Quality Assurance Project Plan

Methow Subbasin Water Quality Restoration and Monitoring Program

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1.0 Table of Contents

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2.0 Abstract

The goal of the Methow Subbasin Water Quality Restoration and Monitoring Program is to maintain and continue a systematic basin-wide water quality monitoring program within the Methow Subbasin. Water quality monitoring will include year-round temperature, seasonal water quality, and annual sediment monitoring. The program builds upon a monitoring framework established in Ecology Centennial/319 grant agreements #G1000282 and #G1100212. The former initiated basin-wide water quality status/trend and effectiveness monitoring; and the latter supported and expanded upon existing water quality monitoring efforts and introduced annual sediment monitoring to provide a more complete picture of benefits from restoration activities, and to better define types, amounts, and locations of loading. Continued water quality monitoring will define short-term and long-term water quality trends, assess the effectiveness of restoration activities, offer a baseline of water quality conditions as they relate to Washington State 303(d) listings in the Methow subbasin, and provide data to support TMDL development as necessitated by the 303(d) listings in the Methow watershed.

3.0 Background

3.1 Study Area and Surroundings

The Methow watershed (WRIA 48) is located in north central Washington on the eastern slope of the North Cascade Mountains (Figure 1). The Methow watershed is one of four primary subbasins within the upper Columbia River Basin. Topography varies from mountainous alpine terrain at elevations over 8,500 feet to wide valleys that slope gently down to the Columbia River at an elevation of 800 feet. This diverse habitat supports well over 300 species of fish and wildlife, some of which are listed as Endangered, Threatened, or as Species of Concern (NPCC 2004). Primary among these are three species of ESA-listed fish, including spring Chinook salmon, summer steelhead, and bull trout.

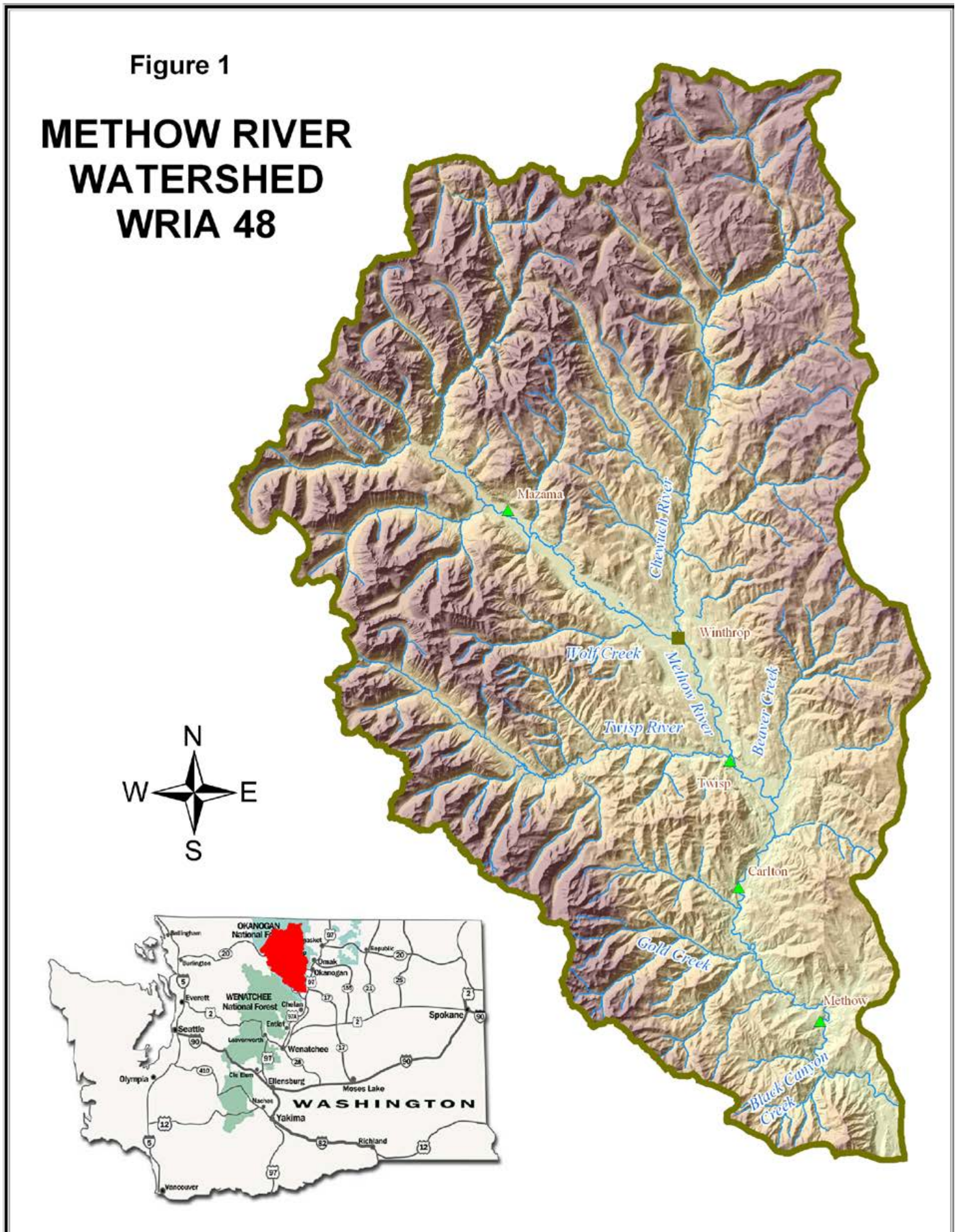

Figure 1. Methow River watershed, Water Resource Inventory Area 48, Washington.

3.1.1 Logistical problems

Logistical problems for this project primarily relate to site access. As stated in section 3.1, the Methow watershed possesses a large elevation gradient and abundant snowfall, especially at the higher elevations. Access to upper elevation monitoring sites during late fall through spring is difficult and often dangerous. In these cases, site access is limited to the summer and early fall. As such, loggers at these locations cannot be checked in early spring during the routine logger checks planned for that time. In these cases, these sites will be visited as soon as access is possible.

High streamflow, often associated with the spring freshet, but possible anytime of the year, poses another logistical challenge. Water quality multiprobes (*Hydrolabs*) are delicate and expensive equipment, and difficult to anchor instream. High flows present a real potential for loss or damage to these units. Icing is another instream monitoring constraint. Ice forms on the banks and riverbed and can freeze and damage the multiprobe sensors. Wildfire is another constraint that may prevent timely access to, and loss of, instruments.

Therefore, all six multiprobes are removed for high water events and during periods of extreme cold and icing. Generally, high water in the Methow watershed is present from late April through early July. Icing is present generally from late November through March. Thus no continuous water quality data collection is possible during these time periods. Multiprobes are installed post-high flow, generally by mid-July, and run until ice develops in November.

The potential for loss or damage of loggers or other monitoring equipment via high flows or vandalism is always present. Equipment is deployed to minimize visibility (i.e., camouflaged casings and no use of flagging) and anchored to the banks or streambed to minimize loss by high flows. However, in the event of a severe high flow episode significant numbers of temperature loggers could be lost or damaged.

3.1.2 History of study area

Over the past century, the extent and viability of riparian vegetation in the Methow has been significantly diminished. Numerous impacts stemming from human alternations to the environment have acted in conjunction with inherent natural variation to influence the Methow watershed (NPCC 2004, UCSRB 2007a). Human impacts in the lower reaches of the Chewuch, Methow, and Twisp Rivers have included road construction, conversion of riparian habitat for agriculture and residential development, water diversions, and diking. Additional impacts extend to the upper reaches of the drainages, including timber harvest, road building, and grazing. These impacts can increase sedimentation and bank erosion, reduce the extent and availability of riparian vegetation, decrease instream flow, and limit channel function.

3.1.3 Parameters of interest

This monitoring program will focus on monitoring seven water quality parameters to evaluate existing contaminants of concern, and identify and monitor potential impairments. These parameters include temperature, pH, dissolved oxygen, chlorophyll *a*, conductivity, turbidity and fine sediment. Currently, temperature is identified as a Category 5 contaminate of concern on Ecology's 303(d) list along segments of the Methow and Chewuch Rivers (Table 1).

Temperature is listed as a contaminant of concern (Category 2) in the Twisp River. pH is considered a Category 2 contaminant of concern in the Methow River. Additional Category 3 listings have been identified for temperature, dissolved oxygen, and pH in the Methow River. Category 3 listings are the result of insufficient data to meet the minimum evaluation criteria. Including these parameters in the project's monitoring program will assist in properly categorizing these contaminants of concern.

Table 1. Ecology's 303(d) category 2-5 contaminants of concern for the Methow, Chewuch and Twisp Rivers.

Streambody	Parameter of Concern	Water Quality Assessment Category	Listing ID #
Methow	Temperature	Polluted (category 5)	3732
Methow	Temperature	Insufficient Data (category 3)	11292, 11459
Methow	Dissolved Oxygen	Insufficient Data (category 3)	11289, 11293, 11457
Methow	pH	Insufficient Data (category 3)	11458
Methow	pH	Contaminant of Concern (category 2)	11290, 11294
Chewuch	Temperature	Polluted (category 5)	39349
Twisp	Temperature	Contaminant of Concern (category 2)	8435, 39350

This monitoring program is focused on assessing the status and trends of existing water quality parameters, especially water temperature, as well as determining the effectiveness of a suite of restoration actions implemented, in part, to improve water quality.

3.1.4 Results of previous studies

Water quality has been monitored in the Methow watershed by several entities, including Ecology, for over a decade. As witnessed by 303(d) listings, stream temperature – a critical component of fish habitat – has been observed exceeding levels detrimental to the threatened and endangered salmonids, including spring Chinook salmon, summer steelhead and bull trout, present in the Methow watershed.

Airborne Thermal Infrared Remote (TIR) Sensing temperature data of the Methow subbasin collected in 2009 (Watershed Sciences 2009) was utilized in the initial development of the temperature monitoring network to select monitoring locations in the Methow, Chewuch, and Twisp Rivers. Although TIR only measures surface temperature, it provided valuable information regarding adequate mixing of converging streams for quality assurance during site selection.

Images were collected using a Forward Looking Infrared (FLIR) system's SC6000 sensor (8-9.2µm). The SC6000 is a calibrated radiometer with internal non-uniformity correction and drift compensation. The thermal infrared radiation received at the sensor is a combination of energy emitted from the water's surface, reflected from the water's surface, and absorbed and reradiated by the intervening atmosphere. Water is a good emitter of TIR radiation and has relatively low reflectivity (~4 to 6%). However, variable water surface conditions, such as pools or riffles, change in viewing aspect, and variable background temperatures can result in differences in the calculated radiant temperatures within the same image or between consecutive images. The apparent temperature variability is generally less than 0.5°C. The presence of these variables will be taken into consideration during image interpretation and analysis.

In general, apparent stream temperature changes of < 0.5°C are not considered significant unless associated with a surface inflow, such as a tributary (Watershed Sciences 2009). The imagery flight was conducted during low water conditions in summer (24-26 August 2009), which yields the highest potential for capturing relatively high water temperatures and also finding the contrasting inputs of cooler water.

Several Ecology funded riparian restoration and monitoring projects have been implemented since 2010 (G1000282 and G1100212), and both of these efforts collected a significant amount of water quality data. This project will follow a similar study design to provide data continuity. The final reports for these prior grants provided insight into the status of water quality in the Methow watershed. Overall, monitoring has revealed a significant amount of water temperature impairment across the basin. Water temperature in several streams exceeded state criteria for this parameter. These observations would expand the current 303(d) list for the Methow watershed. Sediment monitoring carried out under grant G1100212 revealed several locations where fine sediment in the Methow River did not meet USFS and NOAA criteria for a properly functioning stream.

3.1.5 Regulatory criteria or standards

Statewide water quality criteria as outlined in WAC 173-201A-600 (WAC 2014) designate surface water quality criteria based on designated aquatic life use of the stream segments. The aquatic life use of a particular reach or stream is based on the National Hydrology Database (NHD). Specific designations for the Methow, Chewuch, and Twisp Rivers are presented in Table 2The state criteria designations for aquatic life that apply to stream reaches in the Methow watershed include char spawning and rearing in the higher elevation reaches, core summer salmonid habitat throughout the majority of mainstem Methow, Chewuch, and Twisp Rivers, and salmonid spawning, rearing, and migration in the mainstem Methow River from the Twisp River confluence downstream to the mouth (Table 2).

Temperature thresholds for each of the three aquatic life categories relate to the 7-day average daily maximum (7-DADM) temperature. These thresholds include 12°C for char spawning and rearing, 16 °C for core summer salmonid reaches and 17.5 ° for salmonid spawning, rearing and migration (Table 3).

Table 2. Water quality designations for the Methow watershed based on standards for surface waters of the State of Washington.

