Modeling Quality Assurance Project Plan for the Lower Willamette and Clackamas Subbasins Temperature Total Maximum Daily Load

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Abbreviations

AWQMS	Ambient Water Quality Monitoring System
DEQ	Oregon Department of Environmental Quality
DMR	Discharge Monitoring Report
EMSWCD	East Multnomah Soil & Water Conservation District
EQC	Oregon Environmental Quality Commission
MCDD	Multnomah County Drainage District
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
OCS	Oregon Climate Service
OWRD	Oregon Water Resources Department
QAPP	Quality Assurance Project Plan
RAWS	Remote Automatic Weather Stations
STP	Sewage Treatment Plant
TIR	Thermal Infrared Radiometry
TMDL	Total Maximum Daily Load
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 Clackamas Subbasin (17090011) and the Lower Willamette Subbasin (17090012). This QAPP project area excludes the mainstem Willamette River, Multnomah Channel, and the Clackamas River downstream of River Mill Dam. These waterbodies are included in the Willamette River Mainstem and Major Tributaries QAPP.

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 Lower Willamette and Clackamas Subbasins include several waterbodies listed on the Oregon 2018/2020 Section 303(d) Category 5 list as water quality limited for temperature (Table 1). A TMDL was previously developed for the Lower Willamette and Clackamas Subbasins (DEQ, 2006) but it 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 Lower Willamette and Clackamas Subbasins 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 Lower Willamette and Clackamas Subbasins do not meet the water quality standards for temperature and are listed as Category 5, water quality limited on Oregon's 2018/2020 Section 303(d) list (Table 1). 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 Lower Willamette and Clackamas Subbasins 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 340-041-0340 Figure 340A and Figure 340B. 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 Lower Willamette and Clackamas Subbasins. 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 Lower Willamette and Clackamas Subbasins QAPP project area, were obtained from Oregon's 2018/2020 Integrated Report and are summarized in Table 1. 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: Lower Willamette and Clackamas Subbasins 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
Collawash River	OR_SR_1709001101_02_104142	2010	Spawning, Year Round
Collawash River	OR_SR_1709001101_02_104144	2018	Year Round
Columbia Slough (Upper) Watershed	OR_WS_170900120201_02_104554.2	2010	Year Round
Eagle Creek	OR_SR_1709001105_02_104163	2010	Spawning, Year Round
Fish Creek	OR_SR_1709001104_02_104156	2010	Year Round
Fish Creek	OR_SR_1709001104_02_104161	2010	Year Round
Fish Creek	OR_SR_1709001104_02_104161	2018	Spawning
Helion Creek-Clackamas River Watershed	OR_WS_170900110406_02_104539	2018	Year Round
Johnson Creek	OR_SR_1709001201_02_104170	2010	Spawning
Johnson Creek	OR_SR_1709001201_02_104170	2018	Year Round
Lower Johnson Creek Watershed	OR_WS_170900120103_02_104552	2018	Spawning, Year Round
Milton Creek	OR_SR_1709001203_02_104176	2018	Year Round
Nohorn Creek	OR_SR_1709001101_02_104145	2010	Spawning
Nohorn Creek	OR_SR_1709001101_02_104145	2018	Year Round
North Fork Clackamas River	OR_SR_1709001104_02_104152	2018	Year Round
North Fork Clackamas River Watershed	OR_WS_170900110405_02_104538	2018	Year Round
North Fork Eagle Creek	OR_SR_1709001105_02_104165	2010	Year Round
North Scappoose Creek	OR_SR_1709001203_02_104179	2018	Year Round
Rock Creek-Clackamas River Watershed	OR_WS_170900110607_02_104549	2010	Year Round
South Scappoose Creek	OR_SR_1709001203_02_104180	2018	Year Round
South Scappoose Creek Watershed	OR_WS_170900120301_02_104557	2018	Year Round
Upper Eagle Creek Watershed	OR_WS_170900110501_02_104540	2018	Year Round
Upper Johnson Creek Watershed	OR_WS_170900120101_02_104550	2010	Year Round
Upper Johnson Creek Watershed	OR_WS_170900120101_02_104550	2018	Spawning

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,

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

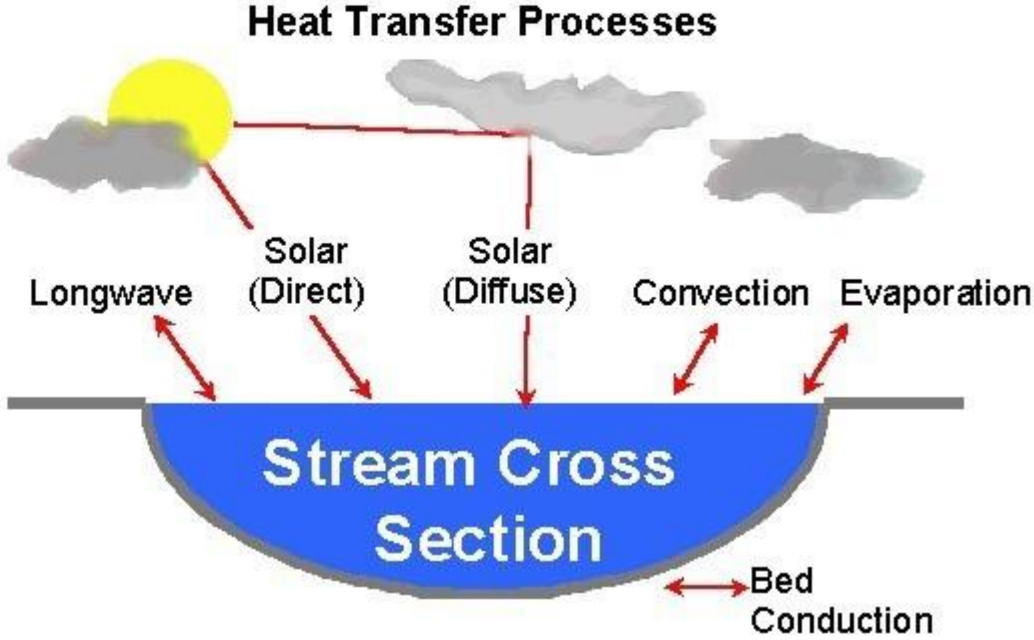

Figure 1: Major heat transfer processes.

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.

