Modeling Quality Assurance Project Plan

North Umpqua Subbasin Temperature Total Maximum Daily Load

March 2022

State of Oregon
DEQ Department of Environmental Quality

This document was prepared by
Oregon Department of Environmental Quality
Erin Costello, Yuan Grund, and Ryan Michie
TMDL Program
700 NE Multnomah Street, Suite 600
Portland Oregon, 97232
Contact: Ryan Michie
Phone: 503-229-6162
www.oregon.gov/deq

In cooperation with USEPA Region 10 and Tetra Tech, Inc.

State of Oregon
DEQ Department of Environmental Quality

Translation or other formats

Español | 한국어 | 繁體中文 | Pусский | Tiếng Việt | العربية
800-452-4011 | TTY: 711 | deqinfo@deq.oregon.gov

Non-discrimination statement

DEQ does not discriminate on the basis of race, color, national origin, disability, age or sex in administration of its programs or activities. Visit DEQ's Civil Rights and Environmental Justice page.

Approval Sheet

Approved By:	______________________ Gene Foster, Watershed Management Section Manager, DEQ	Date:	__________
Approved By:	______________________ Ryan Michie, Senior Water Quality Analyst DEQ	Date:	__________
Approved By:	______________________ Erin Costello, Water Quality Analyst DEQ	Date:	__________
Approved By:	______________________ Heather Tugaw, Basin Coordinator DEQ	Date:	__________
Approved By:	______________________ Chris Moore, QAPP Officer DEQ	Date:	__________
Approved By:	______________________ Ben Cope, Environmental Engineer USEPA, Region 10	Date:	__________
Approved By:	______________________ Teresa Rafi, Task Order Leader Tetra Tech	Date:	__________
Approved By:	______________________ Sen Bai, Project Manager Tetra Tech	Date:	__________
Approved By:	______________________ Mustafa Faizullabhoy, Technical Lead Tetra Tech	Date:	__________
Approved By:	______________________ John O’Donnell, Quality Assurance Officer Tetra Tech	Date:	__________

Signed Copy on File at DEQ

Table of Contents

List of Tables

List of Figures

Abbreviations

AWQMS	Ambient Water Quality Monitoring System
BLM	United States Bureau of Land Management
DEQ	Oregon Department of Environmental Quality
DMR	Discharge Monitoring Report
EQC	Oregon Environmental Quality Commission
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
OWRD	Oregon Water Resources Department
QAPP	Quality Assurance Project Plan
RAWS	Remote Automatic Weather Stations
TIR	Thermal Infrared Radiometry
TMDL	Total Maximum Daily Load
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
WRIS	Water Rights Information System
WWTP	Waste water treatment plant

1 Introduction

This Quality Assurance Project Plan (QAPP) summarizes the modeling approach to be used for the temperature TMDL replacement project applicable within the North Umpqua Subbasin (17100301). The modeling approach to be used in the South Umpqua Subbasin (17100302) and the Umpqua Subbasin (17100303) is described in the modeling QAPP DEQ22-HQ-0007-QAPP (DEQ, 2022).

A TMDL is a water quality restoration plan and the calculation of the maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards for that particular pollutant. The maximum amount of loading a waterbody can receive is called the loading capacity. Loading from all pollutant sources must not exceed the loading capacity (TMDL) of a waterbody, including an appropriate margin of safety.

Load allocations are portions of the loading capacity that are allocated to background sources or non-point sources, such as urban, rural agriculture, or forestry activities. Wasteload allocations are portions of the total load, which are allocated to NPDES permitted sources, such as wastewater treatment plants or industries. Wasteload allocations are used to establish effluent limits in NPDES discharge permits. Allocations may also be reserved for future uses, called reserve capacity. Allocations are quantified measures that assure water quality standards will be met and may distribute the pollutant loads between nonpoint and point sources. This general TMDL concept is represented by Equation 1.

$$TMDL = \sum WLA + \sum LA + Reserve\ Capacity + MOS \qquad \text{Equation 1}$$

Where $\sum WLA$ is the sum of wasteload allocations (NPDES permitted sources), $\sum LA$ is the sum of load allocations (nonpoint sources and background), Reserve Capacity is allocations reserved for future uses, and MOS is a margin-of-safety to account for uncertainty. For a temperature TMDL, these elements establish the maximum thermal loads that a waterbody may receive without exceeding applicable water quality standards for temperature designed to protect aquatic life and other beneficial uses.

The Clean Water Act requires TMDLs be developed for waterbodies that do not meet water quality standards and are listed as water quality impaired on the State’s 303(d) list. The North Umpqua Subbasin includes several waterbodies listed on the Oregon 2018/2020 Section 303(d) Category 5 list as water quality limited for temperature (Table 1). TMDLs were previously developed for the North Umpqua Subbasin (DEQ, 2002a; DEQ, 2006) but they must be replaced due to recent litigation.

In 2013, the United States Environmental Protection Agency (USEPA) disapproved the Natural Conditions Criterion contained in Oregon’s water quality standard for temperature due to the 2012 U.S. District Court decision for NWEA v. EPA, 855 F. Supp. 2d 1199 (D. Or., 2012). This portion of the temperature water quality standard was used in most temperature TMDLs issued from 2003 through 2012. On October 4, 2019, the U.S. District Court issued a judgment for NWEA v. EPA, No. 3:12-cv-01751-HZ (D. Or., Oct. 4, 2019) and required DEQ and USEPA to replace 15 Oregon temperature TMDLs that were based on the Natural Conditions Criterion and to reissue the temperature TMDLs based on the remaining elements of the temperature water quality standard.

This QAPP is consistent with DEQ’s and USEPA’s modeling QAPP guidance (DEQ, 2017; EPA, 2016) and documents the analysis and numerical modeling approach that will support the updated North Umpqua Subbasin TMDL as well as other project details. In particular, this QAPP details the following:

- Definition of the issue and objectives, including the spatial and temporal extents of the water quality impairments (Section 2);
- A high-level description of the key processes and variables for temperature (Section 3);
- The overarching technical approach, including the appropriate modeling and analytical tools to be used (Section 4);
- The data sources for defining and creating inputs to the model, including data that were used in the modeling for the original TMDL. Examples of these inputs include meteorological data, stream flow and temperature, point sources and vegetation characteristics (Sections 5 and 6);
- How the analysis and modeling will be evaluated for acceptability (Sections 7 and 9);
- Scenarios for evaluating management strategies for reducing anthropogenic thermal loads (Section 10);
- Various aspects for managing the TMDL development project, including documentation (Section 8), the project team (Section 11), data and records management (Sections 12 and 13); and
- Aspects relating to this QAPP and its role in the project (Sections 14 and 15).

2 Problem definition and management objectives

Multiple waterbodies in the North Umpqua Subbasin do not meet the water quality standards for temperature and are listed as Category 5 and Category 4A, water quality limited on Oregon's 2018/2020 Section 303(d) list (Table 1 and Table 2). The temperature water quality standards are set at a level to protect the most sensitive beneficial uses. The beneficial uses most sensitive to water temperature are fish and aquatic life. The temperature water quality standards in the North Umpqua Subbasin include the numeric criteria identified below. The numeric temperature criteria are based on a seven-day average daily maximum continuous measurement of temperature.

- Salmon and Steelhead Spawning: 13.0 deg-C (OAR 340-041-0028(4)(a))
- Core Cold Water Habitat: 16.0 deg-C (OAR 340-041-0028(4)(b))
- Salmon and Trout Rearing and Migration: 18.0 deg-C (OAR 340-041-0028(4)(c))

Where and when the applicable criteria apply are based on the designated fish uses maps in OAR 340-041-0320 Figure 320A, Figure 320B and Figure 320C. The fish use designations and applicable criteria are shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

The temperature standard authorizes insignificant additions of heat from human sources in waters that exceed the applicable temperature criteria as follows: Following a temperature TMDL or other cumulative effects analysis, the Human Use Allowance (HUA) will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 deg-C (OAR 340-041-0028(12)(b)).

As described in Chapter 1, the U.S. Environmental Protection Agency (USEPA) and State of Oregon (OR) are required to revise the water temperature TMDL for the North Umpqua Subbasin. In revising the TMDL, all of the allocations will be updated to target the applicable biologically-based numeric criteria (BBNC) and Human Use Allowance (HUA) water quality temperature standards.

Since the issuance of the original TMDL, the extent and number of waterbodies that are identified as water quality limited for temperature has changed. As part of the TMDL update, DEQ will address all current temperature listings based on the most recent integrated report list. The current listings, as they pertain to the North Umpqua Subbasin QAPP project area, were obtained from Oregon's 2018/2020 Integrated Report and are summarized in Table 1 and Table 2. The listings are also shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D.

To the extent existing data and information allow, the primary analysis and modeling objectives for this TMDL include:

1) Complete a source assessment and cumulative effects analysis to characterize or identify:
    a. Anthropogenic sources of stream temperature warming;
    b. How much warming comes from background sources;
    c. How much warming comes from each anthropogenic source or source category;
    d. The cumulative warming from all anthropogenic sources combined;
    e. Where along the stream anthropogenic warming occurs;
    f. Where the point of maximum stream warming is located; and
    g. The amount of stream warming that exceeds the human use allowance and applicable water quality standards.

2) Determine TMDL elements and allocations that attain the applicable temperature criteria by identifying:
    a. The thermal loading capacity for each temperature listed waterbody;
    b. The excess thermal load exceeding the loading capacity for each temperature listed waterbody;
    c. The thermal load and wasteload allocations necessary to meet the applicable water quality standards for each listed waterbody;
    d. Any surrogate measures;
    e. Any reserve capacity;
    f. Any margin of safety; and
    g. The seasonal variation and critical conditions corresponding to the time period when the applicable temperature criteria are exceeded.

3) Support development of the TMDL Water Quality Management Plan and evaluate implementation options.
    a. Evaluate existing land management plans, TMDL implementation plans, or rules for sufficiency in minimizing anthropogenic warming to the level established by the TMDL allocations.
    b. Identify additional management strategies or surrogate measures.
    c. Identify under what timeline and where management strategies need to be implemented.

The effort currently described in the QAPP includes use of existing models and the development of new models or new model scenarios.

Table 1: North Umpqua Subbasin assessment units that are classified as water quality limited category 5 for temperature based on the Section 303(d) 2018/2020 Integrated Report.

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Big Bend Creek	OR_SR_1710030107_02_105337	2010	Year Round
Big Bend Creek	OR_SR_1710030107_02_105337	2018	Spawning
Boulder Creek Watershed	OR_WS_171003010801_02_105655	2018	Spawning, Year Round
Calf Creek Watershed	OR_WS_171003010804_02_105657	2018	Spawning, Year Round
Canton Creek	OR_SR_1710030106_02_105331	2010	Year Round
Canton Creek	OR_SR_1710030106_02_105332	2010	Year Round
Canton Creek	OR_SR_1710030106_02_105332	2018	Spawning
Clover Creek	OR_SR_1710030111_02_105370	2010	Year Round
Cooper Creek-North Umpqua River Watershed	OR_WS_171003011103_02_106425	2010	Year Round
Copeland Creek	OR_SR_1710030108_02_105341	2018	Spawning, Year Round
Copeland Creek Watershed	OR_WS_171003010802_02_105656	2010	Year Round
Deer Creek Watershed	OR_WS_171003010504_02_105646	2018	Year Round
East Fork Rock Creek	OR_SR_1710030109_02_105349	2010	Spawning, Year Round
East Fork Rock Creek Watershed	OR_WS_171003010902_02_105664	2018	Year Round
Harrington Creek	OR_SR_1710030109_02_105344	2010	Year Round
Headwaters Steamboat Creek Watershed	OR_WS_171003010701_02_105650	2010	Year Round
Headwaters Steamboat Creek Watershed	OR_WS_171003010701_02_105650	2018	Spawning
Lake Creek Watershed	OR_WS_171003010204_02_105809	2010	Year Round
Limpy Creek	OR_SR_1710030108_02_105338	2018	Spawning, Year Round
Little Rock Creek	OR_SR_1710030107_02_105333	2010	Year Round
Little Rock Creek	OR_SR_1710030107_02_105333	2018	Spawning
Lower Canton Creek Watershed	OR_WS_171003010603_02_105649	2010	Year Round
Lower Fish Creek Watershed	OR_WS_171003010404_02_105643	2010	Year Round
Lower Rock Creek Watershed	OR_WS_171003010903_02_105665	2010	Spawning

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Lower Steamboat Creek Watershed	OR_WS_171003010706_02_105654	2018	Spawning, Year Round
North Fork East Fork Rock Creek	OR_SR_1710030109_02_105350	2010	Year Round
North Umpqua River	OR_SR_1710030108_02_105339	2004	Spawning
North Umpqua River	OR_SR_1710030108_02_105340	2004	Spawning
North Umpqua River	OR_SR_1710030108_02_105342	2004	Spawning
North Umpqua River	OR_SR_1710030111_02_105365	2004	Spawning
North Umpqua River	OR_SR_1710030111_02_106415	2004	Spawning
North Umpqua River	OR_SR_1710030108_02_105339	2010	Year Round
North Umpqua River	OR_SR_1710030108_02_105340	2010	Year Round
North Umpqua River	OR_SR_1710030108_02_105342	2010	Year Round
North Umpqua River	OR_SR_1710030111_02_105365	2010	Year Round
North Umpqua River	OR_SR_1710030111_02_106415	2010	Year Round
Northeast Fork Rock Creek	OR_SR_1710030109_02_105343	2010	Year Round
Panther Creek Watershed	OR_WS_171003010805_02_105658	2010	Year Round
Panther Creek Watershed	OR_WS_171003010805_02_105658	2018	Spawning
Pass Creek	OR_SR_1710030106_02_105330	2010	Year Round
Pass Creek Watershed	OR_WS_171003010602_02_105648	2010	Year Round
Rock Creek	OR_SR_1710030109_02_105345	2010	Year Round
Rock Creek	OR_SR_1710030109_02_105346	2010	Year Round
Rock Creek	OR_SR_1710030109_02_105347	2010	Spawning, Year Round
Steamboat Creek	OR_SR_1710030107_02_105334	2010	Year Round
Steamboat Creek	OR_SR_1710030107_02_105336	2010	Spawning, Year Round
Susan Creek-North Umpqua River Watershed	OR_WS_171003010809_02_105662	2010	Year Round
Thunder Creek-North Umpqua River Watershed	OR_WS_171003010808_02_105661	2018	Year Round
Upper Canton Creek Watershed	OR_WS_171003010601_02_105647	2010	Year Round
Upper Fish Creek Watershed	OR_WS_171003010401_02_105640	2010	Year Round
Upper Rock Creek Watershed	OR_WS_171003010901_02_105663	2010	Year Round
Upper Steamboat Creek Watershed	OR_WS_171003010702_02_105651	2018	Spawning, Year Round
Williams Creek-North Umpqua River Watershed	OR_WS_171003010807_02_105660	2018	Spawning, Year Round

Table 2: North Umpqua Subbasin assessment units that are classified as water quality limited category 4A for temperature based on the Section 303(d) 2018/2020 Integrated Report.

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Buckhorn Creek	OR_SR_1710030110_02_105351	2002	Year Round
Cavitt Creek	OR_SR_1710030110_02_105363	2002	Year Round
Cavitt Creek	OR_SR_1710030110_02_105364	2002	Year Round
Cavitt Creek	OR_SR_1710030110_02_105364	2018	Spawning
Clover Creek	OR_SR_1710030110_02_105362	2018	Spawning, Year Round
Headwaters Little River Watershed	OR_WS_171003011001_02_105666	2004	Year Round
Jim Creek	OR_SR_1710030110_02_105356	2004	Year Round
Little River	OR_SR_1710030110_02_105352	2002	Year Round
Little River	OR_SR_1710030110_02_105360	2002	Year Round
Little River	OR_SR_1710030110_02_105359	2004	Spawning, Year Round
Little River	OR_SR_1710030110_02_105352	2018	Spawning
Little River	OR_SR_1710030110_02_105360	2018	Spawning
Lower Little River Watershed	OR_WS_171003011008_02_105672	2004	Year Round
Lower Little River Watershed	OR_WS_171003011008_02_105672	2010	Spawning
Middle Little River Watershed	OR_WS_171003011005_02_105806	2004	Year Round
Middle Little River Watershed	OR_WS_171003011005_02_105806	2010	Spawning
Plusfour Creek	OR_SR_1710030110_02_105353	2002	Year Round
Plusfour Creek	OR_SR_1710030110_02_105353	2018	Spawning
Upper Cavitt Creek Watershed	OR_WS_171003011006_02_105670	2004	Year Round

3 Conceptual model: key processes and variables

The current theory to explain the nature of heat is called the kinetic-molecular theory. The modern version of this theory was developed in the mid-19th century by Rudolf Clausis, James Clerk Maxwell, and Ludwig Boltzmann. The theory is based on the assumption that all matter is composed of a tiny population of molecules that are always in motion. The molecules in hot objects are moving faster and hence have greater kinetic energy than the molecules in cold objects. Individual molecules have a certain amount of kinetic energy based on their mass and velocity. The thermal energy of an object is determined by adding up the kinetic energy of all the molecules in that object. When a hot and cold object come into contact with each other, the molecules collide and the kinetic energy flows from the molecules with more kinetic energy to molecules with less kinetic energy. This type of flow of kinetic energy is called heat.

Temperature is an intensive property and much like concentration measures the “strength” rather than “quantity” of kinetic energy. The temperature of an object is the measure of the average kinetic energy of all the molecules in that object. Hot water has greater average kinetic energy than cold water but may not have greater total kinetic energy. For example, a small pot of water with a temperature near the boiling point has a higher average kinetic energy than a swimming pool at room temperature. The swimming pool has a much larger quantity of molecules and therefore a higher total kinetic energy than the pot of water.

Temperature is the water quality parameter of concern, but heat, in particular heat from human activities or anthropogenic sources, is the pollutant of concern. Water temperature change (ΔTw) is a function of the heat transfer in a discrete volume and may be described in terms of changes in heat per unit volume. Conversely, a change in volume can result in water temperature change for a defined amount of heat exchange. With this basic conceptual framework of water temperature change, it is possible to discuss stream temperature change as a function of two variables: heat and mass transfer.

Water Temperature Change as a Function of Heat Exchange and Volume,

$$\Delta Tw = \frac{\Delta Heat}{Density \times Specific\ Heat \times \Delta Volume} \qquad \text{Equation 2}$$

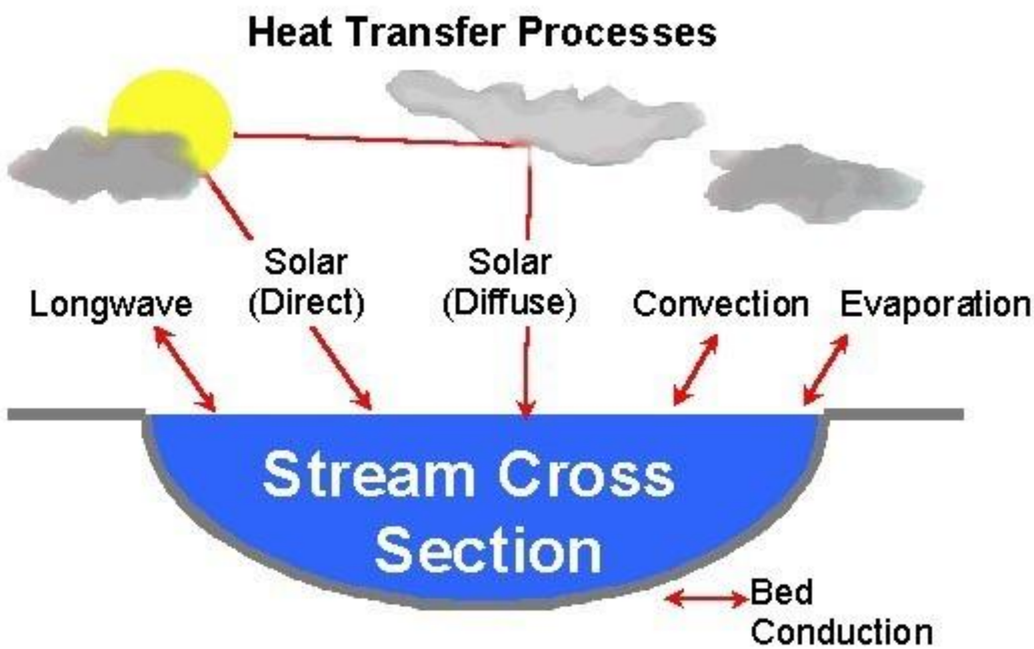

Figure 1: Major heat transfer processes.

Heat transfer relates to processes that change heat in a defined water volume. There are several thermodynamic pathways that can introduce or remove heat from a stream. These different processes are shown in Figure 1. For any given stream reach heat exchange is closely related to the season, time of day and the surrounding environment and the stream characteristics. Heat transfer can be dynamic and change over relatively small distances and time periods. Equation 3 describes the several heat transfer processes that change stream temperature (Wunderlich, 1972; Jobson and Keefer, 1979; Beschta and Weatherred, 1984; Sinokrot and Stefan, 1993; Boyd, 1996; Johnson, 2004; Hannah et al., 2008; Benyahya et al., 2012).

$$\Phi_{total} = \Phi_{solar} + \Phi_{longwave} + \Phi_{streambed} + \Phi_{convection} + \Phi_{evaporation} \qquad \text{Equation 3}$$

Where,
Φ_{total} = Net heat energy flux (+/-)
Φ_{solar} = Shortwave direct and diffuse solar radiation (+ only)
$\Phi_{longwave}$ = Longwave (thermal) radiation (+/-)
$\Phi_{streambed}$ = Streambed conduction (+/-)
$\Phi_{convection}$ = Stream/air convection[1] (+/-)
$\Phi_{evaporation}$ = Evaporation (+/-)

[1]Air/Water convection includes both turbulent and free surface conduction.

Mass transfer relates to transport of flow volume downstream, instream mixing and the introduction or removal of water from a stream. For instance, flow from a tributary will cause a temperature change if the temperature is different from the receiving water. Mass transfer commonly occurs in stream systems as a result of:

- Advection,
- Dispersion,
- Groundwater exchange,
- Hyporheic flows,
- Surface water exchange (e.g. tributary input, precipitation), and
- Other human related activities that alter stream flow volume.

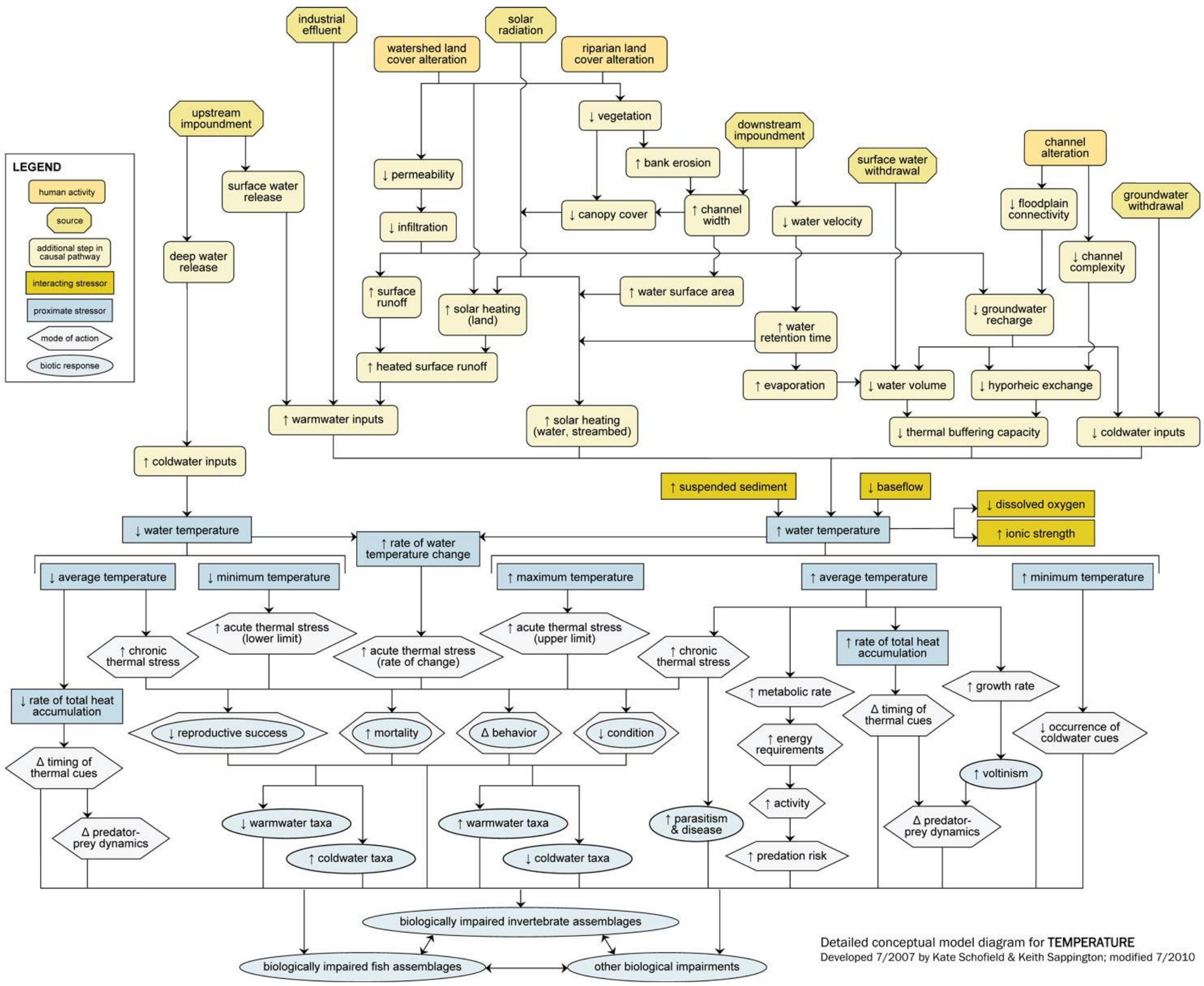

Figure 2: Conceptual diagram that identifies the key processes and variables that drive stream temperature changes and the biological responses (Schofield and Sappington, 2010).

Stream temperature is influenced by both human and natural factors. Figure 2 is a conceptual diagram that identifies the key process and variables that drive stream temperature. Human sources and natural sources are identified. Near the bottom of the diagram the biological responses are identified.

Anthropogenic Nonpoint Sources: Temperature increases from human-caused nonpoint sources are caused by increases in solar radiation loading to the stream network from the disturbance or removal of near-stream vegetation, channel modification and widening, reductions to the stream flow rate or volume, changes in hyporheic flows and channel connectivity, reductions in cold groundwater inflows, and changes to meteorological conditions, such as those caused by climate change.

Background Sources: Background sources include all sources of pollution or pollutants not originating from human activities. In the context of a TMDL, background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state (OAR 340-042-0030(1)). Additionally, effective shade levels on smaller streams are more sensitive to riparian disturbances and so the differences between current condition solar flux and background solar flux can be larger.

Anthropogenic Point Sources: Temperature increases from point sources are those caused by warm water discharges from NPDES permitted facilities, such as industrial outfalls, municipal waste water treatment plants (WWTP), and other point sources.

4 Technical approach

4.1 Overview

Stream temperature TMDLs are generally scaled to a subbasin or basin scale since stream temperatures are affected by cumulative interactions between upstream and local sources. For this reason the TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies. For example, the North Umpqua River is water quality limited for temperature. To address this listing in the TMDL, all upstream waterbodies are considered in the TMDL analysis and TMDL allocations are applied throughout the entire stream network and include all waters of the state.

An important step in the TMDL is to perform a source assessment which quantifies the background and anthropogenic contributions to stream heating. Models provide a way to evaluate potential sources of stream warming and, to the extent existing data allow, the amount of pollutant loading from these sources. The model that is selected for the TMDL analysis should support the needs of the project. Section 4.2 describes the model framework needs for this project and the models that will be used to support the TMDL.

TMDLs also require identification of seasonal variation and critical conditions. The TMDL analysis will determine seasonal variation by including a statistical summary and visual plots summarizing the instream temperatures and flow rates observed at various monitoring locations. The time period when the applicable temperature criteria are exceeded will be described in relation to the critical conditions.

The TMDL will establish a loading capacity which specifies the amount of a pollutant or pollutants that a waterbody can receive and still meet water quality standards. The pollutant addressed in the temperature TMDL is heat. The TMDL will divide the loading capacity into thermal wasteload allocations for NPDES permittees and load allocations for background and nonpoint sources of heat to ensure that the applicable temperature standards are achieved. Anthropogenic nonpoint and NPDES permitted point sources are not permitted to heat a waterbody more than 0.3 deg-C above the applicable criteria, cumulatively at the point of maximum impact. The portion of the human use allowance allocated to each source will be determined in the TMDL with the modeling approach supporting assessment of different allocation options. The modeling approach may also be used to support development of TMDL surrogate measures such as effective shade targets. Nonpoint source allocations can be translated into surrogate measures when a pollutant is difficult to measure, highly variable, or difficult to monitor (OAR 340-042-0040(5)(b)). Thermal load allocations for nonpoint sources can be difficult to measure and monitor. Attainment of the surrogate measures ensures compliance with the nonpoint source allocations.

Stream temperatures for the Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006) were simulated using the computer models (Heat Source version 7 and Heat Source version 8). New Heat Source models are proposed on some of the major tributaries during the designated spawning use period. The model extents include most of the main rivers and their larger tributaries that contain or influence primary fish habitat. Site-specific load allocations will be developed for the streams that are simulated. Other streams are assigned generalized load allocations based on effective shade surrogate measures that target site potential or restored vegetation types. Numeric or narrative wasteload allocations will be developed for all NPDES permittees.

4.2 Model selection

DEQ has developed Heat Source models for the riverine portions of the North Umpqua Subbasin. PacifiCorp also developed a Heat Source version 8 model for Fish Creek (PacifiCorp, 2012) and made it available for use by DEQ. Little River watershed (HUC 1710030111) was excluded from the 2006 TMDL as a TMDL had been previously developed and approved by EPA in 2002. The Little River watershed is considered in the current analysis and will be included in the North Umpqua Subbasin temperature TMDL replacement project area. The modeling framework needs for this project include:

1) Prediction of hourly stream temperatures over a period of months and at a no greater than 500 meter longitudinal resolution.

2) Prediction of hourly solar radiation flux and daily effective shade at a no greater than 100 meter longitudinal resolution.

3) Ability to evaluate hourly stream temperature response from changes in streamside vegetation.

4) Ability to evaluate hourly stream temperature response from changes in water withdrawals and tributary stream flow within the upstream catchment.

5) Ability to evaluate hourly stream temperature response from changes in channel morphology within the upstream catchment.

6) Ability to evaluate hourly stream temperature response from changes in effluent temperature and flow discharge from NPDES permitted facilities.

The Heat Source stream thermodynamics model (Boyd and Kasper, 2003) was used to model several streams for the development of TMDLs in the North Umpqua (DEQ, 2002a; DEQ, 2006). Because these models already exist and meet all the model framework needs, Heat Source was selected for stream temperature simulation in the project area. The Heat Source model was originally developed at Oregon State University as a master's thesis where it was evaluated and approved by an academic committee (Boyd, 1996). Development of the model continued and in 1999 DEQ submitted the model equations and methodology for peer review (DEQ, 1999) and again in 2004 to the Independent Multidisciplinary Science Team (IMST, 2004) where the model was found to be scientifically sound.

The Heat Source model has been used in numerous stream temperature related studies including Loheide and Gorelick (2006), Diabat et al. (2013), Holzapfel et al. (2013), Lawrence et al. (2014), Bond et al. (2015), Woltemade and Hawkins (2016), Justice et al. (2017), and Wondzell et al. (2019). Heat Source has also been used in numerous Oregon TMDLs (DEQ, 2001, 2002b, 2003, 2005, 2006, 2007, 2008, 2010, 2018, 2019).

4.3 Software Development Quality Assessment

We do not anticipate any new software development or model code changes as part of this project.

5 Data availability and quality

This chapter describes the data that is available to support the TMDL project and the quality assurance procedures used when collecting or reviewing the available data.

5.1 Meteorology

Meteorological data includes air temperature, sky conditions, cloudiness, relative humidity, and wind speed. Table 84 through Table 88 in Appendix A list the stations where meteorological data available in the North Umpqua Subbasin, including 25 stations from National Oceanic and Atmospheric Association (NOAA)'s National Climatic Data Center (NCDC), 2 stations from National Interagency Fire Center's Remote Automatic Weather Stations (RAWS), 1 station from Bureau of Reclamation Cooperative Agricultural Weather Network (AgriMet), 10 stations from University of Utah MesoWest database, and 1 station from DEQ's files. The meteorological monitoring stations are also shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D. The station IDs in Table 84 are the NCDC ID, which may differ from the station identifiers used by other sources.

The meteorological data obtained from the NCDC includes the Local Climatological Dataset (NOAA, 2005) and the Global Integrated Surface Dataset (NOAA, 2001). The Local Climatological Dataset includes quality controlled meteorological data from airports and other prominent weather stations managed by the National Weather Service, Federal Aviation Administration, and the U.S. Department of Defense. The Global Integrated Surface Dataset provides a long-term record of hourly, sub-hourly and synoptic weather observations from a variety of meteorological networks around the world. The dataset includes observations from the World Meteorological Organization, Automated Surface Observing System, Automated Weather Observing Stations, U.S. Climate Reference Network, and others.

5.2 Thermal Infrared Radiometry (TIR) data

DEQ contracted with Watershed Sciences, Inc. to provide airborne Thermal Infrared Radiometry (TIR) imagery of spatial temperature patterns within the North Umpqua Subbasin (Watershed Sciences, 2001; Watershed Sciences, 2003). TIR data is used to characterize the thermal regime of the streams and habitat quality. All streams and the TIR collection dates are summarized in Table 3.

Table 3: Streams and the TIR collection dates in the North Umpqua Subbasin.

Stream	Survey Extent	Date	Time	Survey Distance
Canton Creek	Mouth to Pass Creek	2002-07-25	14:30-15:07	10 mi
Cavitt Creek	Mouth to Cultus Creek	2002-07-26	16:36-17:05	10 mi
Clearwater River	Mouth to headwaters	2001-07-09	14:25-15:10	12.53 mi
Clearwater River	Mouth to headwaters	2001-07-10	16:34-16:53	12.71 mi

Stream	Survey Extent	Date	Time	Survey Distance
Fish Creek	Mouth to headwaters	2001-07-10	15:27-16:00	18.03 mi
Lake Creek	Lemolo Lake to Diamond Lake	2001-07-10	16:08-16:30	10.72 mi
Little River	Mouth Hemlock Creek	2002-07-26	15:28-16:26	26 mi
North Umpqua River	Lemolo Lake to Toketee Reservoir	2001-07-09	15:16-15:53	22.8 mi
North Umpqua River	Steamboat Creek to Lemolo Lake	2001-07-10	13:51-14:50	37.75 mi
North Umpqua River	Steamboat Creek to Toketee Reservoir	2001-07-10	17:07-17:37	22.48 mi
North Umpqua River	Mouth to Steamboat Creek	2002-07-25	16:07-17:27	52 mi
Rock Creek	Mouth to NE Fork	2002-07-26	14:07-14:37	12 mi
Steamboat Creek	Mouth to Horse Heaven Creek	2002-07-25	13:51-14:24	19 mi

5.3 Continuous stream temperature data

All available continuous stream temperature data were retrieved from DEQ’s Ambient Water Quality Monitoring System (AWQMS), USGS’s National Water Information System (NWIS), or were obtained during the data solicitation for DEQ’s Temperature TMDL Replacement Project. Some temperature data presented in this QAPP were retrieved from DEQ’s files and were not available in AWQMS or USGS’s database.

The data retrieval period for continuous stream temperature data is from January 1, 1990 to December 31, 2020. Data retrieved from the AWQMS database has a Data Quality Level (DQL) of A, B or E and a result status of “Final” or “Provisional”. The data quality level criteria are outlined in DEQ’s Data Quality Matrix for Field Parameters (DEQ, 2013). The TMDL program uses waterbody results with a data quality level of A, B, or E (DEQ, 2021). Data of unknown quality are used after careful review.

Appendix B summarizes 227 locations where continuous stream temperature data were collected in the North Umpqua Subbasin and the organizations that collected that data in Table 89, and when data were collected at each location in Table 90. The location of these stations is shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D.

5.4 Stream flow data

Table 91 in Appendix C lists the stations where continuous flow volume data were available in the North Umpqua Subbasin, including 22 stations from USGS. Table 93 lists the years that continuous stream flow data were collected at each location. The location of these stations is shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D. Table 92 lists the locations where instantaneous flow volume measurements made by DEQ were available. DEQ relies upon the quality control checks implemented by USGS and OWRD. DEQ-collected stream flow measurements utilize field and quality control methods outlined in DEQ's Mode of Operations Manual (DEQ, 2020).