Use Designations for Fresh Waters by Water Resource Inventory Area (WRIA)	Aquatic Life Uses						Recreation Uses			Water Supply Uses				Misc. Uses				
	Char Spawning /Rearing	Core Summer Habitat	Spawning/Rearing	Rearing/Migration Only	Redband Trout	Warm Water Species	Ex Primary Cont	Primary Cont	Secondary Cont	Domestic Water	Industrial Water	Agricultural Water	Stock Water	Wildlife Habitat	Harvesting	Commerce/Navigation	Boating	Aesthetics
Methow River from mouth to confluence with Twisp River.			✓					✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Methow River from confluence with Twisp River to Chewuch River (river mile 50.1).		✓						✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Methow River and tributaries from Chewuch River (river mile 50.1) to headwaters (except where designated char.		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Methow River, West Fork, (including tributaries) from and including Robinson Creek and its tributaries to headwaters (except unnamed tributary above mouth at latitude 48.6591 longitude -120.5493.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Twisp River from mouth to War Creek.		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Twisp River and War Creek: All waters (including tributaries) above the confluence.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Chewuch River and tributaries from mouth to headwaters (except where designated otherwise).		✓					✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Chewuch River and tributaries above Buck Creek at Section 30, T38, R22E.	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3. Washington surface water criteria for temperature based on designated aquatic life uses in the Methow subbasin.

Category	Highest 7-DADMax
Char Spawning and Rearing	12°C (53.6°F)
Core Summer Salmonid Habitat	16°C (60.8°F)
Salmonid Spawning, Rearing, and Migration	17.5°C (63.5°F)

State criteria also apply to other water quality parameters that will be monitored within the project. WAC criteria for dissolved oxygen (mg/L and % saturation), pH and turbidity have been designated and apply to water within the Methow watershed (Table 4). These criteria dictate that dissolved oxygen should not exceed 9.5 mg/L and/or 110% of saturation, pH should range between 6.5 and 8.5 and turbidity should not exceed 5 NTU.

At this time, criteria for the other water quality parameters to be monitored under this project, including conductivity, chlorophyll a, and fine sediment have not been established for Washington State.

As witnessed by Washington State 303(d) Category 5 listings for the Methow River and a major tributary, the Chewuch River, stream temperature, a critical component of native fish habitat, is at a level potentially detrimental to the threatened and endangered salmonids present in the Methow subbasin. Table 1 in previous section 3.4 entitled Contaminants of Concern presents 303(d) categories 2-5 listings for the Methow, Chewuch, and Twisp Rivers.

Table 4. Washington State surface water criteria for dissolved oxygen, pH, and turbidity based on designated aquatic life uses in the Methow subbasin.

Aquatic Use Category	Dissolved Oxygen	Dissolved Oxygen Saturation	pH	Turbidity
Core Summer Salmonid Habitat	9.5 mg/L	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.	pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units.	Turbidity shall not exceed 5 NTU

Increased temperature, and correlated decreases in dissolved oxygen, can negatively influence salmonid productivity by limiting growth, reducing metabolic rates, increasing susceptibility to disease and predation while creating thermal barriers to migration or reproduction (Andonaegui 2000). One 303(d) listing for the Methow occurred at Ecology's water quality monitoring station 48A070 which is located 5 miles upstream from the mouth of the Methow River. This is an indication that water quality impairment is likely the result of basin-wide affects. Recent monitoring has documented additional locations of water temperatures that exceed state criteria (Gregg and Crandall 2014a).

The Category 5 303(d) listings necessitate a TMDL for the Methow River that, at this time, has not been conducted. In 2008, Ecology, the designated entity responsible for the implementation and enforcement of the federal Clean Water Act in the State of Washington, opted to pursue a 4b "straight to implementation" approach to meet water quality standards for temperature in the Methow subbasin because an active recovery effort was successfully underway (Anderson 2008). However, in 2012, Ecology amended its decision to pursue the 4b "straight to implementation" approach in the Methow and is planning a full temperature TMDL (Coffin 2012). The Methow Subbasin Water Quality Monitoring Project will provide a substantial body of data and observations critical to the development of the Methow TMDL.

Since the 303(d) listings in 2002, the Methow Restoration Council partnership (MRC) has implemented over 30 water quality, water quantity, and habitat complexity related restoration projects and numerous other projects are scheduled for implementation over the next ten years. The Habitat Work Schedule, an online mapping and tracking tool, offers a comprehensive list of habitat protection and restoration projects (HWS 2014). Combined, these projects will assist in the reduction of non-point pollution and sediment contributions that will aid in the reduction of water temperature. Projects have focused on habitat improvements to increase site potential shade and instream habitat complexity.

Over the last decade, restoration activities in the Methow have also focused on addressing habitat related factors that are suspected to limit salmonid productivity, abundance, spatial distribution and diversity in the Methow subbasin. These habitat limiting factors include habitat diversity and quantity, excessive artificial channel stability, water quantity, obstructions, sediment and water quality (UCSRB 2007a). To date, funding priorities have focused on implementation of restoration projects, yet the effectiveness of a majority of these projects in improving water quality conditions remains largely un-documented with monitoring data. Continuous water quality and annual sediment monitoring are identified as a core habitat indicator in the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006) and lack of this type of monitoring was noted in a baseline monitoring assessment for the Methow (Crandall 2010).

The MRC conducts coordinated restoration and monitoring. A key component of this work is the use of reach assessments to develop restoration strategies and sequencing. Reach assessments detail the locations where restoration may address limiting factors on the landscape. These reach assessments are employed to develop specific restoration treatments at specific sites. These reach assessments (USBR 2008, 2010, 2012; Yakama Nation 2010a, 2010b) have been used to assist with monitoring site selection. However, restoration pathways in the Methow watershed are dynamic and change over time. Monitoring efforts will need flexibility to adapt to changes in restoration objectives.

Ecological concerns" (i.e., "limiting factors") have been identified throughout the Methow watershed (UCRTT 2014). The ecological concern of riparian forests and the associated potential for large wood recruitment (i.e. availability of large/mature trees) is the most pervasive ecological concern in the Methow watershed and is only one of two concerns to be identified for all 14 assessment units. Although it does not rank as the highest priority concern in any assessment unit, it ranks as high (priority 2-4) in 11 of the units. Due to the extensive and pervasive nature of this ecological concern, it is critical that restoration activities directly address this ecological concern at a broad scale.

Beginning in 2010, the Water Quality and Restoration Monitoring Program collaborated with existing water quality monitoring networks to create a systematic basin-wide water quality and temperature monitoring network. Annual fine sediment monitoring was introduced in 2011. Data collected from these monitoring efforts provide a baseline of the status and trend of water quality within the Methow Subbasin (Gregg and Crandall 2014a). However, more data are necessary to fully develop trend lines for analysis, assess the effectiveness of projects, monitor changes in water quality relative to Washington State 3039(d) listings and provide data to support TMDL development. Continuous monitoring of water quality in and around these projects will directly address the monitoring need and information gap identified by Crandall (2010).

4.0 Project Description

4.1 Project goals

The goal of the Methow Subbasin Water Quality Restoration and Monitoring Program is to monitor and document the status and trend in a suite of water quality parameters throughout the Methow watershed. The project will use this information to assist in an assessment of the effectiveness of a suite of restoration actions focused on improving water quality conditions and instream habitat. Data will also be used to monitor changes in water quality relative to Washington State 303(d) listings while providing data to develop the TMDL as necessitated by multiple 303(d) listings in the Methow watershed.

This basin-wide monitoring effort is being implemented in conjunction with an on-going stream and riparian habitat restoration effort coordinated through the MRC. Habitat restoration project implementation has been underway for over a decade but has grown in intensity over the past few years. A key component in the development of restoration projects that achieve tangible benefits is using monitoring results to inform project location, design and adaptive management. This project will engage in the process through all stages of project development.

4.2 Project objectives

A key objective of this project is to continue with, and expand upon, the existing water quality monitoring framework in the Methow watershed that was established in 2010 and continued under Ecology grants #G1000282 and #G1100212. Maintaining a systematic water quality monitoring program in the Methow Subbasin will also fill in identified monitoring needs and data gaps identified by Crandall (2010) by continuing the development of a baseline of water quality status and trend dataset.

Water quality monitoring objectives nest within a systematic, basin-wide water quality monitoring program that will assist in the determination of the effectiveness of restoration actions at improving water quality. Project objectives and related tasks include:

1. Continue to develop and implement restoration project water quality effectiveness monitoring on priority reaches of the Methow, Twisp, and Chewuch Rivers. These are the three primary subbasins of the Methow watershed, all of which have had post-303(d) listing riparian restoration projects that have water quality improvements as a primary objective. Six existing water quality monitoring sites that bracket restoration reaches on the Methow, Twisp, and Chewuch rivers will be used to monitor seasonal (April through November) water quality parameters including temperature, dissolved oxygen, pH, conductivity, turbidity, and chlorophyll *a* (Figure 2).
2. Continue to develop and implement continuous year-round water temperature status and trend monitoring in the Methow Subbasin, including post-303(d) listing restoration project locations. Over 100 existing temperature monitoring locations will be utilized to monitor water temperature throughout the Methow Subbasin. The locations of

temperature loggers are shown in Figure 3 and more detailed descriptions of logger locations are presented in Appendix B.

3. Continue to develop longitudinal temperature profiles of the mainstem Methow, Twisp, and Chewuch rivers.
4. Conduct annual sediment monitoring (McNeil core sampling) in three reaches of the mainstem Methow River to assess the effectiveness of water quality and habitat restoration activities. Monitoring will utilize established sediment monitoring sites located upriver and downriver from restoration reaches in the Middle Methow, Big Valley, and Silver reaches (Figure 4).

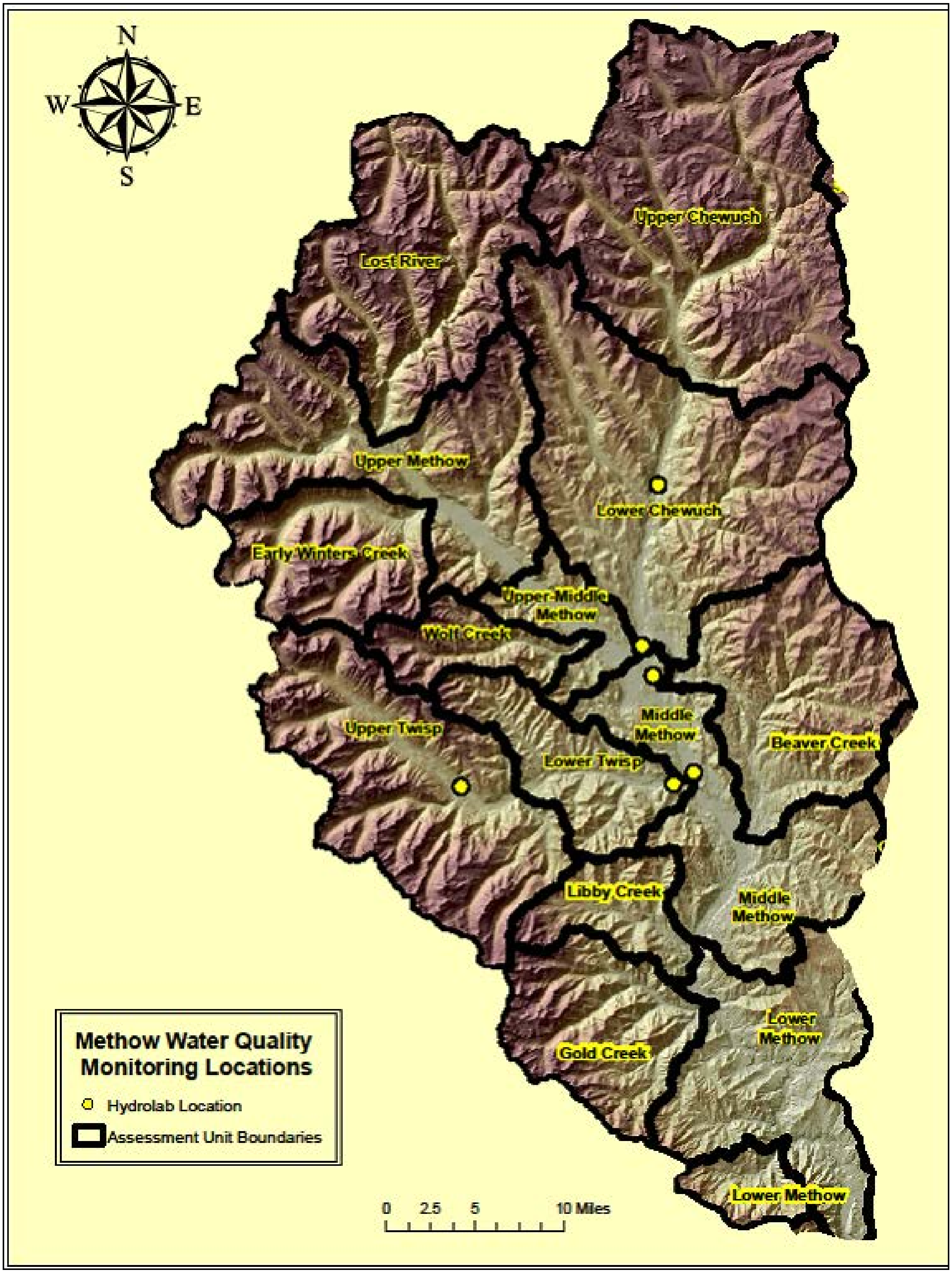

Figure 2. Methow watershed water quality station (Hydrolab multiprobe) locations.

