DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

Naches River Basin Monitoring for Aquatic Life Parameters

July 2024

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Quality Assurance Project Plan

Naches River Basin Monitoring for Aquatic Life Parameters

by
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July 2024

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CRO: Central Regional Office, Department of Ecology
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2.0 Abstract

Limited monitoring within the Naches River basin has shown high water temperature, low dissolved oxygen (DO), and high pH conditions that are harmful to fish and other aquatic life that depend on pH-balanced, cool, oxygenated water.

The Washington State Department of Ecology will conduct a more thorough assessment of temperature, DO, and pH in the Tieton River and Lower Naches River by measuring seasonal levels of temperature, DO, and pH as well as seasonal concentrations of nutrients, organic carbon, alkalinity, and suspended solids.

Data loggers will continuously monitor the temperature and DO of mainstem sites on the Tieton River and Lower Naches River, as well as key water inflows. Short-term data loggers will also monitor diel pH at key locations. Additionally, streamflow will be monitored at selected un-gaged locations.

Data collection will provide baseline water quality data in the lower part of the basin. Data collection will be enough to calibrate a water quality model to simulate DO and pH. Monitoring and sampling will occur from June 2024 through October 2024, capturing critical periods during the irrigation season and some post-irrigation periods.

3.0 Background

3.1 Introduction

Limited monitoring in the Naches River basin has shown high water temperature, high pH, and low dissolved oxygen (DO) levels that are harmful to fish and other aquatic life that depend on cool, pH-balanced, oxygenated water. To protect, enhance, and restore the Naches River basin and Yakima River basin fish populations, water temperatures must be reduced, DO levels must be increased, and pH must be balanced.

The Washington State Department of Ecology (Ecology) is trying to better understand the dynamics of higher water temperature, low DO, and higher pH in the Naches River basin. Improving this understanding will assist the ongoing efforts to improve the basin's water quality. Improving water quality to protect and enhance fish spawning, rearing, and migration throughout the Naches River basin and the Yakima River basin is a high priority for many groups and individuals.

Newell (2018) developed a water temperature model for the study area, which greatly enhanced our understanding of how water releases from Rimrock Reservoir and environmental warming control summer-time water temperature in the Tieton River and the Lower Naches River. Newell (2018) applied a QUAL2Kw hydrodynamic water quality model to the Tieton River, from Rimrock Reservoir to the Tieton River mouth, and the Lower Naches River, from the confluence with the Tieton River to the confluence with the Yakima River.

The Tieton River temperature is controlled by the environmental warming of cold water that flows out of Rimrock Dam. The Tieton River has a significant cooling effect on the Naches River, as indicated by model simulation and thermal aerial imaging. Water temperature in the Naches River is controlled by this mixing of water from the Tieton River with the upper Naches River, plus a relatively small temperature influence from groundwater and relatively minor shading of the river by vegetation as the river water warms in a downstream direction.

There is a gap in water quality monitoring in the Naches River basin to support the development of a water quality model that can simulate DO and pH levels. This current effort, as described by this Quality Assurance Project Plan (QAPP), will fulfill the collection of a baseline data set in the Tieton River and Lower Naches River.

Baseline water quality data is needed to calibrate the water quality model developed by Newell (2018) to simulate DO and pH. A calibrated DO and pH model of the Naches River basin would critically add to the greater effort by Ecology to develop a water quality model of the Yakima River, as the Naches River is one of the largest tributaries to the Yakima River. This project proposal will monitor the Naches River basin waters that enter the Yakima River basin and is complementary to similar water quality monitoring efforts in the Lower and Upper Yakima River basin (Carroll 2022; Urmos-Berry et al. 2021).

3.2 Study area and surroundings

The Naches River basin is the land area where all tributaries drain into the Naches River. It is designated by the Washington State Department of Ecology (Ecology) as Water Resource Inventory Area (WRIA) 38.

The Naches River basin is divided into four distinct subbasins (Figure 1):

- Upper Naches River — consists of the mainstem Naches River from the confluence with the Tieton River at river mile (RM) 17.6 to the headwaters and all tributaries along this reach.
- Lower Naches River — includes the mainstem Naches River from RM 17.6 to the confluence with the Yakima River (RM 0) and all tributaries along this reach, except Cowiche Creek.
- Cowiche Creek — includes the creek and all tributaries.
- Tieton River — includes the mainstem Tieton River and all tributaries to the headwaters.

Two of these subbasins, upper Naches River and Cowiche Creek were addressed in two previous studies:

- Upper Naches River Temperature Total Maximum Daily Load, Volume 1, Water Quality Study Findings (Brock 2008).
- Upper Naches River and Cowiche Creek Temperature Total Maximum Daily Load, Volume 2, Implementation Strategy (Peterschmidt 2010).

Newell (2018) presented a water temperature model study for two of the Tieton River and lower Naches River subbasins, which were not addressed as part of Brock (2008) and Peterschmidt (2010).

In general, neither Newell (2018) nor Brock (2008) addressed surface water on lands owned by the National Forest Service (Figure 1). Water temperatures in surface waters on those lands were addressed in the *Wenatchee National Forest Water Temperature TMDL Technical Report* (Whiley and Cleland 2003).

The two other major water bodies in the Naches River basin included in this assessment are:

- Naches River, from its mouth at the Yakima River to its confluence with the Tieton River at RM 17.5.
- Tieton River, from its mouth at the Naches River to just below Tieton Dam at Rimrock Reservoir. Part of this river lies on National Forest Service land; this portion of the river was included in the study to develop a predictive temperature model for the remainder of the river.