5.5 Point source discharges

Table 4 identifies all the active individual NPDES permittees in the North Umpqua Subbasin. Table 5 lists the registrants covered under the general NPDES GEN01, GEN03, GEN04, and GEN05 permits in the North Umpqua Subbasin. This group of general permits are highlighted because the permits require temperature monitoring at a frequency of at least one grab sample per month. The location of these NPDES permittees is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D. Many of these permittees submit Discharge Monitoring Reports (DMRs) as a condition of their permit. Depending on the monitoring requirements in the permit, some permittees are required to report effluent temperature and effluent flow rates in the DMR. The frequency and type of reporting varies by permit and permit type. Some permits only require monthly, weekly, or daily grab samples while others require summary statistics such as daily maximum, daily mean, or seven-day average daily maximum. The NPDES permits require data be collected and reported on the DMR using appropriate methods based on a quality assurance and quality control plan. Where possible, DEQ will utilize any continuous effluent data that has been provided to DEQ. When continuous data is not available, DMR data will be utilized to characterize point source discharges. Table 6 lists the current number of registrants for all the other general NPDES permits in the North Umpqua Subbasin that are not listed in Table 5.

Table 4: Summary of individual NPDES permitted discharges in the North Umpqua Subbasin.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
Glide-Idleyld Sanitary District (33743)	43.3086/-123.119	NPDES-DOM-Da: Sewage - less than 1 MGD	North Umpqua River RM 27.4
USFS - Umpqua National Forest; Wolf Creek Civilian Conservation Center (90964)	43.239/-122.925	NPDES-DOM-Da: Sewage - less than 1 MGD	Little River RM 11.4

Table 5: Summary of current registrants under the general NPDES GEN01, GEN03, GEN04, and GEN05 permits in the North Umpqua Subbasin.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
DOUGLAS COUNTY FOREST PRODUCTS (24985)	43.2897/-123.361	GEN04: Industrial Wastewater; NPDES log ponds	North Umpqua River RM 5.8
ODFW - ROCK CREEK HATCHERY, DOUGLAS COUNTY (64530)	43.3352/-123.001	GEN03: Industrial Wastewater; NPDES fish hatcheries	Rock Creek RM 0.2
PACIFIC POWER & LIGHT COMPANY - CLEARWATER #1 (66628)	43.2492/-122.34	GEN01: Industrial Wastewater; NPDES cooling water	Clearwater River RM 4.5

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
PACIFIC POWER & LIGHT COMPANY - CLEARWATER #2 (66630)	43.2661/-122.408	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 74.9
PACIFIC POWER & LIGHT COMPANY - FISH CREEK PLANT (66632)	43.2736/-122.449	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 72.3
PACIFIC POWER & LIGHT COMPANY - LEMOLO PLANT #1 (66634)	43.3556/-122.251	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 88.2
PACIFIC POWER & LIGHT COMPANY - LEMOLO PLANT #2 (66636)	43.275/-122.401	GEN01: Industrial Wastewater; NPDES cooling water	South Umpqua River RM 78.9
PACIFIC POWER & LIGHT COMPANY - SLIDE CREEK (66640)	43.2932/-122.469	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 70.6
PACIFIC POWER & LIGHT COMPANY - SODA SPRINGS (66642)	43.295/-122.478	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 69.6
PACIFIC POWER & LIGHT COMPANY - TOKETEE PLANT (66644)	43.2686/-122.446	GEN01: Industrial Wastewater; NPDES cooling water	North Umpqua River RM 74.9
SWANSON GROUP MFG. GLIDE (100170)	43.3073/-123.084	GEN05: Industrial Wastewater; NPDES boiler blowdown	North Umpqua River RM 30

Table 6: Summary of the current number of registrants for all the other general NPDES permits in the North Umpqua Subbasin that are not listed in Table 5.

Permit Type and Description	Current Number of Registrants
GEN02: Industrial Wastewater; NPDES filter backwash	5
GEN12A: Stormwater; NPDES sand & gravel mining	4
GEN12C: Stormwater; NPDES construction more than 1 acre disturbed ground	4
GEN12CA: Stormwater; NPDES government agency construction, more than 1 acre disturbed ground	2
GEN12Z: Stormwater; NPDES specific SIC codes	9

5.6 Water rights/surface water diversions

Data on surface water diversion rates (usage) and the points of diversion (location) are available from the Oregon Water Resources Department (OWRD). OWRD regulates all commercial, industrial, domestic, and agricultural water use in the state of Oregon through water rights.

Estimates of water diversion rates and location of points of diversion can be derived from the following OWRD sources:

- Water Rights Information System (WRIS) – the WRIS database contains all permitted or certificated water rights. Data in the WRIS corresponding to quantities of water for use are expressed as maximum use allowable, generally as monthly, seasonal or annual rates or volumes. These maximum values may not correspond to actual usage, which will likely vary based on factors such as irrigation application rate or household consumer demand. DEQ may choose to incorporate the maximum amount allowable or some lesser quantity provided sufficient information is available to support those rates in the modeling. Water rights information can also be accessed using their online mapping application (https://apps.wrd.state.or.us/apps/gis/wr/Default.aspx).
- Water Use Reports – some, but not all, water rights holders must monitor and report the water they use to the state, typically on a monthly or yearly basis, as a requirement of their water rights. These water use reports will be used to develop withdrawal time series based on available information.

5.7 Effective shade measurements

Effective shade is the percent of potential daily solar radiation flux that is blocked by vegetation and topography. DEQ and/or partner agency staff used an instrument called a solar pathfinder to collect effective shade measurements in the field. The effective shade measurement methods and quality control procedures used are outlined in the Water Quality Monitoring Technical Guide Book (OWEB, 1999) and the solar pathfinder manual (Solar Pathfinder, 2016). Table 7 lists the locations where effective shade measurements were collected and the effective shade value for September 2009.

Table 7: Effective shade data collected in the North Umpqua Subbasin.

Station	Latitude/Longitude	Effective Shade	Data Source
Fish Creek downstream Slipper Creek Site 1	43.2293/-122.448	90%	DEQ
Fish Creek downstream Slipper Creek Site 2	43.2296/-122.447	96%	DEQ
Fish Creek downstream Clear Creek Site 1	43.1509/-122.38	97%	DEQ
Fish Creek downstream Clear Creek Site 2	43.1514/-122.38	60%	DEQ
Fish Creek downstream Black Rock Creek Site 1	43.1649/-122.392	37%	DEQ
Fish Creek downstream Black Rock Creek Site 2	43.1655/-122.392	57%	DEQ
Fish Creek upstream Rough Creek Site 1	43.2058/-122.392	78%	DEQ
Fish Creek upstream Rough Creek Site 2	43.2063/-122.392	95%	DEQ
North Umpqua River at Idleyld Park Site 1	43.3238/-122.998	40%	DEQ

Station	Latitude/Longitude	Effective Shade	Data Source
North Umpqua River at Idleyld Park Site 2	43.3237/-122.997	35%	DEQ
North Umpqua River upstream Loafer Creek Site 1	43.3007/-122.36	88%	DEQ
North Umpqua River upstream Loafer Creek Site 2	43.3004/-122.36	82%	DEQ
Fish Creek at mouth Site 1	43.2841/-122.47	61%	DEQ
Fish Creek at mouth Site 2	43.2846/-122.471	74%	DEQ
Clearwater River near mouth	43.2619/-122.417	81%	DEQ
Lake Creek at mouth Site 1	43.297/-122.18	34%	DEQ
Lake Creek at mouth Site 2	43.2964/-122.18	45%	DEQ
Lake Creek at Highway 138 Site 1	43.2527/-122.17	90%	DEQ
Lake Creek at Highway 138 Site 2	43.2524/-122.172	83%	DEQ
North Umpqua River above Lemolo Site 1	43.3105/-122.155	46%	DEQ
North Umpqua River above Lemolo Site 2	43.3108/-122.154	14%	DEQ
North Umpqua River downstream Lemolo Dam Site 1	43.323/-122.196	46%	DEQ
North Umpqua River downstream Lemolo Dam Site 2	43.3228/-122.195	14%	DEQ
North Umpqua River below Lemolo 2 Diversion Site 1	43.3549/-122.253	55%	DEQ
North Umpqua River below Lemolo 2 Diversion Site 2	43.3549/-122.253	43%	DEQ
North Umpqua River above Lemolo Powerhouse #2 Site 1	43.2807/-122.402	58%	DEQ
North Umpqua River above Lemolo Powerhouse #2 Site 2	43.2811/-122.402	78%	DEQ
North Umpqua River upstream Toketee Reservoir Site ID 18 Site 1	43.2727/-122.404	42%	DEQ
North Umpqua River upstream Toketee Reservoir Site ID 18 Site 2	43.2734/-122.403	64%	DEQ
North Umpqua River upstream Toketee Reservoir Site ID 19	43.2639/-122.422	82%	DEQ
North Umpqua River above Toketee Powerhouse Site 1	43.272/-122.447	96%	DEQ
North Umpqua River above Toketee Powerhouse Site 2	43.2706/-122.447	81%	DEQ
North Umpqua River above Slide Creek Powerplant Site 1	43.2929/-122.471	47%	DEQ

Station	Latitude/Longitude	Effective Shade	Data Source
North Umpqua River above Slide Creek Powerplant Site 2	43.2925/-122.473	54%	DEQ

6 Model development and calibration

Waterbodies where model development was initiated for the Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006) are listed in Table 8. The waterbodies listed in Table 9 will have new models developed. The extent and location of these models is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

Table 8: Waterbodies where a model has already been developed. The model year is identified if another year is proposed for a new model on the same waterbody.

Model Version	Model Waterbody
Heat Source version 7 temperature model	Canton Creek, Cavitt Creek, Clearwater River, Fish Creek (2001), Lake Creek, Little River, North Umpqua River, Rock Creek, Steamboat Creek
Heat Source version 8 temperature model	Fish Creek (2009)

The setup and calibration for the models listed in Table 8 was completed by DEQ and documented in the Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006). The Fish Creek (2009) model was developed by PacifiCorp (WSI and MBG, 2012). Adjustments to the existing calibrated models are unlikely to occur as part of this project. However, if it is determined that the model calibration needs to be updated, the model inputs that are expected to be modified are described in Section 6.1. DEQ will follow the model acceptance criteria and model fit statistics described in Chapter 7.2.

Table 9: Waterbodies for which new models are expected to be developed.

Model Version	Model Waterbody
Heat Source version 8 temperature model	Canton Creek, Clearwater River, Lake Creek, North Umpqua River, Rock Creek, Steamboat Creek

New models will be developed for the North Umpqua River and select tributaries to address spawning period listings. The existing Heat Source models from the 2006 Umpqua Basin TMDL were developed for periods in July 2001 and July 2002 and do not coincide with the salmon and steelhead spawning use designation period. For most streams identified in Table 9, the spawning period is from September 1 through June 15. Because the modeling for the Umpqua temperature TMDLs did not simulate conditions in the spawning season, EPA found that spawning criteria listings in waterbodies affected by dams or point sources were not directly addressed by the TMDL and therefore would remain in Category 5 of the 303(d) list until a TMDL analysis for the spawning criteria is approved (Gearheard, 2007). The North Umpqua River is listed for temperature during the spawning period and is impacted by the North Umpqua hydroelectric project dams on the North Umpqua River, Clearwater River, and Fish Creek. The NPDES permitted ODFW Rock Creek Fish Hatchery also discharges to Rock Creek near the mouth. Spawning period temperature models are proposed on these waterbodies. Spawning period models are also proposed for Canton Creek, Streamboat Creek, and upstream of the hydroelectric project on Lake Creek. These models are being developed to support development of boundary conditions and model linkage under various management scenarios. In 2009 DEQ collected new temperature and flow data to support temperature model development for the spawning period. Temperature data collected by other organizations will also support spawning period model development on major tributaries to the North Umpqua River including Canton Creek.

DEQ will develop effective shade curves for all other waterbodies that were not specifically listed in Table 8 and Table 9. Effective shade curves represent the maximum possible effective shade for different vegetation types, stream widths, and stream aspect. Every combination of these conditions are modeled in Heat Source to develop the estimated effective shade. The results are summarized in a shade curve plot. The results can also be summarized in a lookup table with additional combinations of vegetation height, density, and buffer width included. Effective shade curves were developed for the original Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006). Adjustments to the existing shade curve models are unlikely to occur as part of this project. However, if it is determined that the models need to be updated DEQ will follow the procedures outlined in this QAPP.

6.1 General model inputs and parameters

6.1.1 Heat Source version 7

Table 10 summarizes all of the user entered model inputs and input categories required to run Heat Source version 7; and identifies the subset of inputs that could possibly be modified to improve the calibration of the model. It should be noted, it is unlikely all of these will be used as calibration parameters; rather this list identifies the candidate model inputs that will be considered for adjustment through the calibration process. The following bulleted list of input categories and specific inputs describes the general form and function of the inputs, and why the inputs are candidates for adjustment during calibration:

- Morphology – The morphology inputs that could be used as calibration parameters fall into two categories: channel hydraulics and bed conduction. The reasons for inclusion as calibration parameters are described as follows:
  - Channel hydraulics – These inputs include stream gradient, bottom width, side slope angle, and Manning's *n*. Channel hydraulics are important for predicting stream temperatures because they govern the surface area of water that could be exposed to solar radiation, the residence time for exposure, and the degree of light penetration into the water column. An alternative input to channel side slope input in Heat Source version 7 is the input of a width to depth ratio. Field data for these inputs are often difficult to collect over large spatial scales, and values can vary significantly on a small scale. Heat Source is a one-dimensional model and complex channel configurations are represented as a trapezoidal pattern. Adjustments to inputs that affect channel hydraulic are often necessary to calibrate the model.
  - Bed conduction – These inputs include hyporheic zone thickness, percent hyporheic exchange, and porosity. Bottom width and side slope angle also affect these inputs by controlling the wetted perimeter of the channel (i.e., the portion or lateral length of the

channel bed in direct contact with the stream). These stream morphological characteristics largely govern heat and mass transfer across the stream bed. Typically, information on the waterbody sediment size class (e.g. bedrock, gravel, sand, silt) is used as the basis for selecting literature values for these inputs.

- Meteorology – The two meteorological inputs typically modified in calibration are percent cloudiness and wind speed. Both cloudiness and wind speed can vary significantly on a small geographic scale and the distance to the source of the meteorological data is often much greater than the small-scale localized weather. Hence, adjusting wind and cloudiness is an appropriate calibration method to account for more site-specific weather patterns.

- Mass and thermal flux – Mass and thermal inflows and outflows are inputs often adjusted during the calibration process. These inflows of heat and water consist of tributary and groundwater inflows as well as diversions (i.e., water rights withdrawals) and groundwater losses. The temporal and geographic extents of flow gaging and temperature monitoring on tributaries or groundwater are generally sparse. An effective way of improving the calibration is to complete a flow mass balance with from available data, and then add, subtract, or adjust flows either globally or in specific locations within the bounds of the flow mass balance and available measurements, and the temperature response predicted by the model.

- Vegetation – Vegetation characteristics input into the model are often derived from aerial imagery or LiDAR. The vegetation characteristics determine the degree to which near-stream vegetation has the capacity to block incidental solar radiation on the surface of the modeled waterbody. Three vegetation inputs incorporated into the model calibration process are the vegetation density, overhang, and height. Field measurements offer a general understanding of vegetation characteristics within the watershed, however variability in these parameters can be significant on smaller geographic scales. To improve the model fit these model inputs may be modified on a global scale for different vegetation classes within the bounds of available data.

Table 10: Summary of model inputs required for Heat Source version 7.

Input Type	Input	Units	Calibration Parameter
General	Stream Length	kilometers	NO
General	Modeling Start Date	date (mm/dd/yyyy)	NO
General	Simulation Period	days	NO
General	Flush Initial Condition	days	NO
General	Time Zone	-	NO
General	Model Time Step	minutes	NO
General	Model Distance Step	meters	NO
General	Longitudinal Stream Sample Distance	meters	NO
General	Number Of Tributary Inflow Sites	-	NO
General	Number Of Meteorological Data Sites	-	NO
General	Include Evaporation Losses From Flow (True/False)	-	NO

Input Type	Input	Units	Calibration Parameter
General	Evaporation Method (Mass Transfer/Penman)	-	NO
General	Wind Function Coefficient a	unitless	NO
General	Wind Function Coefficient b	unitless	NO
General	Include Deep Alluvium Temperature (True/False)	-	NO
General	Deep Alluvium Temperature	degrees Celsius	NO
General	Distance Between Transect Samples	meters	NO
Meteorological Data	Meteorological Data Model Kilometers	kilometers	NO
Meteorological Data	Cloudiness	proportion (0-1)	YES
Meteorological Data	Wind Speed	meters/second	YES
Meteorological Data	Relative Humidity	proportion (0-1)	NO
Meteorological Data	Air Temperature	degrees Celsius	NO
Accretion	Stream Kilometers	kilometers	NO
Accretion	Accretion Inflow Rate	cubic meters/second	YES
Accretion	Water Temperature	degrees Celsius	YES
Accretion	Withdrawal Flow Rate	cubic meters/second	YES
Boundary Condition	Boundary Condition Inflow Rate	cubic meters/second	NO
Boundary Condition	Water Temperature	degrees Celsius	NO
Tributary	Tributary Inflow Model Kilometers	kilometers	NO
Tributary	Tributary Inflow Rate	cubic meters/second	YES
Tributary	Water Temperature	degrees Celsius	YES
Land Cover Data	Node Longitude	decimal degrees	NO
Land Cover Data	Node Latitude	decimal degrees	NO
Land Cover Data	Topographic Shade Angle - West	degrees	NO
Land Cover Data	Topographic Shade Angle - South	degrees	NO
Land Cover Data	Topographic Shade Angle - East	degrees	NO
Land Cover data	Landcover Ground Elevation	meters	NO
Land Cover Codes	Landcover Code	-	NO

Input Type	Input	Units	Calibration Parameter
Land Cover Codes	Landcover Height	meters	YES
Land Cover Codes	Canopy Density	proportion (0-1)	YES
Land Cover Codes	Landcover Overhang	meters	YES
Morphology Data	Stream Kilometer	kilometers	NO
Morphology Data	Channel Bed Elevation	meters	NO
Morphology Data	Channel Gradient	meters/meters	YES
Morphology Data	Channel Angle z	meters/meters	YES
Morphology Data	Manning’s Roughness Coefficient, n	seconds/meter	YES
Morphology Data	Sediment Thermal Conductivity	watts/meters/degrees Celsius	NO
Morphology Data	Bed Particle Size	millimeters	YES
Morphology Data	Percent Embeddedness	proportion (0-1)	YES
Morphology Data	Rosgen Level I Stream Type	-	NO
Morphology Data	Width to Depth (W:D) Ratio	unitless	YES
Morphology Data	Bankfull Width	meters	NO
Morphology Data	X Factor	unitless	NO
Morphology Data	Stream Aspect	degrees	NO

6.1.2 Heat Source version 8

The model parameters for Heat Source version 8 are similar to Heat Source version 7 with a few notable exceptions:

• can simulate an unlimited number of days where Heat Source version 7 can model up to 21 days;
• specifies different bed sediment parameters such as thermal conductivity, thermal diffusivity, and hyporheic exchange; and
• Heat Source version 8 allows for the use of LiDAR data to be used for vegetation density and overhang.

Table 11 summarizes the list of model parameters that are different between Heat Source version 7 and Heat Source version 8.

Table 11: Summary of the model inputs that are different between Heat Source version 7 and Heat Source version 8.

Input Type	Input	Units	V7	V8	Calibration Parameter
Morphology Data	Channel Aspect	degrees	NO	YES	NO

Input Type	Input	Units	V7	V8	Calibration Parameter
Morphology Data	Bed Particle Size	millimeters	NO	YES	YES
Morphology Data	Percent Embeddedness	proportion (0-1)	NO	YES	YES
Morphology Data	Rosgen Level I Stream Type	-	NO	YES	NO
Morphology Data	Width To Depth Ratio	meters	NO	YES	NO
Morphology Data	Bankfull Width	meters	NO	YES	NO
Morphology Data	X Factor	unitless	NO	YES	NO
Heat Source Inputs	LiDAR Density	proportion (0-1)	YES	NO	YES
Heat Source Inputs	LiDAR Overhang	meters	YES	NO	YES
Morphology Data	Channel Bottom Width	meters	YES	NO	YES
Morphology Data	Hyporheic Zone Thickness	meters	YES	NO	YES
Morphology Data	Percent Hyporheic Exchange	proportion (0-1)	YES	NO	YES
Morphology Data	Porosity	proportion (0-1)	YES	NO	YES
Heat Source Inputs	Number Of Samples Per Transect	-	YES	NO	NO
Heat Source Inputs	Account For Emergent Veg Shading (True/False)	-	YES	NO	NO
Heat Source Inputs	Land Cover Sample Method (Point/Zone)	-	YES	NO	NO
Heat Source Inputs	LiDAR Data Used For Veg Codes (True/False)	-	YES	NO	NO
Morphology Data	Sediment Thermal Diffusivity	square centimeters/second	YES	NO	NO

6.2 Updating the Heat Source models

Updating the Heat Source models will mainly involve the determination of inflows, water temperatures, and weather conditions. It appears that flow data are limited on the tributaries based on the preliminary review of the data that Tetra Tech received. In the case of limited availability of flow data, flow scaling with the gaged drainage area or other approaches such as the stream flow estimation tool that Tetra Tech is developing for DEQ may be used. Observed temperature probe data collected downstream of reservoirs will be used to configure the Heat Source models for North Umpqua River below the impoundments - Lemolo Lake, Toketee Lake, and Soda Springs Dam.

Weather stations are also limited. It is anticipated that air temperature measurement probes from 2009 can be used. In addition to NCDC, additional sources of weather data such as the USFS and AgriMet will also be explored if appropriate. It is expected that solar radiation will not vary too much within the watershed. Air temperature will decrease from the river mouth to headwater areas based on the elevation. Air temperature data will need to be adjusted based on elevation for each Heat Source model. Shading is a critical controlling factor for the water temperature change along the river. Shading information has been incorporated in the Heat Source models. We assume that the shading is not changing dramatically from July to the fall spawning season and will not be changed in the model. The existing vegetation setup from the summer model period can also be used for the updated spawning models because the majority of trees in the North Umpqua are conifers and the leaves on the deciduous trees will still be on, since deciduous trees in Oregon do not reach peak fall color change until mid-October.

Due to the change of inflows, the Heat Source model may require slight adjustment of stability related parameters such as the Manning's *n* and time step. It is expected that limited model validation will be conducted unless under the TOCORs written technical directive. All the existing Heat Source models have been built using version 7 and will updated using version 8. PacifiCorp has recently developed a Heat Source model for Fish Creek for the spawning period during 2009 that uses version 8 of Heat Source. This model will be made available for use by Tetra Tech. If this model is unstable or incompatible with the other Heat Source models, Tetra Tech will convert it to version 7.

Modeling the water temperature for the entire North Umpqua River during the spawning season will involve running ten linked Heat Source models. For the current conditions, measured flows and temperatures at the upstream boundary for each Heat Source model will be used as the upstream boundary condition. Any tributary to the main-stem model that is configured as a Heat Source model will be calibrated using observed flow and temperature. The downstream output from tributary model will be input to the main-stem model using observed data.

6.3 Data gaps

Non-steady state stream models typically require a significant amount of data because of the large spatial and temporal extents the models typically encompass. As the model size or modeling period increase, the amount of information needed to parameterize it also increases. Often it is not possible to parameterize a model entirely from field data because it can be resource intensive or impractical to collect everything that is needed. In general, these data gaps may be considered and addressed in a number of ways. Table 12 summarizes methods that are used to derive the data needed to parameterize the model.

To the greatest extent possible, the method used to derive the model parameters for the existing TMDL models have been summarized in the boundary conditions and tributary inputs tables in the sections of model inputs in the current Chapter 6.

Table 12: Methods to derive model parameters for data gaps.

Method	Possible Parameters	Description
Direct surrogate	Tributary temperatures, meteorological inputs, sediment	Often, neighboring or nearby tributary watersheds share climatological and landscape features. Model parameters that have an incomplete record or no data may be parameterized using data from a neighboring or nearby location where data is available.
Calibration adjustment	All inputs	In some instances, a significant input may be required for appropriate representation in the modeling, however little may be known about the nature of that input. An example of this is groundwater influx and temperature. Datasets for these inputs can be estimated by adjusting the necessary values within acceptable ranges during the calibration process.
Literature-based values	All inputs	Literature values are often used for model parameters or unquantified model inputs when little is known about the site-specific nature of those inputs. Examples of these types of parameters include stream bed heat transfer properties, hyporheic characteristics or substrate porosity (Bencala and Walters, 1983; Hart, 1995; Pelletier et al., 2006; Sinokrot and Stefan, 1993).
Mass balance	Tributary temperature and flow	On main stem modeled reaches, tributary stream flow or temperature can be estimated using a mass balance approach assuming either flow or temperature data for the tributary are known. If estimating temperature, flow is required, and if estimating flow, temperature is required. Often TIR data are used to estimate tributary flow because upstream, downstream and tributary temperatures are known, and upstream and tributary flows are known (or estimated).
Simple linear regression	Tributary temperature and flow	Parameters such as flow and temperature in neighboring or nearby tributaries often demonstrate similar diurnal patterns or hydrographs which allow for the development of suitable mathematical relationships (simple linear regression) in order to fill the data gaps for those inputs. This method requires at least some data exist for the incomplete dataset in order to develop the relationship.

Method	Possible Parameters	Description
Drainage area ratio	Tributary flow	For ungaged tributaries, flows can be estimated using the ratio between the watershed drainage areas of the ungaged location and from a nearby gaged tributary (Ries et al., 2017; Risley, 2009; Gianfagna, 2015). For example, if the watershed area upstream of a gaged tributary is 10 square kilometers, and the watershed area of an ungaged tributary is 5, the flows in the ungaged tributary are estimated to be half of those in the gaged tributary. The method is typically used to calculate low flow or flood frequency statistics. In that context a weighting factor is recommended when the drainage area ratio of the two sites is between 0.5 and 1.5. Weighting factors can be evaluated if instantaneous observed flows are available at the ungaged location.
Flow-probability-probability-flow (QPPQ)	Tributary flow	The flow-probability-probability-flow (QPPQ) method makes use of relating flow duration curves between a gaged tributary and an ungaged tributary (Lorenz and Ziegeweid, 2016). The flow duration curve at ungaged sites is estimated using regression approaches (Risley et al., 2008) and the online USGS tool StreamStats (Ries et al., 2017).
Adiabatic adjustment	Air temperature	Air temperature can vary significantly throughout a watershed, particularly with large differences in elevation from headwaters to the mouth of the drainage. To account for these differences, air temperatures can be adjusted using an equation that relates air temperature measured at a meteorological station to a location of a given elevation using the dry adiabatic lapse rate of 9.8 °C/km and the differences in elevation.
GIS Data	Channel position, Channel width, Landcover, Gradient, Elevation, Topographic shade angles	Several landscape scale GIS data sets can be used to derive a number of model parameters. Digital orthophotos quads (DOQs) are used to classify landcover and estimate vegetation type, height, density, and overhang. DOQs can also be used to determine stream position, stream aspect, and channel width. A digital elevation model (DEM) consists of digital information that provides a uniform matrix of terrain elevation values. It provides basic quantitative data for deriving surface elevation, stream gradient, and maximum topographic shade angles.

6.4 Effective shade curves and lookup tables

Effective shade curves are plots that present the maximum possible effective shade as a function of different types of natural near-stream vegetation, active channel widths, and stream aspect. Channel width is plotted on the x-axis, effective shade is on the y-axis, and a separate symbol and/or line color is used for each stream aspect. Separate plots are produced for each type of natural vegetation that is expected in the TMDL project area. The plots are called effective shade curves because the pattern on the plot resembles a gentle downward slopping curve. As channel width increases effective shade gets smaller. The plots are produced from the output of Heat Source version 6 shade models that have been parameterized with every combination of the previously mentioned conditions. The effective shade curve approach can be used almost anywhere to quantify the amount of background solar radiation loading and the effective shade necessary to eliminate temperature increases from anthropogenic disturbance or removal of near-stream vegetation.

This model approach can also be used to develop a lookup table to determine the effective shade resulting from other combinations vegetation height, vegetation density, vegetation overhang, and vegetation buffer widths that are different from background conditions. The lookup table provides a convenient way for readers of the TMDL to estimate the effective shade for current conditions without using the model. The lookup table can also be used as a reverse lookup to determine what vegetation height, buffer width, or vegetation density would achieve a certain effective shade.

6.4.1 Model domain

The model domain is not specific to any single waterbody but will be parameterized using a latitude and longitude located in the TMDL watershed to ensure that the modeled solar altitude and sun angles are appropriate for the area.

6.4.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The spatial resolution is not very meaningful however, since each output distance step will represent a unique combination of the different modeled vegetation and channel conditions. The model time step (*dt*) is 1 minute and outputs are generated every hour.

6.4.3 Source characteristics

The effective shade curve approach can be used almost anywhere in the watershed to quantify the amount of background solar radiation loading and the effective shade necessary to eliminate temperature increases from anthropogenic disturbance or removal of near-stream vegetation.

The lookup tables can be used to estimate existing shade or current solar loading. Other potential sources of thermal loading and the temperature response will not be evaluated by this model.

6.4.4 Time frame of simulation

The model period is a single day in late July or early August. This time frame was chosen to characterize the solar loading when maximum stream temperatures are observed, the sun altitude angle is highest, and the period of solar exposure is longest.

6.4.5 Important assumptions

Models used to develop effective shade curves assume no cloud cover and no topographic shade. The modeled terrain is flat so there is no difference in ground elevation between the stream and the adjacent vegetation buffer area. The vegetation density, vegetation height, vegetation overhang, and vegetation buffer width are assumed to be equal on both sides of the stream. The width of the active channel is assumed to be equal to the distance between near-stream vegetation on either side of the stream.

Effective shade curves were developed for the original Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006). Adjustments to the existing shade curve models are unlikely to occur as part of this project. However, if it is determined that the models need to be updated DEQ will follow the procedures outlined in this QAPP.

6.4.6 Model inputs

There are two categories of models each with different sets of inputs:

- Effective shade curves: Model input values for vegetation height, vegetation density, vegetation overhang, and vegetation buffer width correspond to the restored streamside vegetation types expected in areas that are currently lacking streamside vegetation because of anthropogenic disturbance. The specific values will be determined during the TMDL process and will likely be the same or similar to the values presented in the Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006). The other model inputs are the same as what is described in Table 13.

- Effective shade lookup tables: Model input values to be used for the lookup tables are described in Table 13.

Table 13: Range of model inputs to be used for effective shade lookup tables.

Model Input	Value Range
Vegetation height (meters)	0 - 90 (or expected maximum)
Vegetation density (percent)	0 -100
Vegetation overhang (meters)	0 - 3 (or expected maximum)
Vegetation buffer width (meters)	0 - 45
Active channel width (meters)	0 - 100 (or expected maximum)
Stream aspect (degrees)	North/South (0/180); Northeast/Southwest (45/225); East/West (90/270); Southeast/Northwest (135/315)
Topographic shade angles (degrees)	0
Cloudiness	0

6.5 Canton Creek (Spawning period)

The Canton Creek (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA’s contractor Tetra Tech.

6.5.1 Model domain

The extent of the model domain is Canton Creek from just above the confluence of Pass Creek to the mouth of Canton Creek at the confluence of Steamboat Creek. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.5.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.5.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along Canton Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation and background sources (DEQ, 2006). Other potential sources include channel modification and widening, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along Canton Creek is forestry accounting for about 100 percent of the near-stream area. Table 14 summarizes all the land uses within 100 meters of the digitized Canton Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 14: Summary of land uses within 100 meters of the digitized Canton Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	807.3	95.9
Shrub/Scrub	16.2	1.9
Mixed Forest	13.6	1.6
Herbaceous	3.3	0.4
Deciduous Forest	1.3	0.2

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 15).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 15 summarizes the potential designated management agencies and responsible persons along the Canton Creek model extent.

Table 15: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Canton Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Bureau of Land Management	476.8	52.8
Oregon Department of Forestry - Private Forestland	286.3	31.7
U.S. Forest Service	139.9	15.5

6.5.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.5.5 Important assumptions

There is limited availability of temperature or flow data for some of the tributaries to Canton Creek. These model inputs will be derived using the methods described in Section 6.3. It is assumed that these approaches will do a reasonably good job of estimating the tributary temperatures or flow rates. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

6.5.6 Model inputs

Table 16 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 16: Boundary condition and tributary inputs to the Canton Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Canton Creek	16.77	Boundary Condition	Flow	Derived data.	
Canton Creek above Pass Creek (CAPA)	16.85	Boundary Condition	Water Temperature	BLM	
Pass Creek	16.75	Tributary	Flow	Derived data.	
Spring at model kilometer 13.2	13.2	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Trapper Creek	11.6	Tributary	Flow	Derived data.	
Wolverine Creek	10.2	Tributary	Flow	Derived data.	
Brouse Creek	9.1	Tributary	Flow	Derived data.	
Hipower Creek	4.25	Tributary	Flow	Derived data.	
Pass Creek (PASS)	16.75	Tributary	Water Temperature	BLM	
Spring at model kilometer 13.2	13.2	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD.
Trapper Creek	11.6	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD.
Wolverine Creek	10.2	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD.
Brouse Creek	9.1	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD.
Hipower Creek	4.25	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD.
353036	1.25, 10.5, 16.85	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.5.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 17. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 17: Calibration sites and parameters used in the Canton Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Canton Creek at Mouth (UmpNF-016)	1.25	Water Temperature	USFS

6.6 Canton Creek (Summer period)

The Canton Creek (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.6.1 Model domain

The extent of the model domain is Canton Creek from just above the confluence of Pass Creek to the mouth of Canton Creek at the confluence of Steamboat Creek. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.6.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.6.3 Source characteristics

For discussion of the Canton Creek source characteristics, see Section 6.5.3.

6.6.4 Time frame of simulation

The model period is July 12, 2002 to July 31, 2002.

6.6.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.6.6 Model inputs

Table 18 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 18: Boundary condition and tributary inputs to the Canton Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Canton Creek above Pass Creek	16.95	Boundary Condition	Flow	Derived data.	Constant flow input of 0.095 cms.
Canton Creek above Pass Creek (27884-ORDEQ)	16.95	Boundary Condition	Water Temperature	BLM	
Pass Creek	16.75	Tributary	Flow	Derived data.	Constant flow input of 0.14 cms.
Spring at model kilometer 13.2	13.2	Tributary	Flow	Derived data.	Constant flow input of 0.0113 cms.
Trapper Creek	11.6	Tributary	Flow	Derived data.	Constant flow input of 0.0504 cms.
Wolverine Creek	10.2	Tributary	Flow	Derived data.	Constant flow input of 0.0425 cms.
Brouse Creek	9.1	Tributary	Flow	Derived data.	Constant flow input of 0.0085 cms.
Hipower Creek	4.25	Tributary	Flow	Derived data.	Constant flow input of 0.0566 cms.
Pass Creek (27894)	16.75	Tributary	Water Temperature	BLM Roseburg	
Spring at model kilometer 13.2 (TIR)	13.2	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	Derived from TIR. Constant temperature of 18.0 deg-C.
Trapper Creek	11.6	Tributary	Water Temperature	USFS	
Wolverine Creek	10.2	Tributary	Water Temperature	DEQ	
Brouse Creek	9.1	Tributary	Water Temperature	Derived data.	Trapper Creek data used as surrogate.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Hipower Creek	4.25	Tributary	Water Temperature	Derived data.	Trapper Creek data minus 2 °C used as surrogate.
353036	1.25, 10.5, 16.85	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.6.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 19. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 19: Calibration sites and parameters used in the Canton Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Canton Creek above Pass Creek (27884-ORDEQ)	16.85	Water Temperature	BLM
Canton Creek above Grizzly Creek	13.3	Flow	DEQ
Canton Creek above Wolverine Creek	10.65	Flow	DEQ
Canton Creek at Campground above Hipower Creek	4.8	Flow	DEQ
Canton Creek at Mouth (29797)	1.25	Water Temperature	USFS
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

6.7 Cavitt Creek

Cavitt Creek is a major tributary to the Little River. The Cavitt Creek model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ for both the Little River TMDL (DEQ, 2002a) as well as the Umpqua River Basin TMDL (DEQ, 2006).