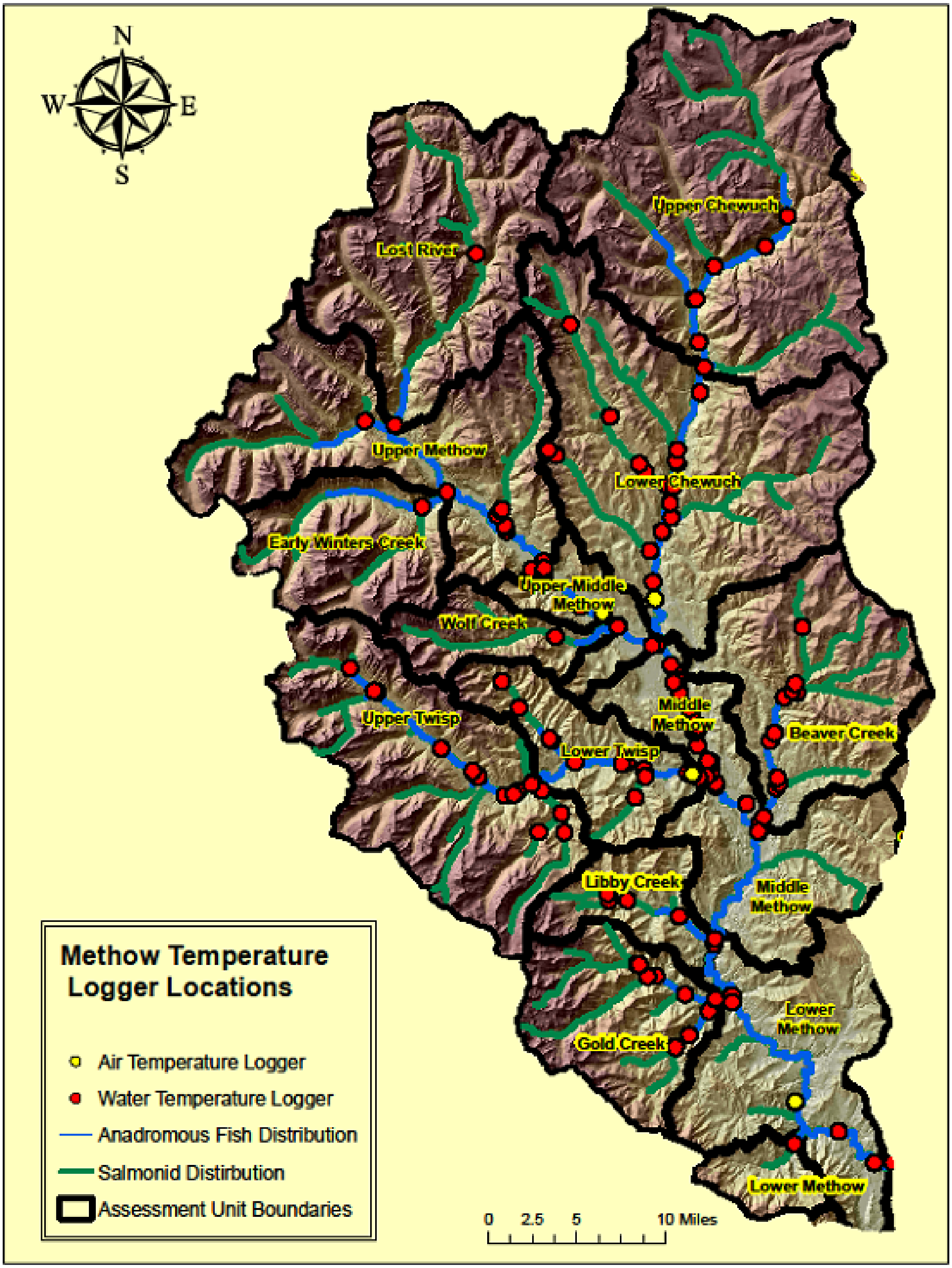

Figure 3. Water temperature and air logger locations in the Methow watershed.

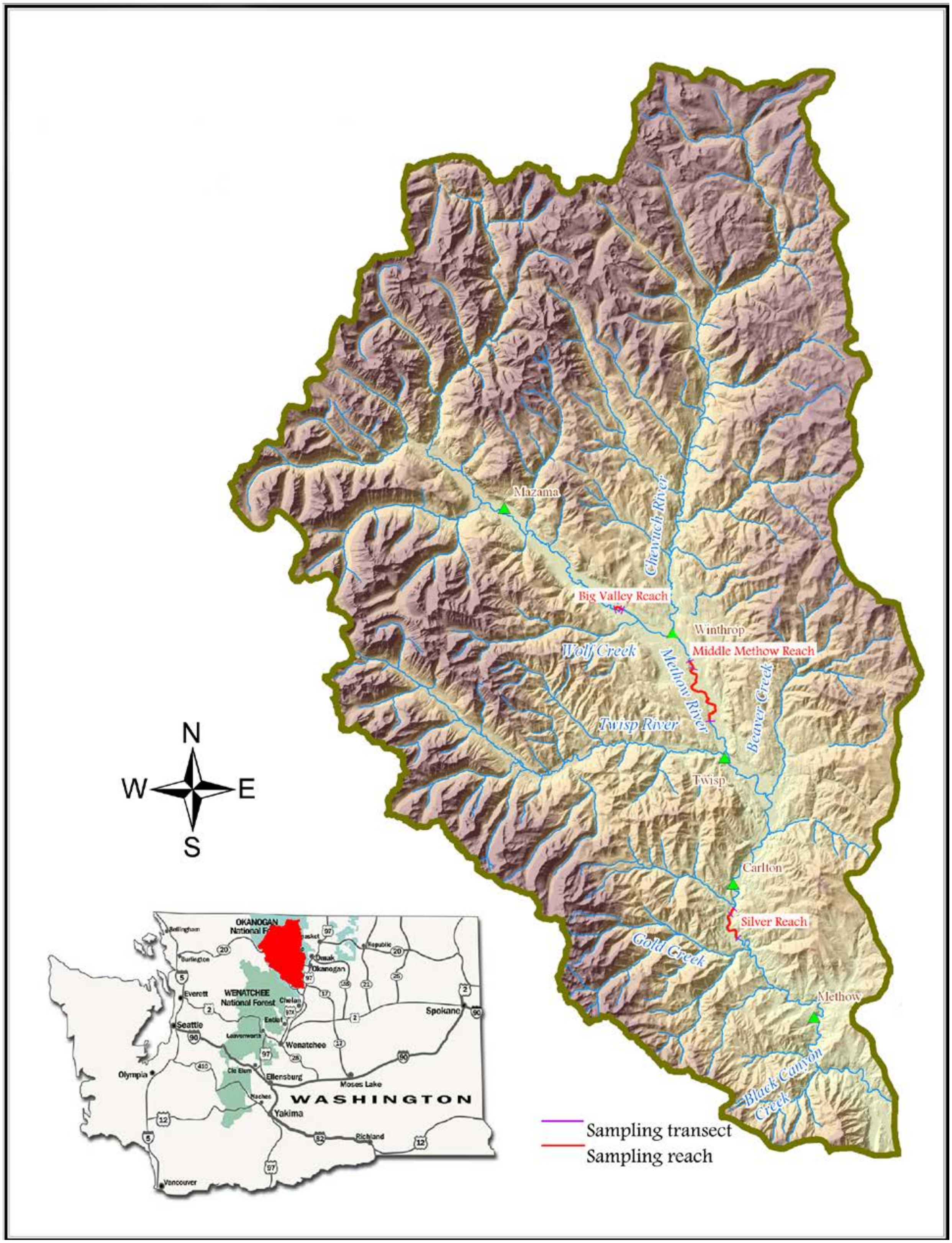

Figure 4. Sediment monitoring sites and reaches within the Methow watershed.

4.3 Information needed and sources

This project has been developed to monitor a suite of parameters that can be used to track the status and trend of water quality in the Methow watershed and support the development of a water temperature TMDL. The data generated by the project can also be used to assess the ability of instream and riparian restoration actions to improve water quality.

This project will rely on data collected during 2010-2014 that was funded, in part, by Ecology grants #G1000282 and #G1100212. These data provide a wealth of information on which to base project effectiveness can be based. Within the Ecology Environmental Information Management (EIM) database[1], data have been through the QA/QC process outlined in previous QAPPs (Gregg and Crandall 2010, 2011) for this project and approved by Ecology.

This project will incorporate water quality data from various restoration, monitoring, and effectiveness efforts in the watershed. Project partners include investigations by the US Forest Service, US Geologic Survey, US Bureau of Reclamation, Yakama Nation, and Douglas County PUD. The quality of data obtained from partners will be evaluated and graded according to the Study Quality Assurance Assessment Levels outlined in Ecology's Environment Information Management System (Appendix C). The quality of data from project partners is presented in Table 5. Additional locations may supplement current monitoring stations to ensure basin-wide and other project specific coverage.

Coordination with habitat restoration project implementation will be an on-going need for this project. Habitat restoration and monitoring activities in the Methow watershed are coordinated through monthly MRC meetings convened in Twisp, Washington. Habitat project implementation information is also tracked by the Upper Columbia Salmon Recovery Board (UCSRB). Information from across the Upper Columbia is posted and tracked through the UCSRB Habitat Work Schedule[2].

4.4 Target population

The project will track a suite of water quality parameters set forth in this QAPP. The target population will consist of the data collected at each discreet data collection event (i.e. water temperature collected every 30 minutes) at each monitoring location. Data collected at each location will be assumed to be representative of the stream reach in which it is deployed.

[1] http://www.ecy.wa.gov/eim/

[2] http://uc.ekosystem.us/

Table 5. Temperature monitoring project collaborators.

Entity	# of loggers	Project duration	Study/data quality	Deployment	Why Monitoring?
U.S. Forest Service	78	Varies by site, but ongoing since 1990s	Level 3	year-round	Implementation of the Forest Plan, also for specific management issues
U.S. Geological Survey	26	2004-present	Level 3	year-round	Effectiveness monitoring of habitat restoration
Methow Salmon Recovery Foundation	8	2009-present	Level 3	year-round	Effectiveness monitoring of habitat restoration
Washington Department of Ecology	2	varies by station	Level 4	year-round	EAP Long-term WQ monitoring
Douglas County PUD	2	2008-present	Level 3	year-round	Effects of dam
Yakama Nation	11	2006-present	Level 2	year-round	Effectiveness monitoring of Hancock Springs and Twisp River Restoration Activities

4.5 Study boundary

While the scope of this monitoring effort will encompass the entire Methow watershed, restoration and monitoring planning efforts led by the MRC have used a subbasin approach to define the watershed and this project will adhere its sampling effort based on these assessment unit boundaries adopted by both the UCSRB and MRC (Figure 5).

Assessment unit boundaries have also been used in the development of the Upper Columbia Biological Strategy that defines habitat limiting factors for each assessment unit. While the unit breaks were largely determined by geology, fish distribution can be tracked within these boundaries and assist with water quality criteria categorization.

Established temperature monitoring sites were selected according to protocol to ensure the water quality data are representative of the main portion of the stream at sample point locations and to give a representative picture of the Methow subbasin. The sample locations are dispersed to provide representative data of specific drainages, stream segments, and specific locations such as seeps, springs, hyporheic flow, or restoration project areas. As the project proceeds, we may incorporate additional locations identified through data analysis of temperature loggers and longitudinal profile data. Additional monitoring sites will be selected appropriately to ensure representative data.

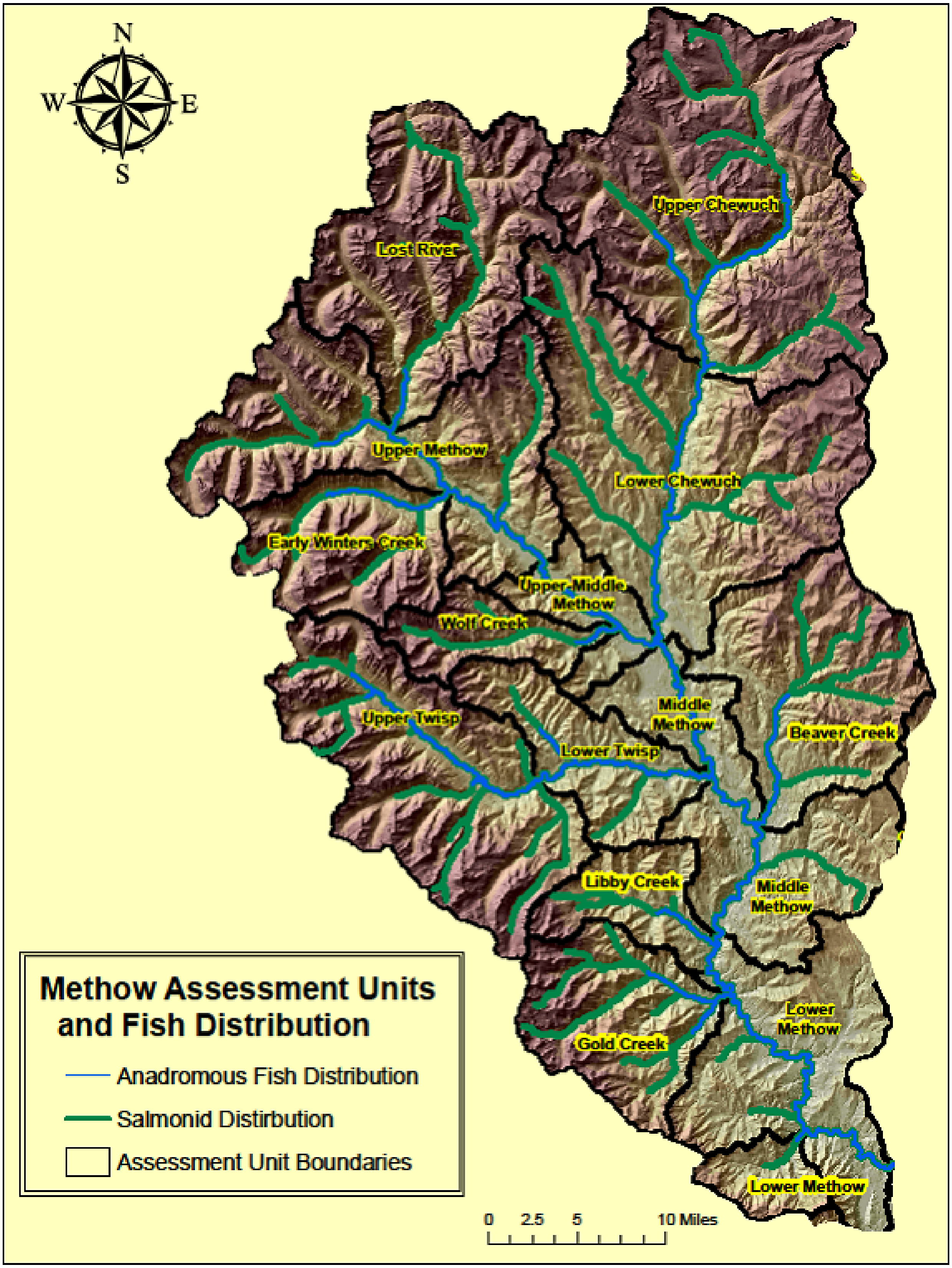

Figure 5. Methow watershed study area with delineated assessment unit boundaries and fish distribution.