The Tieton River flows east from Tieton Dam (an outlet for Rimrock Reservoir) through the Tieton River Canyon until it converges with the Naches River. Land ownership in the Tieton subbasin is predominantly public. The U.S. Forest Service (Wenatchee National Forest) owns and manages most land in the basin. The Washington State Department of Natural Resources (WDNR) and Washington Department of Fish and Wildlife (WDFW) own and manage the next largest proportion of public lands. The private lands consist of small recreational cabins and small resorts.

The lower Naches River flows southeast from the confluence of the Tieton River to the city of Yakima, where it converges with the Yakima River. The lower Naches River subbasin predominantly supports irrigated agriculture croplands. The major crops raised in the basin are apples, pears, and cherries. Two municipalities are located within the lower Naches River basin: Naches and Yakima.

Flow in the Tieton and lower Naches Rivers is strongly influenced by USBR operation of two major water storage reservoirs in the basin: Rimrock Reservoir (approximately 198,000 acre-feet), which is located on the Tieton River, and Bumping Reservoir (approximately 33,700 acre-feet) which is located on the Bumping River. Water collected in these reservoirs is released seasonally to meet demands for irrigation water supply, flood control, and instream flows for fish.

Flow in the Tieton and lower Naches Rivers is also influenced by several water diversions away from, and sometimes back into, the river from irrigation canals and ditches.

The vegetation of the Naches River basin is a complex blend of forest, shrub-steppe, and grasslands. The forests are in the mountainous areas where precipitation is greater and along the riparian edges of streams and rivers. Ponderosa pine, Douglas fir, and grand and noble fir form the majority of complex heterogeneous forests at the higher elevations (Haring 2001). Oregon white oak, cottonwood, birch, and alder are found along the riparian zones in the valleys (Haring 2001). Most of the land in the lower reaches is populated with shrub and grassland that is highly susceptible to erosion if disturbed.

According to WDFW's Salmon Scape application (http://apps.wdfw.wa.gov/salmonscape/, accessed 10/24/2017), spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), steelhead (resident form: rainbow trout. *Oncorhynchus mykiss*), and bull trout (resident form: Dolly Varden. *Salvelinus confluentus*) comprise the cold-water fish species present in the Naches River basin. Pacific lamprey, cutthroat trout, and mountain whitefish have also been documented within the basin (YSFWPB, 2004).

The climate of the Naches River basin ranges from cool and moist in the mountains to warm and dry in the valleys. Most of the precipitation falls from November to February. Annual precipitation in the mountains is from 70 to 140 inches at the Cascade crest and less than 10 inches in the eastern part of the basin. Average summertime temperature ranges from 55°F in the mountains to 85°F in the valleys. These conditions are formed by predominately westerly winds coming over the Cascade crest and the rain shadow effect in the valleys below.

3.2.1 History of study area

Wenatchee National Forest and Washington State public land encompass most of the Tieton subbasin. Timber activities and recreational uses, such as camping, boating, and fishing, are the main uses of the area.

The valleys of the Lower Naches River subbasin are predominantly irrigated agriculture, such as fruit orchards and alfalfa fields, heavily reliant on the Naches River for irrigation water supply. Two municipalities are located within the study area: Naches and Yakima. Naches has a wastewater treatment plant that discharges to the Naches River, while Yakima utilizes the river for municipal water supply.

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 Naches River basin. 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 two storage reservoirs in the Naches River basin.

Management of water volumes for human uses has changed the distribution of water throughout the year in the Naches River from natural and historical conditions. Flow conditions were historically highest during the spring snowmelt and lowest during summer and fall. Because Congress and court adjudications have mandated irrigation water delivery, stored water volumes released later in the summer bring higher flow during the late summer months.

In the latter decades of the 20^{th} century, Congress and the courts mandated that fishery concerns be addressed, including defining minimum flow levels. 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 the restoration of the watershed, riparian areas, and fish habitat.