6.7.1 Model domain

The extent of the model domain is Cavitt Creek from the confluence of Cultus Creek to the mouth of Cavitt Creek at the confluence of the Little River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.7.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.7.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along Cavitt Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, reductions to the stream flow rate or volume, and background sources (DEQ, 2006). Other potential sources include channel modification and widening, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along Cavitt Creek is forestry accounting for about 100 percent of the near-stream area. Table 20 summarizes all the land uses within 100 meters of the digitized Cavitt Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 20: Summary of land uses within 100 meters of the digitized Cavitt Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	618.0	66.6
Mixed Forest	121.9	13.1
Herbaceous	82.3	8.9
Deciduous Forest	74.5	8
Shrub/Scrub	30.2	3.3
Woody Wetlands	1.6	0.2

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 21).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 21 summarizes the potential designated management agencies and responsible persons along the Cavitt Creek model extent.

Table 21: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Cavitt Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
Oregon Department of Forestry - Private Forestland	789.2	68.4
Douglas County	229.9	19.9
U.S. Forest Service	86.8	7.5
U.S. Bureau of Land Management	47.5	4.1

6.7.4 Time frame of simulation

The model period is July 12, 2002 to July 31, 2002.

6.7.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDLs (DEQ, 2002a; DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.7.6 Model inputs

Table 22 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 22: Boundary condition and tributary inputs to the Cavitt Creek Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Cavitt Creek and Cultus Creek confluence	19.15	Boundary Condition	Flow	Derived data.	Constant flow input of 0.06456 cms.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Cavitt Creek and Cultus Creek confluence	19.15	Boundary Condition	Water Temperature	DEQ	
Cultus Creek	19.05	Tributary	Flow	Derived data.	Constant flow input of 0.06 cms.
Springer Creek	14.2	Tributary	Flow	Derived data.	Constant flow input of 0.0142 cms.
Boulder Creek	9.75	Tributary	Flow	Derived data.	Constant flow input of 0.04814 cms.
McKay Creek	4.7	Tributary	Flow	Derived data.	Constant flow input of 0.01416 cms.
Cultus Creek (29813-ORDEQ)	19.05	Tributary	Water Temperature	USFS	
Springer Creek	14.2	Tributary	Water Temperature	Derived data.	Cultus Creek data plus 2 °C used as surrogate.
Boulder Creek	9.75	Tributary	Water Temperature	Derived data.	Cultus Creek data plus 4 °C used as surrogate.
McKay Creek	4.7	Tributary	Water Temperature	Derived data.	Cultus Creek data plus 2 °C used as surrogate.
No Station ID	0.65, 5.8	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.7.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 23. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 23: Calibration sites and parameters used in the Cavitt Creek Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Cavitt Creek at Cavitt Creek Road Bridge	12.8	Flow, Effective Shade	DEQ
Cavitt Creek at BLM Campground	5.9	Flow, Effective Shade	DEQ
Cavitt Creek near Mouth at Douglas County Park	0.5	Flow, Effective Shade	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

6.8 Clearwater River (Spawning period)

The Clearwater River (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA's contractor Tetra Tech.

6.8.1 Model domain

The extent of the model domain is the Clearwater River below Diversion 1 to the mouth. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.8.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.8.3 Source characteristics

Clearwater River is a tributary to the North Umpqua River at Toketee Reservoir. Clearwater River is part of Pacific Power hydroelectric project area and flow below Stump Lake has been reduced by hydroelectric water diversion. As described in the Umpqua River Basin TMDL (DEQ, 2006), the Clearwater River simulation begins at Stump Lake (near river mile 8.1). Since the natural thermal potential scenario has more instream flow than the current condition, there is less variability in the temperature profile. Powerhouse #1 is located near river mile 5, where the current temperature drops approximately 5 deg-C. This temperature decrease is a result of previously diverted water coming back to the Clearwater River through Powerhouse #1.

Increases in solar radiation loading from the disturbance or removal of near-stream vegetation is another source of temperature warming. Other potential sources include channel modification and widening and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

6.8.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.8.5 Important assumptions

Model development for the Clearwater River relies upon deriving flow rates for Powerhouse #1 and Mowich Creek. A flow mass balance, drainage area ratio, or the flow-probability-probability-flow approach will be used to estimate these flow rates. Temperature data for Powerhouse #1 is also not available. These data will be derived using the methods described in Section 6.3. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

6.8.6 Model inputs

Table 24 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 24: Boundary condition and tributary inputs to the Clearwater River (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Clearwater River below Diversion 1 (14314500)	12.4	Boundary Condition	Flow	USGS	
Clearwater River below Diversion 1 (25711-ORDEQ)	12.4	Boundary Condition	Water Temperature	DEQ	
Mowich Creek	8.2	Tributary	Flow	Derived data.	
Powerhouse 1 outlet	8.1	Tributary	Flow	Derived data.	
Watson Creek	2.1	Tributary	Flow	Derived data.	Measured instantaneous flow for 9/10/2009. Derived for other periods
Mowich Creek (UmpNF-064)	8.2	Tributary	Water Temperature	USFS	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Powerhouse 1 outlet	8.1	Tributary	Water Temperature	Derived data.	
Watson Creek (36085-ORDEQ)	2.1	Tributary	Water Temperature	DEQ	

6.8.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 25. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 25: Calibration sites and parameters used in the Clearwater River (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Clearwater River above Clearwater 2 Diversion (25712-ORDEQ)	8.40	Water Temperature	DEQ
Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR (14314700)	8.05	Flow	USGS
Clearwater River below Clearwater 2 Diversion (25714-ORDEQ)	7.60	Water Temperature	DEQ
Clearwater River near mouth (Field Site #52)	0.15	Effective Shade	DEQ
Clearwater River above Toketee Reservoir (36132-ORDEQ)	0.10	Flow	DEQ
Clearwater River near Mouth (upstream of diversion) (36132-ORDEQ)	0.10	Water Temperature	DEQ

6.9 Clearwater River (Summer period)

The Clearwater River (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.9.1 Model domain

The extent of the model domain is the Clearwater River from Stump Lake to the mouth of the Clearwater River at the confluence of the North Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.9.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.9.3 Source characteristics

For discussion of the Clearwater River source characteristics, see Section 6.8.3.

6.9.4 Time frame of simulation

The model period is July 08, 2001 to July 11, 2001.

6.9.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.9.6 Model inputs

Table 26 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 26: Boundary condition and tributary inputs to the Clearwater River (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Clearwater River below Diversion 1 (14314500)	13.45	Boundary Condition	Flow	USGS	Constant flow input of 0.1927 cms.
Clearwater River below Diversion 1 (CLR1T)	13.45	Boundary Condition	Water Temperature	DEQ	
Powerhouse 1 outlet	8.1	Tributary	Flow	DEQ	Constant flow input of 4.28 cms.
Watson Creek	2.1	Tributary	Flow	DEQ	Constant flow input of 0.08 cms.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Powerhouse 1 outlet (CLR1PI (25740-ORDEQ))	8.1	Tributary	Water Temperature	PacifiCorp	CLR1PI, Clearwater 1 Powerhouse intake minus 2 degrees
Watson Creek (25715-ORDEQ)	2.1	Tributary	Water Temperature	USFS	
No Station ID	0.1, 7.8, 8.35, 13	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.9.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 27. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 27: Calibration sites and parameters used in the Clearwater River (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Clearwater 1 Bypass at top (CLR1T)	13	Water Temperature, Flow	PacifiCorp, DEQ
Clearwater 1 Bypass at bottom (CLR1B)	8.35	Water Temperature, Flow	PacifiCorp, DEQ
Clearwater 2 Bypass at top (CLR2T)	8	Flow	DEQ
Clearwater 2 Bypass at top (CLR2T)	7.8	Water Temperature	PacifiCorp
Clearwater 2 Bypass at bottom (CLR2B)	0.1	Water Temperature, Flow	PacifiCorp, DEQ
Clearwater River near mouth		Effective Shade	DEQ

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)

6.10 Fish Creek (2001)

The Fish Creek (2001) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.10.1 Model domain

The extent of the model domain is Fish Creek from the confluence of Clear Creek to the mouth of Fish Creek at the confluence of the North Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.10.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.10.3 Source characteristics

Fish Creek is part of Pacific Power hydroelectric project area and flows into the North Umpqua River below Slide Creek Dam and above Soda Springs Dam. The primary sources of thermal loading contributing to temperatures exceedances along Fish Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, reductions to the stream flow rate from the hydroelectric project, and background sources (DEQ, 2006). Other potential sources include channel modification and widening and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along Fish Creek accounting for about percent of the near-stream area. Table 28 summarizes all the land uses within 100 meters of the digitized Fish Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 28: Summary of land uses within 100 meters of the digitized Fish Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	1069.9	96.5
Shrub/Scrub	31.1	2.8

2016 NLCD Land Cover	Acres	Percent of Total Acres
Mixed Forest	4.0	0.4
Developed, Open Space	2.7	0.2
Developed, Low Intensity	0.4	<0.05
Herbaceous	0.2	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 29).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 29 summarizes the potential designated management agencies and responsible persons along the Fish Creek model extent.

Table 29: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Fish Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	3878.7	99.9
Oregon Department of Transportation	4.4	0.1

6.10.4 Time frame of simulation

The model period is July 08, 2001 to July 11, 2001.

6.10.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.10.6 Model inputs

Table 30 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 30: Boundary condition and tributary inputs to the Fish Creek (2001) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Fish Creek at Clear Creek	22.5	Boundary Condition	Flow	Derived data.	Continuous temperature input of 0.174 cms.
Fish Creek at Clear Creek	22.5	Boundary Condition	Water Temperature	PacifiCorp	
Clear Creek at Mouth	22.25	Tributary	Flow	Derived data.	Constant flow input of 0.32 cms.
Unnamed stream at model kilometer 21.25	21.25	Tributary	Flow	Derived data.	Constant flow input of 0.104 cms.
Black Rock Creek	20.2	Tributary	Flow	Derived data.	Constant flow input of 0.223 cms.
Grave Creek	18	Tributary	Flow	Derived data.	Constant flow input of 0.0617 cms.
Brodie Creek	15.95	Tributary	Flow	Derived data.	Constant flow input of 0.09 cms.
Rough Creek	14.8	Tributary	Flow	Derived data.	Constant flow input of 0.346 cms.
Unnamed stream at model kilometer 11.75	11.75	Tributary	Flow	Derived data.	Constant flow input of 0.014 cms.
Slipper Creek	9.9	Tributary	Flow	Derived data.	Constant flow input of 0.0818 cms.
Eva Creek	7.55	Tributary	Flow	Derived data.	Constant flow input of 0.0283 cms.
Pie Creek	4.15	Tributary	Flow	Derived data.	Constant flow input of 0.01415 cms.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Clear Creek at Mouth (25720-ORDEQ)	22.25	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 21.25	21.25	Tributary	Water Temperature	Derived data.	Used temperature data from Rough Creek (PacifiCorp).
Black Rock Creek	20.2	Tributary	Water Temperature	DEQ	
Grave Creek	18	Tributary	Water Temperature	Derived data.	Used temperature data from Rough Creek (PacifiCorp).
Brodie Creek	15.95	Tributary	Water Temperature	Derived data.	Used temperature data from Rough Creek (PacifiCorp).
Rough Creek	14.8	Tributary	Water Temperature	PacifiCorp	
Unnamed stream at model kilometer 11.75	11.75	Tributary	Water Temperature	DEQ	
Slipper Creek	9.9	Tributary	Water Temperature	DEQ	
Eva Creek	7.55	Tributary	Water Temperature	DEQ	
Pie Creek	4.15	Tributary	Water Temperature	DEQ	
No Station ID	0.2, 9.8, 10.8, 14.9	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.10.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 31. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 31: Calibration sites and parameters used in the Fish Creek (2001) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Above Rough Creek	14.9	Flow	DEQ
Fish Creek upstream Mowich Creek	14.9	Water Temperature	PacifiCorp
Fish Creek below dam (bypass at top) (FISHT)	10.8	Water Temperature	PacifiCorp
FISHT (Below Diversion Dam)	10.8	Flow	DEQ
Below Slipper Creek	9.8	Flow	DEQ
Fish Creek at USGS Gage below Slipper Creek	9.8	Water Temperature	PacifiCorp
Fish Creek at powerhouse/Mouth (FISHB)	0.2	Water Temperature	PacifiCorp
FISHB (Mouth)	0.2	Flow	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)

6.11 Fish Creek (2009)

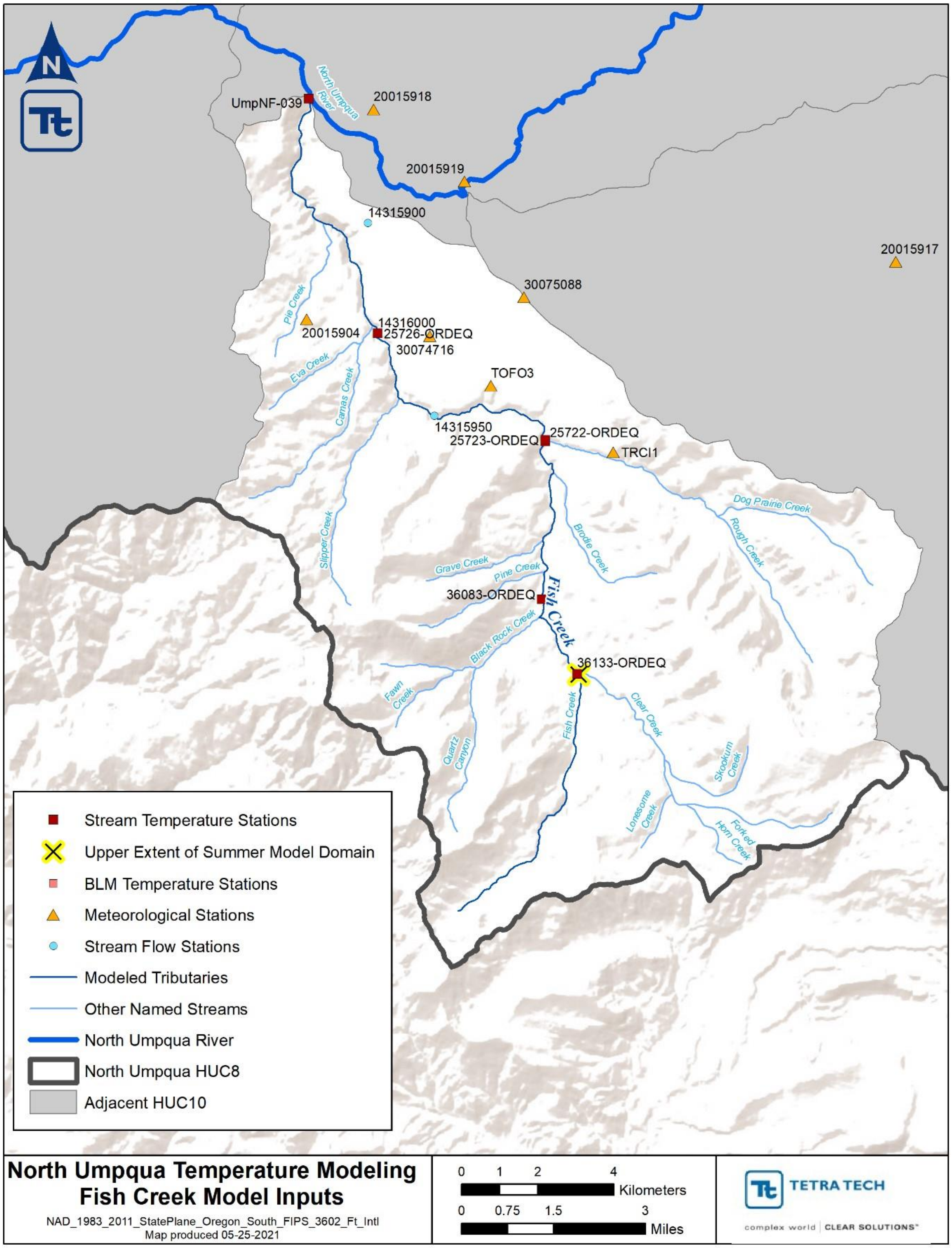

Figure 3: Map of Fish Creek (2009) Model Inputs.

The existing Fish Creek temperature model developed for PacifiCorp (WSI and MBG, 2012) will be utilized for the spawning period Fish Creek temperature calibration and adjusted as needed.

6.11.1 Model domain

The extent of the model domain is Fish Creek from the PacifiCorp diversion structure to the mouth of Fish Creek at the confluence of the North Umpqua River (Figure 3). The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.11.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.11.3 Source characteristics

For discussion of the Fish Creek source characteristics, see Section 6.10.3.

6.11.4 Time frame of simulation

The model period is June 01, 2009 to October 15, 2009.

6.11.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the PacifiCorp model report (WSI and MBG, 2012) and the model user guide (Boyd and Kasper, 2003).

6.11.6 Model inputs

Table 32 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 32: Boundary condition and tributary inputs to the Fish Creek (2009) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Fish Creek Above Slipper Creek Near Toketee Falls (14315950)	11.40	Boundary Condition	Flow	USGS	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Fish Creek below Fish Creek Diversion Dam (FISHT)	11.40	Boundary Condition	Water Temperature	PacifiCorp	
Slipper Creek	9.90	Tributary	Flow	Derived data.	
Camas Creek	7.55	Tributary	Flow	Derived data.	
Pie Creek	4.15	Tributary	Flow	Derived data.	
Slipper Creek	9.90	Tributary	Water Temperature	Derived data.	Set to the same as Fish Creek at the diversion (FISHT).
Camas Creek	7.55	Tributary	Water Temperature	Derived data.	Set to the same as Fish Creek at the diversion (FISHT).
Pie Creek	4.15	Tributary	Water Temperature	Derived data.	Set to the same as Fish Creek at the diversion (FISHT).

6.11.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 33. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 33: Calibration sites and parameters used in the Fish Creek (2009) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Fish Creek downstream of Slipper Creek (Field Site #59)	7.90	Flow	DEQ
Fish Creek downstream Slipper Creek (Field Site #59)	7.90	Effective Shade	DEQ
Fish Creek At Big Camas Rngr Sta Near Toketee Falls (14316000)	7.40	Flow	USGS
Fish Creek Below Slipper Creek, North Umpqua River (25726-ORDEQ)	7.40	Water Temperature	DEQ

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Fish Creek at mouth (UmpNF-039)	0.20	Water Temperature	USFS
Fish Creek at mouth (Field Site #60)	0.15	Flow, Effective Shade	DEQ

6.12 Lake Creek (Spawning period)

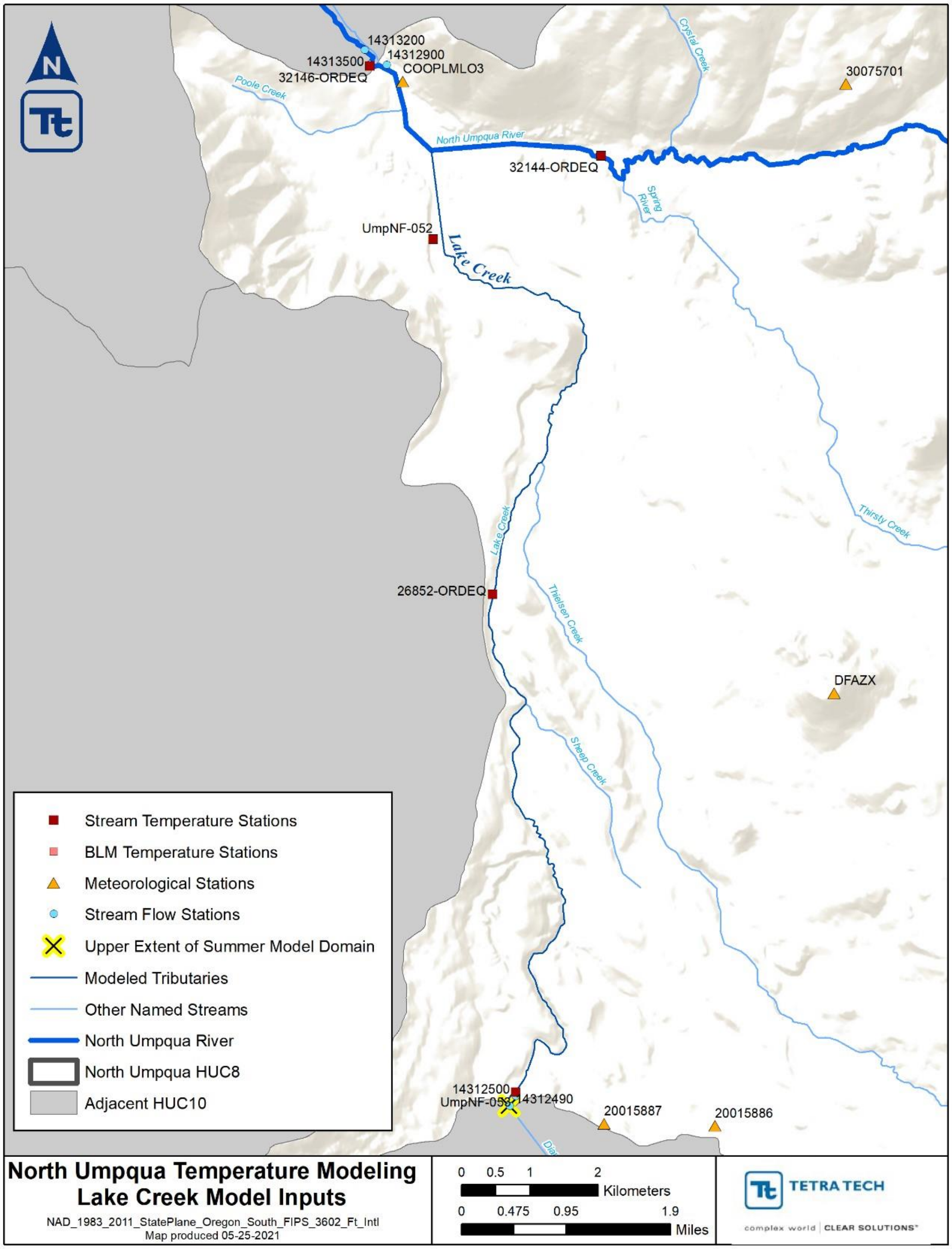

Figure 4: Map of Lake Creek (Spawning period) Model Inputs.

The Lake Creek (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA's contractor Tetra Tech.

6.12.1 Model domain

The extent of the model domain is Lake Creek from Diamond Lake to the mouth of Lake Creek at the confluence of the North Umpqua River (Figure 4). The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.12.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.12.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along Lake Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation and background sources (DEQ, 2006). Other potential sources include reductions to stream flow rates and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along Lake Creek is forestry accounting for about 99 percent of the near-stream area. Table 34 summarizes all the land uses within 100 meters of the digitized Lake Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 34: Summary of land uses within 100 meters of the digitized Lake Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	796.6	95
Shrub/Scrub	18.5	2.2
Woody Wetlands	10.7	1.3
Developed, Open Space	9.6	1.1
Herbaceous	1.8	0.2
Barren Land	1.3	0.2
Emergent Herbaceous Wetlands	0.2	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 35).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 35 summarizes the potential designated management agencies and responsible persons along the Lake Creek model extent.

Table 35: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Lake Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	2019.1	100
Oregon Department of Transportation	1.0	<0.05

6.12.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.12.5 Important assumptions

Thielsen Creek and Sheep Creek were excluded on the Lake Creek summer model due to lack of flow. Thielsen Creek and Sheep Creek may have flow during the spawning period. This will be investigated using the measured flow rates and a flow mass balance. If it deemed necessary to include these small tributaries, the flow rates and temperatures will be derived using the methods described in Section 6.3. It is assumed that these approaches will do a reasonably good job of estimating the tributary temperatures or flow rates. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

6.12.6 Model inputs

Table 36 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 36: Boundary condition and tributary inputs to the Lake Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Lake Creek near Diamond Lake, OR (14312500)	17.15	Boundary Condition	Flow	USGS	
Lake Creek below Diamond Lake_LTWT (UmpNF-053)	17.15	Boundary Condition	Water Temperature	USFS	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Station ID TBD	0.1, 17	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.12.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 37. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 37: Calibration sites and parameters used in the Lake Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Lake Creek (26852-ORDEQ)	8.20	Water Temperature	DEQ
Lake Creek at Highway 138 (Field Site #2)	7.45	Effective Shade	DEQ
Lake Creek at the mouth LTWT (UmpNF-052)	0.50	Water Temperature	USFS
Lake Creek at mouth (Field Site #3)	0.40	Effective Shade	DEQ

6.13 Lake Creek (Summer period)

The Lake Creek (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.13.1 Model domain

The extent of the model domain is Lake Creek from Diamond Lake to the mouth of Lake Creek at the confluence of the North Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.13.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.13.3 Source characteristics

For discussion of the Lake Creek source characteristics, see Section 6.12.3.

6.13.4 Time frame of simulation

The model period is July 08, 2001 to July 11, 2001.

6.13.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDLs (DEQ, 2002a; DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.13.6 Model inputs

Table 38 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 38: Boundary condition and tributary inputs to the Lake Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source
Boundary Condition	17.15	Boundary Condition	Flow	DEQ
Boundary Condition	17.15	Boundary Condition	Water Temperature	DEQ
No Station ID	0.1, 17	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ
Lake Creek near mouth (No Station ID)	0.1	Meteorological	Air Temperature	USFS

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.13.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 39. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 39: Calibration sites and parameters used in the Lake Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Lake Creek downstream of Diamond Lake	17	Water Temperature	USFS
Lake Creek at Highway 138		Effective Shade	DEQ
Lake Creek at mouth		Effective Shade	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)

6.14 Little River

The Little River model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.14.1 Model domain

The extent of the model domain is the Little River from the confluence of Hemlock Creek to the mouth of the Little River at the confluence of the North Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.14.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.14.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Little River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, reductions to the stream flow rate or volume, and background sources (DEQ, 2002a). Other potential sources include channel modification and widening and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There is one permitted individual NPDES point source along the model extent. Detail about the point source is summarized in Table 40.

Table 40: Summary of individual NPDES permitted discharges in the Little River.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
USFS - Umpqua National Forest; Wolf Creek Civilian Conservation Center (90964)	43.239/-122.925	NPDES-DOM-Da: Sewage - less than 1 MGD	Little River RM 11.4

The majority land use along the Little River is forestry accounting for about 92 percent of the near-stream area. Table 41 summarizes all the land uses within 100 meters of the digitized Little River centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 41: Summary of land uses within 100 meters of the digitized Little River centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	1385.3	65.8
Herbaceous	216.2	10.3
Shrub/Scrub	171.5	8.1
Deciduous Forest	115.6	5.5
Hay/Pasture	89.0	4.2
Mixed Forest	54.5	2.6
Developed, Open Space	52.5	2.5
Developed, Low Intensity	7.8	0.4
Developed, Medium Intensity	5.8	0.3
Woody Wetlands	2.9	0.1
Barren Land	2.7	0.1
Emergent Herbaceous Wetlands	0.4	<0.05
Developed, High Intensity	0.2	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 42).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 42 summarizes the potential designated management agencies and responsible persons along the Little River model extent.

Table 42: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Little River centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	756.3	34.2
Douglas County	614.8	27.8
Oregon Department of Forestry - Private Forestland	360.3	16.3
Oregon Department of Agriculture	303.3	13.7
U.S. Bureau of Land Management	157.4	7.1
U.S. Government	11.3	0.5
Oregon Department of Transportation	4.9	0.2

6.14.4 Time frame of simulation

The model period is July 12, 2002 to July 31, 2002.

6.14.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDLs (DEQ, 2002a; DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.14.6 Model inputs

Table 43 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 43: Boundary condition and tributary inputs to the Little River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Little River at Hemlock Creek	43	Boundary Condition	Flow	DEQ	
Little River at Hemlock Creek	43	Boundary Condition	Water Temperature	DEQ	
Hemlock Creek	42.7	Tributary	Flow	Derived data.	Constant flow input.
Junction Creek	42.55	Tributary	Flow	Derived data.	Constant flow input.
Pinnacle Creek	42.1	Tributary	Flow	Derived data.	Constant flow input.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Unnamed stream at model kilometer 40.55	40.55	Tributary	Flow	Derived data.	Constant flow input.
Cedar Creek	39.2	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 38.9	38.9	Tributary	Flow	Derived data.	Constant flow input.
Taft Creek	36.6	Tributary	Flow	Derived data.	Constant flow input.
Clover Creek	34.95	Tributary	Flow	Derived data.	Constant flow input.
Black Creek	33.95	Tributary	Flow	Derived data.	Constant flow input.
Possible Spring LB	32.9	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 32.55	32.55	Tributary	Flow	Derived data.	Constant flow input.
Little Taft Creek	31.1	Tributary	Flow	Derived data.	Constant flow input.
White Creek	29.65	Tributary	Flow	Derived data.	Constant flow input.
Negro Creek	27.65	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 27	27	Tributary	Flow	Derived data.	Constant flow input.
Emile Creek	24.35	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 24.15	24.15	Tributary	Flow	Derived data.	Constant flow input.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring LB	22.5	Tributary	Flow	Derived data.	Constant flow input.
Shivigny Creek	22.3	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 21.85	21.85	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 21.25	21.25	Tributary	Flow	Derived data.	Constant flow input.
Little Creek	18.9	Tributary	Flow	Derived data.	Constant flow input.
Wolf Creek	18.25	Tributary	Flow	Derived data.	Constant flow input.
Greenmand Creek	17.3	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 16.45	16.45	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 14.05	14.05	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 12.95	12.95	Tributary	Flow	Derived data.	Constant flow input.
Bond Creek	12.4	Tributary	Flow	Derived data.	Constant flow input.
Cavitt Creek	11.8	Tributary	Flow	Derived data.	Constant flow input.
Jim Creek	11.75	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 11.5	11.5	Tributary	Flow	Derived data.	Constant flow input.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 10.25	10.25	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 9.9	9.9	Tributary	Flow	Derived data.	Constant flow input.
Engles Creek	9.4	Tributary	Flow	Derived data.	Constant flow input.
Small Tributary	9.25	Tributary	Flow	Derived data.	Constant flow input.
Rattlesnake Creek	8.4	Tributary	Flow	Derived data.	Constant flow input.
Williams Creek	6.9	Tributary	Flow	Derived data.	Constant flow input.
Small Tributary	5.7	Tributary	Flow	Derived data.	Constant flow input.
Falls Creek	4.65	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 2.95	2.95	Tributary	Flow	Derived data.	Constant flow input.
Log Pond	2.25	Tributary	Flow	Derived data.	Constant flow input.
Buckhorn Creek	2.05	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 1.45	1.45	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 1.3	1.3	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 1.15	1.15	Tributary	Flow	Derived data.	Constant flow input.
Hemlock Creek	42.7	Tributary	Water Temperature	DEQ	
Junction Creek	42.55	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Pinnacle Creek	42.1	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 40.55	40.55	Tributary	Water Temperature	DEQ	
Cedar Creek	39.2	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 38.9	38.9	Tributary	Water Temperature	DEQ	
Taft Creek	36.6	Tributary	Water Temperature	DEQ	
Clover Creek	34.95	Tributary	Water Temperature	DEQ	
Black Creek	33.95	Tributary	Water Temperature	DEQ	
Possible Spring LB	32.9	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 32.55	32.55	Tributary	Water Temperature	DEQ	
Little Taft Creek	31.1	Tributary	Water Temperature	DEQ	
White Creek	29.65	Tributary	Water Temperature	DEQ	
Negro Creek	27.65	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 27	27	Tributary	Water Temperature	DEQ	
Emile Creek	24.35	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 24.15	24.15	Tributary	Water Temperature	DEQ	
Spring LB	22.5	Tributary	Water Temperature	DEQ	
Shivigny Creek	22.3	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 21.85	21.85	Tributary	Water Temperature	DEQ	
Spring at model kilometer 21.25	21.25	Tributary	Water Temperature	DEQ	
Little Creek	18.9	Tributary	Water Temperature	DEQ	
Wolf Creek	18.25	Tributary	Water Temperature	DEQ	
Greenmand Creek	17.3	Tributary	Water Temperature	DEQ	
Unnamed stream at model kilometer 16.45	16.45	Tributary	Water Temperature	DEQ	
Spring at model kilometer 14.05	14.05	Tributary	Water Temperature	DEQ	
Spring at model kilometer 12.95	12.95	Tributary	Water Temperature	DEQ	
Bond Creek	12.4	Tributary	Water Temperature	DEQ	
Cavitt Creek	11.8	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Jim Creek (TIR)	11.75	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 14.7 deg-C.
Spring at model kilometer 11.5 (TIR)	11.5	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 17 deg-C.
Spring at model kilometer 10.25 (TIR)	10.25	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 15 deg-C.
Spring at model kilometer 9.9 (TIR)	9.9	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 15 deg-C.
Engles Creek	9.4	Tributary	Water Temperature	DEQ	
Small Tributary	9.25	Tributary	Water Temperature	DEQ	
Rattlesnake Creek	8.4	Tributary	Water Temperature	DEQ	
Williams Creek	6.9	Tributary	Water Temperature	DEQ	
Small Tributary	5.7	Tributary	Water Temperature	DEQ	
Falls Creek	4.65	Tributary	Water Temperature	DEQ	
Spring at model kilometer 2.95 (TIR)	2.95	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 15 deg-C.
Log Pond	2.25	Tributary	Water Temperature	DEQ	
Buckhorn Creek	2.05	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 1.45 (TIR)	1.45	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 15 deg-C.
Unnamed stream at model kilometer 1.3	1.3	Tributary	Water Temperature	DEQ	
Spring at model kilometer 1.15 (TIR)	1.15	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature input of 15 deg-C..
No Station ID	12, 28.3	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.14.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 44. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 44: Calibration sites and parameters used in the Little River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Little River Below FS Rd 27 Culvert	43	Flow, Effective Shade	DEQ
Little River Downstream of Taft Cr	36.65	Flow, Effective Shade	DEQ
Little River Upstream of Black Creek	34	Flow, Effective Shade	DEQ

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Little River Below White Creek (29806)	28.3	Water Temperature	USFS
Little River at Emile Creek Campground	25.45	Flow, Effective Shade	DEQ
Little River above Cavitt Creek (30150-ORDEQ)	12	Water Temperature	DEQ
Little River at Peel	10.35	Flow	DEQ
Little River at Glide	0.25	Flow	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

6.15 North Umpqua River (Spawning period)

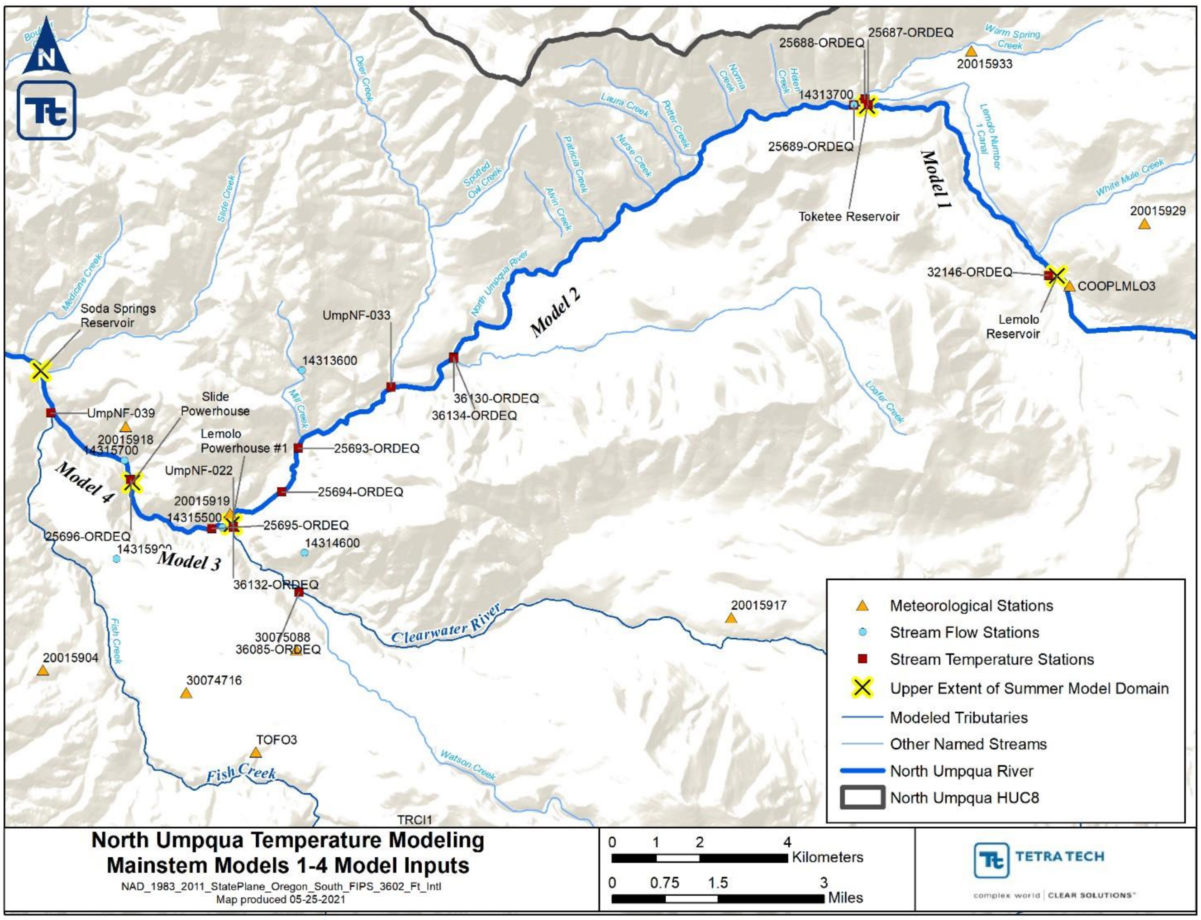

Figure 5: Map of North Umpqua River Spawning Period Models 1-4 Inputs.