4.6 Tasks required

The project will largely follow the required tasks and work flow developed during the initial four years of water quality monitoring in the Methow watershed. This experience has provided the project with a set of project related tasks that are reasonable, efficient and obtainable. All instruments will be deployed, maintained, downloaded and checked on a regular schedule depending on monitoring equipment type and location. The specifics of this schedule are outlined in Section 7. All instruments are checked for accuracy annually during the monitoring season based on equipment type and location within the watershed. A NIST certified thermometer is used to check the individual temperature loggers for accuracy on an annual basis as per existing QAPPs (Gregg and Crandall 2010, 2011). Hydrolab multiprobes are calibrated prior to each new deployment during the deployment season (April and July-November).

Data management, including data downloading, QA/QC and uploading is another key project task that will follow a previously developed schedule. Data are downloaded, reviewed and uploaded to EIM annually. Data analysis techniques applied to water temperature data will examine linear trends of data points and provide a year-round water temperature profile of the Methow subbasin. The maximum weekly maximum (7DADMax) temperatures values will be measured and expressed relative to the designated aquatic life use of a particular reach. Analysis will also include the development of longitudinal temperature profiles of the Methow, Chewuch, and Twisp Rivers to identify water quality trends along the stream continuum. Analysis of water quality data will compare recorded parameter values between the upstream and downstream monitoring locations on the Methow, Chewuch, and Twisp Rivers.

Reporting for the project will occur annually with reports submitted to Ecology by 31 March 2015 and 2016.

4.7 Practical constraints

Practical constraints include safe and efficient access to sampling locations and, if applicable, landowner permission for access. The majority of the monitoring sites have been established, but changes of stream morphology, landownership and site accessibility, and issues of vandalism or disturbance in areas of high public use may require the specific locations are adjusted to ensure the safety of the water quality monitoring equipment and its representative data, as well as field personnel.

High streamflow associated with spring runoff, rain on snow events and excessive rain events could make site access impossible and create discharge depths and velocities that exceed the specifications of the anchoring systems used to install loggers at a specific location. This could result in loss or damage to equipment.

4.8 Systematic planning process

Project planning will be based on previous experience conducting the same field and lab functions that will be undertaken within the guidelines set forth in this QAPP. Field safety is paramount and work will be planned within this context. Work scheduling will be designed to be effective in meeting objectives and efficient in terms of resources employed to meet these objectives.

Temperature sampling events will occur every half hour and year-round in most locations. In some locations, field conditions will prohibit year-round data collection. In these instances, data will be collected for as long as possible given the constraints posed by the specific location that may include frozen water, isolated locations, or unsafe travel pathways.

Multiprobe water quality monitoring will most likely occur in April and July-November. Year-round monitoring is not practical given the extreme cold that is often present within the Methow watershed during the winter months. Multiprobes will be removed from the field during high flow events and when icing is present, or when field conditions preclude accurate data collection and personal safety.

Sediment monitoring will occur annually in late summer/early fall when stream conditions and substrate composition are relatively stable and stream conditions are similar to those that salmon will experience during spawning. No samples will be collected during spawning or when eggs are present. This data collection planning follows a previously established sediment monitoring data collection process.

To meet the project's objectives, the monitoring effort is centered around priority riparian restoration actions that have been implemented to improve water quality. The locations of these projects and their restoration focus are shown in Figure 6 and presented in Table 6. Additional monitors in the network will help define the status and trend of temperature and water quality throughout the subbasin. This data will offer a baseline upon which effectiveness of future restoration activities can be assessed.

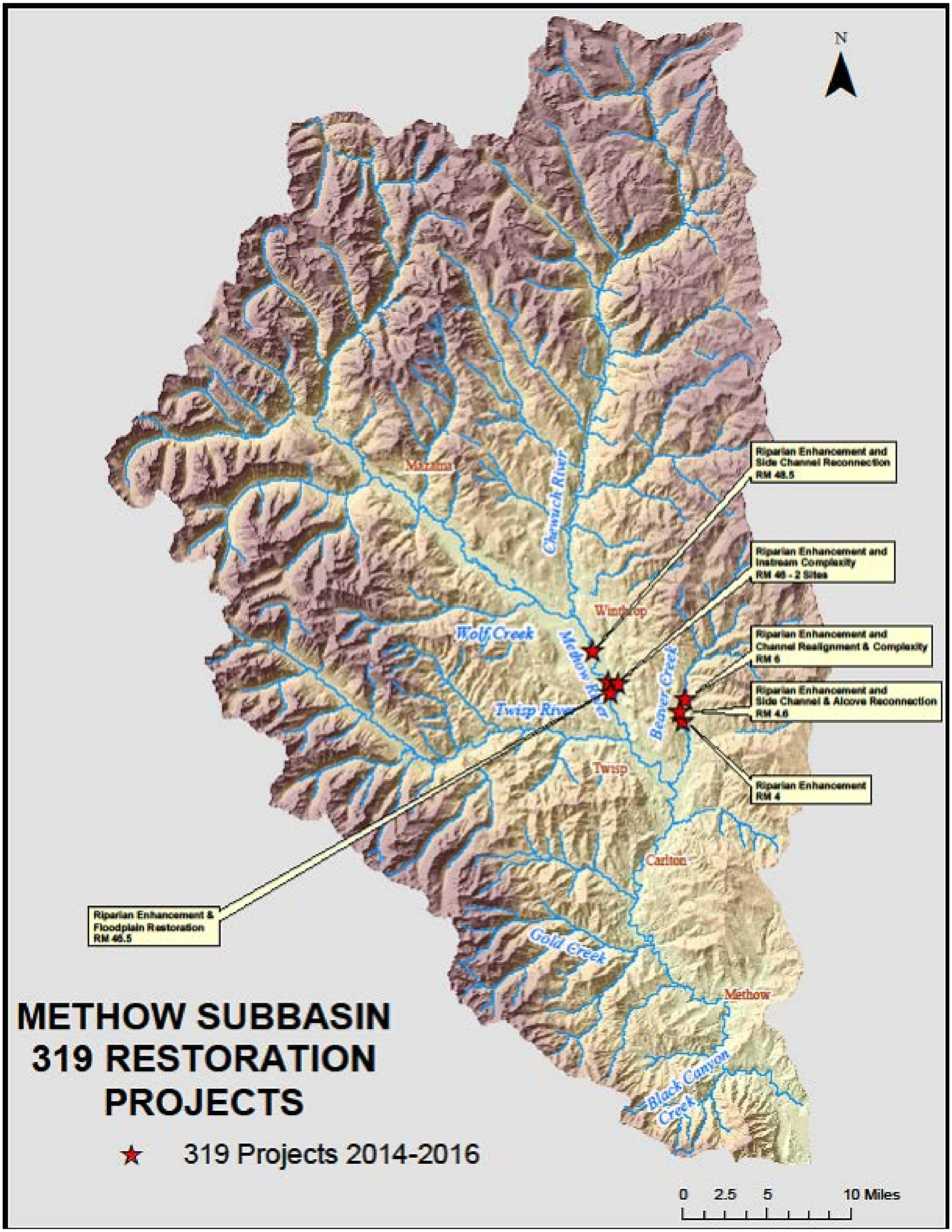

Figure 6. Section 319 / G1400529 funded restoration project locations in the Methow watershed, 2013-2016.

Table 6. Project locations and descriptions for selected 319 restoration projects, 2013-2016.

Stream	River Mile (RM)	Project Type	Primary Limiting Factor Addressed
Methow	46	Riparian and instream complexity and streambank protection through installation of one engineered wood structure and riparian buffer establishment.	Habitat diversity and quantity
Methow	46	Riparian and instream complexity and streambank protection through installation of two engineered wood structures and riparian buffer establishment.	Habitat diversity and quantity
Methow	46.5	Riparian enhancement and floodplain connectivity through re-establishment of riverine connection with floodplain channel and backwater alcove and riparian buffer establishment.	Habitat diversity and quantity
Methow	48.5	Riparian complexity and side channel reconnection through enhancement of hydrologic connection of side channel to mainstem, installation of 400 pieces of large wood and installation of live wood streambank crib and riparian buffer establishment.	Excessive artificial channel stability
Beaver Creek	4	Riparian enhancement through riparian buffer establishment.	Habitat diversity and quantity
Beaver Creek	4.5	Riparian enhancement and side channel and floodplain connectivity through installation of engineered wood structures, spring alcove re-connection, and side channel re-connection and riparian buffer establishment.	Habitat diversity and quantity
Beaver Creek	6	Riparian enhancement and channel realignment through placement of stream into historic configuration and removal of riprap and riparian buffer establishment.	Excessive artificial channel stability

5.0 Organization and Schedule

5.1 Key Individuals and responsibilities

Project staff and responsibilities are presented in Table 7.

Table 7. Project staff and responsibilities.

Name/Contact	Title	Responsibilities
John Crandall Methow Salmon Recovery Foundation (509) 341-4341	Project Manager, Aquatic Ecologist	Grant manager Tasks 2-5.
Tara Gregg Methow Salmon Recovery Foundation (509) 429-5999	Water Quality Monitoring Technician	Field monitoring and data management
Jennifer Molesworth U.S. Bureau of Reclamation (509) 997-0640	Methow sub-Basin Liaison	Project oversight and coordination
Chris Johnson Methow Salmon Recovery Foundation (509) 429-1232	MSRF Senior Project Manager	Project planning
Chris Eliasson Methow Salmon Recovery Foundation (509) 429-1232	MSRF financial manager	Budget and financial reporting
Heather Simmons Ecology (509) 454-7207	Ecology project manager	Ecology project manager
Alissa Ferrell Ecology (360) 407-6509	Ecology financial manager	Ecology financial management

5.2 Special training and certificates

Not applicable.

5.3 Organization chart

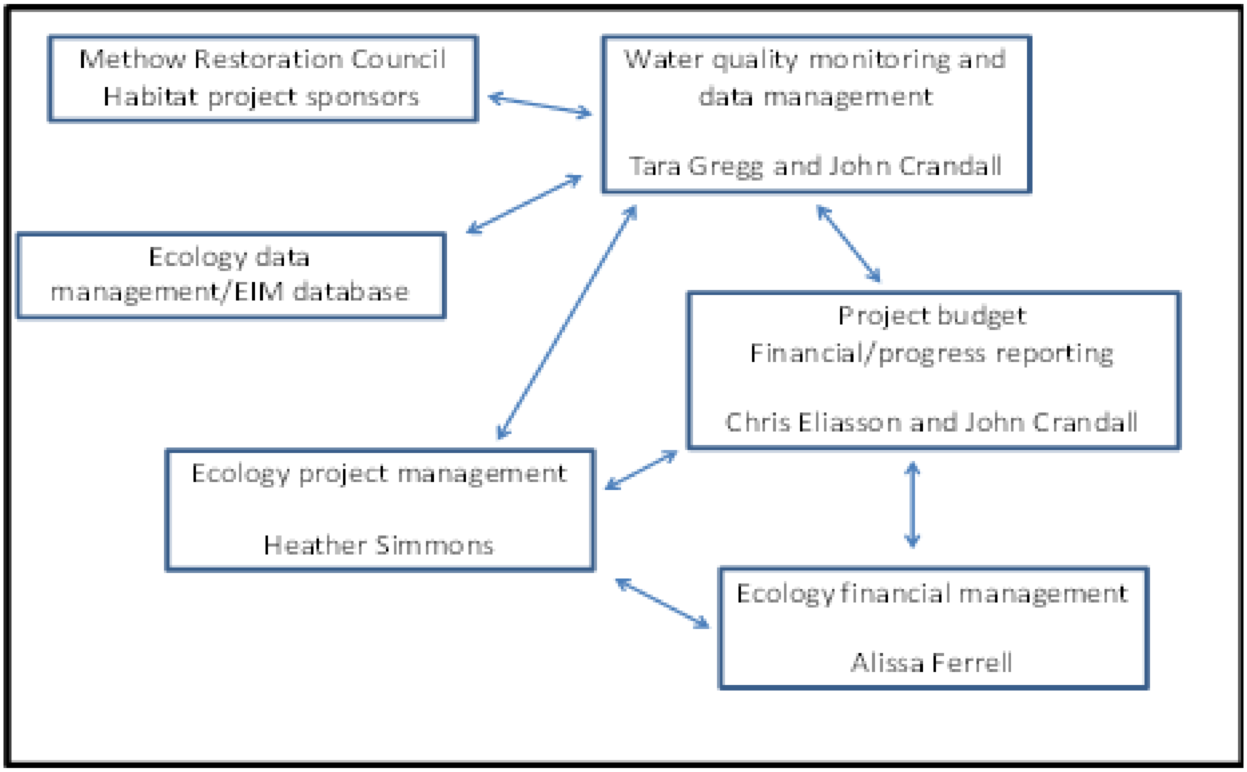

Figure 7. Organizational flow chart for Methow water quality restoration and monitoring project.