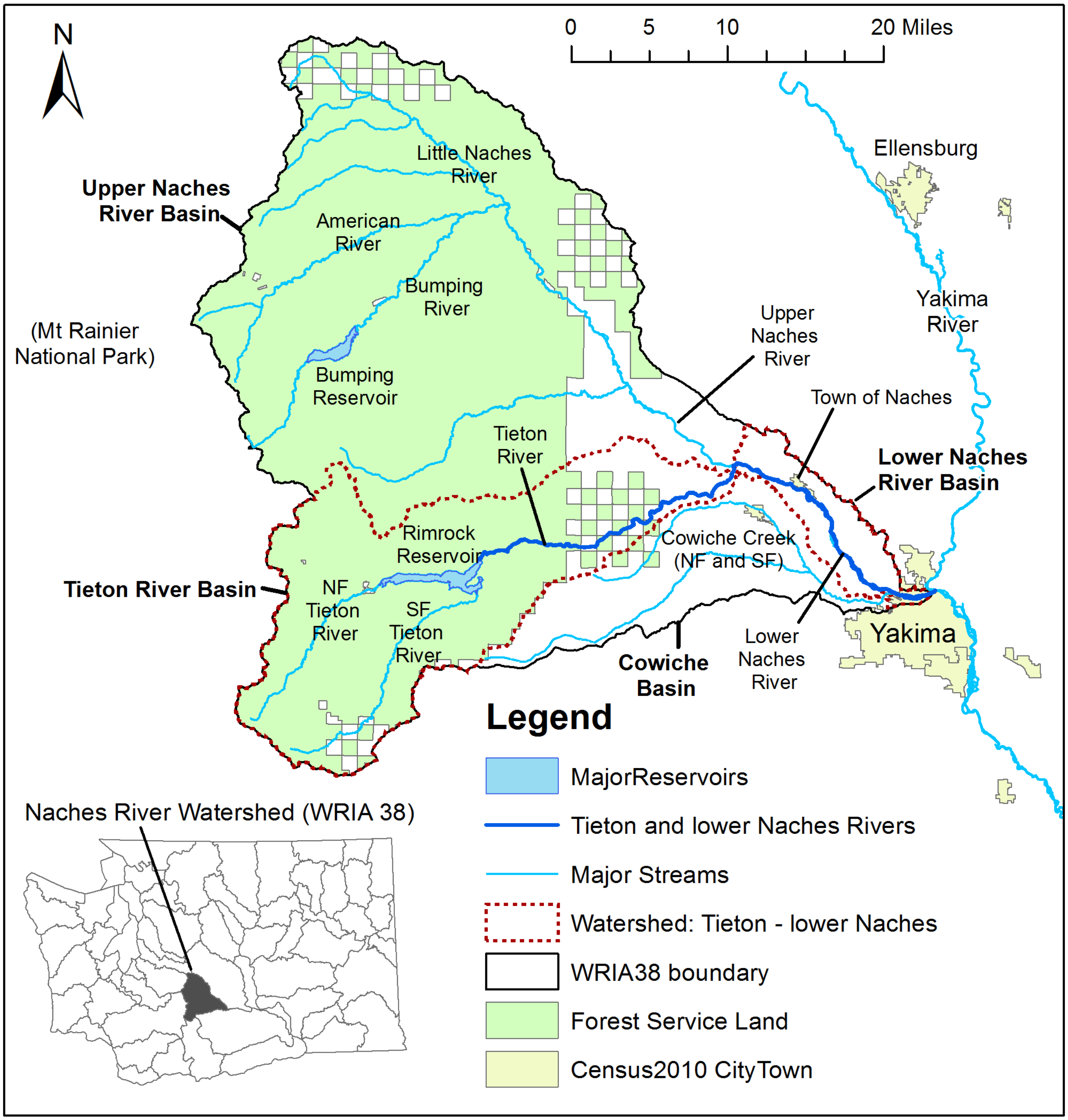

Figure 1. Map of study area, within the Naches River (WRIA 38) basin.
Monitoring will mostly occur within the Tieton and Lower Naches River watersheds.

3.2.2 Parameters of interest and potential sources

This 2024 monitoring study focuses on water temperature, DO, and pH. These parameters play an important role in providing a healthy habitat for salmonids and other aquatic life.

Of these parameters, temperature has received the most attention from the fishery restoration efforts in the Naches River and Yakima River basins. Water temperatures in the Naches River basin are known to reach high levels in the summer, creating a barrier to migration for salmonids.

Studies have shown that the primary causes of high temperatures in the Naches River basin include:

- Summer days in the Naches River basin are hot, dry, and clear, providing maximum solar radiation to the water.
- The width of the Naches River surface water does not allow riparian vegetation shade to block the solar radiation.
- The Naches River has lost floodplain and riparian functions due to channelization, development, disconnection by levees and other structures, and reductions in spring flood flows due to reservoir management.
- Parts of the Naches River basin have low flow due to water diversions. Lower flow and shallow depths allow the water to heat faster than deeper, faster-flowing water.

However, compared to pre-development hydrology, flow is sometimes higher in parts of the Naches River basin during the summer due to reservoir releases. Current river operations attempt to meet fishery needs by requiring minimum instream flow in critical locations.

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

There is only one facility in the study area of the Naches River basin that is covered by a National Pollutant Discharge Elimination System (NPDES) that may be a significant discharge to the Naches River: Naches Publicly Owned Treatment Works (POTW).

The Cowiche POTW discharges to the North Fork of Cowiche Creek (outside of the study area) and would contribute to monitoring and sampling Cowiche Creek at the confluence with the Naches River.

3.2.3 Summary of previous studies and existing data

Newell (2018) developed a water temperature model for the study area. A QUAL2Kw hydrodynamic water quality model was applied to the Tieton River, from Rimrock Reservoir to the mouth, and the Lower Naches River, from the confluence with the Tieton River to the confluence with the Yakima River. The model predictions for water temperature showed good agreement with observed temperature data collected in 2004 and 2015 by Ecology. During 2004 and 2015, monitored water temperature for all sites (except one) in both rivers exceeded (did not meet) the freshwater temperature criteria for aquatic life uses (Newell 2018). The single exception was a site immediately downstream of Tieton Dam. During 2015, water temperature in the Naches River exceeded supplemental spawning temperature criteria in applicable portions of the river.

Model temperature simulation results from Newell (2018) indicate that summer-time water temperature in the Tieton River is controlled by environmental warming of cold water that flows out of Tieton Dam. The Tieton River has a significant cooling effect on the Naches River, as indicated by model simulation and thermal aerial imaging. Water temperature in the Naches River is controlled by this mixing of water from the Tieton River with the upper Naches River, plus a relatively small temperature influence from groundwater and relatively minor shading of the river by vegetation as the river water warms in a downstream direction.

Pickett (2016) provides a detailed summary of past studies and data in the Yakima River basin. Relevant past studies have included modeling of Naches/Tieton River temperature and modeling of Yakima River temperature; 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.

Pickett (2016) showed that metabolism in the Yakima River was associated with aquatic plant growth and 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.

USGS (2009) conducted a eutrophication study in 2004-07 in the Lower Yakima River and included some analysis of eutrophication in a reach of the lower Naches River. Periphyton (attached bottom algae) biomass samples were taken and compared to nutrient levels, water velocity, DO, and pH levels. Periphytometer experiments showed that periphyton growth in the Lower Naches River was nitrogen-limited compared to baseline and phosphorus-addition experiments (USGS 2009). This study may provide useful data to support the development of a water quality model that simulates productivity.