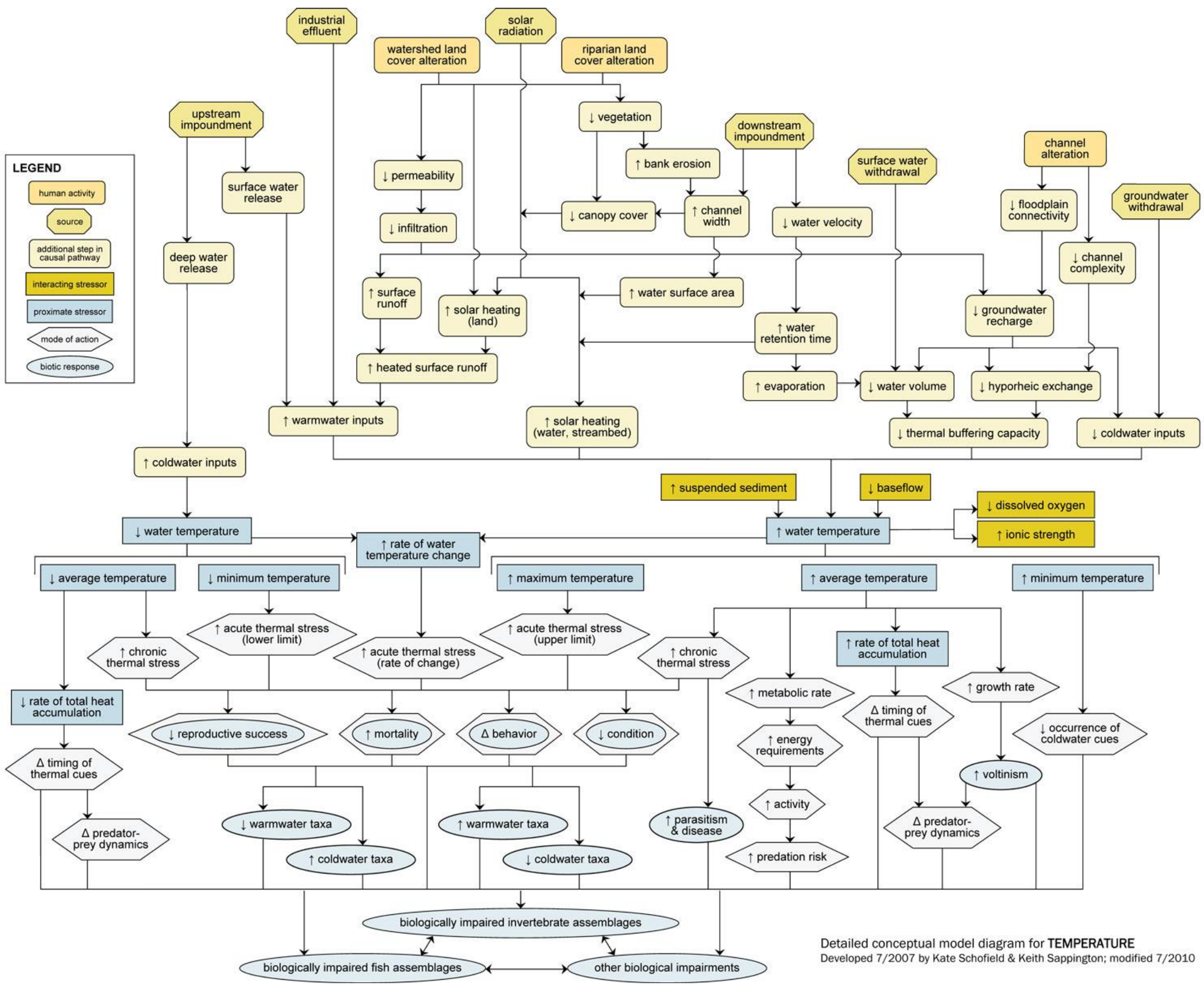

Figure 2: Conceptual diagram that identifies the key processes and variables that drive stream temperature changes and the biological responses (Schofield and Sappington, 2010).

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, Johnson Creek 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 Willamette Basin TMDL and WQMP (DEQ, 2006) were simulated using the computer models (CE-QUAL-W2 version 3 temperature model and Heat Source version 6 temperature model) for the Columbia Slough and Johnson Creek, respectively. These streams were selected for temperature model development because they contain primary fish habitat, have point source discharges, and are the most impacted by urbanization relative to other streams in the project area. New shade models are proposed using Heat Source version 9 . 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

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.

7) Ability to incorporate weirs, culverts, levees, dikes, and other water level control structures used to manage flow in the Columbia Slough into the model domain.

8) Ability to evaluate thermally stratified lakes along the Columbia Slough, including Fairview Lake, and Smith and Bybee Lakes.

The Heat Source stream thermodynamics model (Boyd and Kasper, 2003) meets the model framework needs for non-stratified waterbodies without flow control structures, and was used to model Johnson Creek for the development of the 2006 Willamette Basin TMDL. Because this model already exists, Heat Source was selected for stream temperature simulation in the project area, except for in the Columbia Slough. 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, 2002, 2003, 2005, 2006, 2007, 2008, 2010, 2018, 2019).

The CE-QUAL-W2 model (Cole and Wells, 2000) meets the model framework needs for stratified waterbodies with flow control structures, and was used to model the Columbia Slough for the development of the 2006 Willamette Basin TMDL (DEQ, 2006). Although this model exists and meets model framework needs, numerous changes have occurred in the Columbia Slough since 1992 when the model was last calibrated. See Section 6.4 for additional details on these changes. DEQ staff believe the changes are significant enough that a new model calibration is needed in order to simulate current water management and temperature conditions in the system. A summary of the recommended model updates is included in Appendix E. Due to resource constraints and the rigorous project schedule, the existing Columbia Slough CE-QUAL-W2 model will not be used for TMDL development at this time.

CE-QUAL-W2 is a laterally averaged U.S. Army Corps of Engineers model that consists of directly coupled hydrodynamic and water quality transport algorithms. Developed for reservoirs and narrow, stratified estuaries, CE-QUAL-W2 can handle a branched and/or looped system with flow and/or head boundary conditions. CE-QUAL-W2 simulates temperature, phytoplankton, dissolved oxygen, pH, organic matter, nutrients and residence time.

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 30 through Table 31 in Appendix A list the stations where meteorological data available in the Lower Willamette and Clackamas Subbasins, including 92 stations from National Oceanic and Atmospheric Association (NOAA)'s National Climatic Data Center (NCDC) and 182 stations from University of Utah MesoWest database. 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 30 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 Lower Willamette and Clackamas Subbasins (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 2.

Table 2: Streams and the TIR collection dates in the Lower Willamette and Clackamas Subbasins.

Stream	Survey Extent	Date	Time	Survey Distance
Johnson Creek	Mouth to headwaters	2002-07-31	13:32-14:35	21.5 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 292 locations where continuous stream temperature data were collected in the Lower Willamette and Clackamas Subbasins and the organizations that collected that data in Table 32, and when data were collected at each location in Table 33. 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 34 in Appendix C lists the stations where continuous flow volume data were available in the Lower Willamette and Clackamas Subbasins, including 12 stations from USGS. Table 36 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 35 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 3 identifies all the active individual NPDES permittees in the Lower Willamette and Clackamas Subbasins (including individual MS4 permittees). Table 4 lists the registrants covered under the general NPDES GEN01 and GEN40 (MS4) permits in the Lower Willamette and Clackamas Subbasins. 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 5 lists the current number of registrants for all the other general NPDES permits in the Lower Willamette and Clackamas Subbasins that are not listed in Table 4.