5.4 Project schedule

The schedule for this project is presented in Table 8.

Table 8. Project schedule for the Methow Water Quality Restoration and Monitoring Project.

Project Planning	Dates
Quality Assurance Project Plan	August 2014
Data entry and analysis	On-going and as needed beginning May 2014
Annual report of monitoring program including data input into Ecology's EIM database.	March 31, 2015, and 2016
Field Activities	**Dates**
Temperature monitoring	Year-round, field visits at least 3 times a year (April, July, October)
Water quality (multiprobe) monitoring	April-November or when conditions permit, field visits every 3 weeks or as needed
Sediment Monitoring	Late summer/early fall, annually

5.5 Limitation on schedule

It should be noted that weather and seasonal conditions, additional unplanned work load, or possible changes in landownership or permission that would change the sampling locations may influence the schedule.

Additionally, mechanical failure of monitoring equipment is possible. In these instances, a quick response will be initiated to get the equipment removed from the field, repaired, and re-deployed.

5.6 Budget and funding

The total eligible cost of the Methow Basin Water Quality Restoration and Monitoring Program is $325,000. Monitoring activities described in this QAPP represent a portion of these funds. A specific budget for basin-wide Water Quality Effectiveness Monitoring (Task 3) is presented in Table 9.

Table 9: Estimated Budget for Task 3 of the Methow Basin Water Quality Restoration and Monitoring Program.

Contracts:	$82,500 (Methow Salmon Recovery Foundation staff)
Materials, goods, and services (major items):	$15,000 (Calibration standards, field laptop, replacement temperature monitors, multi-probe repairs, misc. field supplies)
Travel:	$3,500 (field travel to monitoring sites, meetings)
Total Eligible Cost:	**101,000**

6.0 Quality Objectives

6.1 Decision quality objectives (DQOs)

Decision quality objectives will be employed by the project to ensure that data collected are appropriate to address the policy-level objectives of the overall restoration and monitoring effort being undertaken. The key objectives will be to collect representative, precise and accurate information that details spatial and temporal aspects of water quality in the Methow watershed. This information will be used to inform several project objectives including assisting in the determination of riparian and instream restoration project effectiveness at improving water quality, provide quality water quality data to assist in the development of a temperature TMDL for the Methow River.

These data will also be used to develop a long-term status and trend database for the Methow watershed that can be used in many ways, including examining the effects of climate change in water quality in the Methow watershed.

6.2 Measurement quality objectives (MQOs)

Measurement quality objectives for this project will focus on the provision of data that has been obtained following protocol and other data quality parameters outlined in Sections 6.2.1-6.2.2, including precision, bias and sensitivity. A project that follows set protocols for its data collection will ensure that quality data are developed that can be used to inform project and management objectives.

One feature of this project will be the use of several temperature monitoring locations where two duplicate loggers will be deployed in the same location. These duplicate loggers can be used to assess the quality and precision of loggers and filed methods.

6.2.1 Targets for precision, bias, and sensitivity

Sampling and data assessment steps have several sources of error that should be addressed by data quality objectives. Indicators including precision, bias, completeness, representativeness, and comparability are used to establish data quality objectives. All data will be collected following collection protocols and data quality objectives will be used to ensure quality data is available for TMDL development and project effectiveness assessment.

6.2.1.1 Precision

The water quality multiprobes to be employed are the Hydrolab DS5X manufactured by Hach Corporation. To obtain precise measurements, and as per manufacturer recommendations, the DS5X will be downloaded, calibrated, and re-deployed at least every three weeks, or as field conditions warrant. Calibration protocols will follow manufacturer's specifications and *Standard Operating Procedures for Hydrolab® DataSonde® and MiniSonde® Multiprobes* Version 1.0 (Ecology EAP 2007). During calibration procedures, parameter values will be noted before and after calibration (Appendix D). Table 10 describes measurement quality objectives for the Hydrolab DS5X.

Table 10. Targets for range, accuracy, and resolution for Hydrolab DS5X multiprobe.

Sensors	Range	Accuracy	Resolution
Hatch LDO	0 to 60* mg/L *exceeds maximum natural concentrations	± 0.1 mg/L @ ≤ 8 mg/L ± 0.2 mg/L @ > 8 mg/L ± 10% reading > 20 mg/L	0.01 mg/L
pH	0 to 14 pH units	± 0.2 units	0.01 units
Turbidity, Self-Cleaning	0-3000 NTU	Compared to StablCal ± 1% up to 100 NTU ± 3% from 100-400 NTU ± 5% from 400-3000 NTU	0.1 NTU 0-400 NTU; 1 NTU for >400 NTU
Chlorophyll a	Dynamic Range Low sensitivity: 0.03-500µg/L Med sensitivity: 0.03-50µg/L High sensitivity: 0.03-5µg/L	± 3% for signal level equivalents of 1 ppb rhodamine WT dye or higher using a rhodamine sensor	0.01µg/L
Temperature	- 5 to 50°C	± 0.10°C	0.01°C

For water temperature data collection, HOBO U22 Water Temp Pro v2 temperature loggers will be used. Precision and accuracy of temperature data loggers will be noted and maintained by comparisons with a National Institute of Standards and Technology (NIST) certified thermometer. This accuracy check protocol is detailed in the temperature monitoring section in the *Water Quality Monitoring Technical Guide Book: Oregon Plan for Salmon and Watersheds* (ODEQ 1999).

During deployment, logger locations will be visited at three times a year (April, July, and October) to check that they are present at the site and submerged in the proper location. Instruments at higher elevations where snow and ice prevent site access in April will be visited a least twice a year in July and October. Instrument status checks to verify that the loggers are operating properly will be conducted during these visits. The frequency of logger checks is due to their remote location and large geographical distance. Loggers will be checked more frequently based on need or in response to an unusual event such as flooding or lower than expected water levels. Measurement quality objectives for the HOBO U22 Water Temp Pro v2 are presented in Table 11.

Table 11. Targets for precision and resolution for HOBO U22 Water Temp Pro v2.

Sensor	Range	Accuracy	Resolution
Temperature	-40° to 50°C in water	±0.21°C from 0° to 50°C	0.02°C at 25°C

All temperature loggers will be downloaded and cleaned twice annually. One download will occur in the field using a portable data storage device. Loggers will be downloaded and checked for accuracy with a NIST certified thermometer in the office at least once year. The *Water Quality Monitoring Technical Guide Book: Oregon Plan for Salmon and Watersheds* (ODEQ 1999) cites 0.5 °C as the maximum mean error accepted. However, this project desires a high degree of accuracy and will deviate from this guidance and strive to use 0.2°C as the maximum mean difference accepted between the NIST referenced alcohol thermometer and the temperature data loggers. However, if all loggers were within 0.3 °C of one another and within 0.2-0.5 °C of the NIST value the loggers will be deployed. This is consistent with the degree of error outlined in *Continuous Temperature Sampling Protocols for Environmental Monitoring and Trends* (Ward 2001). Values recorded during accuracy checks will be recorded (Appendix D). Duplicate logger sets will be deployed at a minimum of four sites to verify the precision of temperature monitors. Logger sets will be deployed at the mouths of Wolf Creek, Eightmile Creek, Libby Creek, and Gold Creek. Duplicate sets are outlined in red in Appendix B.

Sediment monitoring will follow procedural guidelines (Tussing 2009, *modified from* Schuett-Hames 1999) to reduce effect of procedural errors on the data. Possible sources for procedural errors include: field sampling procedures, handling, transporting, and preparing samples, preparing the sample for analysis, and analysis of the sample (including data handling errors). All measurement equipment will be checked for damage and cleaned between samples.

6.2.1.2 Bias

Possible sources of bias may include: variation in sampling procedure, short-term changes in stream processes, improper site selection, and variation in time of day or year of sample collection. Careful adherence to established procedures for the calibration and placement of equipment, data collection, and data analysis should reduce or eliminate most sources of bias for this project (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999).

Water quality will be collected every hour and temperature data will be collected every thirty minutes. Instrument clocks will be coordinated so that data are collected simultaneously. Sediment samples will be collected in late summer/early fall to minimize any bias due to flow. Conditions are most stable during this time and flows are similar to those encountered by some salmonids when they begin to spawn (Schuett-Hames 1999). The presence and characteristics of any potential bias due to short-term changes in flow, and how the bias might affect the data, will be described.

The presence and characteristics of any potential bias, and how the bias might affect the data, will be described, and attention will be given to the quality of the data and corrective actions taken to remove the source of bias.

6.2.1.3 Sensitivity

Sensitivity for this project will be defined as the lowest concentration or degree to which a water quality parameter can be measured. This varies across parameters and for the purposes of this project, the resolution levels described in Table 10 and Table 11 will be followed. Sensitivity for sediment sampling will be based on the volumetric measurements obtained during this sampling. Resolution for this monitoring is taken to the 1 mL level.

6.2.2 Targets for completeness, representativeness, and comparability

6.2.2.1 Completeness

Completeness is a measure of the amount of valid data needed to meet the goals defined by the project. This project will utilize a minimum of 100 HOBO U22 Water Temp Pro v2 temperature loggers to measure year-round water temperature. Six Hydrolab DS5X water quality multiprobes will be used to monitor water quality on a seasonal basis between April and July-November. Annual sediment monitoring will collect sediment samples in three reaches of the mainstem Methow River. Twelve core samples will be collected along three transects within each reach for 36 total cores.

Completeness will be measured by the number of days of deployment or number of samples collected relative to the number of possible days of deployment or number of samples required to meet project objectives.

6.2.2.2 Representativeness

Representativeness requires that data represent the stream segment at the monitoring site and the monitoring sites are dispersed to provide spatially diverse monitoring of the Methow subbasin as needed to meet the project's goals and objectives. Sample collection locations are selected according to protocol to assure that samples are representative of the stream segment at the collection site (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999). Equipment will be deployed in areas with adequate water mixing and minimum confounding factors to provide a representative sample. Instrument deployment and scheduled site visits will account for changes in water levels throughout the year so that recorded data meets representativeness objectives. Data that do not meet the criteria will be flagged accordingly.

6.2.2.3 Comparability

The goal of this project is to support and expand the systematic basin-wide water quality and sediment monitoring program established in the Methow subbasin to assess the effectiveness of water quality restoration activities. The program will follow the same field and sampling design, and data quality objectives, as prior monitoring efforts outlined in the QAPPs for grant agreements #G1000282 and #G1100202 (Gregg and Crandall 2010, 2011). Hillman (2006) indicates that continuous water quality and annual sediment monitoring are core indicators in the *Monitoring Strategy for the Upper Columbia Basin*. Crandall (2010) noted a lack of continuous baseline monitoring in the Methow. This project will directly address this information gap whilst providing data that can be used alongside previously collected information.

The use of water quality monitoring protocols will also allow this project to incorporate temperature data from local third party studies (ODEQ 1999; Ward 2001). These project partner contributions include investigations by the U.S. Forest Service, US Geologic Survey, US Bureau of Reclamation, Yakama Nation, and Douglas County PUD. The quality of data obtained from project partners is presented in Appendix C and Table 5).

Sediment sampling sites will be located at spawning locations in similarly classified stream segments so that trends can be easily identified and compared. The use of the protocol outlines by Tussing, (2009, *modified from* Schuett-Hames, 1999) will allow for the comparison of spawning gravels in the project area to other streams, such as the Twisp and Chewuch Rivers, watersheds, and eco-regions outside the project area.

7.0 Sampling Process Design

7.1 Study design

The sampling frame for this monitoring program is the entire Methow subbasin. The project will support and expand upon the existing water quality and temperature monitoring network (Figure 2 and Figure 4; Appendix B). This monitoring network is stratified based on the 14 assessment units identified through the *Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (Figure 5; UCRTT 2014).