Other studies that provide useful information include:

- USGS developed a basin-wide groundwater model (USGS 2011) based on the MODFLOW modeling framework. The model includes tributaries, agricultural drains, recharge, and pumpage. The model was calibrated to conditions from October 1959 to September 2001, providing a 42-year record of monthly water budgets.
- Ecology is conducting a project to build and calibrate a water quality model for temperature and DO in the Yakima River (Pickett 2017). The project called for using existing data, some over 20 years old, to calibrate the model. However, new data was also collected to replace historical data and allow for more current and robust model

calibration (Carroll 2022). The project will also identify data gaps that may initiate further monitoring in the basin.

3.2.4 Regulatory criteria or standards and beneficial uses

The main beneficial use addressed by this study is aquatic life use. Aquatic life uses are protected in part by water temperature criteria associated with key species uses (WAC 173-201A-200 and WAC 173-201A-600). Water temperature levels fluctuate over the day and night in response to changes in weather conditions and river flows. Since the health of aquatic species is tied predominantly to the pattern of maximum temperature, the criteria are measured by the 7-day average of the daily maximum temperatures (7-DADMax). Temperatures are not to exceed the criteria at a probability frequency of more than once every ten years on average.

The following key aquatic life uses, and associated water temperature criteria are included within the current study area:

- **Char spawning and rearing (12°C Highest 7-DADMax)**: The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden) or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses include summer foraging and migration of native char, and spawning, rearing, and migration by other salmonid species.
- **Core summer salmonid habitat (16°C Highest 7-DADMax)**: The key identifying characteristics of this use are summer salmonid spawning or emergence or adult holding; use as an important summer rearing habitat by one or more salmonids; or foraging by adult and subadult native char. Other common characteristic aquatic life uses include spawning outside of the summer season, rearing, and salmonid migration.
- **Salmonid spawning, rearing, and migration (17.5°C Highest 7-DADMax)**: The key identifying characteristic of this use is salmon or trout spawning and emergence that only occurs outside of the summer season. Other common characteristic aquatic life uses include salmonid rearing and migration.

Washington State uses the criteria described above to ensure that where a water body is naturally capable of providing full support for its designated aquatic life uses, that condition will be maintained. In addition to the temperature criteria listed above, some water bodies require special protection for spawning and incubation periods. These water bodies are protected by supplemental temperature criteria (Ecology 2019). Some water bodies in this study fall under the supplemental spawning temperature criterion of 13°C highest 7-DADMax for different sensitive time periods (e.g., from February 15 to June 15).

Table 1 summarizes the designated aquatic life uses and water temperature criteria for the major water bodies in this study. 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. Aquatic life uses for major water bodies in this study.

Water Body	Char Spawning and Rearing	Core Summer Habitat	Salmonid Spawning, Rearing, and Migration	Supplemental Spawning Protection
Upper Naches River Basin tributaries (Little Naches, American River, Rattlesnake, etc)	X			X
Most of the Upper Naches River (above the mouth of the Tieton River to the Little Naches River)		X		X
Tieton River and all tributaries (from Rimrock Reservoir to mouth)		X		
Lower Naches River (from Tieton River confluence to Cowiche Creek confluence)			X	X
Lower Naches River (from Cowiche Creek confluence to mouth)			X	
Oak Creek (tributary to Tieton River)			X	X
Buckskin Slough (tributary to lower Naches River)			X	X

Note. This table is adapted from Table 604 (WAC 173-201A-600).

Table 2 summarizes the DO and pH criteria for the designated aquatic life uses found in the study area of the Naches River basin.

Table 2. Washington State water quality criteria (WAC 173-201A-200) for pH and DO based on aquatic life use in the Naches River Basin and tributaries (WRIA 38).

Parameter	Criteria
pH	To protect the designated aquatic life use of “Char Spawning and Rearing,” “Core Summer Habitat,” and Salmonid Spawning, Rearing, and Migration,” the pH shall be within a range of 6.5 to 8.5.
Dissolved Oxygen	To protect the designated aquatic life use of “Char Spawning and Rearing” and “Salmonid Spawning, Rearing, and Migration,” the lowest 1-day minimum oxygen level must not fall below 10.0 mg/L or 90% saturation more than once every ten years on average. To protect the designated aquatic life use of “Core Summer Habitat,” the lowest 1-day minimum oxygen level must not fall below 10.0 mg/L or 95% saturation more than once every ten years on average.

3.2.4.1 Water Quality Assessment and the 303(d) List

The Clean Water Act (CWA) established a process to identify and clean up polluted waters. The CWA requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of (1) designated uses for protection, such as aquatic life uses, and (2) criteria, usually numeric criteria, to achieve those uses.

Every two years, states are required to prepare a list of water bodies that do not meet water quality standards. This list is called the CWA 303(d) list. This list is part of the Water Quality Assessment (WQA) process in Washington State. To develop the WQA, Ecology compiles its own water quality data along with data from local, state, and federal governments, tribes, industries, and citizen monitoring groups. All data in this WQA are reviewed to ensure they were collected using appropriate scientific methods before they are used to develop the assessment.

The WQA divides water bodies into five categories. Those not meeting standards are given a Category 5 designation, collectively becoming the 303(d) list.

Category 1 — Meets standards for parameter(s) for which it has been tested.

Category 2 — Waters of concern.

Category 3 — Waters with no data or insufficient data available.

Category 4 — Polluted waters that do not require a TMDL because they:

- 4a — Have an approved TMDL project being implemented.
- 4b — Have a pollution control program in place that should solve the problem.
- 4c — Are impaired by a non-pollutant such as low water flow, dams, or culverts.