Table 3: Summary of individual NPDES permitted discharges in the Lower Willamette and Clackamas Subbasins.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
Arclin (81714)	45.5888/-122.691	NPDES-IW-B10: Cooling water discharges in excess of 20,000 BTU/sec	Columbia Slough RM 6
Blount Oregon Cutting Systems Division (63545)	45.4356/-122.613	NPDES-IW-B16: All facilities not elsewhere classified which dispose of non-process wastewaters	Mount Scott Creek RM 0.9
Boeing Of Portland - Fabrication Division (9269)	45.5431/-122.465	NPDES-IW-B16: All facilities not elsewhere classified which dispose of non-process wastewaters	Osburn Creek RM 1.6
Estacada STP (27866)	45.2982/-122.344	NPDES-DOM-Da: Sewage - less than 1 MGD	Clackamas River RM 23.3
Portland International Airport (107220)	45.589/-122.593	NPDES-IW-B15: All facilities not elsewhere classified which dispose of process wastewater (includes remediated groundwater) - Tier 2 sources	Columbia Slough RM 2.7
Sandy WWTP (78615)	45.4057/-122.321	NPDES-DOM-Da: Sewage - less than 1 MGD	Tickle Creek RM 3.1
Timberlake STP (90948)	45.0902/-122.063	NPDES-DOM-Da: Sewage - less than 1 MGD	Clackamas River RM 51.1
USFW - Eagle Creek National Fish Hatchery (91035)	45.2763/-122.204	NPDES-IW-B17: Dairies, fish hatcheries and other confined feeding operations on individual permits	Eagle Creek RM 12.3
WES (Boring STP) (16592)	45.4269/-122.374	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	North Fork Deep Creek RM 3

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
WES (Clackamas Co. Service District #1) Municipal Stormwater MS4 (108016)	45.2031/-122.202	NPDES-DOM-MS4-1: Municipal Separate Storm Sewer System - Phase I	Multiple discharge locations

Table 4: Summary of current registrants under the general NPDES GEN01 and GEN40 (MS4) permits in the Lower Willamette and Clackamas Subbasins.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
HYDRO MAIN PLANT (3060)	45.5806/-122.644	GEN01: Industrial Wastewater; NPDES cooling water	
MALARKEY ROOFING (52638)	45.5911/-122.7	GEN01: Industrial Wastewater; NPDES cooling water	Columbia Slough RM 5.9
MILLER PAINT COMPANY (103774)	45.5599/-122.53	GEN01: Industrial Wastewater; NPDES cooling water	
OWENS-BROCKWAY GLASS CONTAINER PLANT (65610)	45.5631/-122.565	GEN01: Industrial Wastewater; NPDES cooling water	
PCC STRUCTURALS, INC. - (SSB) SMALL STRUCTURALS BUSINESS OPERATIONS (71920)	45.4261/-122.57	GEN01: Industrial Wastewater; NPDES cooling water	Mount Scott Creek RM 2.3
VENTURA FOODS, LLC (103832)	45.5663/-122.571	GEN01: Industrial Wastewater; NPDES cooling water	
WOOD VILLAGE, MUNICIPAL STORMWATER MS-4 (98909)	45.5379/-122.418	GEN40: 4000 MS4-Phase 2 General Permit – Water Quality NPDES General Permit	Multiple discharge locations

Table 5: Summary of the current number of registrants for all the other general NPDES permits in the Lower Willamette and Clackamas Subbasins that are not listed in Table 4.

Permit Type and Description	Current Number of Registrants
GEN02: Industrial Wastewater; NPDES filter backwash	2
GEN12A: Stormwater; NPDES sand & gravel mining	7
GEN12C(AGENT): Stormwater; NPDES construction more than 1 acre disturbed ground, issued by agent	19

Permit Type and Description	Current Number of Registrants
GEN12C: Stormwater; NPDES construction more than 1 acre disturbed ground	239
GEN12CA: Stormwater; NPDES government agency construction, more than 1 acre disturbed ground	10
GEN12Z: Stormwater; NPDES specific SIC codes	210
GEN15A: Industrial Wastewater; NPDES petroleum hydrocarbon cleanup	1
GEN17A: Industrial Wastewater; NPDES wash water	3

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 6 lists the locations where effective shade measurements were collected and the effective shade value for July 2002.

Table 6: Effective shade data collected in the Lower Willamette and Clackamas Subbasins.

Station ID	Station	Latitude/Longitude	Effective Shade	Data Source
28728-ORDEQ	Johnson Creek at SE 327th Avenue	45.4605/-122.326	100%	DEQ
28729-ORDEQ	Johnson Creek at Revenue Road	45.4617/-122.337	100%	DEQ
28730-ORDEQ	Johnson Creek at Short Road	45.4627/-122.358	93%	DEQ
11626-ORDEQ	Johnson Creek at Palmblad Road	45.4728/-122.403	91%	DEQ
11327-ORDEQ	Johnson Creek at Regner USGS Gage	45.4867/-122.421	90%	DEQ
11326-ORDEQ	Johnson Creek at Pleasantville / 190th Ave.	45.488/-122.468	82%	DEQ
28731-ORDEQ	Johnson Creek at SE Circle Avenue	45.4864/-122.488	77%	DEQ
10856-ORDEQ	Johnson Creek at SE 122nd Avenue (Portland)	45.4737/-122.536	79%	DEQ
10853-ORDEQ	Johnson Creek at 92nd Avenue near Flavel	45.4678/-122.568	20%	DEQ
28732-ORDEQ	Johnson Creek at Bell Road and Johnson Creek Blvd	45.4556/-122.593	67%	DEQ
11323-ORDEQ	Johnson Creek at 45th Avenue Footbridge	45.4617/-122.616	63%	DEQ
28804-ORDEQ	Johnson Creek at Milwaukie Gage	45.453/-122.643	71%	DEQ

6 Model development and calibration

Waterbodies where model development was initiated for the Willamette Basin TMDL and WQMP (DEQ, 2006) are listed in Table 7. The waterbodies listed in Table 8 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 7: 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
CE-QUAL-W2 version 3 temperature model	Columbia Slough (1992)
Heat Source version 6 temperature model	Johnson Creek (2002)

The setup and calibration for the Johnson Creek (2002) model was completed by DEQ and documented in the Willamette Basin TMDL and WQMP (DEQ, 2006). The setup and calibration of the Columbia Slough (1992) model was completed by Portland State University and documented in Wells and Berger, 1995; Berger, 2003; Berger and Wells, 2005; and DEQ, 2006. Adjustments to the existing Johnson Creek (2002) calibrated model is 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. An improved model fit is defined as an improvement to the model fit statistics described in Chapter 7. The Columbia Slough (1992) model will not be used to support the updated TMDL. Conditions affecting water temperature in the Columbia Slough have changed significantly since the 1992 model calibration. An update to the model will require an effort and timeline that likely does not align with the project schedule or available resources. More details can be found in Section 6.3 and Appendix E.

Table 8: Waterbodies and year for which new models are expected to be developed.

Model Version	Model Waterbody
Heat Source version 9 shade model solar model	Columbia Slough Subwatershed (2019), Johnson Creek Watershed (2019), Tryon Creek Watershed (2019), Tualatin Mountains (2019)

The models named Johnson Creek Watershed (2019), Columbia Slough Watershed (2019), Tryon Creek Watershed (2019), and Tualatin Mountains (2019) (Table 8) are new and will supplement the Johnson Creek model that was developed for the 2006 TMDL. The models are being developed by the City of Portland Bureau of Environmental Services to characterize the current riparian conditions and effective shade on streams within the city. These models will simulate shade but not stream temperature.