Water quality monitoring will collect data to develop status and trends from numerous locations across the watershed in part to assist in the assessment of effectiveness of a suite of riparian and instream habitat restoration projects. Parameters to be measured include temperature, conductivity, pH, dissolve oxygen, chlorophyll *a*, turbidity as well as fine sediment.

7.1.1 Field measurements

Field measurements will be conducted mostly by electronic equipment designed for longer term in-situ data collection. These instruments and their deployment characteristic are detailed in Section 8. Sediment sampling will be completed in-situ following protocol. Post-processing of collected sediments will be done at an off-site facility. This facility is necessary to develop an efficient workflow. This protocol has been used for three years of this same sediment sampling under Ecology Agreement #G1100212.

7.1.2 Sampling location and frequency

Over 100 submersible water temperature loggers will be used to measure year-round water temperature every 30 minutes at established sites throughout the Methow Subbasin (Figure 3). Loggers will be removed from the water only once a year coincident with the NIST-referenced accuracy checks. All sites were selected according to protocol (ODEQ 1999; Ward 2001). Additional monitoring sites may be established as needed to bolster this array. Site selection and instrument deployments will follow the designated protocol (ODEQ 1999; Ward 2001).

Six water quality multi-probes will be used in this study to examine reach-scale effectiveness of a suite of habitat restoration actions by measuring seasonal water quality parameters on an hourly basis from, generally, April and July-November. Water quality parameters collected by these instruments include temperature, dissolved oxygen, pH, conductivity, turbidity, and chlorophyll *a*. These multiprobes will be deployed at established sites in the Methow, Twisp, and Chewuch rivers in association with restoration actions as shown in Figure 3. While descriptions of 319 related projects included as portion of this grant are presented in Table 6, numerous other actions have been completed with planning underway to implement other projects in the near future.

To monitor the effectiveness of these restoration activities, one multiprobe will be placed at the downstream end and one at the upstream end of each reach; or one multiprobe will be placed in a restored area and one multi-probe placed in a control area. All sites were selected according to protocol (ODEQ 1999; Ward 2001). Both sites will be measured simultaneously and the difference between upstream temperature water quality (control site) and downstream water quality (impact site) will measure the effects of stream restoration on water quality (Hillman 2006).

The sampling frame for the sediment monitoring program will focus on three reaches of the mainstem Methow River (Figure 4). Both reaches have undergone reach assessments and are sites of ongoing and future restoration and protection activities. Sampling will occur up and downstream of restoration activities to provide a baseline of water quality within the project area. Sediment monitoring will utilize established locations that have been the site of annual sediment monitoring since 2011.

To select the sediment monitoring locations, restoration reaches were classified into stream segments based on gradient to determine their suitability for sediment sampling (Tussing 2009, *modified from* Scheutt-Hames 1999). Stream gradients of less than 2% are ideal. Gradients of 2% to 6% are suitable. Suitable reaches were inventoried using the Riffle Crest Method, according to procedure, to identify suitable riffles or transects within each reach (Tussing 2009). To be considered suitable, the riffle crest must:

1. Be dominated by spawning gravels between 8 and <100 millimeters.
2. Have a minimum surface area of $1m^2$ `and 0.5 meter width (2.0 m length),
3. Be in the wetted channel under flowing water.
4. Have a water depth less than 0.3 meters.
5. Not have obstructions that affect criteria #2.

Within the sample reaches (Silver, Middle Methow, Big Valley), three suitable transects were randomly selected. Large substrate size and water depth were the primary limiting factors when identifying potential sampling sites in the field (Gregg and Crandall 2014b). Due to the size of the Methow River, no sites across the entire width of the river were identified that fit these criteria. The thalweg was often deeper than 0.3 meters and contained substrate larger than 100 millimeters. Thus, sampling sites were selected based on how much of the river transect met criteria. Within the reaches, three riffles were randomly selected. A minimum of four cores will be sampled within each suitable riffle crest at four different sampling points. Twelve spawning gravel samples, for a total of 36 core samples, will be collected in each reach annually.

Sediment sampling will occur annually in late summer/early fall during low flows when conditions are stable and similar to those encountered by spawning salmonids. Extremely low flows will be avoided so that sampling is representative of all potential spawning habitats.

7.1.3 Parameters to be determined

Parameters to be determined include: water temperature, pH, dissolved oxygen, conductivity, turbidity, chlorophyll *a*, and sediment profile**s**.

7.2 Maps or diagrams

See Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6.

7.3 Assumptions underlying design

It is assumed that our basin-wide study design for water temperature is representative of actual temperature status and trends over the spatial and temporal bounds of the project. It is assumed that the methods employed to select site locations for multiprobe and sediment sampling are representative of the reaches in which they are deployed and that monitoring data have the ability to detect effects and/or influences caused by the implementation of restoration actions on watershed processes.

We also assume the QA/QC procedures utilized will allow for meaningful and precise data collection and interpretation.

7.4 Relation to objectives and site characteristics

The study design selected for this project is directly related to overall project objectives nested within the geographic context of the Methow watershed. Sampling locations and frequency have been selected to capture the spatial and temporal variation within the watershed. Thus, data collection should be representative of real conditions within the watershed and thus an appropriate means to assess the status and trend of water quality with the watershed as well as assisting in the assessment of restoration project effectiveness to improve water quality conditions.

7.5 Characteristics of existing data

Water quality data collected under this program will follow similar field protocols, monitoring locations and QC/QC procedures thus will be consistent with previous water quality monitoring in the Methow watershed that has been on-going since 2010. Similar to previous studies, data management will include storage of all project data in Ecology's EIM database. This compatibility will allow for analysis for all data collected since the initial phases of the project began in 2010.

8.0 Sampling Procedures

8.1 Field measurement and field sampling SOPs

8.1.1 Water quality monitoring

Water quality monitoring will utilize Hydrolab DS5X multiprobes to measure dissolved oxygen, conductivity, pH, turbidity, Chlorophyll *a*, and temperature seasonally between March-April and July-November (Table 11). Calibration and deployment protocols will follow manufacturer's specifications and *Standard Operating Procedures for Hydrolab® DataSonde® and MiniSonde® Multiprobes* Version 1.0 (Ecology EAP 2007). As per manufacturer's specifications, and previous experience from field deployments of the same equipment in the Methow watershed, data will be downloaded at least every three weeks, or as field conditions warrant. Efforts will be made to retrieve instruments, download data, and redeploy instruments on a similar timeframe as is reasonable due to the spatial distance of data collection locations. In the past, this has been about a 2-3 day turnaround. Dangerous weather and streamflow conditions or other logistical factors, can prevent one or all instruments to be retrieved and downloaded on the planned day, will be noted. Data will be downloaded soon as possible when conditions allow. Multiprobes will be removed during high water conditions or during freezing conditions when icing may be present to alleviate the potential for loss or damage.

8.1.2 Water temperature monitoring

Water temperature monitoring using HOBO U22 Water Temp Pro v2 will be conducted year-round as described in the Water Quality Monitoring Technical Guide Book: Oregon Plan for Salmon and Watersheds (Table 11, ODEQ 1999) and Monitoring Strategy for the Upper Columbia Basin (Hillman 2006). One deviation from this protocol is that temperature loggers will be programmed to record data every thirty minutes, on the hour and half hour, instead of every 1 hour. Recording data every 30 minutes will allow this project to more accurately identify temperature highs and lows.

During continuous deployments, logger locations will be visited at least three times a year (April, July, and October) to check that loggers are present at the site and submerged in the proper location. Loggers located at higher elevations may not be accessible in April. If access allows these sites will be visited prior to spring runoff, otherwise they will be visited at least twice a year in July and October. These checks will include battery readings to verify that the loggers are operational. Loggers will be checked more often in response to an unusual event such as flooding or lower than expected water levels.

All temperature loggers will be downloaded and cleaned at least twice annually. One download will occur in the field using a portable data storage device. In addition, loggers will be removed from the field, cleaned, downloaded, and checked for accuracy with a NIST-certified thermometer in the office at least once year. Following downloads, loggers will be redeployed within 7 days or as quickly as possible given the quantity of monitors and the geographical distance between monitoring sites.

8.1.3 Sediment monitoring

McNeil sediment cores will be collected following the protocol outlined by Tussing (2009, *modified from* Schuett-Hames 1999, Table 12). Previous sediment sampling at the established sites has identified water depth and substrate size as the primary limiting factors when collecting sediment samples (Crandall and Gregg 2014). As a result, sampling will focus on the shallow portions of the stream on either side of the thalweg or on inside bends of the river. A minimum of four cores will be sampled within each suitable riffle crest at four different sampling points that met the specified criteria. All samples will be marked with core date, river, riffle, transect, and sample number as described in section 8.5.

Table 12. Equipment used and parameters measured for three types of water quality monitoring in the Methow watershed.

Monitoring Equipment	Parameters Measured
Hydrolab DS5X	Dissolved Oxygen Conductivity pH Turbidity Chlorophyll *a* Temperature
HOBO U22 Water TempPro v2 (or equivalent)	Temperature
McNeil Core	Fine Sediment

8.2 Containers, preservation, holding times

Sediment samples will be transported and stored in sealed 4-5 gallon buckets. Samples will be processed with one week of collection and will not be archived following volumetric processing.

8.3 Invasive species evaluation

Monitoring work will be focused within the Methow watershed. Monitoring equipment is designated for in-basin use only to minimize the spread of aquatic organisms. Currently, there are no identified aquatic invasive species present within the sampling locations, but field staff will remain vigilant to the potential for invasive species presence.

8.4 Equipment decontamination

In the event of instrument or field gear contamination, field staff will follow the *Methow Restoration Council Aquatic Nuisance Species Management Plan* (MRC 2010). This plan calls for a multi-step procedure to remove aquatic invasive species from field gear and/or decontaminate field gear via thorough cleaning, and an application of a mild bleach solution followed by desiccation.

8.5 Sample ID

Sediment samples will be marked with a three-digit numeric ID to reflect reach, transect and sample number. The samples IDs associated with each sample location are presented in Table 13. Each sample ID will be preceded with an M to designate the Methow River. For example, the fourth sample collected at the Above Teepee transect on the Silver reach would be labeled M114.

Table 13. Sample ID coding method.

Reach	Reach ID	Transect	Transect ID	Sample IDs
Silver	1	Above Teepee	11	111, 112, 113, 114
		Judd	12	121, 122, 123, 124
		Kings	13	131, 132, 133, 134
Middle Methow	2	Riverbend	21	211, 212, 213, 214
		Whitefish	22	221, 222, 223, 224
		Witte	23	231, 232, 233, 234
Big Valley	3	Heath	31	311, 312, 313, 314
		Below Wolf Ridge	32	321, 322, 323, 324
		Above Wolf Ridge	33	331, 332, 333, 334

8.6 Field log requirements

Detailed notes on field activities will be kept in a field notebook. Field notes will include:

- Date and time of field activity.
- Project name, sampling location and identification number of instrument.
- Identity of water quality monitoring technician.
- Site and/or atmospheric conditions, including any unusual circumstances or possible bias, which may affect the interpretation of the data.
- Procedures performed including: deployment, retrieval, download, or verification of operation and submergence, coring, sieving.
- Field verification measurement results.

Photography and geographic positioning system (GPS) will be used to document the location of the monitoring location’s data points. Sketches of locations will include monitor locations and nearby landmarks that may assist in the location of the specific monitoring location.

During accuracy checks of the temperature monitors, temperature values of each monitor and the NIST reading will be recorded. Water quality parameters will be recorded before and after each calibration. Samples of accuracy and calibrations logs can be found in appendix D.

9.0 Measurement Methods

The sediment monitoring component of this project will utilize the volumetric processing method as recommended by Hillman (2006) and documented by Tussing (2009) and Schuett-Hames (1999). Samples collected with the McNeil core sampler will be separated into size categories through the use of stacked sieves. The volume of each sediment size category (millimeters) will be determined via a displacement flask. A minimum of 9 sieves of the following sizes will be used for sorting: 75.0 mm, 25.0 mm, 19.0 mm, 9.5 mm, 6.3 mm, 4.0 mm, 2.36 mm, 1.7 mm, 1.0 mm, 0.85 mm, and 0.50 mm. A modified graduated cylinder will be used to determine the volume of sediment smaller than the smallest sieve. The volume of each sediment size category will be calculated as a percentage of the total sample. Measurement method details are presented in Table 14. The intermediate diameter (in millimeters) of the largest particle in the sample will be recorded. See Appendix D for a sample record sheet. Temperature and water quality measurements are described in Section 8 entitled Sampling Procedures.

Table 14. Sediment measurement methods.

Analyte	Sample Matrix	# of Samples	Expected Range of Results	Reporting Limit	Analytic Method
Sediment	Stream Substrate	36	0-2500 mL	1mL	Volumetric Processing

10.0 Quality Control

10.1 Field quality control

All water quality data collection in the field will be overseen by experienced field technicians. Collection methods will follow protocol (ODEQ 1999; Ward 2001) as detailed in this document. If the primary technician is not available for field activities, the project manager will oversee field activities. Both the field technician and project manager have extensive experience with all aspects of the project data collection procedures.