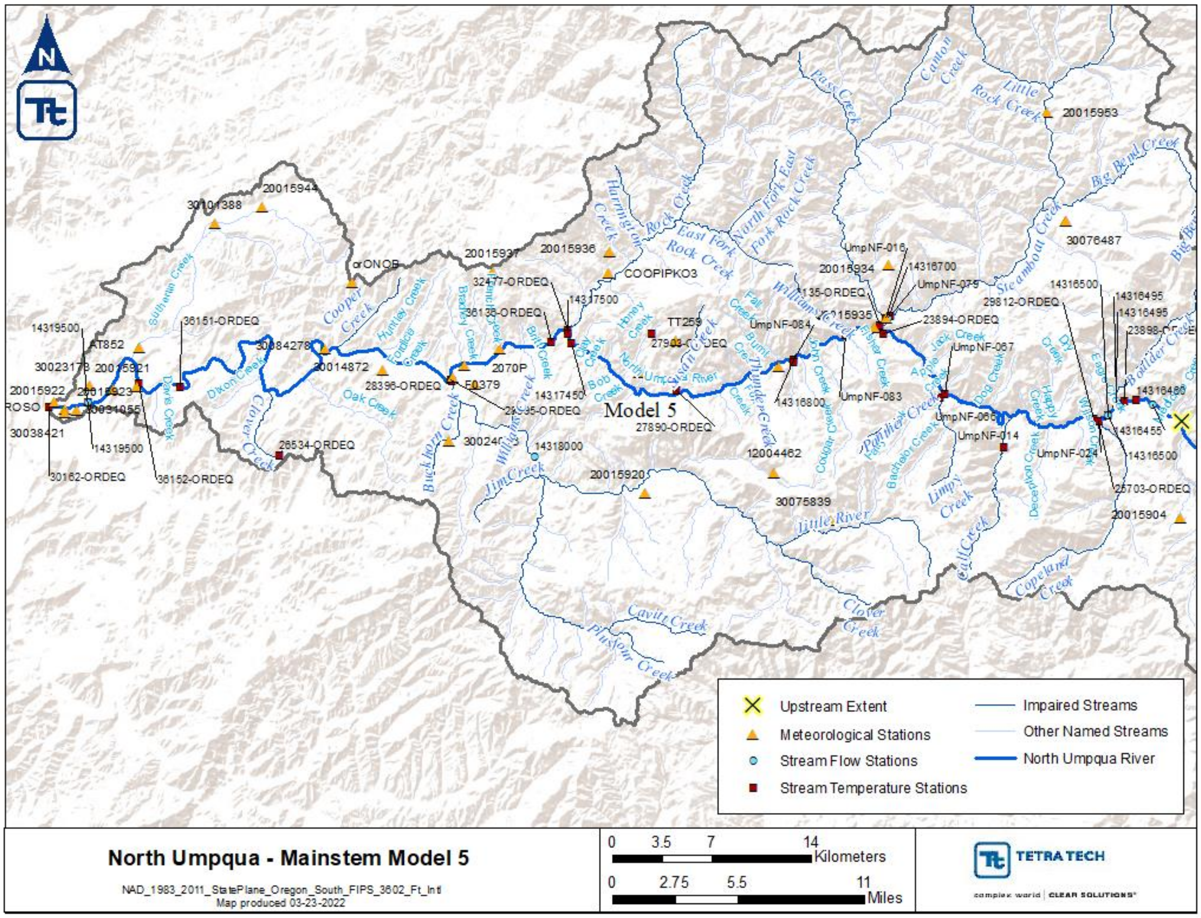

Figure 6: Map of North Umpqua River Spawning Period Model 5 Inputs.

The North Umpqua River (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA's contractor Tetra Tech.

6.15.1 Model domain

The North Umpqua River simulation consists of five separate Heat Source models, each separated by the reservoir or diversion dam (Figure 5 & 6). Since Heat Source is a one-dimensional model, the reservoirs or backwaters behind the dams will not be simulated.

Model 1: Lemolo Reservoir to Lemolo Powerhouse #1.

Model 2: Lemolo Powerhouse #1 to Toketee Reservoir.

Model 3: Toketee Reservoir to Slide Powerhouse.

Model 4: Slide Powerhouse to Soda Springs Reservoir.

Model 5: Soda Springs Reservoir to the mouth.

The specific model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.15.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.15.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the North Umpqua River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, management of water impounded by PacifiCorp's North Umpqua hydroelectric project, point source discharges, and background sources (DEQ, 2006). Other potential sources include warming caused by climate change.

There is one permitted individual NPDES point source along the model extent. Detail about the point source is summarized in Table 45.

Table 45: Summary of individual NPDES permitted discharges in the North Umpqua River.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
Glide-Idleyld Sanitary District (33743)	43.3086/-123.119	NPDES-DOM-Da: Sewage - less than 1 MGD	North Umpqua River RM 27.4

The majority land use along the North Umpqua River is forestry accounting for about 70 percent of the near-stream area. Table 46 summarizes all the land uses within 100 meters of the digitized North Umpqua River centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 46: Summary of land uses within 100 meters of the digitized North Umpqua River centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	3649.0	61.3
Developed, Open Space	783.9	13.2
Hay/Pasture	652.3	11
Herbaceous	201.0	3.4
Emergent Herbaceous Wetlands	142.6	2.4
Shrub/Scrub	137.2	2.3
Woody Wetlands	102.7	1.7
Developed, Low Intensity	101.9	1.7

2016 NLCD Land Cover	Acres	Percent of Total Acres
Mixed Forest	63.6	1.1
Barren Land	62.3	1
Deciduous Forest	34.9	0.6
Developed, Medium Intensity	17.8	0.3
Cultivated Crops	3.6	0.1
Developed, High Intensity	1.8	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 47).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 47 summarizes the potential designated management agencies and responsible persons along the North Umpqua River model extent.

Table 47: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized North Umpqua River centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	11766.1	79
Douglas County	963.1	6.5
Oregon Department of Transportation	811.4	5.5
Oregon Department of Agriculture	663.2	4.5
U.S. Bureau of Land Management	411.2	2.8
Oregon Department of Forestry - Private Forestland	243.8	1.6
Oregon Department of State Lands - Waterway	16.6	0.1
State of Oregon	6.9	<0.05
U.S. Government	2.4	<0.05
Central Oregon & Pacific Railroad	2.0	<0.05
Oregon Department of Fish and Wildlife	0.8	<0.05

6.15.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.15.5 Important assumptions

Model development for the North Umpqua River relies on deriving temperature or flow inputs for a few small tributaries that lack flow and temperature measurements. DEQ plans to use the direct surrogate or linear regression approaches described in Section 6.3 to derive stream temperature, and a combination of a flow mass balance, drainage area ratio, and the flow-probability-probability-flow approaches to estimate stream flow. It is assumed that these approaches do a reasonably good job of estimating the tributary temperatures or flow rates. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available. Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003).

6.15.6 Model inputs

6.15.6.1 Model 1: Lemolo Reservoir to Lemolo Powerhouse #1

Table 48 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 48: Boundary condition and tributary inputs to the Model 1: Lemolo Reservoir to Lemolo Powerhouse #1.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Lemolo Reservoir (14315500)	6.9	Boundary Condition	Flow	USGS	
Lemolo Reservoir (32146-ORDEQ)	6.9	Boundary Condition	Water Temperature	DEQ	
Spring at model kilometer 3.3	3.3	Tributary	Flow	Derived data.	
Spring at model kilometer 3.3	3.3	Tributary	Water Temperature	Derived data.	
Station ID TBD	0.25	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.15.6.2 Model 2: Lemolo Powerhouse #1 to Toketee Reservoir

Table 49 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 49: Boundary condition and tributary inputs to the Model 2: Lemolo Powerhouse #1 to Toketee Reservoir.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
North Umpqua River at Lemolo Powerhouse 1 (14313700)	19.35	Boundary Condition	Flow	USGS	
North Umpqua River at Lemolo Powerhouse 1 (25689-ORDEQ)	19.35	Boundary Condition	Water Temperature	DEQ	
Beverly Creek	17.85	Tributary	Flow	Derived data.	
Helen Creek	17.6	Tributary	Flow	Derived data.	
Dorothy Creek	16.05	Tributary	Flow	Derived data.	
Potter Creek	14.9	Tributary	Flow	Derived data.	
Laura Creek	14.15	Tributary	Flow	Derived data.	
Nurse Creek	13.4	Tributary	Flow	Derived data.	
Barkenburger Creek	12.5	Tributary	Flow	Derived data.	
Patricia Creek	11.75	Tributary	Flow	Derived data.	
Spring at model kilometer 7.65	7.65	Tributary	Flow	Derived data.	
Spring at model kilometer 7.3	7.3	Tributary	Flow	Derived data.	
Loafer Creek	5.8	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Trib from Lemolo Canal	3	Tributary	Flow	Derived data.	
Lemolo Forebay Outlet	1.15	Tributary	Flow	DEQ	
Beverly Creek	17.85	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Helen Creek	17.6	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Dorothy Creek	16.05	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Potter Creek	14.9	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Laura Creek	14.15	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Nurse Creek	13.4	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Barkenburger Creek (25690-ORDEQ)	12.5	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Patricia Creek	11.75	Tributary	Water Temperature	Derived data. PacifiCorp	Surrogate relationship TBD
Spring at model kilometer 7.65	7.65	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Spring at model kilometer 7.3	7.3	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Loafer Creek (36134-ORDEQ)	5.8	Tributary	Water Temperature	DEQ	
Trib from Lemolo Canal	3	Tributary	Water Temperature	Derived data. PacifiCorp	Surrogate relationship TBD
Lemolo Forebay Outlet (LEM2P)	1.15	Tributary	Water Temperature	Derived data. PacifiCorp	Surrogate relationship TBD

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Station ID TBD	1.25, 12.6	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.15.6.3 Model 3: Toketee Reservoir to Slide Powerhouse

Table 50 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 50: Boundary condition and tributary inputs to the Model 3: Toketee Reservoir to Slide Powerhouse.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Toketee Reservoir (14315500)	3.15	Boundary Condition	Flow	USGS	
Toketee Reservoir (25695-ORDEQ)	3.15	Boundary Condition	Water Temperature	DEQ	
Station ID TBD	3	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.15.6.4 Model 4: Slide Powerhouse to Soda Springs Reservoir

Table 51 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 51: Boundary condition and tributary inputs to the Model 4: Slide Powerhouse to Soda Springs Reservoir.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Slide Powerhouse (14315700)	3.15	Boundary Condition	Flow	USGS	
Slide Powerhouse (25696-ORDEQ)	3.15	Boundary Condition	Water Temperature	DEQ	
Fish Creek	0.95	Tributary	Flow	Derived data.	
Fish Creek (UmpNF-039)	0.95	Tributary	Water Temperature	USFS	
Station ID TBD	3	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.15.6.5 Model 5: Soda Springs Reservoir to Mouth

Table 52 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 52: Boundary condition and tributary inputs to the Model 5: Soda Springs Reservoir to Mouth.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Below Soda Springs Powerhouse (14316455)	113.4	Boundary Condition	Flow	USGS	
Below Soda Springs Powerhouse (14316460)	113.4	Boundary Condition	Water Temperature	USGS	
Soda Springs Powerhouse	112.7	Tributary	Flow	Derived data.	
Boulder Creek (14316495)	110.5	Tributary	Flow	USGS	
Copeland Creek	108.45	Tributary	Flow	Derived data.	
Deception Creek	104.2	Tributary	Flow	Derived data.	
Dry Creek	102.05	Tributary	Flow	Derived data.	
Calf Creek	100.65	Tributary	Flow	Derived data.	
Panther Creek	93.9	Tributary	Flow	Derived data.	
Steamboat Creek (14316700)	86.4	Tributary	Flow	USGS	
Fox Creek	70.7	Tributary	Flow	Derived data.	
Rock Creek	56.9	Tributary	Flow	Derived data.	
Little River	46.3	Tributary	Flow	Derived data.	
Soda Springs Powerhouse (14316460)	112.7	Tributary	Water Temperature	USGS	
Boulder Creek (14316495)	110.5	Tributary	Water Temperature	USGS	
Copeland Creek (UmpNF-024)	108.45	Tributary	Water Temperature	USFS	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Deception Creek (25704-ORDEQ)	104.2	Tributary	Water Temperature	Derived data. USFS	Surrogate relationship TBD
Dry Creek (25705-ORDEQ)	102.05	Tributary	Water Temperature	Derived data. USFS	Surrogate relationship TBD
Calf Creek (25706-ORDEQ)	100.65	Tributary	Water Temperature	Derived data. USFS	Surrogate relationship TBD
Panther Creek (UmpNF-067)	93.9	Tributary	Water Temperature	USFS	
Steamboat Creek (36135-ORDEQ)	86.4	Tributary	Water Temperature	DEQ	
Fox Creek	70.7	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Rock Creek (32477-ORDEQ)	56.9	Tributary	Water Temperature	DEQ	
Little River (28396-ORDEQ)	46.3	Tributary	Water Temperature	DEQ	
Station ID TBD	0.2, 13.65, 46.55, 56.95, 77.35, 86.8, 112.5	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS, NCDC, MesoWest	Nearest station(s) with required data will be selected.

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.15.7 Model calibration

6.15.7.1 Model 1: Lemolo Reservoir to Lemolo Powerhouse #1

The expected model calibration sites and data sources are summarized in Table 53. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 53: Calibration sites and parameters used in the Model 1: Lemolo Reservoir to Lemolo Powerhouse #1 Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River Above Lemolo 2 Diversion (25687-ORDEQ)	0.25	Water Temperature	DEQ
North Umpqua River above Lemolo (Field Site #4)	0.20	Effective Shade	DEQ
North Umpqua River downstream Lemolo Dam (Field Site #6)		Effective Shade	DEQ

6.15.7.2 Model 2: Lemolo Powerhouse #1 to Toketee Reservoir

The expected model calibration sites and data sources are summarized in Table 54. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 54: Calibration sites and parameters used in the Model 2: Lemolo Powerhouse #1 to Toketee Reservoir Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River upstream of Barkenburger (25690-ORDEQ)	12.60	Water Temperature	USFS
North Umpqua River upstream of Loafer Creek (36130-ORDEQ)	7.81	Water Temperature	DEQ
North Umpqua River (25693-ORDEQ)	2.87	Water Temperature	DEQ
North Umpqua River (25694-ORDEQ)	1.60	Water Temperature	DEQ
North Umpqua River above Lemolo Powerhouse #2 (Field Site #16)		Effective Shade	DEQ
North Umpqua River below Lemolo 2 Diversion (Field Site #11)		Effective Shade	DEQ
North Umpqua River upstream Loafer Creek (Field Site #13)		Effective Shade	DEQ
North Umpqua River upstream Toketee Reservoir (Field Site #18)		Effective Shade	DEQ

6.15.7.3 Model 3: Toketee Reservoir to Slide Powerhouse

The expected model calibration sites and data sources are summarized in Table 55. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 55: Calibration sites and parameters used in the Model 3: Toketee Reservoir to Slide Powerhouse Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River Above Toketee Powerhouse (25696-ORDEQ)	0	Water Temperature	DEQ
North Umpqua River above Slide Creek Powerplant (Field Site #25)		Effective Shade	DEQ
North Umpqua River above Toketee Powerhouse (Field Site #20)		Effective Shade	DEQ
North Umpqua River upstream Toketee Reservoir (Field Site #19)		Effective Shade	DEQ

6.15.7.4 Model 4: Slide Powerhouse to Soda Springs Reservoir

There are no calibration sites available for the North Umpqua River (Spawning period) Model 4: Slide Powerhouse to Soda Springs Reservoir.

6.15.7.5 Model 5: Soda Springs Reservoir to Mouth

The expected model calibration sites and data sources are summarized in Table 56. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 56: Calibration sites and parameters used in the Model 5: Soda Springs Reservoir to Mouth Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River below Soda Springs Dam (14316455)	113.00	Flow	USGS
North Umpqua Upstream of Boulder Creek (23898-ORDEQ)	111.00	Water Temperature	DEQ
North Umpqua River above Copeland Creek (14316500)	109.00	Water Temperature, Flow	USGS
North Umpqua Upstream Of Steamboat Creek (23894-ORDEQ)	85.00	Water Temperature	DEQ
North Umpqua River at Idleyld Park (Field Site #37)	58.05	Effective Shade	DEQ
North Umpqua River near Idleyld Park, OR (14317450)	57.90	Water Temperature	USGS
North Umpqua River near Idleyld Park (36136-ORDEQ)	55.00	Water Temperature	DEQ

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River downstream of Winchester Dam (Rod & Gun Club Access) (36152-ORDEQ)	13.40	Water Temperature	DEQ
North Umpqua River At Winchester (14319500)	2.90	Flow	USGS
North Umpqua River at Mouth (30162-ORDEQ)	0.20	Water Temperature	DEQ

6.16 North Umpqua River (Summer period)

The North Umpqua River (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.16.1 Model domain

The North Umpqua River simulation consists of six separate Heat Source models, each separated by a reservoir, diversion dam, or Steamboat Creek. Since Heat Source is a one-dimensional model, the reservoirs or backwaters behind the dams were not simulated.

Model 1: Lemolo Reservoir to Lemolo Powerhouse #1.

Model 2: Lemolo Powerhouse #1 to Toketee Reservoir.

Model 3: Toketee Reservoir to Slide Powerhouse.

Model 4: Slide Powerhouse to Soda Springs Reservoir.

Model 5: Soda Springs Reservoir to Steamboat Creek.

Model 6: Steamboat Creek to the mouth.

The specific model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.16.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.16.3 Source characteristics

For discussion of the North Umpqua River source characteristics, see Section 6.15.3.

6.16.4 Time frame of simulation

The model period for North Umpqua Models 1-5 is July 8-11, 2001. The model period for North Umpqua Model 6 is July 12-31, 2002.

6.16.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.16.6 Model inputs

6.16.6.1 Model 1: Lemolo Reservoir to Lemolo Powerhouse #1

Table 57 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 57: Boundary condition and tributary inputs to the Model 1: Lemolo Reservoir to Lemolo Powerhouse #1.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Lemolo Reservoir	6.9	Boundary Condition	Flow	Derived data.	Constant flow input of 0.9466 cms.
Lemolo Reservoir	6.9	Boundary Condition	Water Temperature	Derived data.	Constant temperature input of 8.5 °C.
Spring at model kilometer 3.3	3.3	Tributary	Flow	Derived data.	Constant flow input of 0.08 cms.
Spring at model kilometer 3.3	3.3	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 5.8 °C.
No Station ID	0.25	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.6.2 Model 2: Lemolo Powerhouse #1 to Toketee Reservoir

Table 58 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 58: Boundary condition and tributary inputs to the Model 2: Lemolo Powerhouse #1 to Toketee Reservoir.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
North Umpqua River at Lemolo Powerhouse 1	19.35	Boundary Condition	Flow	Derived data.	Constant flow input of 1.157 cms.
North Umpqua River at Lemolo Powerhouse 1	19.35	Boundary Condition	Water Temperature	DEQ	
Beverly Creek	17.85	Tributary	Flow	Derived data.	Constant flow input.
Helen Creek	17.6	Tributary	Flow	Derived data.	Constant flow input.
Dorothy Creek	16.05	Tributary	Flow	Derived data.	Constant flow input.
Potter Creek	14.9	Tributary	Flow	Derived data.	Constant flow input.
Laura Creek	14.15	Tributary	Flow	Derived data.	Constant flow input.
Nurse Creek	13.4	Tributary	Flow	Derived data.	Constant flow input.
Barkenburger Creek	12.5	Tributary	Flow	Derived data.	Constant flow input.
Patricia Creek	11.75	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 7.65	7.65	Tributary	Flow	Derived data.	Constant flow input.
Spring at model kilometer 7.3	7.3	Tributary	Flow	Derived data.	Constant flow input.
Loafer Creek	5.8	Tributary	Flow	Derived data.	Constant flow input.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Trib from Lemolo Canal	3	Tributary	Flow	Derived data.	Constant flow input.
Lemolo Forebay Outlet	1.15	Tributary	Flow	DEQ	
Beverly Creek	17.85	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 10.6.
Helen Creek	17.6	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 9.6.
Dorothy Creek	16.05	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 9.6.
Potter Creek	14.9	Tributary	Water Temperature	Derived data. PacifiCorp	Used temperature data from LEM2T Lemolo 2 bypass at top station.
Laura Creek	14.15	Tributary	Water Temperature	DEQ	
Nurse Creek	13.4	Tributary	Water Temperature	DEQ	
Barkenburger Creek (25690-ORDEQ)	12.5	Tributary	Water Temperature	Derived data. PacifiCorp	Used temperature data from North Umpqua River upstream of Barkenberger (25690-ORDEQ) plus 1 degree Celsius.
Patricia Creek	11.75	Tributary	Water Temperature	Derived data. PacifiCorp	Used temperature data from North Umpqua River upstream of Barkenberger station plus 1 degree Celsius.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 7.65	7.65	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 8.5.
Spring at model kilometer 7.3	7.3	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 8.5.
Loafer Creek	5.8	Tributary	Water Temperature	Derived data.	TIR derived constant temperature input of 8.5.
Trib from Lemolo Canal	3	Tributary	Water Temperature	Derived data. PacifiCorp	Used temperature data from North Umpqua River upstream of Barkenberger station plus 1 degree Celsius.
Lemolo Forebay Outlet	1.15	Tributary	Water Temperature	DEQ	
No Station ID	1.25, 12.6	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.6.3 Model 3: Toketee Reservoir to Slide Powerhouse

Table 59 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 59: Boundary condition and tributary inputs to the Model 3: Toketee Reservoir to Slide Powerhouse.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Toketee Reservoir	3.15	Boundary Condition	Flow	Derived data.	Constant flow input of 0.53 cms.
Toketee Reservoir	3.15	Boundary Condition	Water Temperature	Derived data.	Toketee Bypass at Top (TOKET) temperature minus 1 °C used as surrogate.
No Station ID	3	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.6.4 Model 4: Slide Powerhouse to Soda Springs Reservoir

Table 60 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 60: Boundary condition and tributary inputs to the Model 4: Slide Powerhouse to Soda Springs Reservoir.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Slide Powerhouse	3.15	Boundary Condition	Flow	Derived data.	Constant flow input of 1.61 cms.
Slide Powerhouse	3.15	Boundary Condition	Water Temperature	Derived data.	Water temperature from Unknown Site at model kilometer 3 input as surrogate.
Fish Creek	0.95	Tributary	Flow	Derived data.	Constant flow input of 1.3 cms.
Fish Creek	0.95	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
No Station ID	3	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.6.5 Model 5: Soda Springs Reservoir to Steamboat Creek

Table 61 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 61: Boundary condition and tributary inputs to the Model 5: Soda Springs Reservoir to Steamboat Creek.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Below Soda Springs Powerhouse	28.9	Boundary Condition	Flow	Derived data.	Constant flow input of 0.9336 cms.
Below Soda Springs Powerhouse	28.9	Boundary Condition	Water Temperature	Derived data.	Temperature data from SODAT station input as surrogate.
Soda Springs Powerhouse	28.2	Tributary	Flow	Derived data.	Constant flow input of 17.98 cms.
Boulder Creek	26	Tributary	Flow	Derived data.	Constant flow input of 0.23 cms.
Copeland Creek	23.95	Tributary	Flow	Derived data.	Constant flow input of 0.142 cms.
Deception Creek	19.7	Tributary	Flow	Derived data.	Constant flow input of 0.024 cms.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Dry Creek	17.55	Tributary	Flow	Derived data.	Constant flow input of 0.0566 cms.
Calf Creek	16.15	Tributary	Flow	Derived data.	Constant flow input of 0.176 cms.
Panther Creek	9.4	Tributary	Flow	Derived data.	Constant flow input of 0.096 cms.
Steamboat Creek	1.9	Tributary	Flow	Derived data.	Constant flow input of 1.93 cms.
Soda Springs Powerhouse	28.2	Tributary	Water Temperature		
Boulder Creek (25701-ORDEQ)	26	Tributary	Water Temperature	USFS	
Copeland Creek (25703-ORDEQ)	23.95	Tributary	Water Temperature	USFS	
Deception Creek (25704-ORDEQ)	19.7	Tributary	Water Temperature	Derived data. USFS	Used temperature data from Copeland Creek (25703-ORDEQ).
Dry Creek (25705-ORDEQ)	17.55	Tributary	Water Temperature	Derived data. USFS	Used temperature data from Copeland Creek (25703-ORDEQ).
Calf Creek (25706-ORDEQ)	16.15	Tributary	Water Temperature	Derived data. USFS	Used temperature data from Copeland Creek (25703-ORDEQ).
Panther Creek (25708-ORDEQ)	9.4	Tributary	Water Temperature	USFS	
Steamboat Creek	1.9	Tributary	Water Temperature	Derived data.	Noted as “estimated data” in model.
No Station ID	2.3, 28	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.6.6 Model 6: Steamboat Creek to Mouth

Table 62 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 62: Boundary condition and tributary inputs to the Model 6: Steamboat Creek to Mouth.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
North Umpqua River at Steamboat Creek	84.5	Boundary Condition	Flow	Derived data.	Constant flow input of 30.519 cms.
North Umpqua River at Steamboat Creek	84.5	Boundary Condition	Water Temperature	Derived data.	Surrogate temperature data from Douglas County gage d/s Steamboat (14316800).
Fox Creek	70.7	Tributary	Flow	Derived data.	Constant flow input of 0.08 cms.
Rock Creek	56.9	Tributary	Flow	Derived data.	Constant flow input of 0.577 cms.
Little River	46.3	Tributary	Flow	Derived data.	Constant flow input of 0.705 cms.
Fox Creek	70.7	Tributary	Water Temperature	Derived data.	Rock Creek (14317600) temperature data minus 3 °C input as surrogate.
Rock Creek (14317600)	56.9	Tributary	Water Temperature	Douglas County	
Little River	46.3	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
No Station ID	0.2, 13.65, 46.55, 56.95, 77.35	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.16.7 Model calibration

6.16.7.1 Model 1: Lemolo Reservoir to Lemolo Powerhouse #1

The expected model calibration sites and data sources are summarized in Table 63. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 63: Calibration sites and parameters used in the Model 1: Lemolo Reservoir to Lemolo Powerhouse #1 Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River at bottom of Lemolo 1 bypass reach (LEM1B)	0.25	Water Temperature	PacifiCorp
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)
North Umpqua River above Lemolo		Effective Shade	DEQ
North Umpqua River downstream Lemolo Dam		Effective Shade	DEQ

6.16.7.2 Model 2: Lemolo Powerhouse #1 to Toketee Reservoir

The expected model calibration sites and data sources are summarized in Table 64. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 64: Calibration sites and parameters used in the Model 2: Lemolo Powerhouse #1 to Toketee Reservoir Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River upstream of Barkenburger (25690-ORDEQ)	12.6	Water Temperature	USFS
North Umpqua River at Lemolo 2 bypass at bottom (LEM2B)	1.25	Water Temperature	PacifiCorp
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)
North Umpqua River above Lemolo Powerhouse #2		Effective Shade	DEQ
North Umpqua River below Lemolo 2 Diversion		Effective Shade	DEQ
North Umpqua River upstream Loafer Creek		Effective Shade	DEQ
North Umpqua River upstream Toketee Reservoir		Effective Shade	DEQ

6.16.7.3 Model 3: Toketee Reservoir to Slide Powerhouse

The expected model calibration sites and data sources are summarized in Table 65. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 65: Calibration sites and parameters used in the Model 3: Toketee Reservoir to Slide Powerhouse Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
North Umpqua River just below Toketee Dam	3	Flow	DEQ
Toketee Bypass at top (TOKET)	3	Water Temperature	PacifiCorp
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)
North Umpqua River above Slide Creek Powerplant		Effective Shade	DEQ
North Umpqua River above Toketee Powerhouse		Effective Shade	DEQ
North Umpqua River upstream Toketee Reservoir		Effective Shade	DEQ

6.16.7.4 Model 4: Slide Powerhouse to Soda Springs Reservoir

The expected model calibration sites and data sources are summarized in Table 66. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 66: Calibration sites and parameters used in the Model 4: Slide Powerhouse to Soda Springs Reservoir Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Unknown Site at model kilometer 3	3	Water Temperature	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)

6.16.7.5 Model 5: Soda Springs Reservoir to Steamboat Creek

The expected model calibration sites and data sources are summarized in Table 67. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 67: Calibration sites and parameters used in the Model 5: Soda Springs Reservoir to Steamboat Creek Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
N Umpqua River above Copeland Creek	28.5	Flow	DEQ
N Umpqua River below Soda Springs Dam	28.5	Flow	DEQ
North Umpqua River below Soda Springs Powerhouse (SODAT)	28	Water Temperature	PacifiCorp
North Umpqua River at Mott Bridge (MOTTB)	2.3	Water Temperature	PacifiCorp
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2001)

6.16.7.6 Model 6: Steamboat Creek to Mouth

The expected model calibration sites and data sources are summarized in Table 68. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 7. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 68: Calibration sites and parameters used in the Model 6: Steamboat Creek to Mouth Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Douglas County Gage d/s Steamboat (14316800)	77.35	Water Temperature	Douglas County
North Umpqua River above Little River Mouth (28395-ORDEQ)	46.55	Water Temperature	DEQ
North Umpqua River at Mouth (30162-ORDEQ)	0.2	Water Temperature	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)
North Umpqua River at Idleyld Park		Effective Shade	DEQ

6.17 Rock Creek (Spawning period)

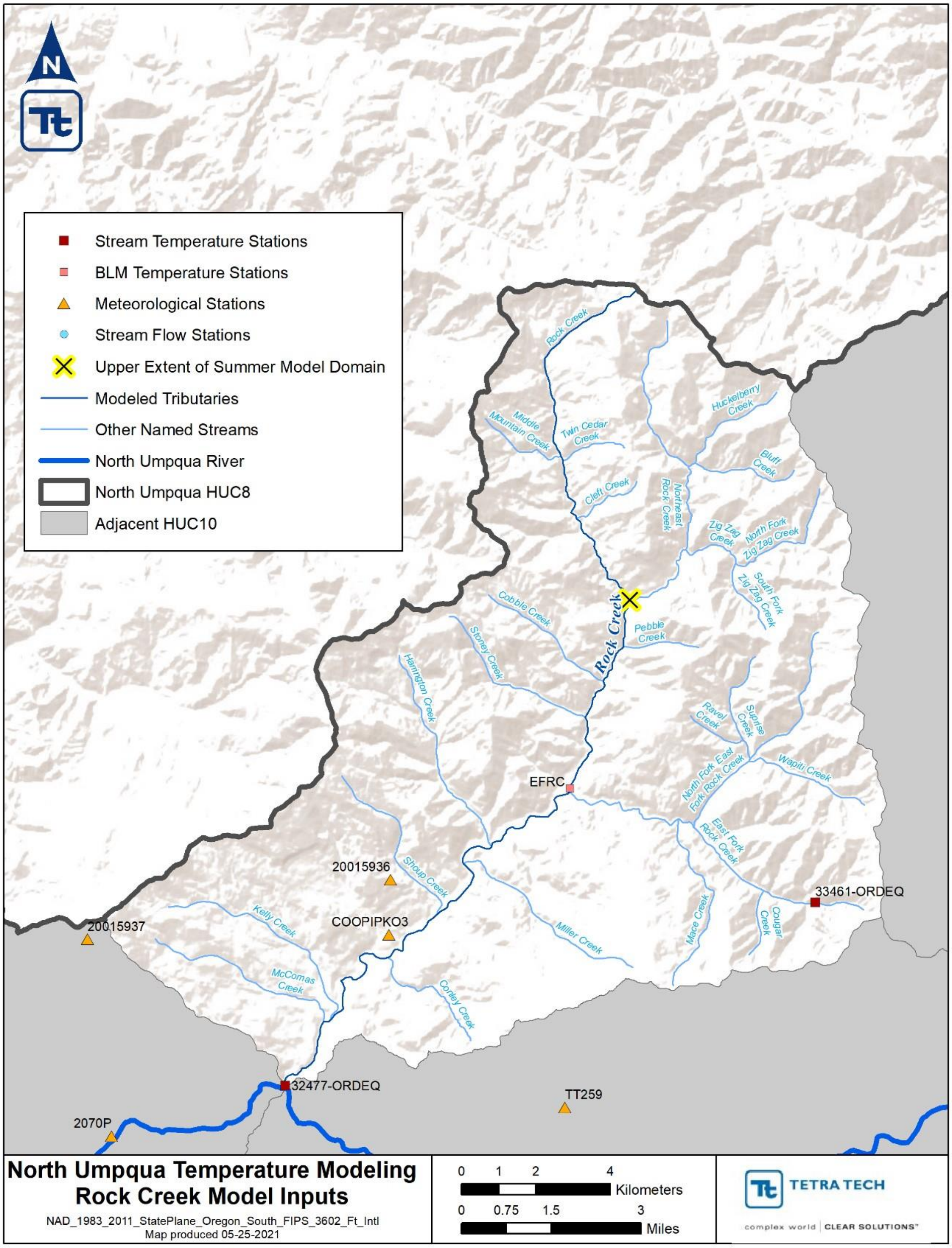

Figure 7: Map of Rock Creek (Spawning period) Model Inputs.

The Rock Creek (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA's contractor Tetra Tech.

6.17.1 Model domain

The extent of the model domain is Rock Creek from the confluence of East Fork Rock Creek to the mouth of Rock Creek at the confluence of the North Umpqua River (Figure 7). The extent differs from the summer model due to data availability. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.17.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.17.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along Rock Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, and background sources (DEQ, 2006). Other potential sources include channel modification and widening and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios

There are no permitted individual NPDES point sources along the model extent. The ODFW Rock Creek Fish Hatchery is a registrant under the NPDES 300-J general permit and discharges to Rock Creek near the mouth.

The majority land use along Rock Creek is forestry accounting for about 97 percent of the near-stream area. Table 69 summarizes all the land uses within 100 meters of the digitized Rock Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 69: Summary of land uses within 100 meters of the digitized Rock Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	683.4	66
Mixed Forest	118.5	11.4
Deciduous Forest	94.1	9.1
Herbaceous	54.5	5.3
Shrub/Scrub	50.9	4.9
Developed, Open Space	26.5	2.6
Hay/Pasture	6.0	0.6

2016 NLCD Land Cover	Acres	Percent of Total Acres
Woody Wetlands	1.1	0.1
Developed, Medium Intensity	0.4	<0.05
Barren Land	0.2	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 70).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 70 summarizes the potential designated management agencies and responsible persons along the Rock Creek model extent.

Table 70: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Rock Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
Oregon Department of Forestry - Private Forestland	670.6	65.3
U.S. Bureau of Land Management	304.0	29.6
Douglas County	35.4	3.4
State of Oregon	12.8	1.2
Oregon Department of Transportation	4.4	0.4

6.17.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.17.5 Important assumptions

Due to the limited availability of temperature data for the spawning period, surrogate relationships will be determined to establish model inputs. The method will rely on relationships established for stations with data available during both the summer and spawning model periods, and estimations will be based on the assumption that the established relationships will also be true for tributaries without data.