DEQ will develop effective shade curves for all other waterbodies that were not specifically listed in Table 7 and Table 8. 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 Willamette 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 CE-QUAL-W2 version 3

The CE-QUAL-W2 version 3 model is a 2-dimensional hydrodynamic and water quality model that incorporates temperature (heat) into its hydrodynamic and water quality subroutines. The heat budget model theory for CE-QUAL-W2 is similar to Heat Source, though its implementation in the model and the level of detail are different. CE-QUAL-W2 is two dimensional in the longitudinal and vertical directions, and the vertical dimension allows for modeling temperature profiles as a function of depth in the water column. This feature is critical for deeper water bodies, such as reservoirs, larger rivers and estuaries where light penetration and density profiles are not easily estimated uniformly throughout the water column. Documentation for CE-QUAL-W2, and the inputs used to set up and calibrate the model, are provided in the CE-QUAL-W2 user's manual (Cole and Wells, 2000).

6.1.2 Heat Source version 6

Table 9 summarizes all of the user entered model inputs required to run Heat Source version 6; 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 include upstream and downstream channel elevations, Manning's *n*, and rating curve coefficients *a* and *b* for a power function. 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. 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 hydraulics are often necessary to calibrate the model.

- Meteorology – The meteorological input modified in calibration is wind speed. 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 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 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 9: Summary of model inputs required for Heat Source version 6.

Input Type	Input	Units	Calibration Parameter
General	Model Date	date (mm/dd/yyyy)	NO
General	Longitudinal Stream Sample Distance	meters	NO
General	Number of Tributary Inflow Sites	-	NO

Input Type	Input	Units	Calibration Parameter
General	Number of Meteorological Data Sites	-	NO
General	Total Longitudinal Distance	meters	NO
General	Stop Distance	meters	NO
General	Latitude	decimal degrees	NO
General	Longitude	decimal degrees	NO
General	Riparian Zone Width	meters	NO
Meteorological Data	Meteorological Data Model Kilometers	kilometers	NO
Meteorological Data	Wind Speed	meters/second	YES
Meteorological Data	Relative Humidity	proportion (0-1)	NO
Meteorological Data	Air Temperature	degrees Celsius	NO
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	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 Code	-	NO
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	Channel Bed Elevation	meters	NO
Morphology Data	Manning’s Roughness Coefficient, n	seconds/meter	YES
Morphology Data	Near-stream Disturbance Zone (NSDZ) Width	meters	NO
Morphology Data	Rating Curve Coefficient, a	unitless	YES
Morphology Data	Rating Curve Coefficient, b	unitless	YES
Morphology Data	Percent Bedrock	proportion (0-1)	NO
Morphology Data	Channel Aspect	degrees	NO
Morphology Data	Channel Incision	meters	NO

Input Type	Input	Units	Calibration Parameter
Morphology Data	Valley Length (optional)	meters	NO

6.1.3 Heat Source version 9 shade model

The Heat Source version 9 shade module is a sub program within Heat Source version 9 used to model effective shade and solar radiation flux. Heat Source 9 is similar to other versions of heat source, especially for the landcover and morphology related inputs used by the shade module. Table 10 summarizes all of the user entered model inputs required to run the shade module of Heat Source version 9. Table 10 also 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.

Table 10: Summary of model inputs required for Heat Source version 9.

Input Type	Input	Units	Calibration Parameter
General	Stream Length	kilometers	NO
General	Modeling Data Start Date	date (mm/dd/yyyy)	NO
General	Modeling Start Date	date (mm/dd/yyyy)	NO
General	Modeling End Date	date (mm/dd/yyyy)	NO
General	Modeling Data End Date	date (mm/dd/yyyy)	NO
General	Flush Initial Condition	days	NO
General	Time Offset From UTC	hours	NO
General	Model Time Step	minutes	NO
General	Model Distance Step	meters	NO
General	Longitudinal Stream Sample Distance	meters	NO
General	Number Of Samples Per Transect	-	NO
General	Distance Between Transect Samples	meters	NO
General	Account For Emergent Veg Shading (True/False)	-	NO
General	Land Cover Sample Method (Point/Zone)	-	NO
Land Cover Data	Longitude	decimal degrees	NO
Land Cover Data	Latitude	decimal degrees	NO
Land Cover Data	Topographic Shade Angle - West	degrees	NO

Input Type	Input	Units	Calibration Parameter
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 Name	-	NO
Land Cover Codes	Landcover Code	-	NO
Land Cover Codes	Landcover Height	meters	YES
Land Cover Codes	Canopy Cover	proportion (0-1)	YES
Land Cover Codes	Landcover Overhang	meters	YES
Morphology Data	Stream Kilometers	kilometers	NO
Morphology Data	Channel Bed Elevation	meters	NO

6.2 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 11 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 11: 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.

Method	Possible Parameters	Description
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.
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.

Method	Possible Parameters	Description
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.

6.3 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 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.

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.

6.3.1 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.

6.3.2 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.

6.3.3 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.

6.3.4 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.

6.3.5 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 Willamette 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.

6.3.6 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 Willamette Basin TMDL and WQMP (DEQ, 2006). The other model inputs are the same as what is described in Table 12.

- Effective shade lookup tables: Model input values to be used for the lookup tables are described in Table 12.

Table 12: 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

6.4 Columbia Slough (1992)

The Columbia Slough CE-QUAL-W2 model setup and calibration were conducted by Portland State University and documented in Wells and Berger, 1995; Berger, 2003; Berger and Wells, 2005; and DEQ, 2006. The model used for the temperature TMDL development was a modified version of a previous series of calibrated CE-QUAL-W2 models that had been developed for the Columbia Slough by Portland State University for the City of Portland Bureau of Environmental Services (Wells and Berger, 1995; Berger and Wells, 1999).

The modified model for the TMDL included a shorter period of simulation focusing on the summer season in the year 1992. This change was made to focus on the period when temperature data were available. The model also included additional macrophyte and shading algorithms. Features of the macrophyte model include the ability to simulate multiple submerged macrophyte species; the transport of nutrient fluxes between plant biomass and the water column and/or sediments; growth limitation due to nutrient, light and temperature; the simulation of the spatial distribution of macrophytes vertically and horizontally; the modeling of light attenuation in the water column caused by macrophyte concentration; and the modeling of channel friction due to macrophytes. Macrophyte growth can significantly affect temperatures in the Columbia Slough because the greater channel friction raises water levels and increases travel time. The amount of shade predicted by the model was based upon DEQ vegetation and land cover classifications provided to Portland State University (DEQ, 2006).