All sample sites and equipment placement will be done with accordance to protocols outlined in the *Water Quality Monitoring Technical Guide Book: Oregon plan for Salmon and Watersheds* (ODEQ 1999); *Stream Sampling Protocols for the Environmental Monitoring Trends Section* (Ward 2001) and *A Field Manual of Scientific Protocols for Fine Sediment Sampling within the Upper Columbia Monitoring Strategy* (Tussing 2009, *modified from* Schuett-Hames 1999*).*

Calibration and deployment protocols for the Hydrolab DS5X multiprobes will follow manufacturer's specifications and *Standard Operating Procedures for Hydrolab® DataSonde® and MiniSonde® Multiprobes* Version 1.0 (Ecology EAP 2007). A NIST certified thermometer will be used to verify the accuracy and precision of temperature loggers as detailed in the temperature monitoring section in the *Water Quality Monitoring Technical Guide Book: Oregon Plan for Salmon and Watersheds* (ODEQ 1999). All measurements taken during calibration procedures will be documented. As recommended by the National Institute of Standards and Technology the NIST certified thermometer will be recalibrated annually to maintain traceability.

Several monitoring sites for water temperature will receive duplicate loggers. Data from these paired locations can be assessed to determine if any discrepancies exist that would warrant further examination of field data collection protocols. Since, the year 2010 data from paired sites indicate that field methods have been achieving a high level of precision.

10.2 Corrective action processes

The project manager and field technician will work together to address any data collection issues that may require corrective action. If, for any reason, it is believed that data collected at a given site is in error, this will be noted and the data will not be uploaded to EIM prior to discussion with Ecology.

Occasionally, water quality monitoring instruments, especially temperature loggers that are deployed continuously and during periods of rapidly changing water levels, can become stranded above the water line. All loggers are checked for submersion during site checks. If a logger is observed to be dry, the data will be reviewed to determine the range of time that the logger was recording air, not water, temperature. These data will be flagged appropriately within the data file. To properly identify dry conditions four air monitoring loggers will be deployed in the Lower Twisp, Lower Chewuch, Lower Methow, and Upper Middle Methow subbasin. The locations of these monitors are presented in Table 15 and shown in Figure 3.

Table 15. Location of air temperature monitoring sites.

Site Name	Subbasin	Latitude	Longitude
Upper Heath Air	Upper Middle Methow	48.501	-120.251
Methow above Black Canyon Air	Lower Methow	48.101	-120.021
Windhaven Air	Lower Chewuch	48.512	-120.187
Twisp Ponds Lower Air	Lower Twisp	48.369	-120.143

The US Forest Service has an additional 13 air temperature loggers located throughout the project area that can be used to identify dry conditions. This monitoring network is part of the Ecology funded Water Quality Improvement through Beaver Restoration in the Methow River Watershed. The locations of these sites are listed in Appendix E.

11.0 Data Management Procedures

11.1 Data recording / reporting requirements

In consultation with the project manager, the water quality monitoring technician will be responsible for project data management activities. The following steps will be followed:

- The water quality data will be downloaded from field equipment bi-annually (temperature loggers) or every three weeks (multiprobes) into Microsoft Excel or Access database within one week of initial instrument download. These regular downloads will safeguard against data loss.
- Sediment data will be collected by the water quality monitoring technician will be recorded in the field on the sampling records sheet (Appendix D). Field notes will be checked for completeness and accuracy.
- All quality control readings taken (i.e., during accuracy checks for temperature loggers) with the NIST thermometer will be recorded.
- All data will be backed up on an external device and stored in a safe location to safeguard against data loss.

11.2 Lab data package requirements

Not applicable.

11.3 Electronic transfer requirements

Data for all parameters will be transferred to Ecology's EIM database annually, following the monitoring season. Data will be submitted to the EIM using the online process.

11.4 Acceptance criteria for existing data

All collected data, including those submitted by project partners, will be reviewed a Microsoft Excel spreadsheet or Access database to ensure the results are within the expected range for the specific parameter. See Table 10 and Table 11 for manufacturer's specifications for each instrument used in this project. If the results fall outside the expected range, the technician will investigate and report the problem and possible reasons for error to the project manager or data manager for outside programs. A Microsoft Access database will be used for archiving, meta-analysis, and submission to EIM.

The uploaded data will also be reviewed in graphic form to assist in the identification of any outlying data. Outlying data will be flagged appropriately.

11.5 EIM data upload procedures

Data acquired for all parameters monitored will be entered into EIM following Ecology’s on-line data submission guidelines. All staff are trained in EIM database use and structure based on work completed in 2010-2014.

12.0 Audits and Reports

12.1 Audit number, frequency, type, and schedule

System audits will be conducted semi-annually in conjunction with temperature logger downloads. All field monitoring sheets will be reviewed for completeness.

12.2 Responsible personnel

All audits will be prepared by the field monitoring technician and overseen and edited by the project manager prior to submission to Ecology.

12.3 Frequency and distribution of reports

A summary of annual monitoring activities will be included in annual monitoring reports submitted to Ecology by 31 March 2015 and 2016. A final report of monitoring activities included in this project will be submitted to Ecology within 45 days of the closing of the grant agreement on 1 November 2016.

12.4 Responsibility for reports

The field monitoring lead will be responsible for initial development of all reports with supervision provided by the project manager. The project manager will provide final editing of all reports and will be the individual responsible for report submission to Ecology.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Routine maintenance and proper deployment of monitoring equipment, as specified by the protocol, will be followed to minimize data error (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999). Field notebooks will be checked by the field monitoring technician for missing or improbable measurements before leaving each site. Field notes will also verify that proper procedures were followed and whether the quality objectives were met. Any estimated results will be qualified and their use restricted as appropriate. Valid data will be moved to a separate file labeled *Final* and then entered into a database. Following approval by the project manager, data will be entered into the EIM database. Data will then be compiled in a data summary and submitted to the project manager.

13.2 Responsible personnel

The field monitoring lead will be responsible for all aspects of on-going monitoring and reporting, including upload of data to Ecology's EIM database. This work will be overseen, and approved by the project manager.

13.3 Validation requirements, if necessary

Not applicable.

14.0 Data Quality Assessment Procedure

14.1 Process for determining whether project objectives have been met

All data will be reviewed to assure that it meets quality objective standards. All data that do not will be flagged. Reviews will be conducted to evaluate any data that is not meeting quality objective standards and corrective actions will be taken. The following methods will be used to assess data usability:

1) Instruments will be calibrated and checked for accuracy based on designated protocol (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999). Data associated that does not meet calibration requirements or fall within a reasonable range will be rejected.
2) Potential bias will be minimized by following the designated protocol (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999). Any existing bias will be identified and the associated data flagged appropriately.
3) Completeness will be measured by the number of possible deployment days relative to the actual days of deployment. Sample collection sites will be selected according to protocol to assure that samples are representative of the main stream segment at the collection site (ODEQ 1999; Ward 2001; Tussing 2009, *modified from* Schuett-Hames 1999). Data that are not representative of site conditions will be flagged appropriately.
4) Established monitoring locations will be utilized so that data is comparable over in time. Significant changes in temperature or water quality monitoring locations (greater ¼ miles) due to changes in stream conditions or access points will be designated as unique sites. Changes in riffle transects for sediment monitoring will be designated as unique sites.

14.2 Data analysis and presentation methods

Data will be kept in a database and will be available for review. The summary report will include a quality assurance section that will summarize quality control results and the procedures used to ensure data quality during the monitoring project. Data results, problems, and corrections will be included in annual reports

Data collected under this project will be analyzed in relation to the continued development of a long-term status and trend database for a suite of water quality parameters. These data will be examined to assist in the assessment of effectiveness of habitat restoration efforts aimed at improving water quality and instream habitat to assist in the recovery of ESA fish species in the Methow watershed. Data collected by the project will be compared to existing data, including those collected by Ecology funded monitoring in 2010-2014.

Data will be presented in annual and final reports and uploaded to Ecology's EIM database. It is assumed that the data collected by this project will form an integral component of the water temperature TMDL required for the Methow watershed.

14.3 Treatment of non-detects

Non-detect samples are not anticipated for this project. Any non-detect samples that are observed will be flagged for inspection and determination for inclusion in the dataset submitted to EIM.

14.4 Sampling design evaluation

The sampling design employed by this project is based on four years of similar data collection that occurred during 2010-2014. This data collection was carried out in similar locations and environmental conditions expected for this project. The project monitoring and management team also remains the same, which should yield consistency across sampling and data management procedures.

However, sampling design will undergo constant evaluation in terms of site selection and methods. Monitoring the effectiveness of restoration actions is a key component of this program and this monitoring effort must be able to respond to changes in approach and locations of restoration actions. In these instances, the design of the monitoring may have to be modified to better characterize the water quality conditions moving into, and out of, the restoration areas.

14.5 Documentation of assessment

The field monitoring technician, in consultation with the project manager, will be responsible for the documentation and assessment of data quality and overall project monitoring progress. All data will be available for review by Ecology, as well as project partners. Annual and final project reports will be available on the Methow Salmon Recovery Foundation (MSRF) website along with project descriptions. Monitoring updates included in the quarterly reports submitted to Ecology will be another means to document to progress and assess the project.

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Appendix A: Definitions of Acronyms

Table 16. Definitions of acronyms.

7-DADM	7-day average daily maximum
DQO	Decision Quality Objectives
EIM	Environmental Information Management
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FLIR	Forward Looking Infrared
MQO	Measurement Quality Objectives
MRC	Methow Restoration Council
MSRF	Methow Salmon Recovery Foundation
NHD	National Hydrology Database
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
PUD	Public Utility District
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
TIR	Thermal Infrared Remote
TMDL	Total Maximum Daily Load
UCSRB	Upper Columbia Salmon Recovery Board
USBR	United States Bureau of Reclamation
USFS	United States Forest Service
USGS	United States Geologic Survey
WAC	Washington Administrative Code
WQA	Water Quality Assessment
WQIP	Water Quality Implementation Plan
WQIR	Water Quality Improvement Report
WRIA	Water Resource Inventory Area
HWS	Habitat Work Schedule
UCRTT	Upper Columbia Regional Technical Team

Appendix B: Locations of Temperature Monitors

Table 17. Locations of temperature monitors.

duplicate loggers deployed

Monitoring site associated with restoration activities

Subbasin	River	Monitoring Site	Latitude	Longitude	
Beaver	Beaver	Beaver Mouth	48.328	-120.061	
Beaver	Beaver	Ott	48.334	-120.056	
Beaver	Beaver	Stokes	48.357	-120.040	
Beaver	Beaver	Upper Beaver Lower	48.396	-120.047	
Beaver	Beaver	Upper Beaver Upper	48.402	-120.042	
Beaver	Beaver	South Fork Beaver Mouth	48.434	-120.014	
Beaver	Beaver	UBR4	48.442	-120.016	
Beaver	Beaver	Blue Buck Mouth	48.488	-120.006	
Lower Chewuch	Eightmile	Eightmile Mouth duplicate	48.605	-120.169	duplicate
Lower Chewuch	Eightmile	Eightmile Mouth	48.605	-120.169	duplicate
Lower Chewuch	Chewuch	Flat CG	48.615	-120.197	
Lower Chewuch	Chewuch	Chewuch Mouth	48.477	-120.186	
Lower Chewuch	Chewuch	Windhaven	48.512	-120.187	
Lower Chewuch	Chewuch	Chewuch below Cub	48.526	-120.189	
Lower Chewuch	Cub	Cub RM 0.4	48.551	-120.192	
Lower Chewuch	Cub	Cub RM 7 (b)	48.635	-120.317	
Lower Chewuch	Chewuch	Chewuch below Diversion	48.566	-120.177	
Lower Chewuch	Chewuch	MacPherson	48.567	-120.177	
Lower Chewuch	Boulder	Boulder RM 0.5	48.579	-120.166	
Lower Chewuch	Chewuch	Upper Chewuch Lower	48.623	-120.158	
Lower Chewuch	Chewuch	Upper Chewuch Upper	48.625	-120.159	
Lower Chewuch	Chewuch	Chewuch below Eightmile	48.590	-120.167	
Lower Chewuch	Chewuch	Chewuch above Eightmile	48.604	-120.162	
Lower Chewuch	Falls	Falls Mouth	48.634	-120.157	

Subbasin	River	Monitoring Site	Latitude	Longitude	
Lower Chewuch	Chewuch	Chewuch above Doe	48.680	-120.129	
Upper Chewuch	Twentymile	Twentymile RM 0.2	48.701	-120.124	
Upper Chewuch	Chewuch	No Snake Side Channel	48.722	-120.130	
Upper Chewuch	Lake	Lake RM 0.8	48.757	-120.136	
Upper Chewuch	Chewuch	Chewuch above Lake	48.757	-120.133	
Upper Chewuch	Andrews	Andrews RM 0.1	48.783	-120.110	
Upper Chewuch	Chewuch	Chewuch above Dibble Springs	48.799	-120.046	
Upper Chewuch	Chewuch	Thirtymile	48.823	-120.019	
Early Winters	Early Winters	Early Winters Mouth	48.601	-120.441	
Early Winters	Cedar	Cedar Mouth	48.589	-120.472	
Gold	Gold	Gold Mouth 1	48.188	-120.097	duplicate
Gold	Gold	Gold Mouth 2 (b)	48.188	-120.097	duplicate
Gold	Gold	South Fork Gold RM 0.8	48.176	-120.125	
Gold	Gold	South Fork Gold at Sno-Park	48.156	-120.149	
Gold	Gold	North Fork Gold above South Fork	48.185	-120.117	
Gold	Gold	North Fork Gold below Foggy Dew	48.205	-120.189	
Gold	Foggy Dew	Foggy Dew Mouth	48.205	-120.200	
Gold	Crater	Crater Mouth	48.214	-120.213	
Libby	Libby	Libby Below Hwy 153 Bridge	48.230	-120.118	duplicate
Libby	Libby	Libby Above Hwy 153 Bridge	48.230	-120.118	duplicate
Libby	Libby	Libby above Ben Canyon	48.267	-120.223	
Lost	Lost	Lost River Mouth	48.655	-120.506	
Lost	Lost	Upper Lost River	48.795	-120.404	
Lower Methow	Methow	Methow RM 5.6	48.077	-119.969	
Lower Methow	Methow	Black Canyon Cr. RM 1	48.067	-120.023	
Lower Methow	Methow	Methow above Black Canyon	48.101	-120.021	
Lower Methow	Methow	Methow below Gold	48.183	-120.097	
Lower Methow	Methow	Methow below Silver Reach	48.235	-120.117	