Category 5 — Polluted waters that require a TMDL — the 303(d) list.

Further information is available at Ecology's Water Quality Assessment website: Assessment of state waters 303d.[1]

Water bodies within the study area included on the 303(d) list are presented in Table 3.

[1] https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d

Table 3. Water bodies in the study area with Category 5 listings on the 2018 303[d] list.

Water Body	Listing ID	Reach Code	Category	Parameter
Naches River	8336	17030002006948	5	Temperature
Naches River	6735	17030002006948	5	pH
Naches River	48443	17030002000024	5	Temperature
Naches River	48444	17030002001307	5	Temperature
Naches River	48445	17030002001319	5	Temperature
Naches River	48446	17030002001336	5	Temperature
Naches River	93329	17030002001306	5	Temperature
Naches River	93332	17030002000061	5	Temperature
Naches River	93349	17030002001335	5	Temperature
Naches River	93436	17030002000025	5	Temperature
Naches River	93501	17030002000064	5	Temperature
Upper Naches R	93251	17030002000065	5	Temperature
Tieton River	48471	17030002000305	5	Temperature
Tieton River	48472	17030002000306	5	Temperature
Tieton River	48474	17030002000310	5	Temperature
Tieton River	93515	17030002002539	5	Temperature
Cowiche Creek	11214	17030002000408	5	pH
Cowiche Creek	50698	17030002000407	5	pH
Wapatox return	93253	17030002003021	5	Temperature
Wapatox return	93433	17030002001530	5	Temperature
Buckskin Slough	93485	17030002001146	5	Temperature
Oak Creek	93562	17030002000490	5	Temperature

4.0 Project Description

4.1 Project goals

The goal of this study is to collect field measurements and water samples from the Naches River basin. Ecology will collect this data to support the collection of observed data for calibrating a water quality model of the Tieton River and the Lower Naches River by Ecology. The data will be part of a larger data set that models and simulates water temperature, pH, and DO levels in the Yakima and Naches River basins.

4.2 Project objectives

Fieldwork is planned from June 2024 through October 2024.

Specific objectives of the study are to:

- Collect biweekly (every other week) samples of suspended solids, turbidity, nutrients, organic carbon, and alkalinity in the Tieton River and Lower Naches River mainstem and tributaries. Collect monthly samples, as above, in select upper Naches River tributaries and the Naches POTW
- Use dataloggers to monitor continuous stage (pressure transducers), turbidity, DO, and temperature. Also, use short-term synoptic sonde deployments to monitor temperature, conductivity, DO and pH at several sites. Table 12 lists the locations of these monitoring activities.
- Deploy dataloggers and synoptic sonde deployments.
- Collect streamflow measurements at certain monitoring locations (see Table 12).
- Submit monitoring results into Ecology's Environmental Information Management (EIM) database, as appropriate.

4.3 External information needed and sources

Flow and water quality data will be needed from the Naches River basin within the study area. It will be downloaded from online streamflow databases: USBR, USGS, Ecology, or acquired from permitted facilities (Naches POTW), and other sources (city of Yakima and Yakima County).

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 (Sections 3 and 4).
- Project organization, responsible personnel, and schedule (Sections 5 and 12).

- Study design to support the project goals/objectives and data collection (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

The key responsibilities of individuals are listed in Table 4.

Table 4. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Jim Carroll CRO, EOS, EAP 509-406-2459	Project Manager	Writes the QAPP. Conducts QA review of data and analyzes and interprets data. Tracks schedule and budget. Reviews and approves draft and final data summary report.
Rylynn Carney CRO, EOS, EAP 509-406-2403	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.
Eiko Urmos-Berry CRO, EOS, EAP 509-454-4244	Unit Manager	Reviews the project scope and budget, tracks budget and progress, reviews the draft QAPP, and approves the final QAPP.
Rob Waldrop MEL, EAP Phone: 360-871-8801	Laboratory Director	Reviews and approves the final QAPP.
Interim: Ken Nelson Phone: 360-522-2722	Ecology QA Officer	Reviews the draft QAPP 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
EOS: Eastern Operation Section
MEL: Manchester Environmental Laboratory
QA: Quality Assurance
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 lacks sufficient experience will always be paired with someone with the necessary training and experience, who will then lead the field data collection and oversee/mentor less experienced staff.

5.3 Organization chart

See Table 4, Section 5.1.

5.4 Project schedule

See Table 5 – 7 for the project schedule.

Table 5. Schedule for completing field and laboratory work.

Task	Due Date	Lead Staff
Fieldwork completed	October 2024	Rylynn Carney
Laboratory analyses completed	December 2024	N/A

Table 6. Schedule for data entry.

Task	Due Date	Lead Staff
EIM data loaded[a]	February 2025	Jim Carroll
EIM data entry review	March 2025	Evan Newell
EIM complete	December 2025	Jim Carroll

[a] EIM Project ID: JICA0010
EIM: Environmental Information Management database.

Table 7. Schedule for final report.

Task	Due Date	Lead Staff
Final data summary report due on the web	December 2025	Jim Carroll

5.5 Limitations on schedule

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

5.6 Budget and funding

The budget for analyses is listed in Table 8 and assumes 12 sampling events from June through October 2024. Table 9 shows the number of weekly sample locations, sample QA replicates, and sample blanks.

Table 8. Tentative project budget.