Conditions affecting water temperature in the Columbia Slough have changed significantly since the 1992 model calibration period (MCDD, personal communication June 2021; CSWC, 2013). These changes include the removal or replacement of multiple culverts; replacement of older pumps with new ones that have increased pumping capacity; removal of the weir and control structure at the outlet of Bybee Lake; channel modification and channel dredging in the Middle and Upper Slough; riparian replanting; and changes to flow management. All these changes are expected to affect water level, flow rate, and water temperature. Due to the extensive changes in the system, DEQ believes the existing model should be updated and recalibrated before it is used for simulation of current water temperature conditions and new management scenarios. DEQ investigated, to the extent that time allowed, some of the model setup changes required for recalibration. This summary, found in Appendix D, is not exhaustive and should be treated as a starting point. Based on this initial investigation, it was determined that a recalibration of the Columbia Slough model will require an effort and timeline that likely does not align with the project schedule or available resources. The Columbia Slough model is a complex system and DEQ is concerned that an attempt to proceed with a recalibration would put the project at risk of missing critical court mandated deadlines. For this reason, the existing Columbia Slough CE-QUAL-W2 model will not be updated or used for new management scenarios at this time. The implication of this decision is that it will not be possible to quantify the amount of warming caused by anthropogenic activities separate from the warming caused by background sources. As a result, the TMDL may be more general and lump all nonpoint sources into a general nonpoint source load allocation. The existing calibrated model is summarized in this section to document its existence and that it was considered for TMDL development.

6.4.1 Model domain

The extent of the model domain is Columbia Slough from Fairview Lake to the confluence with the Willamette River. The model includes Fairview Lake and Smith and Bybee Lakes. The model extent is shown in Figure 3 through Figure 6 (extracted from Berger and Wells, 2005) and also included in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

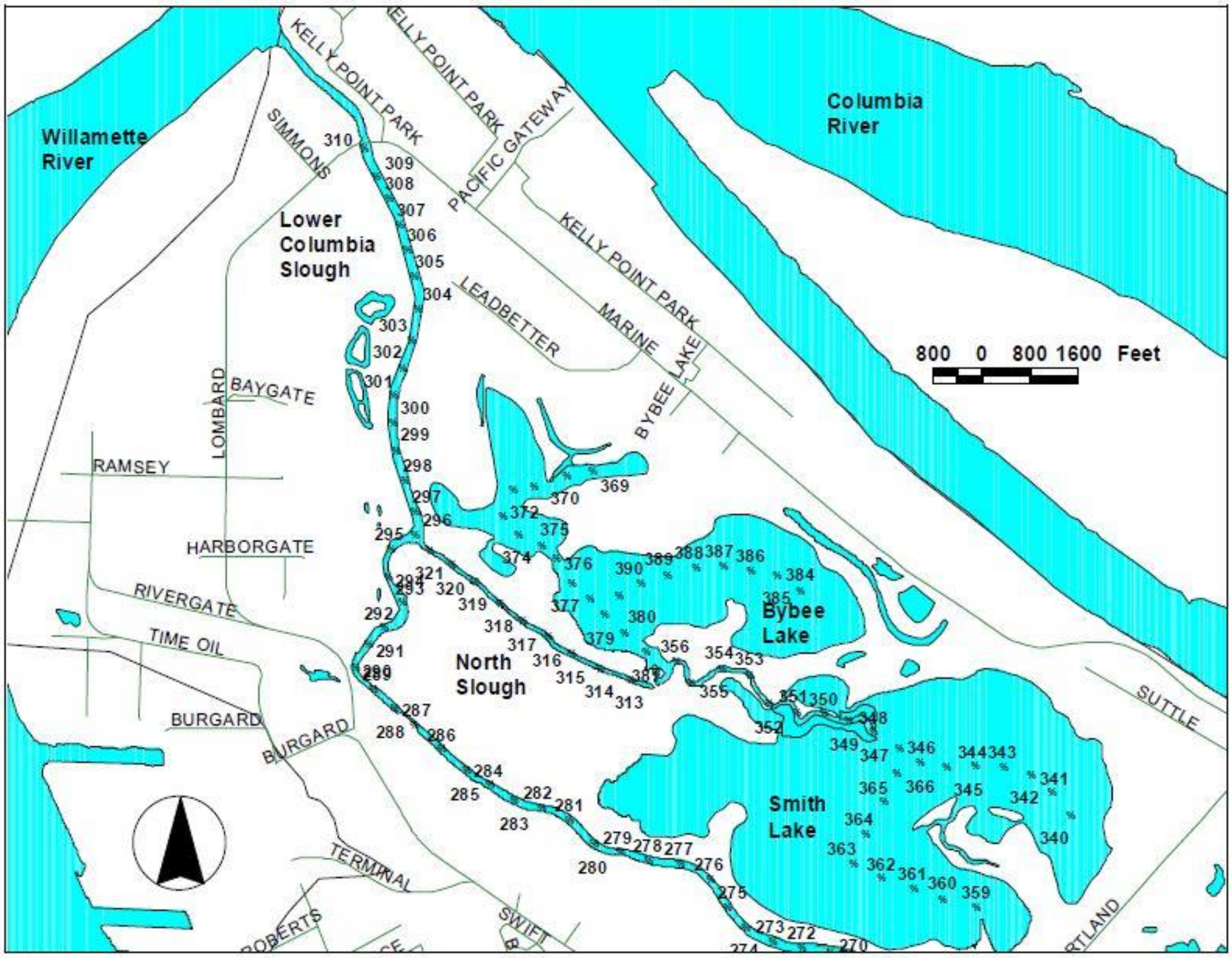

Figure 3: Columbia Slough (1992) model segments for the west end of the Lower Columbia Slough (Berger and Wells, 2005).