6.17.6 Model inputs

Table 71 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 71: Boundary condition and tributary inputs to the Rock Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Rock Creek upstream of East Fork Rock Creek	14.5	Boundary Condition	Flow	Derived data.	
Rock Creek upstream of East Fork Rock Creek (23874-ORDEQ)	14.5	Boundary Condition	Water Temperature	Derived data.	Surrogate relationship TBD
ODFW - Rock Creek Fish Hatchery	0.3	Point Source	Flow	ODFW	
ODFW - Rock Creek Fish Hatchery	0.3	Point Source	Water Temperature	ODFW	
East Fork Rock Creek	14.45	Tributary	Flow	Derived data.	
Unnamed stream at model kilometer 12.6	12.6	Tributary	Flow	Derived data.	
Unnamed stream at model kilometer 11.8	11.8	Tributary	Flow	Derived data.	
Harrington Creek	11.35	Tributary	Flow	Derived data.	
Conley Creek	6.3	Tributary	Flow	Derived data.	
Unnamed stream at model kilometer 5.85	5.85	Tributary	Flow	Derived data.	
Kelly Creek	3.2	Tributary	Flow	Derived data.	
Unnamed stream at model kilometer 3	3	Tributary	Flow	Derived data.	
McComas Creek	2.65	Tributary	Flow	Derived data.	
East Fork Rock Creek (EFRC)	14.45	Tributary	Water Temperature	BLM	
Unnamed stream at model kilometer 12.6	12.6	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Unnamed stream at model kilometer 11.8	11.8	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Harrington Creek	11.35	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Conley Creek	6.3	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Unnamed stream at model kilometer 5.85	5.85	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Kelly Creek	3.2	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Unnamed stream at model kilometer 3	3	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
McComas Creek	2.65	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
353036	5, 12.15	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.17.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 72. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 72: Calibration sites and parameters used in the Rock Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Rock Creek at Mouth (32477-ORDEQ)	0	Water Temperature	DEQ

6.18 Rock Creek (Summer period)

The Rock Creek (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.18.1 Model domain

The extent of the model domain is Rock Creek from the confluence of Northeast Fork Rock Creek to the mouth of Rock Creek at the confluence of the North Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.18.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.18.3 Source characteristics

For discussion of the Rock Creek source characteristics, see Section 6.17.3.

6.18.4 Time frame of simulation

The model period is July 12, 2002 to July 31, 2002.

6.18.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.18.6 Model inputs

Table 73 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 73: Boundary condition and tributary inputs to the Rock Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Rock Creek at Northeast Rock Creek Confluence	20.9	Boundary Condition	Flow	Derived data.	Constant flow input of 0.148 cms.
Rock Creek at Northeast Rock Creek Confluence	20.9	Boundary Condition	Water Temperature	DEQ	
Northeast Rock Creek	20.8	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 20.45	20.45	Tributary	Flow	Derived data.	Constant flow input.
East Fork Rock Creek	14.5	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 12.6	12.6	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 11.8	11.8	Tributary	Flow	Derived data.	Constant flow input.
Harrington Creek	11.35	Tributary	Flow	Derived data.	Constant flow input.
Conley Creek	6.3	Tributary	Flow	Derived data.	Constant flow input.
Unnamed stream at model kilometer 5.85	5.85	Tributary	Flow	Derived data.	Constant flow input.
Kelly Creek	3.2	Tributary	Flow	Derived data.	Constant flow input.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Unnamed stream at model kilometer 3	3	Tributary	Flow	Derived data.	Constant flow input.
McComas Creek	2.65	Tributary	Flow	Derived data.	Constant flow input.
Northeast Rock Creek (27963-ORDEQ)	20.8	Tributary	Water Temperature	BLM	
Unnamed stream at model kilometer 20.45	20.45	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data minus 1 °C input as surrogate.
East Fork Rock Creek	14.5	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data minus 1.5 °C input as surrogate.
Unnamed stream at model kilometer 12.6 (TIR)	12.6	Tributary	Water Temperature	Derived data. Watershed Sciences (2003)	TIR derived constant temperature data input of 16 deg-C.
Unnamed stream at model kilometer 11.8	11.8	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data input as surrogate.
Harrington Creek	11.35	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data plus 2 °C input as surrogate.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Conley Creek	6.3	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data input as surrogate.
Unnamed stream at model kilometer 5.85	5.85	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data plus 2 °C input as surrogate.
Kelly Creek	3.2	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data input as surrogate.
Unnamed stream at model kilometer 3	3	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data input as surrogate.
McComas Creek	2.65	Tributary	Water Temperature	Derived data.	Northeast Rock Creek (27963-ORDEQ) temperature data input as surrogate.
353036	5, 12.15	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.18.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 74. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 74: Calibration sites and parameters used in the Rock Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Rock Below Northeast Fork	20.6	Flow	DEQ
Rock Creek above Cobble Creek	18.25	Effective Shade	DEQ
Rock Creek below Stoney Creek (above East Fork Rock)	16.65	Flow, Effective Shade	DEQ
Rock Creek at Rock Creek Rec Site	12.45	Flow	DEQ
Rock above Mill Pond Rec Site	9.65	Flow, Effective Shade	DEQ
Rock Creek at Gage near Glide	2.05	Flow	DEQ
Rock Creek Gage near Glide	2.05	Water Temperature	DEQ
Rock Creek at Mouth	0.05	Effective Shade	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

6.19 Steamboat Creek (Spawning period)

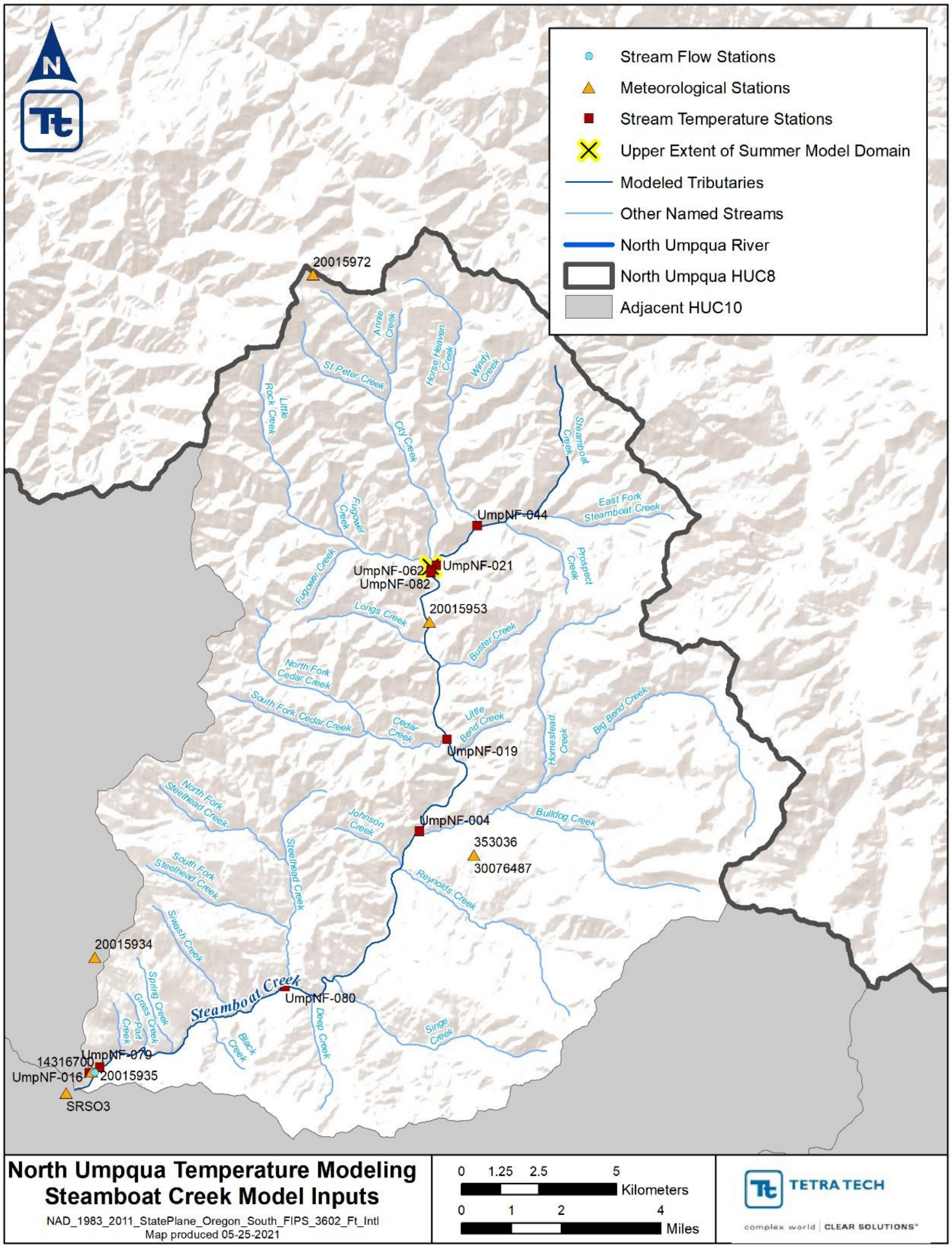

Figure 8: Map of Steamboat Creek (Spawning period) Model Inputs.

The Steamboat Creek (Spawning period) model is a temperature model developed using Heat Source 8.0. The model will be developed by USEPA's contractor Tetra Tech.

6.19.1 Model domain

The extent of the model domain is Steamboat Creek from the confluence of Little Rock Creek to the mouth of Steamboat Creek at the confluence of the North Fork Umpqua River (Figure 8). The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.19.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.19.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along Steamboat Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation and background sources (DEQ, 2006). Other potential sources include channel modification and widening and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along Steamboat Creek is forestry accounting for about 100 percent of the near-stream area. Table 75 summarizes all the land uses within 100 meters of the digitized Steamboat Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al., 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 75: Summary of land uses within 100 meters of the digitized Steamboat Creek centerline based on the 2016 National Land Cover Database (Yang et al., 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	1364.8	96.5
Shrub/Scrub	36.0	2.5
Mixed Forest	4.4	0.3
Developed, Open Space	3.3	0.2
Herbaceous	1.8	0.1
Developed, Low Intensity	1.6	0.1
Deciduous Forest	1.6	0.1
Hay/Pasture	1.3	0.1

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, activity, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 76).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 76 summarizes the potential designated management agencies and responsible persons along the Steamboat Creek model extent.

Table 76: Summary of designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Steamboat Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	1990.7	99.8
Oregon Department of Transportation	1.9	0.1
U.S. Bureau of Land Management	1.1	0.1

6.19.4 Time frame of simulation

The model period is August 01, 2009 to October 15, 2009.

6.19.5 Important assumptions

Due to the limited availability of temperature data for the spawning period, surrogate relationships will be determined to establish model inputs. The method will rely on relationships established for stations with data available during both the summer and spawning model periods, and estimations will be based on the assumption that the established relationships will also be true for tributaries without data.

6.19.6 Model inputs

Table 77 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 77: Boundary condition and tributary inputs to the Steamboat Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Steamboat Creek at the confluence of Little Rock Creek	28.65	Boundary Condition	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Steamboat Creek at the confluence of Little Rock Creek (UmpNF-82)	28.65	Boundary Condition	Water Temperature	USFS	
Little Rock Creek	28.45	Tributary	Flow	Derived data.	
Longs Creek	25.45	Tributary	Flow	Derived data.	
Buster Creek	24.5	Tributary	Flow	Derived data.	
Cedar Creek	21.9	Tributary	Flow	Derived data.	
Big Bend Creek	17.6	Tributary	Flow	Derived data.	
Reynolds Creek	16.2	Tributary	Flow	Derived data.	
Singe Creek	11.1	Tributary	Flow	Derived data.	
Deep Creek	9.85	Tributary	Flow	Derived data.	
Steelhead Creek	8.85	Tributary	Flow	Derived data.	
Canton Creek	0.9	Tributary	Flow	Derived data.	
Little Rock Creek (UmpNF-62)	28.45	Tributary	Water Temperature	USFS	
Longs Creek	25.45	Tributary	Water Temperature	Derived data.	
Buster Creek	24.5	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Cedar Creek (UmpNF-019)	21.9	Tributary	Water Temperature	USFS	
Big Bend Creek (UmpNF-004)	17.6	Tributary	Water Temperature	USFS	
Reynolds Creek	16.2	Tributary	Water Temperature	Derived data.	
Singe Creek	11.1	Tributary	Water Temperature	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Deep Creek	9.85	Tributary	Water Temperature	Derived data.	Surrogate relationship TBD
Steelhead Creek (UmpNF-080)	8.85	Tributary	Water Temperature	USFS	
Canton Creek (UmpNF-016)	0.9	Tributary	Water Temperature	USFS	
353036	2, 17.4, 18.1	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.19.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 78. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 78: Calibration sites and parameters used in the Steamboat Creek (Spawning period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Steamboat Creek above Canton Creek (UmpNF-079)	2.0	Water Temperature	USFS
Steamboat Creek Near Glide	1.1	Flow	DEQ
Steamboat Creek Near Mouth (36135-ORDEQ)	0.0	Water Temperature	DEQ

6.20 Steamboat Creek (Summer period)

The Steamboat Creek (Summer period) model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.20.1 Model domain

The extent of the model domain is Steamboat Creek from the confluence of Little Rock Creek to the mouth of Steamboat Creek at the confluence of the North Fork Umpqua River. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.20.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.20.3 Source characteristics

For discussion of the Steamboat Creek source characteristics, see Section 6.19.3.

6.20.4 Time frame of simulation

The model period is July 12, 2002 to July 31, 2002.

6.20.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006) and the model user guide (Boyd and Kasper, 2003).

6.20.6 Model inputs

Table 79 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 79: Boundary condition and tributary inputs to the Steamboat Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Steamboat Creek at the confluence of Little Rock Creek	28.65	Boundary Condition	Flow	DEQ	
Steamboat Creek at the confluence of Little Rock Creek	28.65	Boundary Condition	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Little Rock Creek	28.45	Tributary	Flow	Derived data.	Constant flow input.
Longs Creek	25.45	Tributary	Flow	Derived data.	Constant flow input.
Buster Creek	24.5	Tributary	Flow	Derived data.	Constant flow input.
Cedar Creek	21.9	Tributary	Flow	Derived data.	Constant flow input.
Big Bend Creek	17.6	Tributary	Flow	Derived data.	Constant flow input.
Reynolds Creek	16.2	Tributary	Flow	Derived data.	Constant flow input.
Singe Creek	11.1	Tributary	Flow	Derived data.	Constant flow input.
Deep Creek	9.85	Tributary	Flow	Derived data.	Constant flow input.
Steelhead Creek	8.85	Tributary	Flow	Derived data.	Constant flow input.
Canton Creek	0.9	Tributary	Flow	Derived data.	Constant flow input.
Little Rock Creek	28.45	Tributary	Water Temperature	USFS	
Longs Creek	25.45	Tributary	Water Temperature	USFS	
Buster Creek	24.5	Tributary	Water Temperature	DEQ	
Cedar Creek	21.9	Tributary	Water Temperature	DEQ	
Big Bend Creek (29795-ORDEQ)	17.6	Tributary	Water Temperature	DEQ	
Reynolds Creek	16.2	Tributary	Water Temperature	DEQ	
Singe Creek	11.1	Tributary	Water Temperature	DEQ	
Deep Creek	9.85	Tributary	Water Temperature	USFS	
Steelhead Creek	8.85	Tributary	Water Temperature	USFS	
Canton Creek	0.9	Tributary	Water Temperature	USFS	
353036	2, 17.4, 18.1	Meteorological	Air Temperature, Relative Humidity, Wind Speed	RAWS	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted to improve the calibration using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.20.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 80. The model location in the table below describes the distance of each calibration site from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 80: Calibration sites and parameters used in the Steamboat Creek (Summer period) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Steamboat Creek above City Creek	28.65	Flow, Effective Shade	DEQ
Steamboat Creek above Cedar Creek	22.2	Flow, Effective Shade	DEQ
Steamboat Creek above Big Bend Creek	18.1	Flow	DEQ
Steamboat Creek above Big Bend Creek (23885-ORDEQ)	18.1	Water Temperature	DEQ
Steamboat Creek below Big Bend Creek	17.4	Flow, Effective Shade	DEQ
Steamboat Creek below Big Bend Creek (30156-ORDEQ)	17.4	Water Temperature	DEQ
Steamboat Creek above Canton Creek	2	Water Temperature	USFS
Steamboat Creek at Gage	0.6	Flow	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

7 Model evaluation and acceptance

7.1 Model uncertainty and sensitivity

Model uncertainty can arise from a number of sources including error associated with measuring field parameters used for model input or calibration, lack of knowledge on the appropriate value to use for model parameters or constants, or an imperfect mathematical formulation in the model of real world physical processes. A model’s sensitivity is the degree to which predictions are affected by changes in a single or multiple input parameters.

In many cases, the major source of uncertainty is due to uncertainty in spatial representation of the river channel and adjacent landcover (e.g., bathymetry, vegetation height and density) from lack of data or simplification, configuration of the boundary conditions (e.g., uncertainty in estimation of ungaged tributary flows or temperatures), and uncertainty from limited amount or spatial distribution of observed data used for calibration. These sources of uncertainty are largely unavoidable, but do not invalidate the use of the model for decision purposes.

During the calibration process, it is good practice to evaluate and minimize uncertainty associated with the model parameters to the greatest extent practical (Beck, 1987; EPA, 2009). During the model calibration process, the responsiveness of the model predictions to various assumptions and rate constants should be evaluated. The model setup should include parameters based on literature recommendations and best professional judgment.

Reducing uncertainty in measured field parameters used for model input and calibration is accomplished in the following ways:

- Data used for the TMDL must have been collected based on a project plan with quality assurance and quality control protocols for collecting and analyzing samples.
- The sampling and laboratory analysis must follow widely accepted scientific methods and protocols. These may include DEQ's Mode of Operations Manual (DEQ, 2020), USEPA's methods (EPA, 1983), USGS's published techniques of water-resources investigations, the USGS National Field Manual, or Standard Methods for the Examination of Water and Wastewater. All acceptable methods include applicable precision and accuracy checks.
- When possible, accuracy and precision should be evaluated using DEQ's data validation criteria as outlined in DEQ Data Quality Matrix for Field Parameters (DEQ, 2013). The TMDL program uses waterbody results that demonstrate a data quality level of A, B, or E with careful review (DEQ, 2021). For continuous temperature data a data quality of A or B corresponds to an absolute accuracy 1.0 deg-C and absolute precision 2.0 deg-C. Data of unknown quality lacking audit and pre and post accuracy checks may also be used following a careful review where it is determined the results appear reasonable and free of issues based on professional judgment.

Uncertainties in the mathematical formulation are addressed by using open source models that allow free and transparent inspection of model code; and models that have had their methodologies peer reviewed and evaluated. It is not anticipated that additional uncertainty or sensitivity analyses will be performed on the existing calibrated models.

7.2 Model acceptance

This section identifies the model acceptance criteria. Model acceptance relies on satisfying seven (7) conditions:

1) Incorporation of all available field observations of the system (e.g., geometry, flow, boundary inputs/withdrawals, and meteorology) for the time period simulated.
2) Model parameters and unmeasured boundary conditions that are within literature-supported and physically defensible ranges.
3) Model predicted results have been compared with the associated observed measurements using graphical presentations. Visual comparisons are useful in evaluating model performance over the appropriate temporal or spatial scales.

4) Goodness of fit statistics have been calculated comparing the model predicted results to the associated observed measurements. The calibration goodness of fit statistics are shown in Equation 4 through Equation 8.

5) Goodness of fit statistics have been used to inform the appropriate use of the model. Where a model achieves an excellent or good fit it can generally assume a strong role in decision making about appropriate management options. Conversely, where a model achieves only a fair or poor fit it should assume a much less prominent role in decision making about appropriate management options. If a desired level of quality is not achieved on some or all measures, the model might still be useful; however, a detailed description of its potential range of applicability will be provided.

6) Written documentation of all important elements in the model, including model setup, model parameterization, key assumptions, and known areas of uncertainty.

7) Peer review as described in Section 9.

Equation 5 through Equation 8 are the goodness of fit statistics to be calculated for each calibrated temperature model. Equation 4 through Equation 7 are the goodness of fit statistics to be calculated for each calibrated shade model.

Coefficient of Determination – R squared (R^2): A coefficient of determination, or R^2, of one indicates a perfect fit. R^2 is a measure of how well predicted values fit the observed data. It compares the variations in the residuals to the variation of the observed data.

$$R^2 = 1 - \frac{\sum(X_{obs} - X_{mod})^2}{\sum\left(X_{obs} - \overline{X_{obs}}\right)^2} \qquad \text{Equation 4}$$

Mean Error (ME): A mean error of zero indicates a perfect fit. A positive value indicates on average the model predicted values are less than the observed data. A negative value indicates on average the model predicted values are greater than the observed data. The mean error statistic may give a false ideal value of zero (or near zero) if the average of the positive deviations between predictions and observations is about equal to the average of the negative deviations in a data set. Because of this, the mean absolute error (MAE) statistic should be used in conjunction with mean error to evaluate model performance.

$$ME = \frac{1}{n}\sum(X_{mod} - X_{obs}) \qquad \text{Equation 5}$$

Mean Absolute Error (MAE): A mean absolute error of zero indicates a perfect fit. The magnitude of the mean absolute error indicates the average deviation between model predicted values and observed data. The mean absolute error cannot give a false zero.

$$MAE = \frac{1}{n}\sum|X_{mod} - X_{obs}| \qquad \text{Equation 6}$$

Root Mean Square Error (RMSE): A root mean square error of zero indicates a perfect fit. Root mean square error is a measure of the magnitude of the difference between model predicted values and observed data.

$$RMSE = \sqrt{\frac{1}{n}\sum(X_{mod} - X_{obs})^2} \qquad \text{Equation 7}$$

Nash-Sutcliffe efficiency coefficient (NS): Nash-Sutcliffe efficiencies can range from -∞ to 1. An efficiency of 1 corresponds to a perfect match of modeled predicted value to the observed data. An efficiency of 0 indicates that the model predictions are as accurate as the mean of the observed data, whereas an efficiency less than zero occurs when the observed mean is a better predictor than the model.

$$NS = 1 - \frac{\sum(X_{obs} - X_{mod})^2}{\sum\left(X_{obs} - \overline{X_{obs}}\right)^2} \qquad \text{Equation 8}$$

where,
X_{mod} = The model predicted results;
X_{obs} = The observed or measured results;
$\overline{X}_{obs}$ = The mean of the observed or measured temperature;
n = The sample size.

8 Documentation in model reports

Model documentation will consist of a series of TMDL technical appendices describing the model setup, model calibration results, model scenario setup, and model scenario results.

The model setup and calibration documentation will include details on the calibrated model domain and layout; spatial and temporal resolution; timeframe of simulation; summary of data used for model inputs; summary of methods used to fill data gaps; summary of data used for calibration; time series plots comparing observed and model predicted temperatures and other parameters as appropriate; goodness-of-fit statistics, and plots and tables summarizing temperature and effective shade model results.

The model scenario setup and scenario results documentation will include a description of the scenario, what model elements were modified for the scenario; tables, plots, or narrative summarizing the final values for any modified inputs or parameters; methods or data sources used to setup the scenario; and plots and tables that summarize the scenario results.

When no changes or minor changes are made to the existing TMDL models, the existing TMDL technical appendices will be amended as necessary to document any changes to the existing calibration or management scenarios. For more extensive changes or entirely new models new technical appendices may need to be developed to document the models and results.

9 Peer review

Peer review of the models and model results will be conducted in the following ways:

DEQ will conduct internal peer review during the modeling process with input from USEPA Region 10 as needed. For models being developed by USEPA's contractor, Tetra Tech, USEPA and DEQ will peer review all contractor developed models and model documentation.

DEQ will consider feedback on model scenarios and results from the TMDL advisory group and make changes as appropriate.

DEQ will review and respond to any public comments received on the model and model results, and make changes as appropriate.

10 Management scenarios

Management scenarios described in this section summarize the means by which the current conditions and other alternatives will be evaluated. Some of these model scenarios may not be developed due to lack of sufficient data and information, because the management scenario is not applicable to the specific waterbody, or because it is determined the scenario will require an effort and timeline that does not align with the project schedule or available resources. In some cases, the management scenario has already been developed as part of the previous TMDL and does not need further adjustment. DEQ will review all available data and information during model development and document final model scenario decisions, setup, and results in the TMDL technical appendix.

10.1 Current conditions

This scenario evaluates the stream temperature response under current existing conditions. This scenario is similar to the calibrated model except that some sources conditions will be modified, may be removed, or new ones added to reflect the current conditions or discharge loads if they are significantly different from the calibrated model. Elements of this scenario or scenarios may include:

- Updating the Little River model to include current discharges from the USFS-Wolf Creek Civilian Conservation Center.
- Updating the North Umpqua River summer period model to include current discharges from the Glide-Idleyld Sanitary District.
- Updating the North Umpqua model to include Douglas County's permitted water withdrawal of 7 cfs from the North Umpqua River below Steamboat Creek.
- Updating the Rock Creek summer period model to include current discharges from the ODFW Rock Creek Fish Hatchery.

10.2 Background

This scenario evaluates the stream temperature response from background sources only. Background sources include all sources of pollution or pollutants not originating from human activities. Background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state (OAR 340-042-0030(1)). This scenario essentially combines the following model scenarios: restored vegetation, restored stream flow, improvements to channel morphology, and potentially elements of the climate scenario. The background scenario will be compared to the current conditions model scenario to determine the point of maximum impact, and the amount of cumulative warming originating from human activities that DEQ or another Oregon state agency have authority to regulate.

10.3 Restored vegetation

This scenario evaluates the stream temperature response with streamside vegetation at restored conditions. The stream temperature warming or cooling contributed by removal of streamside vegetation is evaluated by comparing this scenario to the current condition model. Elements of this scenario or scenarios may include:

- Restoring streamside vegetation in areas along the model extent that are currently characterized as lacking streamside vegetation because of anthropogenic disturbance. The restored vegetation type, height, density, and overhang values will be determined during the TMDL process and will likely be the same or similar to the values presented in the Little River Watershed TMDL (DEQ, 2002a) and Umpqua Basin TMDL and WQMP (DEQ, 2006).
- Model inputs for land cover height, canopy density, and overhang will be modified to reflect the restored conditions.
- All other model inputs will be the same as the current condition model.

10.4 Protected vegetation

This scenario is specific to the shade models and evaluates the effective shade response from only streamside vegetation along the stream that is currently protected by statue, rule, ordinance, or some other approved management plan (voluntary or regulatory). The purpose of this scenario is to determine the amount of effective shade contributed by streamside vegetation in unprotected areas and if existing management strategies are sufficient to achieve allocations and surrogate measure effective shade targets. This scenario may be a subset of the TMDL implementation scenario. The amount of effective shade contributed by streamside vegetation in unprotected areas is evaluated by comparing this scenario to the current condition model. Attainment of the effective shade targets and allocations assigned to riparian management nonpoint sources are evaluated by comparing this scenario to the background model scenario. Elements of this scenario or scenarios may include:

- Identifying streamside vegetation areas along the model extent that are protected and will not be removed. The exact definition of a protected area will be determined during the TMDL process.
- Model inputs for land cover height, density, and overhang outside protected areas will be set to zero.
- Model inputs for land cover height, density, and overhang inside protected areas will be set to current conditions.
- All other model inputs will be the same as the current condition model.

10.5 Stream flow

This scenario evaluates the stream temperature response from water withdrawals. The stream temperature warming or cooling is evaluated by comparing the water withdrawal scenario to a model scenario with the stream flow rates set to a natural flow. Assumptions and methods used to estimate natural stream flow will be documented in the TMDL.

10.6 Tributary temperatures

This scenario evaluates the stream temperature response from restoration actions on tributaries. The stream temperature warming or cooling contributed by removal of streamside vegetation on tributaries is evaluated by comparing this scenario to the current condition model. Assumptions and methods used to estimate restored tributary conditions will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Tributary inputs will be set to reflect restored temperature and flow conditions. The tributary flow will reflect maintaining all currently permitted water withdrawals as instream flow.
- All other model inputs will be the same as the current condition model.

10.7 Climate

This scenario evaluates the stream temperature response from changes in air temperature and relative humidity connected to human caused changes to global or micro climate conditions. Warming or cooling from climate related impacts will be evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Model inputs for air temperature and relative humidity may be modified to reflect potential conditions or conditions without climate change impacts assuming enough information exists that would allow downscaling to the site specific conditions in model extent.
- Model inputs for groundwater or stream flow may also be modified if sufficient information exists that would allow downscaling to the site specific conditions in model extent.
- All other model inputs will be the same as the current condition model.

10.8 Channel morphology

This scenario evaluates stream temperature response from improvements to channel morphology, including projects to restore cold water refuges. The warming or cooling from channel morphology improvements is evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Modifying channel width and/or depth to reflect locations where improvements to channel morphology are needed. The location of channel morphology projects will be determined during the TMDL process.

- Model configurations for channel width, bank angle, channel position, Manning's *n*, gradient, elevation, porosity, percent hyporheic flow, hyporheic zone thickness, land cover height, density, and overhang may be modified in areas with improved channel morphology.
- All other model inputs will be the same as the current condition model.

10.9 No point sources

This scenario evaluates the stream temperature response from removing point source heat load. The stream temperature warming or cooling from permitted NPDES point sources is evaluated by comparing this scenario to the current conditions model scenario. Elements of this scenario or scenarios may include:

- Removal of all point sources from the North Umpqua and Little River models.
- All other model inputs will be the same as the current condition model.

10.10 TMDL wasteload allocations

This scenario evaluates stream temperature warming or cooling from the TMDL wasteload allocations. These scenarios will be compared to the background model scenario to evaluate attainment of the human use allowance allocations. Numeric or narrative wasteload allocations will be developed for all NPDES permittees but some of the permittees may not be included in this model scenario due to availability of effluent data, lack of discharge, or because the discharge is not a significant source or thermal loading. Elements of this scenario or scenarios may include:

- Modifying point source discharges to reflect proposed or existing TMDL wasteload allocations.
- All other model inputs will be the same as the current condition model.

10.11 TMDL implementation plans

This set of scenarios evaluate the stream temperature response from proposed or existing DMA and responsible person management plans, TMDL implementation plans, or rules. These scenarios will be compared to the background model scenario to evaluate attainment of the human use allowance allocations or surrogate measures. It is likely that multiple model scenarios will be developed evaluating a single implementation plan or multiple implementation plans together. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Modifying streamside vegetation, instream flow, and/or channel morphology to reflect the proposed or existing implementation plan. Translating the plan elements to the modeled landscape conditions will be determined during the TMDL process.
- Model inputs for land cover height, density, overhang, boundary condition flow and temperature, channel width, bank angle, Manning's *n*, porosity, percent hyporheic flow, and hyporheic zone thickness, may be modified.
- All other model inputs will be the same as the current calibrated model.

DEQ may also rely upon the results of relevant studies, reports, or published articles to supplement the model scenario; or as the primary source of information for locations or situations where the model results are not applicable.

- Alternative management options for the North Umpqua hydroelectric project.

10.12 No Dams

The no-dams scenario will require the development of a riverine Heat Source model in place of each of the three impoundments and running all the Heat Source models from upstream to downstream to evaluate the impacts of no dams along the system. A critical piece of information required for the development of the no-dams Heat Source model is the main channel information to identify the length, width, slope and manning's roughness coefficient. Existing bathymetry if available will also be evaluated to identify the historic channel, if evident and/or channel shape. In addition, Tetra Tech will evaluate the shading from the upstream and downstream Heat Source models and configure the model using average shading. Minimal or no shading is expected for the riverine reaches along Lemolo Lake and Toketee Lake which are both wide, compared to the Soda Springs reservoir reach which is relatively narrow and has a lot of vegetation along the reach. In the absence of any morphological or shading information Tetra Tech will interpolate the channel characteristics upstream and downstream of the reservoir or use an average of the upstream and downstream conditions.

For the no-dams scenario each of the Heat Source model will be run sequentially from upstream to downstream with each model feeding into the model downstream.

10.13 Douglas County Water Right Withdrawal

This scenario evaluates stream temperature warming or cooling from keeping Douglas County's permitted water withdrawal of 7 cfs from the North Umpqua River below Steamboat Creek as instream flow. This scenario will be compared to the current conditions model scenario.

11 Project organization

11.1 Project team/roles

Project roles and responsibilities are described in Table 81.

Table 81: The roles and responsibilities of each team member involved in the temperature TMDL replacement project.

Name	Position	Role and Responsibilities
Jennifer Wigal	Water Quality Administrator, Oregon DEQ	Sponsor 1. Provide guidance to team and project manager 2. Approve project plan and changes to the project, scope, budget, and schedule (pending

Name	Position	Role and Responsibilities
		manager elevation as necessary) 3. Sustain support of decision makers at their level, all stakeholders 4. Remove roadblocks 5. Communicate progress to other managers and WQ Director 6. Review project status 7. Manage resistance 8. Ensure communication with employees affected by changes 9. Provide forum to listen to concerns
Gene Foster	Manager, Watershed Management, Oregon DEQ	Manager 1. Review and approve team work products 2. Communicate progress to other managers 3. Approve project plan, changes to the project, and any changes that affect scope and schedule 4. Approve development and finalization of solutions to issues that occur during the project 5. Decide measures of project success
Michele Martin	Project Manager, Water Quality, Oregon DEQ	Project Manager 1. Facilitate meetings, effective meeting management 2. Provide feedback and leadership in the development of meeting agendas, activities during meetings, and tasks. 3. Provide feedback on project planning and design 4. Keep sponsor informed 5. Develop project charter 6. Develop project plan (including major tasks, milestones, project schedule, communication plan, risk analysis, etc.) 7. Develop team meeting agendas 8. Keep track of meeting decisions and notes (very brief), and team ideas 9. Ensure team's work drives towards outcomes and deliverables 10. Sustain engagement of team members and team performance 11. Control project scope (with Technical Lead) 12. Coordinate team communication: Emails, SharePoint, shared drives 13. Closeout project and document lessons learned

Name	Position	Role and Responsibilities
Ryan Michie	Senior Water Quality Analyst, Watershed Management, Oregon DEQ	Project Technical Lead 1. Lead, oversee, and direct development of the project QAPP 2. Lead, oversee, and direct the public data solicitation process 3. Coordination with EPA and Contractor 4. Lead, oversee, and direct DEQ technical staff 5. Perform model calibration/evaluation 6. Run model scenarios 7. Analyze and interpret model results 8. Lead, oversee, and direct TMDL document writing 9. Participate and present at TMDL public meetings 10. Respond to public comments
Jim Bloom	Senior Water Quality Analyst, Watershed Management, Oregon DEQ	1. Develop and configure models 2. Perform model calibration/evaluation 3. Run model scenarios 4. Analyze and interpret model results 5. Write TMDL 6. Participate and present at TMDL public meetings 7. Respond to public comments
Erin Costello	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Develop and configure models 3. Perform model calibration/evaluation 4. Run model scenarios 5. Analyze and interpret model results 6. Write TMDL 7. Participate and present at TMDL public meetings 8. Respond to public comments
David Fairbarin	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Develop and configure models 3. Perform model calibration/evaluation 4. Run model scenarios 5. Analyze and interpret model results 6. Write TMDL 7. Participate and present at TMDL public meetings 8. Respond to public comments

Name	Position	Role and Responsibilities
Yuan Grund	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Perform data evaluation 3. Run model scenarios 4. Analyze and interpret model results
Heather Tugaw	Basin Coordinator, Oregon DEQ	1. Review QAPP and TMDL 2. Write WQMP 3. TMDL Advisory Committee coordinator 4. Participate and present at TMDL public meetings 5. Respond to public comments
Chris Moore	DEQ QAPP Officer, Oregon DEQ	Review QAPP
Dianne Lloyd	Oregon Department of Justice	Legal Counsel
Rob Burkhardt	Water Quality Specialist, Oregon DEQ	Project team point of contact to NPDES permit program and permittees Review wasteload allocations
Tetra Tech	Contractor	TMDL development support
Claire Schary	EPA Region 10	Non-technical TMDL reviewer
Ben Cope	EPA Region 10 QAPP Officer for Modeling Projects	EPA Modeling Lead 1. Review QAPPs 2. Review EPA Contractor work products
Jayshika Ramrakha	EPA Region 10 EPA Task Order Manager	Direct EPA Contractor
TMDL Advisory Committee	Each TMDL will have a local, public advisory committee	1. Participate in TMDL Advisory Committee Meetings 2. Provide input to DEQ on TMDL and WQMP elements

11.2 Expertise and special training requirements

Additional expertise or special training is not necessary at this time.

DEQ staff involved in developing and configuring models, performing model calibration, running model scenarios, and analyzing and interpreting model results have experience in these tasks from numerous other modeling projects. The Project Manager has extensive experience managing large complex projects and will ensure strict adherence to the project protocols.