Parameter	Method	Total # of Samples[a]	MEL Cost Sample	MEL Subtotal
Alkalinity (carbonate & bicarbonate)	SM2320B	325	$20.00	$6,100
Dissolved organic carbon - DOC	SM5310B	325	$45.00	$13,725
Total organic carbon (TOC)	SM5310B	325	$35.00	$10,675
Ammonia (NH3)	SM4500NH3H	325	$15.00	$4,575
Orthophosphate (OP)	SM4500PG	325	$20.00	$6,100
Total Phosphorus (TP) Low level	SM4500PH	325	$40.00	$12,200
Nitrate/Nitrite (NO2/NO3)	SM4500NO3I	325	$15.00	$4,575
Total Persulfate Nitrogen	SM4500NB	325	$20.00	$6,100
TSS/TNVSS	SM2540D /EPA160.4	325	$45.00	$13,725
Grand Total	N/A	N/A	N/A	$76,000

MEL: Manchester Environmental Laboratory
TNVSS: total non-volatile suspended solids
TSS: total suspended solids
[a] Total number of samples includes QA/QC and blank samples.

Table 9. Tentative count of weekly sample sites, sample QA, and sample blanks.

Sample Week[a]	Number of Sample Sites	Number of QA Samples	Number of Blank Samples
6/3 to 6/6	15	2	1
6/17 to 6/20	22	2	1
7/8 to 7/11	15	2	1
7/22 to 7/25	22	2	1
8/5 to 8/8	15	2	1
8/19 to 8/22	22	2	1
9/2 to 9/5	15	2	1
9/16 to 9/19	22	2	1
9/30 to 10/3	15	2	1
10/14 to 10/17	22	2	1
10/28 to 10/31	15	2	1

QA: quality assurance
[a] Sample weeks for the year 2024.

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) with standard and approved requirements for project quality objectives. This 2024 QAPP will refer to the 2017 Ecology publication for these statements.

6.1 Data quality objectives

All 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 amount of error allowed 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 and 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 used in this study. Table 10 below presents the MQOs for additional equipment used in the project that are not included in the Programmatic QAPP.

Table 10. 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%–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

RSD: relative standard deviation.

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 analyzing lab control samples, matrix spikes, and standard reference materials. Field and 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 11 below shows the most recent method reporting limits and method detection limits for laboratory analyses performed at MEL and may 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 11 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 and is commonly described as the detection limit. See Table 6 in the Programmatic QAPP (McCarthy and Mathieu 2017) for a list of method reporting limits (MRL) and method detection limits (MDL) for the parameters of interest for this project. See Table 11 below for current MRLs and MDLs at MEL that differ from the Programmatic QAPP.

Table 11. Current measurement reporting limits for analyses.

Analysis	Method	Method Lower Reporting (Detection) Limit
Alkalinity	SM2320B	5.0 (0.570) mg/L
Ortho-Phosphate	SM4500PG	0.003 (0.0014) mg/L
Total Phosphorus	SM4500PH	0.005 (0.0025) mg/L
Nitrate/Nitrite	SM4500NO3I	0.010 (0.00117) mg/L
Ammonia	SM4500NH3H	0.010 (0.00235) mg/L
Total Persulfate Nitrogen	SM4500NB	0.10 (0.0571) mg/L
Dissolved Organic Carbon	SM5310B	0.50 (0.237) mg/L
Total Organic Carbon	SM5310B	0.50 (0.237) mg/L
Total Suspended Solids	SM2540D	1.00 mg/L
Total Non-Volatile Suspended Solids	EPA 160.4	1.00 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: 38, Naches River basin
- HUC number: 17030002

Figure 1 shows the boundary of WRIA 38 and highlights the section of the Naches River basin that pertains to the project study area.

7.2 Field data collection

7.2.1 Sampling location and frequency

Water sample collection will be conducted bi-weekly (every other week) from June 2024 through October 2024. 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 Naches River basin. Sites listed in Table 12 are proposed monitoring sites. 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 12. The water quality monitoring will include in situ field measurements of water temperature, DO, pH, conductivity, and turbidity. Field monitoring will use dataloggers to monitor continuous stage (pressure transducers), turbidity, DO, and temperature. Also, short-term synoptic sonde deployments will monitor temperature, conductivity, DO, and pH at several sites. The water quality sampling will also include collection of water samples for the following laboratory analyses:

- Nitrate + Nitrite
- Ammonia
- Total Nitrogen
- Orthophosphate
- Total Phosphorus
- Total Organic Carbon
- Dissolved Organic Carbon
- Total Suspended Solids
- Total Non-volatile Suspended Solids
- Alkalinity