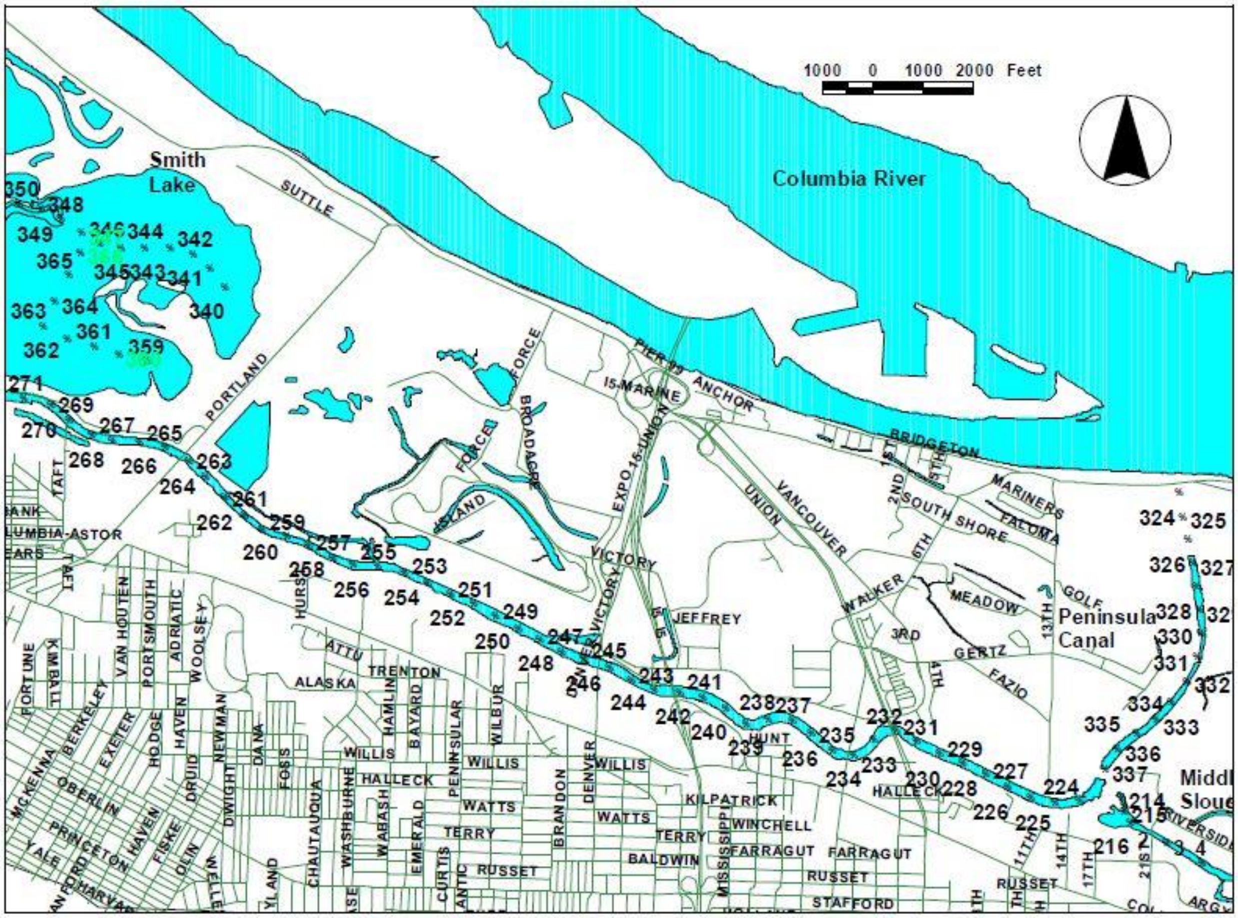

Figure 4: Columbia Slough (1992) model segments for the east end of the Lower Columbia Slough (Berger and Wells, 2005).

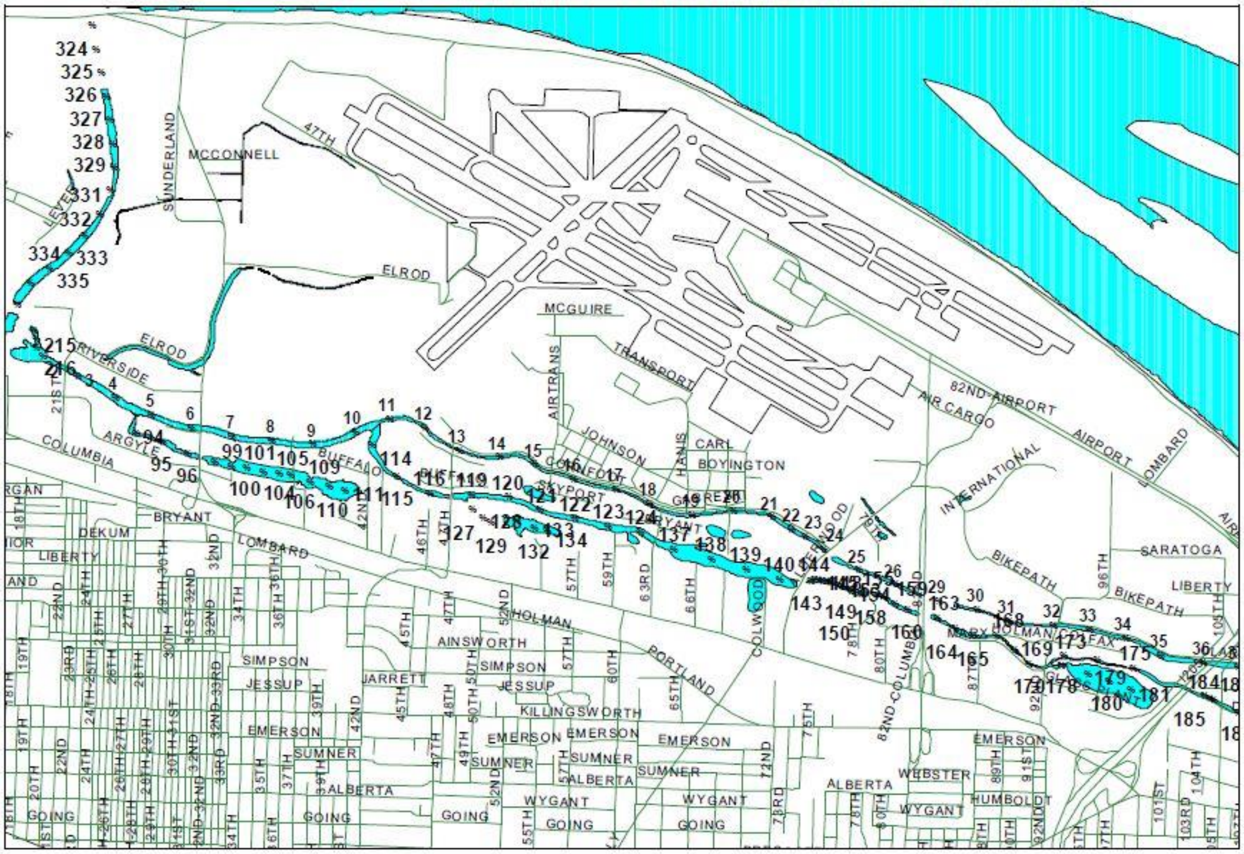

Figure 5: Columbia Slough (1992) model segments for the west end of the Middle Columbia Slough (Berger and Wells, 2005).