Subbasin	River	Monitoring Site	Latitude	Longitude
Middle Methow	Methow	Methow above Silver Reach	48.344	-120.077
Middle Methow	Methow	Blaine Upper	48.321	-120.062
Middle Methow	Methow	Blaine Lower	48.322	-120.063
Middle Methow	Methow	Methow RM 39.4	48.359	-120.114
Middle Methow	Methow	Methow below Twisp	48.362	-120.115
Middle Methow	Methow	Methow above Twisp (b)	48.379	-120.120
Middle Methow	Methow	Sugar Dike Lower	48.379	-120.121
Middle Methow	Methow	Sugar Dike Upper	48.380	-120.124
Middle Methow	Methow	Above Riverbend Campground	48.392	-120.136
Middle Methow	Methow	Beaver Pond 1	48.403	-120.140
Middle Methow	Methow	Habermehl Lower	48.405	-120.136
Middle Methow	Methow	Habermehl Upper	48.408	-120.134
Middle Methow	Methow	Methow below MVID East Diversion	48.414	-120.144
Middle Methow	Methow	Beaver Pond 2	48.414	-120.146
Middle Methow	Methow	WDFW Side Channel	48.419	-120.143
Middle Methow	Methow	Methow above MVID East Diversion	48.423	-120.146
Middle Methow	Methow	Bedrock Springs	48.441	-120.159
Middle Methow	Methow	Emerald Pool	48.435	-120.157
Middle Methow	Methow	RRR Upper	48.436	-120.157
Middle Methow	Methow	RRR Lower	48.435	-120.158
Middle Methow	Methow	Methow below Barkley Diversion	48.453	-120.163
Middle Methow	Methow	Whitefish Upper	48.446	-120.161
Middle Methow	Methow	Whitefish Lower	48.444	-120.164
Middle Methow	Methow	Methow above Barkley Diversion	48.458	-120.168
Middle Methow	Spring	Spring Creek	48.475	-120.185
Lower Twisp	Twisp	Twisp Ponds Upper	48.366	-120.135
Lower Twisp	Twisp	Twisp Ponds Lower	48.369	-120.143
Lower Twisp	Twisp	Twisp at Poorman Bridge	48.370	-120.149
Lower Twisp	Poorman	Poorman Lower	48.368	-120.201
Lower Twisp	Poorman	Poorman Upper	48.351	-120.213
Lower Twisp	Twisp	Right Elbow Side Channel	48.379	-120.224

Subbasin	River	Monitoring Site	Latitude	Longitude
Lower Twisp	Twisp	Elbow Coulee	48.378	-120.229
Lower Twisp	Twisp	Twisp at Elbow Coulee	48.378	-120.228
Lower Twisp	Little Bridge	Little Bridge Mouth	48.380	-120.286
Lower Twisp	Little Bridge	Little Bridge at Vetch	48.425	-120.354
Lower Twisp	Little Bridge	Little Bridge below Diversion	48.397	-120.314
Lower Twisp	Little Bridge	Little Bridge above Diversion	48.399	-120.317
Lower Twisp	Little Bridge	Little Bridge at Creek End of Road	48.446	-120.375
Upper Twisp	Twisp	TR 3.1	48.364	-120.338
Upper Twisp	Twisp	TR 3.2	48.356	-120.357
Upper Twisp	Twisp	TR 3.3	48.353	-120.372
Upper Twisp	Buttermilk	Buttermilk RM 0.2	48.362	-120.338
Upper Twisp	Buttermilk	Buttermilk above Diversion	48.357	-120.328
Upper Twisp	Twisp	Twisp above Buttermilk (b)	48.362	-120.339
Upper Twisp	War	War Mouth	48.368	-120.406
Upper Twisp	Twisp	Twisp above War	48.368	-120.406
Upper Twisp	Twisp	TR 4.1	48.368	-120.405
Upper Twisp	Twisp	TR 4.2	48.373	-120.411
Upper Twisp	Twisp	TR 4.3	48.391	-120.450
Upper Twisp	South	South Mouth	48.438	-120.528
Upper Twisp	Twisp	Twisp above South	48.439	-120.532
Upper Twisp	North	North Mouth	48.457	-120.561
Upper Middle Methow	Methow	Methow above Chewuch	48.474	-120.191
Upper Middle Methow	Methow	Methow above Wolf	48.491	-120.233
Upper Middle Methow	Methow	Heath Lower	48.500	-120.249
Upper Middle Methow	Methow	Heath Upper	48.501	-120.251
Upper Middle Methow	Methow	Cable Car	48.506	-120.278
Upper Methow	Methow	Weeman Bridge	48.544	-120.323

Subbasin	River	Monitoring Site	Latitude	Longitude	
Upper Methow	Hancock	Last Pool	48.532	-120.324	
Upper Methow	Hancock	Bottom of Reach 2	48.534	-120.331	
Upper Methow	Hancock	Division of Reach 1 and 2	48.535	-120.334	
Upper Methow	Hancock	Milk House	48.537	-120.338	
Upper Methow	Methow	Stansbury Lower (b)	48.533	-120.322	
Upper Methow	Methow	Stansbury Upper	48.535	-120.322	
Upper Methow	Pond	Fender Mill Pond	48.538	-120.323	
Upper Methow	Methow	Methow below Supension	48.569	-120.368	
Upper Methow	Suspension	Suspension Mouth	48.571	-120.370	
Upper Methow	Methow	Methow above Suspension	48.573	-120.370	
Upper Methow	Goat	Goat Mouth	48.582	-120.379	
Upper Methow	Goat	Goat below Diversion	48.585	-120.376	
Upper Methow	Goat	Goat above Diversion	48.587	-120.374	
Upper Methow	Methow	West Fork Methow above Robinson	48.659	-120.542	
Wolf	Wolf	Wolf Mouth 1	48.490	-120.232	duplicate
Wolf	Wolf	Wolf Mouth 2	48.490	-120.232	duplicate
Wolf	Wolf	Wolf above Diversion	48.482	-120.310	

Appendix C: Study/Data Quality Levels

Data Quality Levels:

Level 1: Data neither verified nor assessed for usability
Level 2: Data verified
Level 3: Data verified and assessed for Usability
Level 4: Data verified and assessed for usability in a formal study report
Level 5: Data verified and assessed for usability in a peer-reviewed study report

Definition of Terms:

Data Verified: Study quality control (QC) results have been examined for compliance with acceptance criteria specified in the QAPP, SAP or field/analytical

Data Assessed for Usability: Study data package has at a minimum been evaluated for precision, bias, representativeness, comparability, and completeness

Formal Study Report: Document describing Study objectives, procedures, results, conclusions and assessment of the quality of the data. Bibliographic

Peer Reviewed Study Report: Report was checked or reviewed for accuracy and completeness by a supervisor or colleague with appropriate experience (does not require independent, outside scientific review, as for juried publications).

Study Quality Levels

Level 1: Informal or no QA documentation
Level 2: Generic or incomplete document
Level 3: QAPP, SAP, or equivalent
Level 4: Approved QAPP or SAP

Definition of Terms:

QA Planning Document: includes a description of the Study, statements of Study objectives, detailed sampling design including rational and sampling locations, and descriptions of, or references to, sampling, analysis and quality control procedures.

Quality Assurance Project Plan (QAPP): must follow the guidance in Ecology Document 04-03-030, Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies at http://www.ecy.wa.gov/biblio/0403030.html, and/or EPA Document 841-B-96-003, The Volunteer Monitor's Guide to Quality Assurance Project Plans.

Sampling and Analysis Plan (SAP): must follow Model Toxics Control Act WAC 173-340-820, Sampling and Analysis Plans AND Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies at http://www.ecy.wa.gov/biblio/0403030.html.

Approved QAPP or SAP: the QAPP or SAP was reviewed and approved for accuracy and completeness prior to the start of sampling by Study participants, peers, supervisors, laboratory staff, and/or quality assurance officers, typically from the organization that conducted or funded the Study.

These levels have been established by Washington Department of Ecology and are also available through their Environmental Information Management System.

Appendix D: Water Quality Monitoring Calibration/Data Sheets

Instrument Name:			Date:	
Calibration Performed by:				

Maintenance

Hydrolab Sensors Cleaned	yes	no
Replaced pH Electrolyte	yes	no
Replaced pH Teflon Junction	yes	no
Replaced LDO sensor cap	yes	no
Batteries Replaced	yes	no

Calibration		Post Calibration	Pre Calibration
Scale factor (1.5 to 0.5) (LDO only)			
Conductivity zero (air) calibration verified (+/- .005mS)			
Conductivity calibration verified (+/- .2mS)	500 µS/cm		
pH 7 buffer calibration verified (+/-.2pH)			
pH slope calibration verified at ______ units			
Turbidity Calibration accepted & verified with DI water (0.0 +/-0.7 NTU)			
Turbidity Calibration accepted and verified at (40 +/-1NTU) with Hach StablCal			
Chlorophyll baseline (0 µg/L) verified			
Chlorophyll verified (1.6 µg/L) with solid standard			

Battery Volts Remaining	

Deployment

Start Date/Time	
Logging Interval	
Sensor Warmup	
Circulator Warmup	
Stop Date/Time	
Parameters Measured	

Time	
Temp (°C)	
pH (units)	
SpCond (mS/cm)	
CHL (µg/L + Volts)	
TurbSC (NTU + Volts)	
LDO (%Sat + mg/L)	
Int. Battery (Volts)	
Sal (ppt)	

Figure 8. Hydrolab calibration sheet.

Date:

Accuracy Check Performed by:

Start Time of 20 ° Bath:

Time	Temperature

Start Time of 10 ° Bath:

Time	Temperature

Figure 9. Temperature logger accuracy check record.

Sample Processing Dataforms

(Modified from dataforms used by the USFS in the Wenatchee and Entiat Rivers)

OBSERVERS____

DATE CORED______________DATE SCREENED________________DATE ENTERED____________

STREAM____________________SAMPLE LOCATION______________________________

SITE #

TRANSECT #

SAMPLE #

SIEVE DIAMETER	**SIEVE NUMBER**	VOLUME DISPLACED (mL)	TOTAL DISPLACED (mL)
75.0 mm	**1**		
25.0 mm	**2**		
19.0 mm	**3**		
9.5 mm	**4**		
6.3 mm	**5**		
4.0 mm	**6**		
2.36 mm	**7**		
1.7 mm	**8**		
1.0 mm	**9**		
0.85 mm	**10**		
0.50 mm	**11**		
silts			
DIAMETER OF LARGEST PARTICLE IN SAMPLE (mm)			

SITE #

TRANSECT #

SAMPLE #

SIEVE DIAMETER	**SIEVE NUMBER**	VOLUME DISPLACED (mL)	TOTAL DISPLACED (mL)
75.0 mm	**1**		
25.0 mm	**2**		
19.0 mm	**3**		
9.5 mm	**4**		
6.3 mm	**5**		
4.0 mm	**6**		
2.36 mm	**7**		
1.7 mm	**8**		
1.0 mm	**9**		
0.85 mm	**10**		
0.50 mm	**11**		
silts			
DIAMETER OF LARGEST PARTICLE IN SAMPLE (mm)			

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Figure 10. Sediment data sheet.

Appendix E: Air Temperature Monitoring Sites

Table 18. Air temperature monitoring sites.

Subbasin	Monitoring Site	Latitude	Longitude
Beaver	BEAVER9925556	48.42489	-119.89657
Black Canyon	BLACKC9925510	48.04944	-120.05896
Libby	LIBBY9925543	48.27157	-120.27606
Lower Chewuch	CUB9925501	48.62867	-120.30423
Lower Chewuch	FALLS9925557	48.69828	-120.22166
Lower Chewuch	PEARYGIN9929822	48.49554	-120.15261
Lower Chewuch	RAMSEY9925504	48.54529	-120.14996
Lower Methow	MCFLND9929797	48.13506	-120.12444
Lower Methow	SQUAW9929796	48.08809	-120.09882
Middle Methow	BENSON9925562	48.30196	-119.99717
Middle Methow	BENSON9929793	48.26815	-119.96134
Upper Chewuch	20MILE9925502	48.74062	-119.97982
Upper Chewuch	JULY9929817A	48.72482	-120.12843