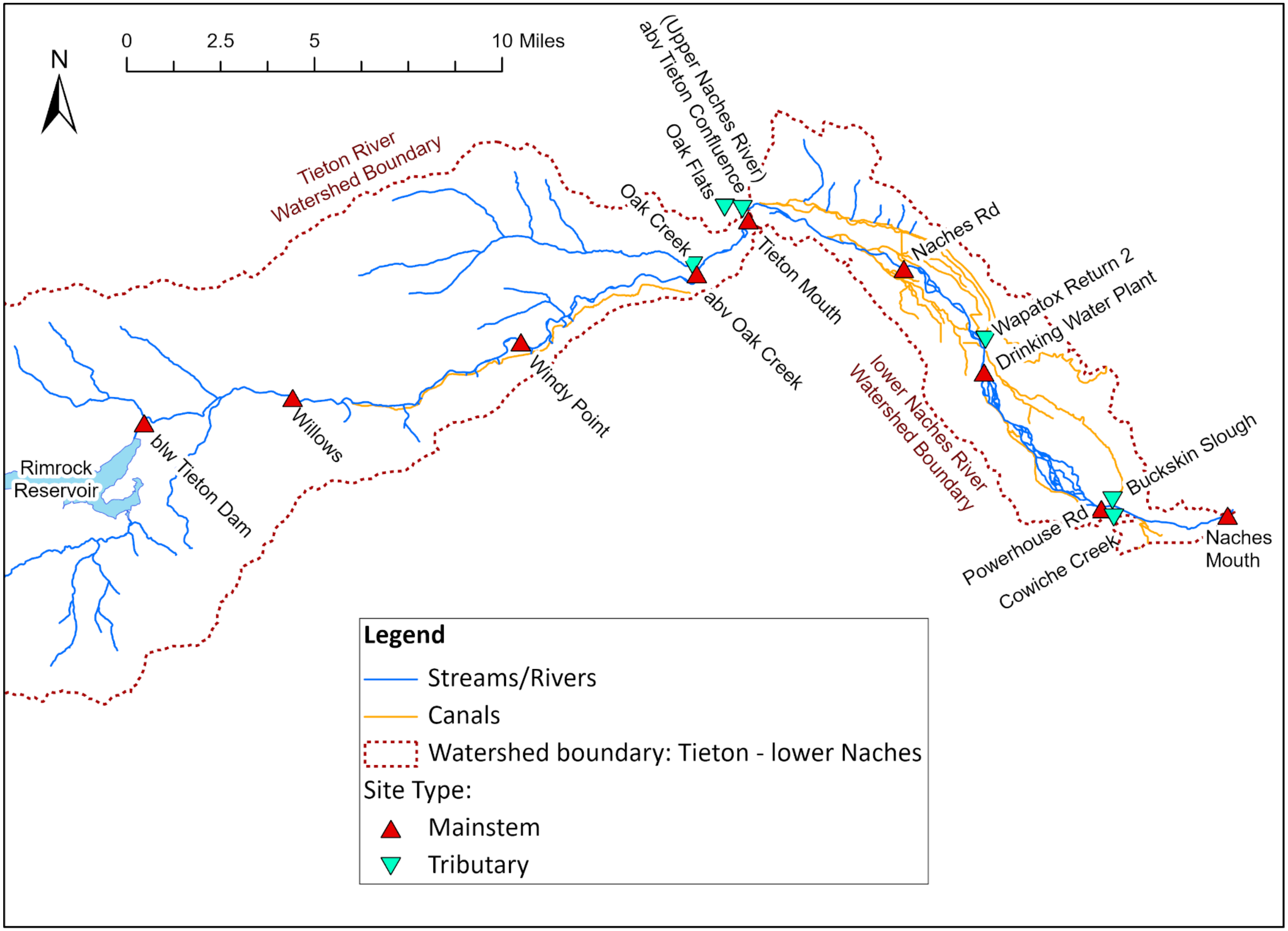

Figure 2. 2024 monitoring locations.

Table 12. List of measurements and parameters to be determined at each site location.

Short Name	EIM Location ID	River Mile	Description	Water Temperature Data lger	Water Quality Samples	Dissolved Oxygen Data Logger	Turbidity data Logger	Flow Measurements	Continuous Flow Gage	Air and Dew Temperature Data Logger	Short-term Water Quality Sonde
blw Tieton Dam	38TIE20.8	20.8	Tieton River below Dam	X	X[a]	X				X	
Willows	38TIE16.2	16.2	Tieton River at Willows campground	X	X						
Windy Point	38TIE09.0	9	Tieton River at Hwy 12 near Windy Point Campground	X	X						
abv Oak Creek	38TIE02.3	2.3	Tieton River at Hwy 12 upstream of Oak Creek	X							
Tieton Mouth	38TIE00.4	0.4	Tieton River near mouth	X	X	X	X				
Oak Flats	38NAC18.0	18	Naches River below Naches Selah Canal (gage 38A140)	X		X	X	X	X	X	X
abv Tieton Confluence	38NAC17.6	17.6	Naches River near Confluence with Tieton Y		X						
Naches Rd	38NAC12.8	12.8	Naches River at S Naches Rd Bridge	X	X	X					
Drinking water plant	38NAC9.0	9	Naches River at City of Yakima water treatment plant	X	X	X					X
Powerhouse Rd	38NAC03.84	3.84	Naches River at Powerhouse Road	X	X	X					

Short Name	EIM Location ID	River Mile	Description	Water Temperature Data lger	Water Quality Samples	Dissolved Oxygen Data Logger	Turbidity data Logger	Flow Measurements	Continuous Flow Gage	Air and Dew Temperature Data Logger	Short-term Water Quality Sonde
Naches Mouth	38NAC0.18	0.18	Naches River near mouth	X	X	X	X	X	X	X	X
Oak Creek	38OAK0.05	0.05	Oak Creek near mouth	X	X			X			
Kelly Lowry	38KLYW	13.7	Kelly Lowry Diversion					X			
WAPW	38WAPW2	9.7	Wapatox Canal Return 2	X	X			X			
Chapman Nelson	38CHFW	6.1	Chapman Nelson Diversion					X			
Buckskin Slough	38BINW	0.1	Buckskin Slough near Naches River 1	X	X			X			
Cowiche Creek	38COW00.5	0.5	Cowiche Creek at Powerhouse Road	X	X	X		X			
American River[b]	38E070	0.05	American River at Bumping River Rd bridge	X	X	X					
Bumping River[b]	TBD	TBD	Bumping River below Bumping Lake	X						X	
Bumping River[b]	38D070	0.05	Bumping River above American River	X	X	X				X	
Little Naches River[b]	38LIT00.1	0.1	Little Naches River at Hwy 410 bridge	X	X	X					

Short Name	EIM Location ID	River Mile	Description	Water Temperature Data lger	Water Quality Samples	Dissolved Oxygen Data Logger	Turbidity data Logger	Flow Measurements	Continuous Flow Gage	Air and Dew Temperature Data Logger	Short-term Water Quality Sonde
Upper Naches above Cliffdell[b]	38NAC41.1	41.1	Naches River at Boulder Cave Rd bridge	X	X	X				X	
Upper Naches above Rattlesnake[b]	38NAC31.1	31.1	Naches River at upper Nile Rd bridge	X	X	X	X				
Rattlesnake Creek[b]	38RAT00.2	0.2	Rattlesnake Creek near mouth on Nile Rd bridge	X	X	X		X	X		
Naches POTW[b]	Naches POTW - Effluent	N/A	Naches POTW	X	X						

EIM: Environmental Information Management database.