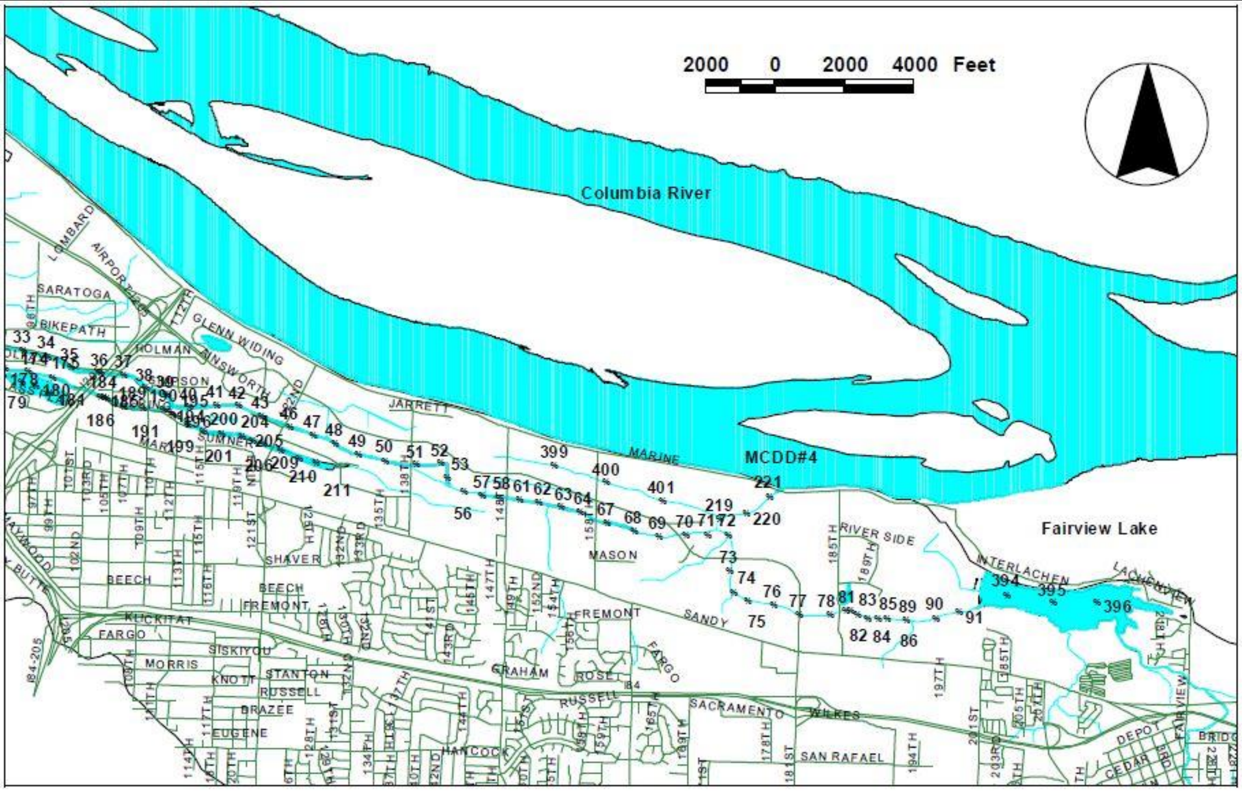

Figure 6: Columbia Slough (1992) model segments for the east end of the Middle Columbia Slough and the Upper Slough (Berger and Wells, 2005).

6.4.2 Spatial and temporal resolution

The Columbia Slough (1992) model is composed of 397 longitudinal segments (25-231 meters in length), 17 vertical layers (layer height of 0.30-0.61 meters), and 41 branches (separate water bodies or branches off the main stem), many of which are segregated by culverts. The number of model time step intervals (NDT) is 2 and the minimum time step (DLTMIN) is 0.025 seconds. The maximum timestep (DLTMAX) is 20 seconds. The characteristics of the Columbia Slough (1992) model regions are shown in Table 17. For additional details regarding model setup and resolution, see Berger and Wells, 2005.

Table 13: Model characteristics of the Columbia Slough CE-QUAL-W2 grids.

Model Region	Segment Numbers	Number of Layers	Number of Branches	Longitudinal cell spacing, Δx, meters, (feet)	Vertical cell spacing, Δz, meters, (feet)
Upper and Middle Columbia Slough	1-222	17	38	25.2-230.8 (82.7-757)	0.457 (1.50)
Lower Columbia Slough	223-386	17	3	149.6-152.9 (491-502)	0.305-0.61 (1.0-2.0)

Model Region	Segment Numbers	Number of Layers	Number of Branches	Longitudinal cell spacing, Δx, meters, (feet)	Vertical cell spacing, Δz, meters, (feet)
GW Aquifer	387-391	17	1	NA	NA

6.4.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Columbia Slough include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, channel modification, flow management, and background sources (Wells and Berger, 1995; Berger, 2003; DEQ, 2006). Other potential sources include warming caused by climate change.

Over the years the Slough system has been extensively dredged, diked, filled and channelized, principally by the U.S. Army Corps of Engineers, the City of Portland, and the Port of Portland. Originally a series of wetlands and marshes created by annual flooding of the Columbia and Willamette Rivers, the Slough is now a highly managed water system with dikes, levees, pipes, culverts, and pumps to provide watershed drainage and flood control for the lowlands surrounding it. Multnomah County Drainage District (MCDD) manages this complex set of infrastructure. The district also clears debris and other blockages within the system. Due to the extensive modifications to the Columbia Slough, water no longer drains naturally, but relies on two primary pump stations that lift water over the levees, and into the Columbia River or lower Columbia Slough which drains to the Willamette River. The hydraulic management of the Slough can have a significant impact on the water quality and the uses supported by the Slough (Wells and Berger ,1995; Berger, 2003; DEQ, 2006).

There are two permitted individual NPDES point sources along the model extent. Detail about each point source is summarized in Table 14.

Table 14: Summary of individual NPDES permitted discharges in the Columbia Slough (1992).

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
Arclin (81714)	45.5888/-122.691	NPDES-IW-B10: Cooling water discharges in excess of 20,000 BTU/sec	Columbia Slough RM 6
Portland International Airport (107220)	45.589/-122.593	NPDES-IW-B15: All facilities not elsewhere classified which dispose of process wastewater (includes remediated groundwater) - Tier 2 sources	Columbia Slough RM 2.7

The majority land use along the Columbia Slough (1992) is developed areas accounting for about 72 percent of the near-stream area. Table 15 summarizes all the land uses within 100 meters of the digitized Columbia Slough (1992) 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 15: Summary of land uses within 100 meters of the digitized Columbia Slough (1992) centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Developed, Low Intensity	436.8	26.1
Developed, Medium Intensity	317.1	19
Emergent Herbaceous Wetlands	304.2	18.2
Developed, High Intensity	293.8	17.6
Developed, Open Space	156.1	9.3
Woody Wetlands	91.0	5.4
Hay/Pasture	56.7	3.4
Herbaceous	13.6	0.8
Shrub/Scrub	1.6	0.1
Cultivated Crops	1.3	0.1
Barren Land	0.7	<0.05
Evergreen Forest	0.4	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, 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 16).

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 16 summarizes the potential designated management agencies and responsible persons along the Columbia Slough (1992) model extent. This table is based on land ownership and does not include special districts like the MCDD. The MCDD area overlaps with much of the Columbia Slough.

Table 16: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Columbia Slough (1992) centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
City of Portland	1536.5	83.4
Port of Portland	183.9	10
City of Gresham	65.6	3.6
Oregon Department of Transportation	35	1.9
Union Pacific Railroad	12	0.7
City of Fairview	5.7	0.3
BNSF Railway	3	0.2

6.4.4 Time frame of simulation

The model period is May 01, 1992 to August 01, 1992.

6.4.5 Important assumptions

Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006), the model setup and calibration documentation (Wells and Berger 1995; Berger and Wells 2005), and the CE-QUAL-W2 user guide (Cole and Wells, 2000).

6.4.6 Model inputs

For a complete description of model setup and inputs, see Wells and Berger (1995), and Berger and Wells (2005).

The near-stream vegetation inputs to the model include vegetation height and canopy cover. These inputs were derived by digitizing and classifying riparian vegetation type polygons based on aerial photos and through discussions with Multnomah County Drainage District personnel (DEQ, 2006).

6.4.7 Model calibration

Model calibration was completed by PSU (Berger, 2003; Berger and Wells, 2005). Please refer to these reports for more information.

6.5 Columbia Slough Subwatershed (2019)

The Columbia Slough Subwatershed (2019) model is a shade model developed using Heat Source 9.0. The model will be developed by City of Portland Bureau of Environmental Services.