11.3 Reports to management

The DEQ Project Manager (or designee) will provide progress reports to DEQ Management and USEPA as needed based on new project information. As appropriate, these reports will provide information on the following:

- Adherence to project schedule and/or budget.
- Deviations from approved QAPP, as determined from project assessment and oversight activities.
- The impact of any deviations on model application quality and uncertainty.
- The need for and results of response actions to correct any deviations.
- Potential uncertainties in decisions based on model predictions and data.
- Data quality assessment findings regarding model input data and model outputs.

11.4 Project schedule

The project schedule for the North Umpqua Subbasin TMDL is scheduled to occur in two phases. The pre TMDL project phase, and the TMDL and WQMP development phase.

Pre TMDL project phase

The pre TMDL project phase will generally occur between January 2020 through the end of August 2022. In this phase most of the planning and technical work occurs. Specific tasks include:

Task P1 Data gathering and project organization.

P1.1 Organize and gather effluent data from all active NPDES permittees in the temperature TMDL replacement project area.

P1.2 Organize and gather all available and relevant river temperature, stream flow, habitat, effective shade, and channel morphology.

P1.3 Complete an open data solicitation. During the solicitation period, the public may submit continuous stream temperature data and NPDES effluent data to DEQ in the watersheds subject to the temperature TMDL replacements.

P1.4 Review data collected. Data submitted to DEQ will be screened for completeness and quality, and whether the results are within the typical range expected for that season and time of day.

P1.5 Stream temperature data will be made available in DEQ’s Ambient Water Quality Monitoring System database (AWQMS).

Task P2 Develop modeling Quality Assurance Project Plans (QAPPs). The modeling QAPPs will identify the available data and overall technical approach to be taken for each TMDL project.

Task P3 Mapping of Designated Management Agencies (DMAs) and Responsible Persons for counties that are within the project area. All Oregon counties are within the project area except Tillamook, Clatsop, and Deschutes counties.

Task P4 Development of computer code to streamline analysis tasks and TMDL document production.

Task P5 Development of template TMDL and WQMP section outlines and language.

Task P6 Implement Modeling QAPPs. This task is a follow-up to Task P2. Gathering of new data and completion of new technical work described in the modeling QAPPs.

TMDL and WQMP development phase

The TMDL and WQMP development phase is scheduled to begin in 2023 with USEPA's final agency action approving or disapproving of the TMDL no later than February 28, 2025. In this phase, the draft TMDL and WQMP documents will be written; a TMDL advisory committee will be convened to discuss the updated TMDL allocations, any revisions to the WQMP, and potential fiscal impacts in the case of a rulemaking process; and finally DEQ will conduct a public comment period. DEQ will respond to all public comments received, revise the TMDL and WQMP as necessary, and issue the final TMDL to USEPA for their action.

12 Data management

DEQ does not anticipate collecting additional field samples. Water quality data gathered and used for this project will be managed in DEQ's AWQMS database or the project files.

The modeling software to be used for this project is available on DEQ's TMDL program website (https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Tools.aspx).

Model-generated data resulting from testing, calibration, and scenarios will be stored in spreadsheets and text files by DEQ in the TMDL project directory. Metadata describing the content, date, and personnel involved in modeling will be documented alongside raw and summarized data.

Secondary data developed as part of this task will be maintained as hardcopy only, both hardcopy and electronic, or electronic only, depending on their nature.

All electronic data will be maintained on DEQ's computers and servers. DEQ's computers are serviced by in-house specialists. When a problem with DEQ's computers and servers occurs, in-house computer specialists diagnose the problem and correct it if possible. When outside assistance is necessary, the computer specialists call the appropriate vendor. For other computer equipment requiring outside repair and not covered by a service contract, local computer service companies are used on a time-and-materials basis.

Routine maintenance of DEQ's computers and servers is performed by in-house computer specialists. Electric power to each computer flows through a surge suppressor to protect electronic components from potentially damaging voltage spikes. All computer users have been instructed on the importance of routinely archiving work assignment data files from hard drive to server storage. The office network server is backed up on tape nightly during the week. Screening for viruses on electronic files loaded on DEQ's computers or the network is standard policy. Automated screening systems have been placed on all computer systems and are updated regularly to ensure that viruses are identified and destroyed. Annual maintenance of software is performed to keep up with evolutionary changes in computer storage, media, and programs.

13 Recordkeeping and archiving

All data and documents generated during the course of the TMDL project will be archived according to the current Oregon State Archives Records Retention Schedules. Generally TMDL documents will be retained until 15 years after the TMDL is no longer operational.

Records that are stored in electronic format will be located in either the TMDL project folder or Master TMDL folder located on DEQ's TMDL server. The TMDL project folder will contain at minimum the following subfolders: "Project Plans", "Data", "Models", and "Meetings". Alternative names and additional subfolders can be used as appropriate. The Master TMDL folder will contain the written TMDL documents (Word, PDF) along with supporting written documents that support the public comment period and TMDL issuance. The contents and organization of these subfolders is described below.

Project Plans: All documents related to project planning, project proposals, project schedules, and the modeling QAPPs. Each will reside in their relevant subfolders. The final versions of documents will be clearly identified from drafts and ideally located in separate folders.

Data: All field data organized or collected in support of the TMDL project. This may include water quality samples, NPDES effluent data, field sheets, photos, monitoring metadata, sampling project plans, or other documentation. The data should be organized by parameter and data source if possible.

Models: All models used for the TMDL project including calibration and scenario models. The models should be organized into subfolders for each model domain and model scenario. Draft models and the final TMDL models will be clearly identified and ideally saved in separate folders. The model folders should include:

- The model with all input and output files and any executable code used;
- Copy of all raw and summarized data (including GIS files) used for model input with data source and location metadata included;
- Scripts or spreadsheets used to transform raw data or used to derive model inputs;
- Key assumptions and documentation for the model setup and parameterization;
- Documentation of newly developed model code or modifications to the existing model; and
- Identification of staff that completed the model.

Meetings: All documents produced for external meetings including agendas, presentations, posters, and meeting handouts. Material for each meeting will be saved in a subfolder organized by date and meeting type. For example the folder name for the first meeting of the TMDL advisory group would be "2022-08-15 Temperature AG 1". Draft documents and final documents will be clearly identified and ideally saved in separate folders.

TMDL documents: At each key stage of TMDL and WQMP development copies of the following documents will be saved in separate subfolders within the project folder on the Master TMDL directory. The final versions of documents will be clearly identified from drafts and ideally saved in separate folders.

- Public Comment Draft:
  - Briefing memo to DEQ Water Quality Division Administrator or Director on public comment draft
  - Draft TMDL and WQMP Report (Both Word and PDF)
  - Draft TMDL Appendices (Both Word and PDF)
  - Public Notice document
  - TMDL Summary Fact Sheet
  - News release
  - GovDelivery Notice and email
  - Other public notification emails
  - Mailing List (if used)
  - Public Comments Errata

- Public Comments Received: Copy of all public comments received

- Final TMDL and WQMP documents:
  - Briefing memo to DEQ Water Quality Division Administrator or Director on final TMDL
  - Signed TMDL order (both Word and PDF)
  - TMDL issuance letter to USEPA (both Word and PDF)
  - USEPA approval letter (USEPA)
  - Response to Comment Document (both Word and PDF)
  - TMDL and WQMP Report (both Word and PDF)
  - TMDL Appendices (both Word and PDF)
  - TMDL Summary Fact Sheet
  - News release
  - GovDelivery Notice and email
  - Other public notification emails
  - Relevant EQC agenda documents
  - Designated Management Agency/Responsible Person notification letters (both Word and PDF)
  - Addendums
  - Errata
  - Petitions
  - Director's Petition Action (acceptance or rejection of petition)
  - Response to Petition
  - ATTAINS upload files

14 QAPP review and approval

The DEQ Project Technical Lead will distribute the draft QAPP to the respective DEQ and USEPA project team members for review. Comments will be provided to the Project Technical Lead for further discussion. When possible, revision and submittal of the final plan will be made within 10 business days of receipt of comments. Following approval, the Project Technical Lead will distribute the final, signed copy to the respective DEQ and USEPA project team members.

USEPA has an independent responsibility for this QAPP and must complete a separate approval protocol. USEPA approval is necessary for USEPA contractors to begin any modeling work.

Official copies of the final, approved QAPP will be retained in DEQ’s document control system. If any change(s) to the QAPP are required during the project, they must be described in a memorandum and approved by the signatories to this QAPP and attached to the QAPP.

15 Implementation and adaptive management

DEQ plans to develop a Risk Management Plan to identify project constraints, the risks that may arise during project implementation, and potential solutions. Identified project constraints include the abbreviated project schedule with hard deadlines established via court order, limited resources, uncertain funding from USEPA, and a complex TMDL technical effort which may require additional time and public process. Projects risks from these constraints and proposed solutions are described in Table 82.

Table 82: Projects risks and proposed solutions.

Risk Description	Solution
Extended public process for complex TMDLs	Communication to DEQ manager and external contacts as deemed necessary by the manager
Team member availability: Inadequate resources to effectively produce the TMDL	Dedicate additional resources to support the effort from internal staff
Delivery commitment	Designate the projects as priority and dedicate additional resources to support the effort from internal staff or contractor (depending on contractor funding)
Scope creep: Working on the TMDLs could be an opportunity for attempts to add additional technical work that are outside the project scope	Sponsor and Manager to address scope creep with stakeholders as necessary

Should a situation arise that requires a significant change in the technical approach, the project team will update the QAPP as needed through revisions or addenda.

16 References

Beck, M.B. 1987. "Water Quality Modeling: A Review of the Analysis of Uncertainty". Water Resources Research 23(8), 1393.

Bencala, K.E. and R.A. Walters. 1983. "Simulation of solute transport in a mountain pool-and-riffle stream: A transient storage model." Water Resources Research. 19(3), 718-724.

Benyahya, L., D. Caissie, M.G. Satish, and N. El-Jabi. 2012. "Long-wave radiation and the heat flux estimates within a small tributary in Catamaran Brook (New Brunswick, Canada)." Hydrological Processes. 26(4): 475-484.

Beschta, R.L. and J. Weatherred. 1984. "A computer model for predicting stream temperatures resulting from the management of streamside vegetation." USDA Forest Service. WSDG-AD-00009.

Bond, R.M, A.P. Stubblefields, and R.W. Van Kirk. 2015. "Sensitivity of summer stream temperatures to climate variability and riparian reforestation strategies." Journal of Hydrology: Regional Studies. 4(B): 267-279.

Boyd, M. and B. Kasper. 2003. "Analytical Methods for Dynamic Open Channel Heat and Mass Transfer: Methodology for Heat Source Model Version 7.0."

Boyd, M.S. 1996. "Heat Source: Stream, River, and Open Channel Temperature Prediction (Master's Thesis)." Oregon State University: Corvallis.

DEQ (Oregon Department of Environmental Quality). 1999. "Heat Source methodology review and comments." https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLS-Heat-Source-Review.aspx

DEQ (Oregon Department of Environmental Quality). 2001. "Tualatin Subbasin Total Maximum Daily Load (TMDL)."

DEQ (Oregon Department of Environmental Quality). 2002a. "Little River Watershed TMDL." https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Umpqua-Basin.aspx

DEQ (Oregon Department of Environmental Quality). 2002b. "Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)."

DEQ (Oregon Department of Environmental Quality). 2003. "Alvord Lake Subbasin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)."

DEQ (Oregon Department of Environmental Quality). 2006. "Umpqua Basin TMDL and WQMP." https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Umpqua-Basin.aspx

DEQ (Oregon Department of Environmental Quality). 2013. "Data validation criteria for water quality parameters measured in the field. DEQ04-LAB-0003-QAG Version 5.0."

DEQ (Oregon Department of Environmental Quality). 2017. "Guidance for Quality Assurance Project Plans for Total Maximum Daily Load Modeling Projects."

DEQ (Oregon Department of Environmental Quality). 2018. “Western Hood Subbasin Temperature Total Maximum Daily Load, Revision to the 2001 Western Hood Subbasin TMDL.”

DEQ (Oregon Department of Environmental Quality). 2019. “Upper Klamath and Lost Subbasins Temperature TMDL and Water Quality Management Plan.”

DEQ (Oregon Department of Environmental Quality). 2020. “Water monitoring mode of operations manual (MOMs). DEQ03-LAB-0036-SOP Volume 4: Field Analysis Methods”.

DEQ (Oregon Department of Environmental Quality). 2021. “Quality Assurance Project Plan, Monitoring and assessment for Total Maximum Daily Loads”. DEQ21-LAB-0013-QAPP Version 1.0.

DEQ (Oregon Department of Environmental Quality). 2022. “Modeling Quality Assurance Project Plan for the South Umpqua and Umpqua Subbasins Temperature Total Maximum Daily Load”. DEQ22-HQ-0007-QAPP Version 1.0.

Diabat, M., R. Haggerty, and S.M. Wondzell. 2013. “Diurnal timing of warmer air under climate-change affects magnitude, timing and duration of stream temperature change.” Hydrological. Processes. 27(16): 2367–2.

EPA (U.S. Environmental Protection Agency). 1983. “Methods for Chemical Analysis of Water and Wastes”. Environmental Monitoring and Support Laboratory, Cincinnati, OH. EPA/600/4-79/020.

EPA (U.S. Environmental Protection Agency). 2009. “Guidance on the Development, Evaluation, and Application of Environmental Models”. Council for Regulatory Environmental Modeling, Washington D.C., EPA/100/K-09/003.

EPA (U.S. Environmental Protection Agency). 2016. “Guidance for Quality Assurance Project Plans for Water Quality Modeling Projects”. EPA Region 10, Office of Environmental Review and Assessment, Seattle, WA. EPA 910-R-16-007.

Gearheard M.F. 2007. Letter to Stephanie Hallock, Director, Oregon Department of Environmental. Quality. April 13, 2007. RE: Approval of Total Maximum Daily Loads (TMDLs) for the Umpqua River Basin.

Gianfagna, C.J. 2015. “Watershed area ratio accurately predicts daily streamflow in nested catchments in the Catskills, New York.” Journal of Hydrology, 583-594.

Hannah, D.M., I.A. Malcom, C. Soulsby, and A.F. Youngson. 2008. “A comparison of forest and moorland stream microclimate, heat exchanges and thermal dynamics.” Hydrological Processes. 22(7):919-940.

Hart, D.R. 1995. “Parameter estimation and stochastic interpretation of the transient storage model for solute transport in streams.” Water Resources Research. 31(2), 323-328.

Holzapfel, G., P. Weihs, and H.P. Rauch. 2013. Use of the Shade-a-lator 6.2 model to assess the shading potential of riparian purple willow (Salix purpurea) coppices on small to medium sized rivers. Ecological Engineering. 61(B): 697–705.

IMST (Independent Multidisciplinary Science Team). 2004. “Oregon’s water temperature standard and its application: causes, consequences, and controversies associated with stream temperature.” Technical Report 2004-1 to the Oregon Plan for Salmon and Watersheds, Oregon Watershed Enhancement Board, Salem, OR.

Jobson, H.E. and T.N. Keefer. 1979. “Modeling highly transient flow, mass and heat transfer in the Chattahoochee River near Atlanta, Georgia.” Geological Survey Professional Paper 1136. U.S. Gov. Printing Office, Washington D.C.

Johnson S.L. 2004. “Factors influencing stream temperature in small streams: substrate effects and a shading experiment.” Canadian Journal of Fish and Aquatic Sciences. 61(6):913-923.

Justice, C., S.M. White, D.A. McCullough, D.S. Graves, and M.R. Blanchard. 2017. “Can Stream and riparian restoration offset climate change impacts to salmon populations?” Journal of Environmental Management. 188: 212-227.

Lawrence, D.J., B. Stewart-Koster, J.D. Olden, A.S. Ruesch, C.E. Torgersen, J.J. Lawler, D.P.Butcher, and J.K. Crown. 2014. “The interactive effects of climate change, riparian management, and a nonnative predator on stream-rearing salmon.” Ecological Applications. 24(4): 895-912.

Loheide, S.P. and S.M. Gorelick. 2006. Quantifying stream-aquifer interactions through the analysis of remotely sensed thermographic profiles and in situ temperature histories.” Environmental Science and Technology. 40(10): 3336-3341.

Lorenz, D.L. and S.M. Ziegeweid. 2016. “Methods to estimate historical daily streamflow for ungaged stream locations in Minnesota. No. 2015-5181.” US Geological Survey, 2016.

NOAA (National Oceanic and Atmospheric Administration). 2001. Global Surface Hourly Datasets. NOAA National Centers for Environmental Information. Dataset identifier: gov.noaa.ncdc:C00532.

NOAA (National Oceanic and Atmospheric Administration). 2005. U.S. Local Climatological Data. NOAA National Centers for Environmental Information. Dataset identifier: gov.noaa.ncdc:C00684.

OWEB (Oregon Watershed Enhancement Board). 1999. “Water Quality Monitoring Technical Guide Book. Addendum Chapter 14, Stream Shade and Canopy Cover Monitoring Methods.”

Pelletier, G.J., C. Chapra, and H. Taob. 2006. “QUAL2Kw – A framework for modeling water quality in streams and rivers using a genetic algorithm for calibration.” Environmental Modelling & Software. 21(3), 419-425.

Ries III, K.G., J.K. Newson, M.J. Smith, J.D. Guthrie, P.A. Steeves, T.L. Haluska, K.R. Kolb, R.F. Thompson, R.D. Santoro, and H.W. Vraga. 2017. “StreamStats, version 4: U.S. Geological Survey Fact 2017–3046, 4 p.” [Supersedes USGS Fact Sheet 2008–3067.] https://doi.org/10.3133/fs20173046

Risley, J. S. 2009. “Estimating flow-duration and low-flow frequency statistics for unregulated stream in Oregon.” Reston, VA: U.S. Geological Survey.

Risley, J., A. Stonewall, and T. Haluska. 2008. “Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon. No. FHWA-OR-RD-09-03”. Geological Survey (US), 2008.

Schofield, K.A. and K. Sappington. 2010. "Detailed conceptual diagram for temperature." In EPA (U.S. Environmental Protection Agency). Causal Analysis/Diagnosis Decision Information System (CADDIS) Volume II. https://www.epa.gov/caddis-vol2/caddis-volume-2-sources-stressors-responses-temperature

Sinokrot, B.A. and H.G. Stefan. 1993. "Stream Temperature Dynamics: Measurements and Modeling." Water Resources Research. 29(7), 2299-2312.

Solar Pathfinder. 2016. "Instruction Manual for the Solar Pathfinder Unit. Item number: PF, and PF-TC". https://www.solarpathfinder.com/pdf/pathfinder-manual.pdf

Watershed Sciences. 2001. "Aerial Surveys in the North Umpqua River Basin, Thermal Infrared and Color Videography. Prepared for Oregon Department of Environmental Quality. December 3, 2001."

Watershed Sciences. 2003. "Aerial Surveys in the Umpqua River Basin, Thermal Infrared and Color Videography. Prepared for Oregon Department of Environmental Quality. May 2, 2003."

Woltemade, C.J. and T.W. Hawkins. 2016. "Stream temperature impacts because of changes in air temperature, land cover, and stream discharge: Navarro River watershed, California, USA." River Research Applications. 32(10): 2020-2031.

Wondzell, S.M., M. Diabat, and R. Haggerty. 2019. "What matters most: Are future stream temperatures more sensitive to changing air temperatures, discharge, or riparian vegetation?" Journal of the American Water Resources Association. 55(1): 116-132.

WSI and MBG (Watershed Sciences, Inc. and Mason, Bruce, & Girard). 2012. "Fish Creek Stream Temperature Modeling." June 5, 2012.

Wunderlich, T.E. 1972. "Heat and mass transfer between a water surface and the atmosphere." Water Resources Research Laboratory, Tennessee Valley Authority. Report No. 14, Norris Tennessee. Pp 4.20.

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S.M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G.C. Liknes, M. Rigge, and G. Xian. 2018. "A new generation of the United States National Land Cover Database: Requirements, research priorities, design, and implementation strategies." Journal of Photogrammetry and Remote Sensing 146: 108-123.

17 Revision history

Table 83: QAPP revision history.

Revision	Date	Changes	Editor
1.0	3/29/2022	New QAPP	R. Michie

Appendix A Meteorology data summary

Table 84: Meteorological stations and data available in the National Climatic Data Center (NCDC) database in the North Umpqua Subbasin.

Station ID	Station	Latitude/Longitude
20015918	TOKETEE FALLS	43.2833/-122.45
20015920	LITTLE RIVER	43.25/-122.917
20015921	WINCHESTER	43.2853/-123.356
20015923	WINCHESTER 3 W	43.2667/-123.417
20015933	LEMOLO LAKE 3 NNW	43.3194/-122.187
20015934	STEAMBOAT CREEK	43.35/-122.73
20015935	STEAMBOAT RANGERSTN	43.3436/-122.737
20015936	IDLEYLD PARK 4 NE	43.3667/-122.967
20015944	SUTHERLIN 4 NE	43.4167/-123.233
20015953	UPPER STEAMBOAT CREEK	43.4869/-122.6
30014872	GLIDE 2NW	43.3019/-123.16
30021523	IDLEYLD PARK 4 ESE	43.3087/-122.94
30023173	ROSEBURG NORTH 4.7 WNW	43.2824/-123.406
30024016	GLIDE 2.9 SSW	43.2594/-123.102
30031055	ROSEBURG 4.6 NNW	43.2809/-123.391
30038421	ROSEBURG 4.9 NW	43.2644/-123.434
30048462	GLIDE 1.1 SE	43.2957/-123.079
30074716	TOKETEE AIRSTRIP	43.23/-122.43
30074758	DIAMOND LAKE	43.19/-122.14
30075088	TOKETEE OREGON	43.2397/-122.4
30075701	CINNAMON OREGON	43.3208/-122.107
30075839	TAFT BENCH OREGON	43.2217/-122.768
30076487	GRANDAD OREGON	43.4158/-122.577
30084278	ROSEBURG 9.9 NE	43.3131/-123.209
30101388	SUTHERLIN 0.1 ESE	43.3881/-123.312

Table 85: Meteorological stations and data, including humidity, precipitation, temperature, wind direction, and wind speed, available in the Remote Automatic Weather Station (RAWS) database in the North Umpqua Subbasin.

Station ID	Station	Latitude/Longitude	Agency
orOGAD	GRANDAD	43.4158/122.577	USFS

Station ID	Station	Latitude/Longitude	Agency
orONOB	NORTH BANK	43.3556/-123.191	BLM

Table 86: Meteorological stations and data, including air temperature, precipitation, relative humidity and wind, available in the USBR AgriMet database in the North Umpqua Subbasin.

Station ID	Station	Latitude/Longitude
ROSO	ROSEBURG, OR AGRIMET WEATHER STATION	43.2708/-123.439

Table 87: Meteorological stations and data, including air temperature, precipitation, relative humidity, wind speed and wind direction, available in the MesoWest database in the North Umpqua Subbasin.

Station ID	Station	Latitude/Longitude
2070P	GRIDBASE	43.3192/-123.06
AT852	NK7G ROSEBURG	43.3082/-123.368
COOPLMLO3	LEMOLO LAKE 3NNW	43.32/-122.19
D1628	DW1628 GLIDE	43.3/-123.1
DFAZX	DFAZ TOKETEE	43.2406/-122.109
F0379	FW0379 GLIDE	43.3075/-123.088
ODT45	OR138 NB AT DIAMOND LAKE MP83.08	43.1266/-122.132
TOFO3	TOKETEE	43.2186/-122.413
TRCI1	TREGO CANAL NEAR GROVELAND 1SE	43.2036/-122.371
TT259	UMPQUA NF PORTABLE #1	43.3294/-122.909

Table 88: Meteorological data provided to DEQ from the various sources for the North Umpqua Subbasin.

Source	Latitude/Longitude	Available Data
Lake Creek near mouth (No Station ID), USFS		Air Temperature

Appendix B Continuous stream temperature data summary

Table 89: Continuous temperature monitoring stations in the North Umpqua Subbasin currently available in public databases and DEQ files.

Station ID	Station	Latitude/Longitude	Organization
21830-ORDEQ	Emile Creek tributary at River Mile 0.76	43.2457/-122.796	DEQ
23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek	43.4072/-122.912	DEQ
23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek	43.4068/-122.912	DEQ
23878-ORDEQ	North East Fork Rock Creek at River Mile 3.9	43.4914/-122.885	DEQ
23880-ORDEQ	Canton Creek upstream of Pass Creek	43.4564/-122.763	DEQ
23884-ORDEQ	Steamboat Creek upstream of Steelhead Creek	43.3762/-122.653	DEQ
23885-ORDEQ	Steamboat Creek upstream of Big Bend Creek	43.4229/-122.601	DEQ
23888-ORDEQ	Horse Heaven Creek above confluence with Steamboat Creek	43.5112/-122.582	DEQ
23889-ORDEQ	East Fork Steamboat Creek at mouth	43.5153/-122.559	DEQ
23894-ORDEQ	North Umpqua upstream of Steamboat Creek	43.3403/-122.733	DEQ
23898-ORDEQ	North Umpqua upstream of Boulder Creek	43.3048/-122.523	DEQ
24553-ORDEQ	North Fork Umpqua River at mouth	43.2681/-123.445	DEQ
25682-ORDEQ	Crystal Springs, North Umpqua River	43.313/-122.142	DEQ
25687-ORDEQ	North Umpqua River above Lemolo 2 diversion	43.3549/-122.248	DEQ
25688-ORDEQ	Warm Springs Creek at mouth, North Umpqua River	43.356/-122.249	DEQ
25689-ORDEQ	North Umpqua River below Lemolo 2 diversion	43.3547/-122.252	DEQ
25690-ORDEQ	North Umpqua River above Barkenberger Creek	43.3324/-122.314	DEQ
25692-ORDEQ	Deer Creek at mouth, North Umpqua River	43.2932/-122.377	DEQ
25693-ORDEQ	North Umpqua River above Lemolo 2 Powerhouse Tailrace Inlet	43.2805/-122.402	DEQ
25694-ORDEQ	North Umpqua River above Toketee Lake	43.2715/-122.406	DEQ

Station ID	Station	Latitude/Longitude	Organization
25695-ORDEQ	North Umpqua River below Toketee Lake	43.2634/-122.425	DEQ
25696-ORDEQ	North Umpqua River above Toketee Powerhouse	43.2726/-122.448	DEQ
25699-ORDEQ	Slide Creek at mouth, North Umpqua River	43.2941/-122.473	DEQ
25703-ORDEQ	Copeland Creek at Mouth, North Umpqua River	43.2918/-122.545	DEQ
25711-ORDEQ	Clearwater River below Diversion 1, North Umpqua River	43.2468/-122.291	DEQ
25712-ORDEQ	Clearwater River above Clearwater 2 Diversion, North Umpqua River	43.2507/-122.336	DEQ
25714-ORDEQ	Clearwater River below Clearwater 2 Diversion, North Umpqua River	43.249/-122.343	DEQ
25720-ORDEQ	Clear Creek at Mouth	43.151/-122.378	DEQ
25722-ORDEQ	Fish Creek above Rough Creek, North Umpqua River	43.2057/-122.392	DEQ
25723-ORDEQ	Rough Creek at mouth, Fish Creek, North Umpqua River	43.2061/-122.392	DEQ
25726-ORDEQ	Fish Creek below Slipper Creek, North Umpqua River	43.2304/-122.447	DEQ
25727-ORDEQ	Fish Creek at mouth, North Umpqua River	43.286/-122.471	DEQ
26534-ORDEQ	Park Creek upstream of campground	43.2454/-123.245	DEQ
26852-ORDEQ	Lake Creek	43.2527/-122.172	DEQ
26854-ORDEQ	Fish Creek	43.0982/-122.409	DEQ
27876-ORDEQ	Egglestron Creek	43.2277/-122.947	DEQ
27878-ORDEQ	Lower Jim Creek	43.2408/-123.023	DEQ
27879-ORDEQ	Rattlesnake Creek	43.2712/-123.028	DEQ
27880-ORDEQ	Rock Creek above North East Fork	43.4536/-122.894	DEQ
27881-ORDEQ	Upper Pass Creek above East Fork	43.4894/-122.785	DEQ
27884-ORDEQ	Canton Creek (above Pass Creek)	43.4567/-122.762	DEQ
27886-ORDEQ	Woodstock Creek	43.3956/-122.929	DEQ
27889-ORDEQ	Trapper Creek	43.4245/-122.778	DEQ
27890-ORDEQ	Susan Creek	43.2988/-122.908	DEQ
27892-ORDEQ	Scaredman Creek at mouth	43.3883/-122.765	DEQ
27894-ORDEQ	Pass Creek	43.4566/-122.764	DEQ
27896-ORDEQ	Miller Creek	43.3886/-122.943	DEQ
27897-ORDEQ	Mellow Moon Creek	43.4663/-122.771	DEQ
27903-ORDEQ	Honey Creek	43.333/-122.931	DEQ
27904-ORDEQ	Harrington below slide	43.4058/-122.952	DEQ

Station ID	Station	Latitude/Longitude	Organization
27908-ORDEQ	Fall Creek	43.2132/-123.087	DEQ
27909-ORDEQ	Emile Creek	43.2559/-122.893	DEQ
27911-ORDEQ	East Fork Rock Creek at mouth	43.4068/-122.912	DEQ
27912-ORDEQ	East Fork Pass Creek at mouth	43.4892/-122.785	DEQ
27932-ORDEQ	Upper Northeast Fork rock	43.4934/-122.887	DEQ
27934-ORDEQ	Rock above Miller	43.3909/-122.946	DEQ
27936-ORDEQ	North East Fork Rock Creek	43.4061/-122.864	DEQ
27937-ORDEQ	Canton Creek	43.4169/-122.78	DEQ
27963-ORDEQ	North East Fork Rock Creek	43.4541/-122.89	DEQ
27964-ORDEQ	Kelly Creek	43.3536/-122.988	DEQ
28395-ORDEQ	North Umpqua above Little River mouth	43.2982/-123.102	DEQ
28396-ORDEQ	Little River at mouth (North Umpqua tributary)	43.2976/-123.101	DEQ
29795-ORDEQ	Big Bend Creek at mouth	43.4225/-122.602	DEQ
29812-ORDEQ	North Umpqua below Copeland Creek (River Mile 66.6)	43.2929/-122.549	DEQ
30150-ORDEQ	Little River above Cavitt	43.2386/-123.012	DEQ
30152-ORDEQ	Cavitt Creek - Shadow	43.1523/-122.95	DEQ
30153-ORDEQ	Upper Little River	43.2218/-122.734	DEQ
30156-ORDEQ	Steamboat Creek below Big Bend Creek	43.4217/-122.604	DEQ
30158-ORDEQ	Steamboat Creek at Road 3831	43.5141/-122.569	DEQ
30162-ORDEQ	North Umpqua River at mouth	43.2681/-123.445	DEQ
32144-ORDEQ	North Umpqua River above Lemolo Lake near Inlet Campground	43.3107/-122.154	DEQ
32146-ORDEQ	North Umpqua River downstream of Lemolo Lake	43.3219/-122.196	DEQ
32477-ORDEQ	Rock Creek at mouth	43.3327/-123.003	DEQ
33461-ORDEQ	Rock Creek East Fork (ODFW)	43.3807/-122.829	DEQ
36083-ORDEQ	Fish Creek d/s of Black Rock Creek - No. Umpqua Basn.	43.1684/-122.392	DEQ
36085-ORDEQ	Watson Creek u/s of culvert at Hwy. 138	43.2513/-122.4	DEQ
36130-ORDEQ	Umpqua R. N us Loafer CR	43.3002/-122.36	DEQ
36131-ORDEQ	Clear River us Stump Reservoir	43.2455/-122.273	DEQ
36132-ORDEQ	Clearwater River near Mouth (us of diversion)	43.2638/-122.419	DEQ
36133-ORDEQ	Fish CR ds Clear CR	43.151/-122.38	DEQ
36134-ORDEQ	Loafer CR at Mouth, N Umpqua R Basin	43.3/-122.36	DEQ

Station ID	Station	Latitude/Longitude	Organization
36135-ORDEQ	Steamboat CR near, Mouth N. Umpqua R Basin	43.3453/-122.736	DEQ
36136-ORDEQ	N. Umpqua near Idleyld Park	43.3247/-123.017	DEQ
36151-ORDEQ	North Umpqua River u/s of Winchester Dam off Page Rd.	43.2852/-123.333	DEQ
36152-ORDEQ	North Umpqua River d/s of Winchester Dam (Rod & Gun Club access)	43.2854/-123.369	DEQ
41101-ORDEQ	Oak Creek Near mouth South Bank Dr.	43.2934/-123.224	DEQ
41104-ORDEQ	Sutherlin Creek at Del Rio Rd	43.3029/-123.376	DEQ
41105-ORDEQ	Sutherlin Creek East of Exit 135	43.3645/-123.328	DEQ
41108-ORDEQ	North Umpqua River at Lone Rock Boat Ramp	43.317/-123.062	DEQ
CLR1T	Clearwater River below Diversion 1		DEQ
No Station ID	Wolverine Creek		DEQ
No Station ID	Cavitt Creek and Cultus Creek confluence		DEQ
No Station ID	Black Rock Creek		DEQ
No Station ID	Unnamed stream at model kilometer 11.75		DEQ
No Station ID	Slipper Creek		DEQ
No Station ID	Eva Creek		DEQ
No Station ID	Pie Creek		DEQ
No Station ID	Boundary Condition		DEQ
No Station ID	Little River at Hemlock Creek		DEQ
No Station ID	Hemlock Creek		DEQ
No Station ID	Junction Creek		DEQ
No Station ID	Pinnacle Creek		DEQ
No Station ID	Unnamed stream at model kilometer 40.55		DEQ
No Station ID	Cedar Creek		DEQ
No Station ID	Unnamed stream at model kilometer 38.9		DEQ
No Station ID	Taft Creek		DEQ
No Station ID	Clover Creek		DEQ
No Station ID	Black Creek		DEQ
No Station ID	Possible Spring LB		DEQ
No Station ID	Unnamed stream at model kilometer 32.55		DEQ
No Station ID	Little Taft Creek		DEQ
No Station ID	White Creek		DEQ
No Station ID	Negro Creek		DEQ
No Station ID	Unnamed stream at model kilometer 27		DEQ

Station ID	Station	Latitude/Longitude	Organization
No Station ID	Emile Creek		DEQ
No Station ID	Spring at model kilometer 24.15		DEQ
No Station ID	Spring LB		DEQ
No Station ID	Shivigny Creek		DEQ
No Station ID	Unnamed stream at model kilometer 21.85		DEQ
No Station ID	Spring at model kilometer 21.25		DEQ
No Station ID	Little Creek		DEQ
No Station ID	Wolf Creek		DEQ
No Station ID	Greenmand Creek		DEQ
No Station ID	Unnamed stream at model kilometer 16.45		DEQ
No Station ID	Spring at model kilometer 14.05		DEQ
No Station ID	Spring at model kilometer 12.95		DEQ
No Station ID	Bond Creek		DEQ
No Station ID	Cavitt Creek		DEQ
No Station ID	Engles Creek		DEQ
No Station ID	Small Tributary		DEQ
No Station ID	Rattlesnake Creek		DEQ
No Station ID	Williams Creek		DEQ
No Station ID	Falls Creek		DEQ
No Station ID	Log Pond		DEQ
No Station ID	Buckhorn Creek		DEQ
No Station ID	Unnamed stream at model kilometer 1.3		DEQ
No Station ID	North Umpqua River at Lemolo Powerhouse 1		DEQ
No Station ID	Laura Creek		DEQ
No Station ID	Nurse Creek		DEQ
No Station ID	Lemolo Forebay Outlet		DEQ
No Station ID	Unknown Site at model kilometer 3		DEQ
No Station ID	Fish Creek		DEQ
No Station ID	Little River		DEQ
No Station ID	Rock Creek at Northeast Rock Creek Confluence		DEQ
No Station ID	Rock Creek Gage near Glide		DEQ
No Station ID	Steamboat Creek at the confluence of Little Rock Creek		DEQ
No Station ID	Buster Creek		DEQ
No Station ID	Reynolds Creek		DEQ