[a] Environmental Assessment Program Freshwater Monitoring Unit’s basin station site for the water year 2024.

[b] These are background sites that will be sampled monthly and are not shown in Figure 2.

7.2.2.1 Streamflow measurements

Ecology will take streamflow measurements during each survey at selected tributary locations that do not have streamflow gage stations, following Ecology protocols (Kardouni 2019). Other streamflow data for the Naches River and its tributaries will be acquired from USBR and others that have already measured streamflow. Table 13 shows the location and station names of the gages that this project will use to help determine streamflow. Ecology may take periodic streamflow measurements at locations measured by other agencies to conduct QC checks.

This study follows the example used in the temperature modeling study (Newell 2018), where a detailed water budget was performed. A map and a detailed description of each source of flow data listed in Table 13 are documented in the modeling report (Newell 2018).

Table 13. List of streamflow measurement sites and streamflow gages.

Location	Site ID	2024 Measurements or Source of Flow Data
Oak Creek	38OAK0.05	Ecology
Buckskin Slough	38BINW	Ecology
Cowiche Creek	38COW00.5	Ecology
Naches River at Oak Flats	38NAC18.0	Ecology
Chapman-Nelson Canal	38CHFW	Ecology
Kelly-Lowry Canal	38KLYW	Ecology
Tieton River — Rimrock Reservoir Outflow	RIM	USBR
Tieton Canal Diversion	TIEW	USBR
Tieton River below Tieton Canal Diversion	TICW	USBR
Naches River near Cliffdell	CLFW	USBR
Naches-Selah Canal Diversion	NSCW	USBR
Wapatox Power Canal Diversion	WOPW	USBR
Naches River below Wapatox Canal Diversion	NACW	USBR
South Naches Canal Diversion	SOUW	USBR
Naches River near Yakima	NRYW	USBR/Ecology
Wapatox Power Canal Return Flow	WAPW	Ecology
Clark Ditch Diversion	CLCW	USBR

Location	Site ID	2024 Measurements or Source of Flow Data
Yakima Valley Canal Diversion	CODW	USBR
Yakima City Irrigation Diversion	CYIW	USBR
Fruitvale Power Canal Diversion	FRUW	USBR
Gleed Canal Diversion	GLEW	USBR
Naches-Cowiche Canal Diversion	NCOW	USBR
Old Union Canal Diversion	OLDW	USBR
Yakima M&I Diversion	CYOW	City of Yakima

7.2.2.2 Continuous water quality monitoring

Ecology will install dataloggers to measure continuous temperature, DO, pH, turbidity, and conductivity at several locations to improve the understanding of diel variability in water quality (Table 12). Meters will be installed and maintained following Ecology's protocols (McCarthy and Mathieu 2017) and other more current SOPs:

- Standard Operating Procedures, EAP034, Version 1.5, Collection, Processing, and Analysis of Stream Samples (wa.gov)[2]
- Standard Operating Procedure EAP033, Version 2.2: Hydrolab®, DataSonde®, MiniSonde®, and HL4 Multiprobes (wa.gov)[3]
- Standard Operating Procedure EAP080, Version 2.2: Continuous Temperature Monitoring of Freshwater Rivers and Streams[4]
- Standard Operating Procedure EAP129, Version 1.0: Short-term Continuous Data Collection with a Multiparameter Sonde, Part 1: Field Procedures (wa.gov)[5]
- Standard Operating Procedure EAP130, Version 1.0: Short-term Continuous Data Collection with a Multiparameter Sonde, Part 2: Data Processing (wa.gov)[6]

[2] https://apps.ecology.wa.gov/publications/SummaryPages/1703207.html

[3] https://apps.ecology.wa.gov/publications/SummaryPages/2003201.html

[4] https://apps.ecology.wa.gov/publications/SummaryPages/2203216.html

[5] https://apps.ecology.wa.gov/publications/SummaryPages/1903229.html

[6] https://apps.ecology.wa.gov/publications/SummaryPages/1903230.html

7.2.2.3 Special studies

Some sites in Table 12 are labeled for monthly sampling. Most of these sites are in the upper Naches River basin and will provide data on background water quality in the basin. Sampling at these sites will be attempted, depending on safe access and appropriate river conditions. In addition, monthly sampling will be attempted at the Naches POTW to characterize the water quality of the effluent discharged to the Naches River. There will also be short-term synoptic sonde deployments at several stations, primarily to record pH diel ranges during the synoptic sampling. Table 12 lists several candidate locations for the short-term sonde deployment.

7.3 Maps or diagram

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

7.4 Assumptions underlying design

This 2024 field study is specifically designed to generate a data set that will allow calibration of a water quality model that can simulate water temperature, DO, and pH in the Tieton River and Lower Naches River. This 2024 data collection is specifically designed to provide enough detail to construct a time series for each tributary and source to the Lower Naches River. The assumption is that these monitored tributaries and sources represent the bulk of the mass balance terms in the model domain to successfully simulate water temperature, DO, and pH in the Tieton River and the Lower Naches 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.[7]

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).

[7] 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, the 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 2024 study. However, there could be a field consistency review by another experienced field staff member during this project. This type of review aims 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).

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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