 10.1 (Table 13) in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of the types and frequency of QC samples needed for lab and field samples.

10.2 Corrective action processes

See Section 10.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.0 Data Management Procedures

11.1 Data recording/reporting requirements

See Section 11.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.2 Laboratory data package requirements

See Section 11.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.3 Electronic transfer requirements

See Section 11.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.4 EIM data upload procedures

See Section 11.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

12.0 Audits and Reports

12.1 Number, frequency, type, and schedule of audits

No audits are planned for this 2022 study. However, there could be a field consistency review by another experienced field staff member during this project. The aim of this type of review is to improve fieldwork consistency, improve adherence to SOPs, provide a forum for sharing innovations, and strengthen the data QA/QC.

12.2 Responsible personnel

See Table 3 in Section 5.1 of this QAPP.

12.3 Frequency and distribution of report

A summary of the data collected under this project will be published in a formal, peer-reviewed report that includes results, methods, and data quality assessment. The final data summary report will be published according to the project schedule in Table 4, Section 5.4.

12.4 Responsibility for reports

The project manager and principal investigator will co-author the final data summary report.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

See Section 13.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.2 Verification of laboratory data

See Section 13.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.3 Validation requirements, if necessary

See Section 13.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.0 Data Quality (Usability) Assessment

14.1 Process for determining whether project objectives have been met

See Section 14.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.2 Treatment of non-detects

See Section 14.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.3 Data analysis and presentation methods

See Section 14.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.4 Sampling design evaluation

See Section 14.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.5 Documentation of assessment

See Section 14.5 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

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16.0 Appendix. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

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

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.)

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.

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

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.

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.

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.

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.

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.

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.

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).

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.

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.

Acronyms and Abbreviations

BCD	Benton Conservation District
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
i.e.	In other words
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
NPDES	(See Glossary above)
PNNL	Pacific Northwest National Laboratory
POTW	Publicly owned treatment works
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RM	River mile
SOP	Standard operating procedures
TNVSS	Total non-volatile suspended solids
TOC	Total organic carbon
TSS	(see Glossary above)
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
WWTP	Wastewater treatment plant
YBIP	Yakima Basin Integrated Plan

Units of Measurement

°C	degrees centigrade
Cfs	cubic feet per second
Ft	feet
G	gram, a unit of mass
km	kilometer, a unit of length equal to 1,000 meters
m	meter
mg	milligram
mg/L	milligrams per liter (parts per million)
NTU	nephelometric turbidity units
s.u.	standard units
µg/L	micrograms per liter (parts per billion)
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter, a unit of conductivity

Quality Assurance 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

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