Station ID	Station	Latitude/Longitude	Organization
No Station ID	Singe Creek		DEQ
CAPA	Canton Creek above Pass Creek	43.4563/-122.763	BLM
EFRC	East Fork Rock Creek	43.4066/-122.911	BLM
PASS	Pass Creek	43.4563/-122.764	BLM
27894	Pass Creek	43.4565/-122.762	BLM Roseburg
14316800	Douglas County Gage d/s Steamboat		Douglas County
14317600	Rock Creek		Douglas County
CLR1B	Clearwater 1 Bypass at bottom	43.2507/-122.336	PacifiCorp
CLR1PI (25740-ORDEQ)	Powerhouse 1 outlet	43.2563/-122.321	PacifiCorp
CLR1T	Clearwater 1 Bypass at top	43.2449/-122.292	PacifiCorp
CLR2B	Clearwater 2 Bypass at bottom	43.267/-122.41	PacifiCorp
CLR2T	Clearwater 2 Bypass at top	43.2496/-122.341	PacifiCorp
FISHB	Fish Creek at powerhouse/Mouth	43.2742/-122.449	PacifiCorp
FISHT	Fish Creek below dam (bypass at top)	43.2109/-122.429	PacifiCorp
FISHT	Fish Creek below Fish Creek Diversion Dam	43.2109/-122.428	PacifiCorp
LEM1B	North Umpqua River at bottom of Lemolo 1 bypass reach	43.355/-122.248	PacifiCorp
LEM2B	North Umpqua River at Lemolo 2 bypass at bottom	43.2805/-122.402	PacifiCorp
MOTTB	North Umpqua River at Mott Bridge	43.3385/-122.73	PacifiCorp
No Station ID	Fish Creek at Clear Creek	43.151/-122.378	PacifiCorp
No Station ID	Fish Creek upstream Mowich Creek	43.2057/-122.392	PacifiCorp
No Station ID	Rough Creek	43.2061/-122.392	PacifiCorp
No Station ID	Fish Creek at USGS Gage below Slipper Creek	43.2293/-122.447	PacifiCorp
SODAT	North Umpqua River below Soda Springs Powerhouse	43.3033/-122.495	PacifiCorp
TOKET	Toketee Bypass at top	43.2631/-122.425	PacifiCorp
25701-ORDEQ	Boulder Creek	43.3038/-122.529	USFS
25708-ORDEQ	Panther Creek	43.2918/-122.545	USFS
25715-ORDEQ	Watson Creek	43.2475/-122.397	USFS
29797	Canton Creek at Mouth	43.3498/-122.728	USFS
29806	Little River Below White Creek	43.229/-122.868	USFS
29813-ORDEQ	Cultus Creek	43.1469/-122.954	USFS

Station ID	Station	Latitude/Longitude	Organization
No Station ID	Trapper Creek	43.425/-122.778	USFS
No Station ID	Lake Creek downstream of Diamond Lake		USFS
No Station ID	Little Rock Creek		USFS
No Station ID	Longs Creek		USFS
No Station ID	Deep Creek		USFS
No Station ID	Steelhead Creek		USFS
No Station ID	Steamboat Creek above Canton Creek		USFS
No Station ID	Canton Creek		USFS
UmpNF-002	Bear Creek_LTWT	43.2304/-122.26	USFS
UmpNF-004	Big Bend Creek at the Mouth_LTWT	43.4223/-122.602	USFS
UmpNF-014	Calf Creek base Station_LTWT	43.2725/-122.625	USFS
UmpNF-016	Canton Creek at the mouth_LTWT	43.3496/-122.731	USFS
UmpNF-018	Cavitt Creek above Cultus Creek LTWT	43.1471/-122.955	USFS
UmpNF-019	Cedar Creek at the Mouth_LTWT	43.4492/-122.592	USFS
UmpNF-021	City Creek at the Mouth_LTWT	43.4997/-122.598	USFS
UmpNF-022	Clearwater River above Reconnect_LTWT	43.264/-122.419	USFS
UmpNF-023	Clover Creek at the mouth_LTWT	43.2044/-122.813	USFS
UmpNF-024	Copeland Creek at the mouth_LTWT	43.2917/-122.545	USFS
UmpNF-030	Cultus Creek at the mouth_LTWT	43.1469/-122.956	USFS
UmpNF-033	Deer Creek at the mouth LTWT	43.2936/-122.377	USFS
UmpNF-039	Fish Creek at the mouth LTWT	43.2854/-122.471	USFS
UmpNF-041	Flat Rock Creek at the mouth LTWT	43.193/-122.784	USFS
UmpNF-044	Horse Heaven at the mouth LTWT	43.5115/-122.582	USFS
UmpNF-052	Lake Creek at the mouth LTWT	43.2993/-122.184	USFS
UmpNF-053	Lake Creek below Diamond Lake_LTWT	43.1872/-122.166	USFS
UmpNF-060	Little River above Clover Creek_LTWT	43.2046/-122.812	USFS
UmpNF-061	Little River below White Creek_LTWT	43.2269/-122.858	USFS
UmpNF-062	Little Rock Creek at the Mouth_LTWT	43.4982/-122.6	USFS
UmpNF-064	Mowich Creek at the mouth_LTWT	43.2517/-122.338	USFS
UmpNF-065	NU below Clearwater WT	43.2634/-122.42	USFS
UmpNF-066	Panther Creek abv Limpy on 4719 LTWT	43.3021/-122.681	USFS
UmpNF-067	Panther Creek at the mouth_LTWT	43.3042/-122.677	USFS
UmpNF-079	Steamboat above Canton_LTWT	43.3513/-122.727	USFS
UmpNF-080	Steelhead Creek at the Mouth_LTWT	43.3762/-122.654	USFS
UmpNF-082	Upper Steamboat below Little Rock_LTWT	43.4976/-122.6	USFS

Station ID	Station	Latitude/Longitude	Organization
UmpNF-083	Williams Creek at the mouth LTWT	43.3385/-122.765	USFS
UmpNF-084	Wright Creek at the Mouth WT	43.3201/-122.809	USFS
UmpNF-087	Boulder Creek Wilderness_LTWT	43.304/-122.529	USFS
UmpNF-090	North Umpqua River above Barkenburger LTWT	43.3324/-122.314	USFS
UmpNF-62	Little Rock Creek		USFS
UmpNF-82	Steamboat Creek at the confluence of Little Rock Creek		USFS
14312600	Lake Creek At Highway 138 Near Diamond Lake, OR	43.2576/-122.171	USGS
14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	43.306/-122.513	USGS
14316495	Boulder Creek Near Toketee Falls, OR	43.3035/-122.53	USGS
14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	43.296/-122.537	USGS
14317450	North Umpqua River Near Idleyld Park, OR	43.3246/-123	USGS
14317500	N Umpqua River Ab Rock Cr Nr Glide OR	43.3307/-123.003	USGS
14318000	Little River At Peel, OR	43.2526/-123.026	USGS
14319500	North Umpqua River At Winchester, OR	43.2721/-123.412	USGS

Table 90: Summary of existing temperature data in the North Umpqua Subbasin. Columns Jan – Dec indicate the number of daily maximum temperature results in each month. Data from the DEQ file that are not in the databases were not summarized in the table.

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	23		15	6	28
1991	14319500	North Umpqua River At Winchester, OR	31	28	31	5		25	31	31	29			
1992	14317500	N Umpqua River Ab Rock Cr Nr Glide OR											26	28
1993	14317500	N Umpqua River Ab Rock Cr Nr Glide OR	19	17	15	13	20	30	31	31	30	31	29	31
1994	14317500	N Umpqua River Ab Rock Cr Nr Glide OR	26	25	22	26	31	30	31	31	30	31	24	2
1995	14317500	N Umpqua River Ab Rock Cr Nr Glide OR	8		22	15	30	15	25	31	30	31	12	
1996	14317500	N Umpqua River Ab Rock Cr Nr Glide OR	11		9	23	10	30	31	31	30	26	17	
1997	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR										3	30	28
1997	14317500	N Umpqua River Ab Rock Cr Nr Glide OR		14	27	24	11	5	17	21	20	1	6	25
1998	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	23	31	30	31	30	27	24	30	31	24	9
1998	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR						5	30	31	19			
1998	14317450	North Umpqua River Near Idleyld Park, OR	9	28	31	30	31	30	31	31	30	31	30	
1998	14317500	N Umpqua River Ab Rock Cr Nr Glide OR	10											
1999	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	21	13	30	26	31	30	31	27	13	26	6	25
1999	14316495	Boulder Creek Near Toketee Falls, OR		19	31	30	31	30	31	31	30	31	30	31
1999	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR						9	5	25	30			
1999	14317450	North Umpqua River Near Idleyld Park, OR		26	31	30	22	30	31	31	30	30	30	31
1999	14318000	Little River At Peel, OR						6	31	31	30	31	30	31
1999	21830-ORDEQ	Emile Creek tributary at River Mile 0.76						23	31	31	30	3		
1999	27876-ORDEQ	Egglestron Creek								29	30	18		
1999	27878-ORDEQ	Lower Jim Creek								29	30	18		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	27879-ORDEQ	Rattlesnake Creek					7	30	31	31	11			
1999	27886-ORDEQ	Woodstock Creek									11	18		
1999	27890-ORDEQ	Susan Creek									15	18		
1999	27894-ORDEQ	Pass Creek							30	31	15			
1999	27896-ORDEQ	Miller Creek									21	18		
1999	27903-ORDEQ	Honey Creek							22	31	30	18		
1999	27904-ORDEQ	Harrington below slide							22	31	30	18		
1999	27908-ORDEQ	Fall Creek									8	18		
1999	27909-ORDEQ	Emile Creek									8	11		
1999	27911-ORDEQ	East Fork Rock Creek at mouth							22	31	30	18		
1999	27912-ORDEQ	East Fork Pass Creek at mouth							29	31	15			
2000	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	10	28	31	30	31	20	11	31	30	30	30	31
2000	14316495	Boulder Creek Near Toketee Falls, OR	19		22	30	31	30	31	31	29	27	29	31
2000	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR						30	31	31	29	2		
2000	14317450	North Umpqua River Near Idleyld Park, OR	29	28	31	30	31	30	31	31	29	31	30	31
2000	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						18	31	31	30	18		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	23878-ORDEQ	North East Fork Rock Creek at River Mile 3.9						17	31	8				
2000	23880-ORDEQ	Canton Creek upstream of Pass Creek						18	31	31	30	17		
2000	23884-ORDEQ	Steamboat Creek upstream of Steelhead Creek						1	31	7				
2000	23888-ORDEQ	Horse Heaven Creek above confluence with Steamboat Creek						1	31	7				
2000	23889-ORDEQ	East Fork Steamboat Creek at mouth						16	31	7				
2000	26534-ORDEQ	Park Creek upstream of campground							18	31	21			
2000	27876-ORDEQ	Egglestron Creek						29	31	31	30	15		
2000	27881-ORDEQ	Upper Pass Creek above East Fork						14	31	31	30	17		
2000	27886-ORDEQ	Woodstock Creek								24	19			
2000	27889-ORDEQ	Trapper Creek						18	31	31	30	17		
2000	27890-ORDEQ	Susan Creek						14	31	31	30	17		
2000	27892-ORDEQ	Scaredman Creek at mouth						21	31	31	30	17		
2000	27894-ORDEQ	Pass Creek						36*	62*	62*	60*	34*		
2000	27896-ORDEQ	Miller Creek								24	30	18		
2000	27897-ORDEQ	Mellow Moon Creek						14	31	31	30	17		
2000	27903-ORDEQ	Honey Creek						14	31	31	30	19		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	27912-ORDEQ	East Fork Pass Creek at mouth						14	31	31	30	17		
2000	27932-ORDEQ	Upper Northeast Fork rock						23	31	18				
2000	27934-ORDEQ	Rock above Miller								24	30	18		
2000	27936-ORDEQ	North East Fork Rock Creek						23	31	31	30	18		
2000	27937-ORDEQ	Canton Creek								21	30	17		
2001	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	17	31	30	31	30	31
2001	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR						30	18	31	30	8		
2001	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	11	23	30	31	30	30
2001	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek							29	31	18			
2001	25682-ORDEQ	Crystal Springs, North Umpqua River						9	9					
2001	25695-ORDEQ	North Umpqua River below Toketee Lake							22	20				
2001	25723-ORDEQ	Rough Creek at mouth, Fish Creek, North Umpqua River						14	31					
2001	27876-ORDEQ	Egglestron Creek					7	30	31	31	6			
2001	27878-ORDEQ	Lower Jim Creek								9	18			
2001	27880-ORDEQ	Rock Creek above North East Fork							29	31	18			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	27881-ORDEQ	Upper Pass Creek above East Fork							21	31	17			
2001	27886-ORDEQ	Woodstock Creek							21	31	6			
2001	27892-ORDEQ	Scaredman Creek at mouth							21	31	17			
2001	27897-ORDEQ	Mellow Moon Creek							21	31	27			
2001	27904-ORDEQ	Harrington below slide							29	31	19			
2001	27909-ORDEQ	Emile Creek								9	18			
2001	27911-ORDEQ	East Fork Rock Creek at mouth								11	18			
2001	27912-ORDEQ	East Fork Pass Creek at mouth							21	31	17			
2001	27937-ORDEQ	Canton Creek							21	31	17			
2001	27963-ORDEQ	North East Fork Rock Creek							29	31	18			
2001	27964-ORDEQ	Kelly Creek							21	31	6			
2002	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	29	31	30	30	31	30	31	30	31
2002	14316495	Boulder Creek Near Toketee Falls, OR	31	26	31	30	31	30	31	31	30	31	30	31
2002	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR				4	31	30	31	31	30			
2002	14317450	North Umpqua River Near Idleyld Park, OR	10	18	30	25	31	30	31	31	30	31	30	31
2002	14318000	Little River At Peel, OR	31	25	31	30	31	30	31	31	30	31	30	31
2002	23880-ORDEQ	Canton Creek upstream of Pass Creek						6	31	31	8			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	23885-ORDEQ	Steamboat Creek upstream of Big Bend Creek							56*	62*	60*	4		
2002	25690-ORDEQ	North Umpqua River above Barkenberger Creek						18	31	31	25			
2002	25692-ORDEQ	Deer Creek at mouth, North Umpqua River						18	31	31	25			
2002	25699-ORDEQ	Slide Creek at mouth, North Umpqua River					3	30	31	31	25			
2002	25703-ORDEQ	Copeland Creek at Mouth, North Umpqua River					3	30	31	31	25			
2002	25727-ORDEQ	Fish Creek at mouth, North Umpqua River						18	31	31	25			
2002	26854-ORDEQ	Fish Creek								7				
2002	27880-ORDEQ	Rock Creek above North East Fork						5	31	31	3			
2002	27884-ORDEQ	Canton Creek (above Pass Creek)						6	31	31	8			
2002	27890-ORDEQ	Susan Creek						6	31	31	8			
2002	27894-ORDEQ	Pass Creek						12	62*	36*				
2002	27936-ORDEQ	North East Fork Rock Creek						5	31	31	30	23		
2002	27963-ORDEQ	North East Fork Rock Creek						5	31	31	3			
2002	28395-ORDEQ	North Umpqua above Little River mouth							28	31	26			
2002	29795-ORDEQ	Big Bend Creek at mouth							28	31	30	2		
2002	29812-ORDEQ	North Umpqua below Copeland Creek (River Mile 66.6)					3	30	31	31	25			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	30150-ORDEQ	Little River above Cavitt							28	31	26			
2002	30152-ORDEQ	Cavitt Creek - Shadow							28	31	30	1		
2002	30153-ORDEQ	Upper Little River							28	31	26			
2002	30156-ORDEQ	Steamboat Creek below Big Bend Creek							28	31	26			
2002	30158-ORDEQ	Steamboat Creek at Road 3831							28	31	30	2		
2002	30162-ORDEQ	North Umpqua River at mouth							30	31	15			
2003	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14316495	Boulder Creek Near Toketee Falls, OR	30	25	31	30	31	30	31	31	30	31	30	31
2003	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR						28	31	31	26			
2003	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14318000	Little River At Peel, OR	31	26	31	30	31	30	31	31	30	31	30	31
2004	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR							31	31	30	31	30	31
2004	14317450	North Umpqua River Near Idleyld Park, OR	31	29	31	30	31	30	30	31	30	31	30	31
2004	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek							19	31	23			
2004	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek							19	31	23			
2004	23880-ORDEQ	Canton Creek upstream of Pass Creek							22	31	23			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	27894-ORDEQ	Pass Creek							22	31	23			
2004	UmpNF-014	Calf Creek base Station_LTWT						21	31	31	12			
2004	UmpNF-019	Cedar Creek at the Mouth_LTWT						22	31	31	28			
2004	UmpNF-021	City Creek at the Mouth_LTWT						22	31	31	6			
2004	UmpNF-023	Clover Creek at the mouth_LTWT						14	31	31	12			
2004	UmpNF-024	Copeland Creek at the mouth_LTWT						18	31	31	30	12		
2004	UmpNF-030	Cultus Creek at the mouth_LTWT						14	31	31	12			
2004	UmpNF-041	Flat Rock Creek at the mouth LTWT						15	31	31	13			
2004	UmpNF-044	Horse Heaven at the mouth LTWT						23	31	31	29			
2004	UmpNF-052	Lake Creek at the mouth LTWT						19	31	31	30	7		
2004	UmpNF-053	Lake Creek below Diamond Lake_LTWT						18	31	31	30	6		
2004	UmpNF-062	Little Rock Creek at the Mouth_LTWT						22	31	31	6			
2004	UmpNF-067	Panther Creek at the mouth_LTWT						3	31	31	5			
2004	UmpNF-079	Steamboat above Canton_LTWT							31	31	15			
2004	UmpNF-080	Steelhead Creek at the Mouth_LTWT							31	31	28			
2004	UmpNF-082	Upper Steamboat below Little Rock_LTWT							31	31	28			
2004	UmpNF-090	North Umpqua River above Barkenburger LTWT						19	31	31	30	7		
2005	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	27	27	31
2005	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek							16	31	30	10		
2005	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek							16	31	30	10		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	23880-ORDEQ	Canton Creek upstream of Pass Creek							16	31	30	10		
2005	27894-ORDEQ	Pass Creek							16	31	30	10		
2005	UmpNF-004	Big Bend Creek at the Mouth_LTWT						5	31	31	11			
2005	UmpNF-014	Calf Creek base Station_LTWT					3	30	31	31	12			
2005	UmpNF-016	Canton Creek at the mouth_LTWT						5	31	31	11			
2005	UmpNF-019	Cedar Creek at the Mouth_LTWT						23	31	31	11			
2005	UmpNF-021	City Creek at the Mouth_LTWT								31	11			
2005	UmpNF-023	Clover Creek at the mouth_LTWT							23	31	12			
2005	UmpNF-024	Copeland Creek at the mouth_LTWT					5	30	31	31	20			
2005	UmpNF-030	Cultus Creek at the mouth_LTWT					3	30	31	31	11			
2005	UmpNF-033	Deer Creek at the mouth LTWT						14	31	31	20			
2005	UmpNF-041	Flat Rock Creek at the mouth LTWT					4	30	31	31	13			
2005	UmpNF-044	Horse Heaven at the mouth LTWT					5	30	31	31	12			
2005	UmpNF-052	Lake Creek at the mouth LTWT						15	31	31	20			
2005	UmpNF-053	Lake Creek below Diamond Lake_LTWT						14	31	31	17			
2005	UmpNF-061	Little River below White Creek_LTWT					2	30	31	31	11			
2005	UmpNF-062	Little Rock Creek at the Mouth_LTWT						23	31	31	11			
2005	UmpNF-067	Panther Creek at the mouth_LTWT						22	31	31	6			
2005	UmpNF-079	Steamboat above Canton_LTWT						5	31	31	11			
2005	UmpNF-080	Steelhead Creek at the Mouth_LTWT						5	31	31	11			
2005	UmpNF-082	Upper Steamboat below Little Rock_LTWT						5	31	31	11			
2005	UmpNF-090	North Umpqua River above Barkenburger LTWT						14	31	31	20			
2006	14312600	Lake Creek At Highway 138 Near Diamond Lake, OR								2	30	31	26	31
2006	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	29	30	31	31	30	31	30	31
2006	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	28	31	30	31	31	30	31	30	31
2006	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek						4	31	31	27			
2006	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						4	31	31	27			
2006	23880-ORDEQ	Canton Creek upstream of Pass Creek						4	31	31	27			
2006	27894-ORDEQ	Pass Creek						4	31	31	27			
2006	33461-ORDEQ	Rock Creek East Fork (ODFW)					6	30	31	31	4			
2006	UmpNF-004	Big Bend Creek at the Mouth_LTWT						16	31	31	19			
2006	UmpNF-014	Calf Creek base Station_LTWT						19	31	31	2			
2006	UmpNF-016	Canton Creek at the mouth_LTWT						16	31	31	19			
2006	UmpNF-019	Cedar Creek at the Mouth_LTWT						16	31	31	19			
2006	UmpNF-021	City Creek at the Mouth_LTWT						16	31	31	19			
2006	UmpNF-023	Clover Creek at the mouth_LTWT						20	31	31	12			
2006	UmpNF-024	Copeland Creek at the mouth_LTWT						17	31	31	30	1		
2006	UmpNF-030	Cultus Creek at the mouth_LTWT						19	31	31	12			
2006	UmpNF-033	Deer Creek at the mouth LTWT						18	31	31	30	2		
2006	UmpNF-041	Flat Rock Creek at the mouth LTWT						20	31	31	12			
2006	UmpNF-052	Lake Creek at the mouth LTWT						18	31	31	30	3		
2006	UmpNF-060	Little River above Clover Creek_LTWT						19	31	31	12			
2006	UmpNF-061	Little River below White Creek_LTWT						19	31	31	12			
2006	UmpNF-062	Little Rock Creek at the Mouth_LTWT						16	31	31	19			
2006	UmpNF-067	Panther Creek at the mouth_LTWT						7	31	31	6			
2006	UmpNF-079	Steamboat above Canton_LTWT						16	31	31	19			
2006	UmpNF-080	Steelhead Creek at the Mouth_LTWT						16	31	31	19			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	UmpNF-082	Upper Steamboat below Little Rock_LTWT						16	31	31	19			
2006	UmpNF-090	North Umpqua River above Barkenburger LTWT						18	31	31	30	2		
2007	14312600	Lake Creek At Highway 138 Near Diamond Lake, OR	27	28	31	30	31	30	31	29	25	30	6	
2007	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	27	30	30	31	31	30	31	26	31
2007	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14318000	Little River At Peel, OR	31	28	30	30	31	30	31	31	30	31	30	31
2007	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek					20	30	31	31	26			
2007	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek					20	30	31	31	26			
2007	23880-ORDEQ	Canton Creek upstream of Pass Creek						11	31	31	30	9		
2007	27894-ORDEQ	Pass Creek						11	31	31	30	9		
2007	33461-ORDEQ	Rock Creek East Fork (ODFW)					7	30	31	31	23			
2007	UmpNF-004	Big Bend Creek at the Mouth_LTWT						19	31	31	28			
2007	UmpNF-014	Calf Creek base Station_LTWT						16	31	31	30	3		
2007	UmpNF-016	Canton Creek at the mouth_LTWT						16	31	31	28			
2007	UmpNF-019	Cedar Creek at the Mouth_LTWT						20	31	31	28			
2007	UmpNF-021	City Creek at the Mouth_LTWT						20	31	31	28			
2007	UmpNF-023	Clover Creek at the mouth_LTWT						16	31	31	29			
2007	UmpNF-024	Copeland Creek at the mouth_LTWT						9	31	31	27			
2007	UmpNF-030	Cultus Creek at the mouth_LTWT						16	31	31	30			
2007	UmpNF-033	Deer Creek at the mouth LTWT						10	31	31	27			
2007	UmpNF-041	Flat Rock Creek at the mouth LTWT						15	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	UmpNF-044	Horse Heaven at the mouth LTWT						20	31	31	28			
2007	UmpNF-052	Lake Creek at the mouth LTWT						10	31	31	30			
2007	UmpNF-053	Lake Creek below Diamond Lake_LTWT						9	31	31	29			
2007	UmpNF-060	Little River above Clover Creek_LTWT						16	31	31	30			
2007	UmpNF-061	Little River below White Creek_LTWT						16	31	31	30			
2007	UmpNF-062	Little Rock Creek at the Mouth_LTWT						20	31	31	28			
2007	UmpNF-067	Panther Creek at the mouth_LTWT						16	31	31	30	2		
2007	UmpNF-079	Steamboat above Canton_LTWT						16	31	31	16			
2007	UmpNF-080	Steelhead Creek at the Mouth_LTWT						20	31	31	30	3		
2007	UmpNF-082	Upper Steamboat below Little Rock_LTWT						20	31	31	28			
2007	UmpNF-090	North Umpqua River above Barkenburger LTWT						10	31	31	30			
2008	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14316495	Boulder Creek Near Toketee Falls, OR	31	25	31	30	31	30	31	31	30	31	30	31
2008	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14317450	North Umpqua River Near Idleyld Park, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14318000	Little River At Peel, OR	28	29	31	30	31	30	31	31	30	31	30	31
2008	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek						13	31	31	30	14		
2008	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						13	31	31	30	14		
2008	23880-ORDEQ	Canton Creek upstream of Pass Creek						13	31	31	30	14		
2008	27894-ORDEQ	Pass Creek						13	31	31	30	14		
2008	UmpNF-002	Bear Creek_LTWT						17	31	31	30	8		
2008	UmpNF-004	Big Bend Creek at the Mouth_LTWT						7	31	31	29			
2008	UmpNF-014	Calf Creek base Station_LTWT						7	31	31	28			
2008	UmpNF-016	Canton Creek at the mouth_LTWT						7	31	31	29			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	UmpNF-019	Cedar Creek at the Mouth_LTWT						7	31	31	29			
2008	UmpNF-021	City Creek at the Mouth_LTWT						2	31	31	29			
2008	UmpNF-022	Clearwater River above Reconnect_LTWT						22	31	31	30	5		
2008	UmpNF-023	Clover Creek at the mouth_LTWT						6	31	31	27			
2008	UmpNF-024	Copeland Creek at the mouth_LTWT						21	31	31	30	5		
2008	UmpNF-030	Cultus Creek at the mouth_LTWT						4	31	31	27			
2008	UmpNF-033	Deer Creek at the mouth LTWT						10	31	31	30	6		
2008	UmpNF-039	Fish Creek at the mouth LTWT						11	31	31	30	5		
2008	UmpNF-041	Flat Rock Creek at the mouth LTWT						6	31	31	27			
2008	UmpNF-044	Horse Heaven at the mouth LTWT						7	31	31	29			
2008	UmpNF-052	Lake Creek at the mouth LTWT						21	31	31	30	8		
2008	UmpNF-053	Lake Creek below Diamond Lake_LTWT						21	31	31	30	5		
2008	UmpNF-060	Little River above Clover Creek_LTWT						6	31	31	27			
2008	UmpNF-061	Little River below White Creek_LTWT						6	31	31	27			
2008	UmpNF-062	Little Rock Creek at the Mouth_LTWT						7	31	31	29			
2008	UmpNF-064	Mowich Creek at the mouth_LTWT						17	31	31	30	8		
2008	UmpNF-067	Panther Creek at the mouth_LTWT						7	31	31	29			
2008	UmpNF-079	Steamboat above Canton_LTWT						7	31	31	15			
2008	UmpNF-080	Steelhead Creek at the Mouth_LTWT						7	31	31	29			
2008	UmpNF-082	Upper Steamboat below Little Rock_LTWT						7	31	31	29			
2008	UmpNF-090	North Umpqua River above Barkenburger LTWT						16	31	31	30	6		
2009	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	29	31	29	31	30	31
2009	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	29	31
2009	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek						28	31	31	30	19		
2009	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						28	31	31	30	19		
2009	23880-ORDEQ	Canton Creek upstream of Pass Creek						8	31	31	30	19		
2009	23894-ORDEQ	North Umpqua upstream of Steamboat Creek								14	30	12		
2009	23898-ORDEQ	North Umpqua upstream of Boulder Creek								7	23	11		
2009	25687-ORDEQ	North Umpqua River above Lemolo 2 diversion								6	30	13		
2009	25688-ORDEQ	Warm Springs Creek at mouth, North Umpqua River								6	30	13		
2009	25689-ORDEQ	North Umpqua River below Lemolo 2 diversion								6	30	13		
2009	25693-ORDEQ	North Umpqua River above Lemolo 2 Powerhouse Tailrace Inlet								12	30	14		
2009	25694-ORDEQ	North Umpqua River above Toketee Lake								6	30	12		
2009	25695-ORDEQ	North Umpqua River below Toketee Lake								12	30	12		
2009	25696-ORDEQ	North Umpqua River above Toketee Powerhouse								5	30	11		
2009	25711-ORDEQ	Clearwater River below Diversion 1, North Umpqua River								14	23	12		
2009	25712-ORDEQ	Clearwater River above Clearwater 2 Diversion, North Umpqua River								12	23	12		
2009	25714-ORDEQ	Clearwater River below Clearwater 2 Diversion, North Umpqua River								12	30	12		
2009	25722-ORDEQ	Fish Creek above Rough Creek, North Umpqua River								11	30	14		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	25723-ORDEQ	Rough Creek at mouth, Fish Creek, North Umpqua River								11	30	14		
2009	25726-ORDEQ	Fish Creek below Slipper Creek, North Umpqua River								11	31	16		
2009	26852-ORDEQ	Lake Creek								14	23	13		
2009	27894-ORDEQ	Pass Creek						8	31	31	30	19		
2009	28396-ORDEQ	Little River at mouth (North Umpqua tributary)								14	30	11		
2009	30162-ORDEQ	North Umpqua River at mouth								7	23	11		
2009	32144-ORDEQ	North Umpqua River above Lemolo Lake near Inlet Campground								13	29	12		
2009	32146-ORDEQ	North Umpqua River downstream of Lemolo Lake								14	30	13		
2009	32477-ORDEQ	Rock Creek at mouth								11	30	11		
2009	33461-ORDEQ	Rock Creek East Fork (ODFW)							24	13				
2009	36083-ORDEQ	Fish Creek d/s of Black Rock Creek - No. Umpqua Basn.								11	30	14		
2009	36085-ORDEQ	Watson Creek u/s of culvert at Hwy. 138								12	23	13		
2009	36130-ORDEQ	Umpqua R. N us Loafer CR								10	30	13		
2009	36131-ORDEQ	Clear River us Stump Reservoir								14	30	13		
2009	36132-ORDEQ	Clearwater River near Mouth (us of diversion)								12	30	12		
2009	36133-ORDEQ	Fish CR ds Clear CR								11	23	14		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	36134-ORDEQ	Loafer CR at Mouth, N Umpqua R Basin								10	30	13		
2009	36135-ORDEQ	Steamboat CR near, Mouth N. Umpqua R Basin								14	30	11		
2009	36136-ORDEQ	N. Umpqua near Idleyld Park								11	23	11		
2009	36151-ORDEQ	North Umpqua River u/s of Winchester Dam off Page Rd.								7	30	11		
2009	36152-ORDEQ	North Umpqua River d/s of Winchester Dam (Rod & Gun Club access)								4	30	11		
2009	UmpNF-002	Bear Creek_LTWT							30	31	30	20		
2009	UmpNF-004	Big Bend Creek at the Mouth_LTWT						8	31	31	21			
2009	UmpNF-014	Calf Creek base Station_LTWT						6	31	31	21			
2009	UmpNF-016	Canton Creek at the mouth_LTWT						6	31	31	21			
2009	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						11	31	31	30	8		
2009	UmpNF-019	Cedar Creek at the Mouth_LTWT						8	31	31	21			
2009	UmpNF-021	City Creek at the Mouth_LTWT						8	31	31	21			
2009	UmpNF-022	Clearwater River above Reconnect_LTWT						6	31	31	30	26		
2009	UmpNF-023	Clover Creek at the mouth_LTWT						15	31	31	13			
2009	UmpNF-024	Copeland Creek at the mouth_LTWT						6	31	31	30	19		
2009	UmpNF-030	Cultus Creek at the mouth_LTWT						11	31	31	30	8		
2009	UmpNF-033	Deer Creek at the mouth LTWT							30	31	30	26		
2009	UmpNF-039	Fish Creek at the mouth LTWT						6	31	31	30	20		
2009	UmpNF-041	Flat Rock Creek at the mouth LTWT						15	31	31	13			
2009	UmpNF-044	Horse Heaven at the mouth LTWT						8	31	31	21			
2009	UmpNF-052	Lake Creek at the mouth LTWT						8	31	31	30	21		
2009	UmpNF-053	Lake Creek below Diamond Lake_LTWT						8	31	31	30	25		
2009	UmpNF-060	Little River above Clover Creek_LTWT						15	31	31	13			
2009	UmpNF-061	Little River below White Creek_LTWT						15	31	31	13			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	UmpNF-062	Little Rock Creek at the Mouth_LTWT						8	31	31	21			
2009	UmpNF-064	Mowich Creek at the mouth_LTWT							30	31	30	26		
2009	UmpNF-067	Panther Creek at the mouth_LTWT						6	31	31	21			
2009	UmpNF-079	Steamboat above Canton_LTWT						8	31	31	15			
2009	UmpNF-080	Steelhead Creek at the Mouth_LTWT						8	31	31	21			
2009	UmpNF-082	Upper Steamboat below Little Rock_LTWT						8	31	31	21			
2009	UmpNF-090	North Umpqua River above Barkenburger LTWT							29	31	30	21		
2010	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	27	31	30	30	30	31	28	30	31	30	31
2010	14316495	Boulder Creek Near Toketee Falls, OR	31	26	31	30	31	30	31	31	30	26	30	31
2010	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	29	30	29	31	30	31
2010	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	30	30	31
2010	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek							30	31	19			
2010	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek							30	31	19			
2010	23880-ORDEQ	Canton Creek upstream of Pass Creek						14	31	31	19			
2010	27894-ORDEQ	Pass Creek						14	31	31	19			
2010	UmpNF-002	Bear Creek_LTWT						14	31	31	23			
2010	UmpNF-004	Big Bend Creek at the Mouth_LTWT						14	31	31	21			
2010	UmpNF-014	Calf Creek base Station_LTWT						13	31	31	22			
2010	UmpNF-016	Canton Creek at the mouth_LTWT						13	31	31	22			
2010	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						8	31	31	26			
2010	UmpNF-019	Cedar Creek at the Mouth_LTWT						14	31	21				
2010	UmpNF-021	City Creek at the Mouth_LTWT						14	31	12				
2010	UmpNF-022	Clearwater River above Reconnect_LTWT							30	31	23			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	UmpNF-023	Clover Creek at the mouth_LTWT							24	31	30	11		
2010	UmpNF-024	Copeland Creek at the mouth_LTWT						14	31	31	22			
2010	UmpNF-033	Deer Creek at the mouth LTWT							30	31	27			
2010	UmpNF-039	Fish Creek at the mouth LTWT							30	31	23			
2010	UmpNF-041	Flat Rock Creek at the mouth LTWT							24	31	30	11		
2010	UmpNF-044	Horse Heaven at the mouth LTWT						14	31	31	21			
2010	UmpNF-052	Lake Creek at the mouth LTWT						16	31	31	23			
2010	UmpNF-053	Lake Creek below Diamond Lake_LTWT						13	31	31	27			
2010	UmpNF-062	Little Rock Creek at the Mouth_LTWT						14	31	31	21			
2010	UmpNF-064	Mowich Creek at the mouth_LTWT						13	31	31	23			
2010	UmpNF-067	Panther Creek at the mouth_LTWT						13	31	15				
2010	UmpNF-079	Steamboat above Canton_LTWT						14	31	31	22			
2010	UmpNF-082	Upper Steamboat below Little Rock_LTWT						14	31	31	22			
2010	UmpNF-083	Williams Creek at the mouth LTWT						13	31	31	30	6		
2010	UmpNF-090	North Umpqua River above Barkenburger LTWT						13	31	31	23			
2011	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	26	31	28	31	30	31	31	30	31	30	31
2011	14316495	Boulder Creek Near Toketee Falls, OR	23	28	4	3	31	30	10	26	30	31	30	29
2011	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14318000	Little River At Peel, OR	31	28	31	30	31	30	30	31	30	31	30	31
2011	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek						15	31	31	30	24		
2011	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						15	31	31	30	24		
2011	23880-ORDEQ	Canton Creek upstream of Pass Creek						23	31	31	30	24		
2011	27894-ORDEQ	Pass Creek						23	31	31	30	24		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	UmpNF-002	Bear Creek_LTWT						16	31	31	30	6		
2011	UmpNF-004	Big Bend Creek at the Mouth_LTWT							23	31	28			
2011	UmpNF-014	Calf Creek base Station_LTWT							11	31	28			
2011	UmpNF-016	Canton Creek at the mouth_LTWT							23	31	21			
2011	UmpNF-018	Cavitt Creek above Cultus Creek LTWT							10	31	30	12		
2011	UmpNF-019	Cedar Creek at the Mouth_LTWT							23	31	28			
2011	UmpNF-021	City Creek at the Mouth_LTWT							23	31	28			
2011	UmpNF-022	Clearwater River above Reconnect_LTWT							20	31	30	6		
2011	UmpNF-023	Clover Creek at the mouth_LTWT							10	31	30	12		
2011	UmpNF-024	Copeland Creek at the mouth_LTWT							19	31	30	4		
2011	UmpNF-030	Cultus Creek at the mouth_LTWT							10	31	30	12		
2011	UmpNF-033	Deer Creek at the mouth LTWT							20	31	30	6		
2011	UmpNF-039	Fish Creek at the mouth LTWT							15	31	30	6		
2011	UmpNF-041	Flat Rock Creek at the mouth LTWT							10	31	30	12		
2011	UmpNF-044	Horse Heaven at the mouth LTWT							23	31	28			
2011	UmpNF-052	Lake Creek at the mouth LTWT						17	31	31	30	4		
2011	UmpNF-053	Lake Creek below Diamond Lake_LTWT						3	31	31	30	9		
2011	UmpNF-060	Little River above Clover Creek_LTWT							10	31	30	12		
2011	UmpNF-061	Little River below White Creek_LTWT							10	31	30	12		
2011	UmpNF-062	Little Rock Creek at the Mouth_LTWT							23	31	28			
2011	UmpNF-064	Mowich Creek at the mouth_LTWT						16	31	31	30	4		
2011	UmpNF-067	Panther Creek at the mouth_LTWT							11	31	28			
2011	UmpNF-079	Steamboat above Canton_LTWT							23	31	28			
2011	UmpNF-080	Steelhead Creek at the Mouth_LTWT							23	31	28			
2011	UmpNF-082	Upper Steamboat below Little Rock_LTWT							23	31	28			
2011	UmpNF-083	Williams Creek at the mouth LTWT							11	31	28			
2011	UmpNF-090	North Umpqua River above Barkenburger LTWT							19	31	30	6		
2012	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	14316495	Boulder Creek Near Toketee Falls, OR	19	29	31	30	31	30	31	31	30	31	30	31
2012	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	24	31	30	31	30	31
2012	14317450	North Umpqua River Near Idleyld Park, OR	31	29	31	30	31	29	31	31	30	31	26	31
2012	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek						16	31	31	30	10		
2012	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						16	31	31	30	10		
2012	23880-ORDEQ	Canton Creek upstream of Pass Creek						15	31	31	30	15	30	31
2012	27894-ORDEQ	Pass Creek						15	31	31	30	14		
2012	UmpNF-002	Bear Creek_LTWT						16	31	31	30	2		
2012	UmpNF-004	Big Bend Creek at the Mouth_LTWT						9	31	31	11			
2012	UmpNF-018	Cavitt Creek above Cultus Creek LTWT								31	30	8		
2012	UmpNF-019	Cedar Creek at the Mouth_LTWT						10	31	31	30	1		
2012	UmpNF-021	City Creek at the Mouth_LTWT						10	31	31	11			
2012	UmpNF-022	Clearwater River above Reconnect_LTWT						15	31	31	30	3		
2012	UmpNF-023	Clover Creek at the mouth_LTWT							13	31	30	5		
2012	UmpNF-024	Copeland Creek at the mouth_LTWT						16	31	31	30	2		
2012	UmpNF-030	Cultus Creek at the mouth_LTWT								31	30	8		
2012	UmpNF-033	Deer Creek at the mouth LTWT						16	31	31	30	2		
2012	UmpNF-039	Fish Creek at the mouth LTWT						16	31	31	30	11		
2012	UmpNF-041	Flat Rock Creek at the mouth LTWT							13	31	30	5		
2012	UmpNF-044	Horse Heaven at the mouth LTWT						10	31	31	11			
2012	UmpNF-052	Lake Creek at the mouth LTWT						12	31	31	30	2		
2012	UmpNF-053	Lake Creek below Diamond Lake_LTWT						15	31	31	30	2		
2012	UmpNF-060	Little River above Clover Creek_LTWT							13	31	30	5		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	UmpNF-061	Little River below White Creek_LTWT							13	31	30	31	30	31
2012	UmpNF-062	Little Rock Creek at the Mouth_LTWT						10	31	31	30	1		
2012	UmpNF-064	Mowich Creek at the mouth_LTWT						16	31	31	30	1		
2012	UmpNF-067	Panther Creek at the mouth_LTWT						9	31	31	30	1		
2012	UmpNF-079	Steamboat above Canton_LTWT						9	31	31	12			
2012	UmpNF-080	Steelhead Creek at the Mouth_LTWT						4	31	31	12			
2012	UmpNF-082	Upper Steamboat below Little Rock_LTWT						10	31	31	30	1		
2012	UmpNF-083	Williams Creek at the mouth LTWT						9	31	31	30	1		
2012	UmpNF-090	North Umpqua River above Barkenburger LTWT						15	31	31	30	2		
2013	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	29
2013	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	27	31	30	31
2013	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14318000	Little River At Peel, OR	26	7	31	30	31	30	31	31	30	31	30	31
2013	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek									21	31	30	31
2013	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	30	31	30	31	31	30	31	30	31
2013	27894-ORDEQ	Pass Creek										6	30	31
2013	UmpNF-002	Bear Creek_LTWT							21	31	30	29		
2013	UmpNF-004	Big Bend Creek at the Mouth_LTWT						5	31	31	16			
2013	UmpNF-014	Calf Creek base Station_LTWT						4	31	31	16			
2013	UmpNF-016	Canton Creek at the mouth_LTWT						4	31	31	16			
2013	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						3	31	31	30	21		
2013	UmpNF-019	Cedar Creek at the Mouth_LTWT						5	31	31	16			
2013	UmpNF-021	City Creek at the Mouth_LTWT						5	31	31	16			
2013	UmpNF-022	Clearwater River above Reconnect_LTWT							26	31	30	28		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	UmpNF-023	Clover Creek at the mouth_LTWT						3	31	31	17			
2013	UmpNF-024	Copeland Creek at the mouth_LTWT							26	31	30	27		
2013	UmpNF-030	Cultus Creek at the mouth_LTWT						3	31	31	30	21		
2013	UmpNF-033	Deer Creek at the mouth LTWT							26	31	30	28		
2013	UmpNF-039	Fish Creek at the mouth LTWT							26	31	30	28		
2013	UmpNF-041	Flat Rock Creek at the mouth LTWT						3	31	31	17			
2013	UmpNF-044	Horse Heaven at the mouth LTWT						5	31	31	16			
2013	UmpNF-052	Lake Creek at the mouth LTWT							23	31	30	8		
2013	UmpNF-053	Lake Creek below Diamond Lake_LTWT							23	31	30	20		
2013	UmpNF-060	Little River above Clover Creek_LTWT						3	31	31	17			
2013	UmpNF-061	Little River below White Creek_LTWT	31	28	31	30	31	29	31	31	17			
2013	UmpNF-062	Little Rock Creek at the Mouth_LTWT						5	31	31	16			
2013	UmpNF-064	Mowich Creek at the mouth_LTWT							21	31	30	29		
2013	UmpNF-067	Panther Creek at the mouth_LTWT						4	31	31	17			
2013	UmpNF-079	Steamboat above Canton_LTWT						4	31	31	16			
2013	UmpNF-080	Steelhead Creek at the Mouth_LTWT						5	31	31	16			
2013	UmpNF-082	Upper Steamboat below Little Rock_LTWT						5	31	31	16			
2013	UmpNF-083	Williams Creek at the mouth LTWT						5	31	31	17			
2013	UmpNF-090	North Umpqua River above Barkenburger LTWT							25	31	30	28		
2014	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	28	30	31	30	31
2014	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	29	20
2014	14317450	North Umpqua River Near Idleyld Park, OR	31	25	26	26	31	30	31	31	30	31	28	31
2014	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek					1	30	31	31	30	31	30	31
2014	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek	31	28	30	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	30	31	30	31	31	30	31	30	31
2014	27894-ORDEQ	Pass Creek	31	28	30	30	31	30	31	31	30	31	30	31
2014	UmpNF-002	Bear Creek_LTWT							24	31	24			
2014	UmpNF-004	Big Bend Creek at the Mouth_LTWT						17	31	31	15			
2014	UmpNF-014	Calf Creek base Station_LTWT						17	31	31	23			
2014	UmpNF-016	Canton Creek at the mouth_LTWT						17	31	31	23			
2014	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						17	31	31	24			
2014	UmpNF-019	Cedar Creek at the Mouth_LTWT						17	31	31	23			
2014	UmpNF-021	City Creek at the Mouth_LTWT						17	31	31	23			
2014	UmpNF-022	Clearwater River above Reconnect_LTWT							28	31	24			
2014	UmpNF-023	Clover Creek at the mouth_LTWT						17	31	31	24			
2014	UmpNF-024	Copeland Creek at the mouth_LTWT							24	31	28			
2014	UmpNF-030	Cultus Creek at the mouth_LTWT						17	31	31	24			
2014	UmpNF-033	Deer Creek at the mouth LTWT							21	31	28			
2014	UmpNF-039	Fish Creek at the mouth LTWT							22	31	28			
2014	UmpNF-041	Flat Rock Creek at the mouth LTWT						17	31	31	24			
2014	UmpNF-044	Horse Heaven at the mouth LTWT						17	31	31	23			
2014	UmpNF-052	Lake Creek at the mouth LTWT						4	31	31	30			
2014	UmpNF-053	Lake Creek below Diamond Lake_LTWT						4	31	31	24			
2014	UmpNF-060	Little River above Clover Creek_LTWT						17	31	31	24			
2014	UmpNF-061	Little River below White Creek_LTWT						17	31	31	24			
2014	UmpNF-062	Little Rock Creek at the Mouth_LTWT						17	31	31	23			
2014	UmpNF-064	Mowich Creek at the mouth_LTWT							24	31	30	2		
2014	UmpNF-067	Panther Creek at the mouth_LTWT						17	31	31	23			
2014	UmpNF-079	Steamboat above Canton_LTWT						17	31	31	23			
2014	UmpNF-080	Steelhead Creek at the Mouth_LTWT						17	31	31	23			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	UmpNF-082	Upper Steamboat below Little Rock_LTWT						17	31	31	23			
2014	UmpNF-083	Williams Creek at the mouth LTWT						17	31	31	23			
2014	UmpNF-090	North Umpqua River above Barkenburger LTWT							20	31	28			
2015	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	30	30	31	30	31
2015	14316495	Boulder Creek Near Toketee Falls, OR	27	28	31	30	31	30	31	31	30	31	30	31
2015	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	22	28	31	30	31	30	31	31	30	31	30	31
2015	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	30	30	30	31	30	31
2015	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek	31	28	30	30	31	30	31	31	30	31	30	31
2015	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek	31	28	30	30	31	10						
2015	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	22		19	31	31	30	31	30	30
2015	27894-ORDEQ	Pass Creek	31	28	30	30	31	29	31	31	30	31	30	31
2015	UmpNF-002	Bear Creek_LTWT						27	31	31	30	14		
2015	UmpNF-004	Big Bend Creek at the Mouth_LTWT						30	31	31	28			
2015	UmpNF-014	Calf Creek base Station_LTWT						30	31	31	28			
2015	UmpNF-016	Canton Creek at the mouth_LTWT						30	31	31	28			
2015	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						30	31	31	30			
2015	UmpNF-019	Cedar Creek at the Mouth_LTWT						30	31	31	28			
2015	UmpNF-021	City Creek at the Mouth_LTWT						30	31	31	28			
2015	UmpNF-022	Clearwater River above Reconnect_LTWT						27	31	31	30			
2015	UmpNF-023	Clover Creek at the mouth_LTWT						30	31	31	30			
2015	UmpNF-024	Copeland Creek at the mouth_LTWT						19	31	31	30	6		
2015	UmpNF-030	Cultus Creek at the mouth_LTWT						30	31	31	30			
2015	UmpNF-033	Deer Creek at the mouth LTWT						19	31	31	30	6		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	UmpNF-039	Fish Creek at the mouth LTWT						19	31	31	30	14		
2015	UmpNF-041	Flat Rock Creek at the mouth LTWT						30	31	31	30			
2015	UmpNF-044	Horse Heaven at the mouth LTWT						30	31	31	28			
2015	UmpNF-052	Lake Creek at the mouth LTWT						27	31	31	30	14		
2015	UmpNF-053	Lake Creek below Diamond Lake_LTWT						27	31	31	30	14		
2015	UmpNF-060	Little River above Clover Creek_LTWT						30	31	31	30			
2015	UmpNF-061	Little River below White Creek_LTWT						30	31	31	30			
2015	UmpNF-062	Little Rock Creek at the Mouth_LTWT						30	31	31	28			
2015	UmpNF-064	Mowich Creek at the mouth_LTWT						27	31	31	30	6		
2015	UmpNF-065	NU below Clearwater WT						27	31	31	30			
2015	UmpNF-066	Panther Creek abv Limpy on 4719 LTWT						20	31	31	28			
2015	UmpNF-067	Panther Creek at the mouth_LTWT						30	31	31	28			
2015	UmpNF-079	Steamboat above Canton_LTWT						20	31	31	28			
2015	UmpNF-080	Steelhead Creek at the Mouth_LTWT						30	31	31	28			
2015	UmpNF-082	Upper Steamboat below Little Rock_LTWT						30	31	31	28			
2015	UmpNF-083	Williams Creek at the mouth LTWT						30	31	31	28			
2015	UmpNF-090	North Umpqua River above Barkenburger LTWT						18	31	31	30	14		
2016	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	3		
2016	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14317450	North Umpqua River Near Idleyld Park, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14319500	North Umpqua River At Winchester, OR									4	31	30	31
2016	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek	31	29	30	30	31	9			22	31	30	31
2016	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						20	31	31	7			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	29	30	30	31	30	31	31	30	31	30	31
2016	27894-ORDEQ	Pass Creek	31	29	30	30	31	30	31	31	28			
2016	UmpNF-002	Bear Creek_LTWT						9	31	31	30	10		
2016	UmpNF-004	Big Bend Creek at the Mouth_LTWT						21	31	31	28			
2016	UmpNF-014	Calf Creek base Station_LTWT						16	31	31	28			
2016	UmpNF-016	Canton Creek at the mouth_LTWT						21	31	31	28			
2016	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						21	31	31	27			
2016	UmpNF-019	Cedar Creek at the Mouth_LTWT						21	31	31	28			
2016	UmpNF-021	City Creek at the Mouth_LTWT						21	31	31	28			
2016	UmpNF-022	Clearwater River above Reconnect_LTWT						1	31	31	30	10		
2016	UmpNF-023	Clover Creek at the mouth_LTWT						21	31	31	27			
2016	UmpNF-024	Copeland Creek at the mouth_LTWT						1	31	31	30	11		
2016	UmpNF-030	Cultus Creek at the mouth_LTWT						21	31	31	27			
2016	UmpNF-033	Deer Creek at the mouth LTWT						1	31	31	30	11		
2016	UmpNF-039	Fish Creek at the mouth LTWT						1	31	31	30	11		
2016	UmpNF-044	Horse Heaven at the mouth LTWT						21	31	31	28			
2016	UmpNF-052	Lake Creek at the mouth LTWT						9	31	31	25			
2016	UmpNF-053	Lake Creek below Diamond Lake_LTWT						9	31	31	25			
2016	UmpNF-060	Little River above Clover Creek_LTWT						21	31	31	27			
2016	UmpNF-061	Little River below White Creek_LTWT						21	31	31	27			
2016	UmpNF-062	Little Rock Creek at the Mouth_LTWT						21	31	31	28			
2016	UmpNF-064	Mowich Creek at the mouth_LTWT						9	31	31	26			
2016	UmpNF-065	NU below Clearwater WT						9	31	31	26			
2016	UmpNF-066	Panther Creek abv Limpy on 4719 LTWT						16	31	31	28			
2016	UmpNF-067	Panther Creek at the mouth_LTWT						16	31	31	28			
2016	UmpNF-079	Steamboat above Canton_LTWT						21	31	31	28			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	UmpNF-080	Steelhead Creek at the Mouth_LTWT						21	31	31	28			
2016	UmpNF-082	Upper Steamboat below Little Rock_LTWT						21	31	31	28			
2016	UmpNF-083	Williams Creek at the mouth LTWT						16	31	31	28			
2016	UmpNF-084	Wright Creek at the Mouth WT						16	31	31	28			
2016	UmpNF-090	North Umpqua River above Barkenburger LTWT							31	31	30	10		
2017	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	26	30	31	31	30	31	30	31
2017	14318000	Little River At Peel, OR	31	27	31	30	31	30	31	31	30	31	30	31
2017	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek	31	28	30	30	31	29	31	31	26			
2017	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek						8	31	31	26			
2017	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	30	31	29	31	31	30	31	30	31
2017	23888-ORDEQ	Horse Heaven Creek above confluence with Steamboat Creek							48*	62*	60*	14		
2017	27894-ORDEQ	Pass Creek						8	31	31	29	31	30	31
2017	UmpNF-002	Bear Creek_LTWT						8	31	31	30	4		
2017	UmpNF-004	Big Bend Creek at the Mouth_LTWT						30	31	31	30	3		
2017	UmpNF-014	Calf Creek base Station_LTWT						29	31	31	30	10		
2017	UmpNF-016	Canton Creek at the mouth_LTWT						30	31	31	26			
2017	UmpNF-018	Cavitt Creek above Cultus Creek LTWT						29	31	31	27			
2017	UmpNF-019	Cedar Creek at the Mouth_LTWT						30	31	31	30	3		
2017	UmpNF-021	City Creek at the Mouth_LTWT						30	31	31	30	3		
2017	UmpNF-023	Clover Creek at the mouth_LTWT						29	31	31	27			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	UmpNF-024	Copeland Creek at the mouth_LTWT						9	31	31	30	10		
2017	UmpNF-030	Cultus Creek at the mouth_LTWT						29	31	31	27			
2017	UmpNF-033	Deer Creek at the mouth LTWT						1	31	31	30	1		
2017	UmpNF-039	Fish Creek at the mouth LTWT						1	31	31	30	3		
2017	UmpNF-044	Horse Heaven at the mouth LTWT						30	31	31	30	3		
2017	UmpNF-053	Lake Creek below Diamond Lake_LTWT						8	31	31	30	4		
2017	UmpNF-060	Little River above Clover Creek_LTWT						29	31	31	27			
2017	UmpNF-061	Little River below White Creek_LTWT						29	31	31	27			
2017	UmpNF-062	Little Rock Creek at the Mouth_LTWT						30	31	31	30	3		
2017	UmpNF-064	Mowich Creek at the mouth_LTWT						8	31	31	30	4		
2017	UmpNF-065	NU below Clearwater WT						8	31	31	30	3		
2017	UmpNF-066	Panther Creek abv Limpy on 4719 LTWT						29	31	31	27			
2017	UmpNF-067	Panther Creek at the mouth_LTWT						29	31	31	27			
2017	UmpNF-079	Steamboat above Canton_LTWT						9	31	31	26			
2017	UmpNF-080	Steelhead Creek at the Mouth_LTWT						30	31	31	30	2		
2017	UmpNF-082	Upper Steamboat below Little Rock_LTWT						30	31	31	30	3		
2017	UmpNF-083	Williams Creek at the mouth LTWT						30	31	31	27			
2017	UmpNF-084	Wright Creek at the Mouth WT						29	31	31	27			
2017	UmpNF-087	Boulder Creek Wilderness_LTWT										23	29	31
2017	UmpNF-090	North Umpqua River above Barkenburger LTWT							31	31	30	1		
2018	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	30
2018	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	27	30	31	30	31	31	30	31	30	31
2018	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	29	30	31	31	30	31	25	31
2018	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek												25

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	30	31	30	31	31	30	31	30	31
2018	24553-ORDEQ	North Fork Umpqua River at mouth						25	31	31	30	2		
2018	27894-ORDEQ	Pass Creek	31	28	30	30	31	30	31	31	30	31	30	31
2018	32477-ORDEQ	Rock Creek at mouth						25	31	31	30	2		
2018	41101-ORDEQ	Oak Creek Near mouth South Bank Dr.					23	30	10					
2018	41104-ORDEQ	Sutherlin Creek at Del Rio Rd					23	30	31	31	30	2		
2018	41105-ORDEQ	Sutherlin Creek East of Exit 135					23	30	31	31	30	2		
2018	41108-ORDEQ	North Umpqua River at Lone Rock Boat Ramp						25	31	31	30	2		
2018	UmpNF-004	Big Bend Creek at the Mouth_LTWT						29	31	31	26			
2018	UmpNF-014	Calf Creek base Station_LTWT						29	31	31	27			
2018	UmpNF-016	Canton Creek at the mouth_LTWT						29	31	31	26			
2018	UmpNF-019	Cedar Creek at the Mouth_LTWT						29	31	31	26			
2018	UmpNF-021	City Creek at the Mouth_LTWT						29	31	31	26			
2018	UmpNF-023	Clover Creek at the mouth_LTWT						29	31	31	27			
2018	UmpNF-024	Copeland Creek at the mouth_LTWT						23	31	31	30	2		
2018	UmpNF-030	Cultus Creek at the mouth_LTWT						29	31	31	27			
2018	UmpNF-033	Deer Creek at the mouth LTWT						10	31	31	30	3		
2018	UmpNF-052	Lake Creek at the mouth LTWT						15	31	31	30	3		
2018	UmpNF-053	Lake Creek below Diamond Lake_LTWT						15	31	31	30	2		
2018	UmpNF-060	Little River above Clover Creek_LTWT						29	31	31	27			
2018	UmpNF-061	Little River below White Creek_LTWT						29	31	31	27			
2018	UmpNF-062	Little Rock Creek at the Mouth_LTWT						29	31	31	26			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	UmpNF-067	Panther Creek at the mouth_LTWT						29	31	31	27			
2018	UmpNF-079	Steamboat above Canton_LTWT						29	31	31	26			
2018	UmpNF-080	Steelhead Creek at the Mouth_LTWT						29	31	31	26			
2018	UmpNF-082	Upper Steamboat below Little Rock_LTWT						9	31	31	26			
2018	UmpNF-084	Wright Creek at the Mouth WT						29	31	31	27			
2018	UmpNF-087	Boulder Creek Wilderness_LTWT	31	28	30	30	31	30	31	31	30	29	29	31
2018	UmpNF-090	North Umpqua River above Barkenburger LTWT						15	31	31	30	3		
2019	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	24	28	31	28	31	30	31	31	30	31	30	31
2019	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	29	30	31	30	30	31	30	31	30	31
2019	14317450	North Umpqua River Near Idleyld Park, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14318000	Little River At Peel, OR	31	28	31	29	31	30	31	31	30	31	30	31
2019	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	23874-ORDEQ	Rock Creek upstream of East Fork Rock Creek	31	28	30	30	31	30	31	31	30	14		
2019	23877-ORDEQ	East Fork Rock Creek at confluence with Rock Creek							30	31	30	14		
2019	23880-ORDEQ	Canton Creek upstream of Pass Creek	31	28	30	30	31	29	31	31	30	24		
2019	27894-ORDEQ	Pass Creek	31	28	30	16		17	31	31	30	24		
2019	UmpNF-004	Big Bend Creek at the Mouth_LTWT					7	30	31	31	19			
2019	UmpNF-014	Calf Creek base Station_LTWT					7	30	31	31	22			
2019	UmpNF-016	Canton Creek at the mouth_LTWT					7	30	31	31	19			
2019	UmpNF-019	Cedar Creek at the Mouth_LTWT					7	30	31	31	19			
2019	UmpNF-021	City Creek at the Mouth_LTWT					7	30	31	31	19			
2019	UmpNF-023	Clover Creek at the mouth_LTWT					8	30	31	31	22			
2019	UmpNF-024	Copeland Creek at the mouth_LTWT						21	31	31	22			
2019	UmpNF-030	Cultus Creek at the mouth_LTWT					8	30	31	31	22			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	UmpNF-033	Deer Creek at the mouth LTWT						10	31	31	30			
2019	UmpNF-052	Lake Creek at the mouth LTWT						10	31	31	30	17		
2019	UmpNF-053	Lake Creek below Diamond Lake_LTWT						10	31	31	30	17		
2019	UmpNF-060	Little River above Clover Creek_LTWT					8	30	31	31	22			
2019	UmpNF-061	Little River below White Creek_LTWT					8	30	31	31	22			
2019	UmpNF-062	Little Rock Creek at the Mouth_LTWT					7	30	31	31	19			
2019	UmpNF-067	Panther Creek at the mouth_LTWT					8	30	31	31	22			
2019	UmpNF-079	Steamboat above Canton_LTWT					7	30	31	31	19			
2019	UmpNF-080	Steelhead Creek at the Mouth_LTWT					7	30	31	31	19			
2019	UmpNF-082	Upper Steamboat below Little Rock_LTWT					7	30	31	31	19			
2019	UmpNF-084	Wright Creek at the Mouth WT					7	30	31	31	19			
2019	UmpNF-087	Boulder Creek Wilderness_LTWT	31	28	30	30	31	30	31	31	30	31	29	31
2019	UmpNF-090	North Umpqua River above Barkenburger LTWT						10	31	31	30			
2020	14316460	North Umpqua R At Soda Spgs, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14317450	North Umpqua River Near Idleyld Park, OR	31	29	31	30	31	30	31	31	30	31	30	30
2020	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	UmpNF-087	Boulder Creek Wilderness_LTWT	31	29	30	30	31	21						

* Some stations have more daily maximum results than the number of days in the month due to multiple probes being deployed at the same location or due to duplicate entries in AWQMS. These data are not proposed to support the modeling so we did not investigate these specific situations further.

Appendix C Stream flow data summary

Table 91: Continuous flow measurements available from the USGS flow gaging stations in the North Umpqua Subbasin.

Station ID	Station	Latitude/Longitude
14312490	Lake Creek Canal Near Diamond Lake, OR	43.1854/-122.1667
14312500	Lake Creek Near Diamond Lake, OR	43.18667/-122.1664
14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	43.32207/-122.1928
14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	43.32401/-122.197
14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	43.32207/-122.1956
14313600	Lemolo No.2 Canal Near Toketee Falls, OR	43.29623/-122.402
14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	43.35485/-122.252
14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	43.25262/-122.2984
14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	43.24429/-122.2873
14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	43.25929/-122.3995
14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	43.25096/-122.3384
14315500	North Umpqua River At Toketee Falls, OR	43.26373/-122.4217
14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	43.27642/-122.45
14315900	Fish Creek Power Canal Near Toketee Falls, OR	43.25641/-122.4508
14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	43.21123/-122.4275
14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	43.2304/-122.447
14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	43.30373/-122.4989
14316495	Boulder Creek Near Toketee Falls, OR	43.30345/-122.5303
14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	43.29595/-122.5367
14316700	Steamboat Creek Near Glide, OR	43.34984/-122.7289
14318000	Little River At Peel, OR	43.25262/-123.0262
14319500	North Umpqua River At Winchester, OR	43.27206/-123.4123

Table 92: Instantaneous flow measurements made by DEQ in the North Umpqua Subbasin.

Station	Date	Time	Flow (cfs)	Latitude/Longitude
Bear Creek Near Mouth #4785 Crossing	2009-09-28	11:10	9.29	
Bear Creek Near Mouth #4785 Crossing	2009-09-08	11:10	9.28	
Bear Creek Near Mouth #4785 Crossing	2009-08-26	13:50	9.68	

Station	Date	Time	Flow (cfs)	Latitude/Longitude
Bear Creek near Diamond Lake	2009-09-16	09:37	9.91	43.2301/-122.26
Calf Creek at Mouth	2009-09-02	13:25	1.04	
Calf Creek at Mouth	2009-09-16	11:00	1.05	
Clearwater River above Diversion Dam 2	2009-09-09	09:07	42.44	43.2508/-122.331
Clearwater River above Stump Reservoir	2009-09-15	12:00	113.19	43.2456/-122.273
Clearwater River above Stump Reservoir	2009-09-08	11:57	117.59	43.2456/-122.273
Clearwater River above Toketee Reservoir	2009-09-01	09:07	135.77	43.2625/-122.418
Clearwater River above Toketee Reservoir	2009-09-08	11:17	135.01	43.2625/-122.418
Copeland Creek at Mouth	2009-09-02	11:45	6.29	
Copeland Creek at Mouth	2009-09-16	15:00	5.38	
Deer Creek at Mouth	2009-09-28	16:00	8.07	
Deer Creek at Mouth	2009-09-08		8.02	
Fish Creek d/s of Slipper Creek	2009-09-02	10:45	47.46	
Fish Creek d/s of Slipper Creek	2009-09-09	14:54	42.38	
Fish Creek at Mouth	2009-09-09	09:05	36.81	
Fish Creek d/s of Black Rock Cr	2009-09-02	14:40	28.43	
Fish Creek above Rough Creek	2009-09-16	11:02	30.43	43.1989/-122.389
Fish Creek near Diamond Lake	2009-09-16	13:26	17.56	43.1506/-122.38
Fish Creek d/s of Clear Creek	2009-09-09	12:20	19.95	
Lake Creek at Road 138	2009-09-09	11:33	7.56	
Lake Creek at Mouth	2009-09-09	16:15	8.13	
Little River at Glide	2009-09-01	13:06	16.79	43.2957/-123.1
Little River at Glide	2009-09-01	08:01	19.13	43.2957/-123.1
Loafer Creek at Mouth	2009-09-10	11:00	28.92	43.2982/-122.359
Loafer Creek at Mouth	2009-09-17	11:50	27.41	43.2982/-122.359
North Umpqua River u/s of Toketee Reservoir	2009-09-10	12:30	486.77	43.2278/-123.36
North Umpqua River u/s of Lemolo Reservoir	2009-09-09	15:15	288.15	43.3105/-122.155
North Umpqua River u/s of Lemolo Reservoir	2009-09-15	09:37	288.38	43.3105/-122.155
Panther Creek at Mouth	2009-09-02	15:00	1.45	
Rough Creek near Mouth, u/s of Fish Creek Rd.	2009-09-02	12:20	10.93	43.2085/-122.377
Warm Springs Creek at Mouth	2009-09-09	13:00	19.74	43.3616/-122.238
Watson Creek u/s of Culvert 138	2009-09-10	15:10	4.79	43.2507/-122.402
Watson Creek near Diamond Lake	2009-08-31	13:59	6.10	43.2518/-122.402

Table 93: Summary of existing flow data in the North Umpqua Subbasin. Columns Jan – Dec indicate the number of daily mean flow results in each month.

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1992	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
1993	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1996	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
1997	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14316495	Boulder Creek Near Toketee Falls, OR										31	30	31
1997	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14312500	Lake Creek Near Diamond Lake, OR										31	30	31
1999	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14318000	Little River At Peel, OR							31	31	30	31	30	31
1999	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2000	14312500	Lake Creek Near Diamond Lake, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2001	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR										31	30	31
2003	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14313600	Lemolo No.2 Canal Near Toketee Falls, OR										31	30	31
2003	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR										31	30	31
2003	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR										31	30	31
2003	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR										31	30	31
2003	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR										31	30	31
2003	14315500	North Umpqua River At Toketee Falls, OR										31	30	31
2003	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR										31	30	31
2003	14315900	Fish Creek Power Canal Near Toketee Falls, OR										31	30	31
2003	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR										31	30	31
2003	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR										31	30	31
2003	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2004	14312500	Lake Creek Near Diamond Lake, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14315500	North Umpqua River At Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	29			
2004	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	29			
2004	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2005	14312490	Lake Creek Canal Near Diamond Lake, OR												31
2005	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	30					31	30	31
2005	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR										31	30	31
2005	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14312490	Lake Creek Canal Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	29			
2006	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14316000	Fish Ck @ Big Camas Rngr Sta Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	29			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14312490	Lake Creek Canal Near Diamond Lake, OR	31	28	30									
2007	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	24			11	30	31	30	31
2007	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2008	14312500	Lake Creek Near Diamond Lake, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	21		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR										31	30	31
2008	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14315500	North Umpqua River At Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2009	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14313600	Lemolo No.2 Canal Near Toketee Falls, OR				12	31	30	31	31	30	31	30	31
2009	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	30	30	31	31	30	31	30	31
2010	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR										31	30	31
2011	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	20
2011	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14315900	Fish Creek Power Canal Near Toketee Falls, OR										31	30	31
2011	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2012	14312500	Lake Creek Near Diamond Lake, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14313600	Lemolo No.2 Canal Near Toketee Falls, OR		16	31	30	31	30	31	31	30	31	30	31
2012	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	29	31	30	31	30	14					
2012	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14315500	North Umpqua River At Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2013	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR			3	30	31	30	31	31	30	31	30	31
2013	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	28	27	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	15		19	30	31
2014	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	29	29	17	2	19	31	30	31	30	31
2015	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	12
2015	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2016	14312500	Lake Creek Near Diamond Lake, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	29	31	30	31	30	31	31	30	30	30	31
2016	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14313500	N Umpqua River Blw Lemolo Lk, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30			
2016	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	29	21	31	30	31
2016	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	5	29	31	30	31	30	31	31	30	31	30	31
2016	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	30	30	31
2016	14315500	North Umpqua River At Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	28
2016	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	30
2016	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	27
2016	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	30	30	31
2016	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31
2017	14312500	Lake Creek Near Diamond Lake, OR	31	28	31	30	31	30	11					
2017	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	27	30	30	31	30	31	31	30	31	30	31
2017	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	30	27	31	30	31	30	31	31	30	31	30	31
2017	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	30	27	30	30	31	30	31	31	30	31	30	31
2017	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	27	30	30	31	30	31	31	30	31	30	31
2017	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	26	31	30	31	30	31	31	30	31	30	31
2017	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	27	31	30	31	30	31	31	30	31	30	31
2018	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	31	28	31	30	31	30	31	31	30	31	30	30
2019	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14315500	North Umpqua River At Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14316495	Boulder Creek Near Toketee Falls, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14316700	Steamboat Creek Near Glide, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14318000	Little River At Peel, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	14319500	North Umpqua River At Winchester, OR	31	28	31	30	31	30	31	31	30	31	30	31
2020	14312900	Lemolo No.1 Power Canal Near Toketee Falls OR	28	29	31	30	31	28	31	31	30	30	30	31
2020	14313200	N.umpqua R Abv White Mule Ck, Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14313600	Lemolo No.2 Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14313700	N.umpqua R Blw Warm Springs Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14314400	Clearwater No 1 Power Canal, Near Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14314500	Clearwater River Abv Trap Ck Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14314600	Clearwater No.2 Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14314700	Clearwater R Blw Mowich Creek, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14315500	North Umpqua River At Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14315700	N.umpqua R Blw Slide Ck Dam Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14315900	Fish Creek Power Canal Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14315950	Fish Creek Abv Slipper Creek Nr Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14316455	N.umpqua R Blw Soda Spgs Resv, Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14316495	Boulder Creek Near Toketee Falls, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14316500	N Umpqua River Abv Copeland Ck Nr Toketee Falls,OR	31	29	31	30	31	30	31	31	30	31	30	30
2020	14316700	Steamboat Creek Near Glide, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14318000	Little River At Peel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14319500	North Umpqua River At Winchester, OR	31	29	31	30	31	30	31	31	30	31	30	31

Appendix D HTML map

DEQ prepared an interactive HTML map to display relevant information described in this QAPP. The map will be posted to DEQ's website alongside this QAPP and saved in same location as the QAPP in DEQ's files. The interactive map contains the following layers and location information:

1. OpenStreetMap base map.
2. USGS hydro cache base map that represents hydrologic information of the National Hydrography Dataset (NHD).
3. 2017 and 2018 one foot Oregon Statewide Imagery Program (OSIP) aerial imagery.
4. TMDL project area boundary.
5. Available continuous stream temperature monitoring locations, organizations that collected that data, and the count of days per month for each year when temperature data are available.
6. Available stream flow monitoring locations, organizations that collected that data, and the count of days per month for each year when flow data are available.
7. The location of meteorological monitoring locations and the source of the data.
8. The location of active individual NPDES permitted facilities, the permit type, and DEQ file number.
9. The locations of current registrants covered under the general NPDES GEN01, GEN03, GEN04, GEN05, GEN19, or GEN40 (MS4) permits.
10. The extent of existing calibrated models described in this QAPP.
11. The extent of newly proposed calibrated models described in this QAPP.
12. The location of temperature calibration sites.
13. The location of temperature monitoring used for model boundary conditions and tributary inputs.
14. The location of flow monitoring locations used for model boundary conditions and tributary inputs.
15. Eight-digit hydrologic unit boundaries (HUC8 Subbasins).
16. Ten-digit hydrologic unit boundaries (HUC10 Watersheds).
17. Twelve-digit hydrologic unit boundaries (HUC12 Subwatersheds).
18. 2018/2020 303(d) Integrated Report status that are classified as water quality limited Category 5 and/or Category 4A for temperature.
19. Fish use designations depicted in OAR 340-041-0320 Figure 320A.

20. Salmon and Steelhead spawning use extent and period depicted in OAR 340-041-0320 Figure 320B.