6.5.1 Model domain

The extent of the model domain is Columbia Slough and multiple connected waterbodies in the Columbia Slough subwatershed (170900120201) including Blind Slough, Buffalo Slough, Inverness Slough, Miller Slough, North Slough, Peninsula Drainage Canal, Prison Pond, Spada Slough, Trappold Slough, Wapato Wetland, Warren Slough, Whitaker Slough, Wilkes Creek, and other unnamed waterbodies. 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 25 meters. Outputs are generated every 25 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 25 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

For the discussion of source characteristics, see Section 6.3.3 for the existing Columbia Slough (1992) model.

6.5.4 Time frame of simulation

The model period is July 01, 2019 to August 31, 2019.

6.5.5 Important assumptions

Model development for the Columbia Slough Subwatershed (2019) will be completed by City of Portland Bureau of Environmental Services. Model development assumptions are expected to be documented in the City of Portland final model report. DEQ will review the model and model assumptions and include or reference them in the TMDL. Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.5.6 Model inputs

The inputs to the model include LiDAR derived vegetation heights and stream position (latitude and longitude) derived from aerial imagery and LiDAR. The model is setup to assume no cloud cover. This is done to isolate the solar radiation flux blocked by vegetation and topography only.

6.5.7 Model calibration

Model calibration will be completed by the City of Portland Bureau of Environmental Services. DEQ and the City of Portland will coordinate and communicate on model development and quality assurance procedures outlined in this QAPP. The model will be calibrated primarily by comparing the model effective shade predictions to field measured effective shade values and making adjustments to canopy cover values as necessary. Canopy cover will be the primary calibration parameter. Field measurements of canopy cover collected with a densiometer by the City of Portland will be utilized during the calibration process to inform the range of values to consider. Other calibration parameters identified in Section 6.1.3 (landcover height and landcover overhang) will be determined directly from LiDAR with minimal adjustment. DEQ will review the model and model assumptions and recommend adjustments as necessary. The model and final calibration report will be made available to DEQ upon completion (COP BES personal communication August 2021).

6.6 Johnson Creek (2002)

The Johnson Creek (2002) model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

6.6.1 Model domain

The extent of the model domain is Johnson Creek at Revenue Road to the mouth of Johnson Creek at the confluence with the Willamette River. 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 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 30 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

The primary sources of thermal loading contributing to temperatures exceedances along the Johnson Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, channel modification, reductions to stream flow, and background sources (DEQ, 2006). Inline ponds, which are small ponds within the stream channel created by small dams, are also a source of increased temperatures (Holzer, 2020). There are at least 70 inline ponds in the Johnson Creek watershed. Other potential sources include warming caused by climate change.

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

The majority land uses along the Johnson Creek (2002) are developed areas and forestry accounting for about 86 percent of the near-stream area. Table 17 summarizes all the land uses within 100 meters of the digitized Johnson Creek (2002) 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 17: Summary of land uses within 100 meters of the digitized Johnson Creek (2002) centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Developed, Low Intensity	427.0	24.6
Developed, Open Space	280.2	16.1
Developed, Medium Intensity	225.5	13
Woody Wetlands	206.8	11.9
Hay/Pasture	179.9	10.4
Evergreen Forest	154.3	8.9
Developed, High Intensity	135.4	7.8
Emergent Herbaceous Wetlands	55.8	3.2
Mixed Forest	42.3	2.4
Cultivated Crops	10.7	0.6
Shrub/Scrub	8.0	0.5
Herbaceous	5.1	0.3
Deciduous Forest	4.2	0.2

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, 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 18).

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 18 summarizes the potential designated management agencies and responsible persons along the Johnson Creek (2002) model extent.

Table 18: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Johnson Creek (2002) centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
City of Portland	613.9	33
City of Gresham	427	22.9
Oregon Department of Agriculture	303.2	16.3
City of Milwaukie	201.1	10.8
Clackamas County	163.4	8.8
Multnomah County	75.5	4.1
Oregon Department of Transportation	61.8	3.3
Oregon Department of State Lands - Waterway	14.3	0.8
Union Pacific Railroad	1.1	0.1
TriMet	0.4	<0.05
Oregon Pacific Railroad	<0.05	<0.05

6.6.4 Time frame of simulation

The model period is for a single day: 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).

6.6.6 Model inputs

Table 19 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 19: Boundary condition and tributary inputs to the existing Johnson Creek (2002) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Johnson Creek at Revenue Road (28729-ORDEQ)	0	Boundary Condition	Flow	DEQ	Used measured flow from 327th Ave plus 0.2 cfs to account for seepage based on USGS study.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Johnson Creek at Revenue Road (28729-ORDEQ)	0	Boundary Condition	Water Temperature	DEQ	
Spring Creek	36.94	Tributary	Flow	Derived data.	Estimated using a flow mass balance based on measured rates and TIR.
Crystal Springs Creek (11329-ORDEQ)	35.5	Tributary	Flow	DEQ	Flow measured by DEQ
Errol Spring	32.74	Tributary	Flow	Derived data.	Estimated using a flow mass balance based on measured rates and TIR.
Veterans Creek	26.91	Tributary	Flow	Derived data.	Estimated using a flow mass balance based on measured rates and TIR.
Kelly Creek (14211499)	19.08	Tributary	Flow	USGS	
Butler Creek	15.19	Tributary	Flow	Derived data.	Estimated using a flow mass balance based on measured rates and TIR.
Sunshine Creek	5.98	Tributary	Flow	Derived data.	Estimated using a flow mass balance based on measured rates and TIR.
Spring Creek	36.94	Tributary	Water Temperature	Derived data.	Used temperature data from Kelly Creek (14211499-USGS).

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Crystal Springs Creek (11329-ORDEQ)	35.5	Tributary	Water Temperature	DEQ	
Errol Spring	32.74	Tributary	Water Temperature	City of Portland Parks & Recreation	Constant temperature of 14.5.
Veterans Creek	26.91	Tributary	Water Temperature	Derived data.	Used temperature data from Kelly Creek (14211499-USGS).
Kelly Creek (14211499)	19.08	Tributary	Water Temperature	USGS	
Butler Creek	15.19	Tributary	Water Temperature	Derived data.	Used temperature data from Kelly Creek (14211499-USGS).
Sunshine Creek	5.98	Tributary	Water Temperature	Derived data.	Used temperature data from Kelly Creek (14211499-USGS).
10009634 - Portland International Airport	0, 2.02, 7.24, 10.06, 15.8, 17.55, 22.83, 27.21, 29.94, 32.49, 36.42, 37.18	Meteorological	Air Temperature, Relative Humidity, Wind Speed	NCDC	

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 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 20. The model location in the table below describes the distance of each input from the most upstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 20: Calibration sites and parameters used in the existing Johnson Creek (2002) Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Johnson Creek at 17th Avenue (11321-ORDEQ)	37.18	Water Temperature	DEQ
Johnson Creek at Milwaukie Gage (28804-ORDEQ)	36.42	Water Temperature	USGS
Johnson Creek at 45th Avenue Footbridge (11323-ORDEQ)	32.49	Water Temperature	DEQ
Johnson Creek at Bell Road and Johnson Creek Blvd (28732-ORDEQ)	29.94	Water Temperature	DEQ
Johnson Creek at 92nd Avenue near Flavel (10853-ORDEQ)	27.21	Water Temperature	DEQ
Johnson Creek at 122nd and Leach Botanical Gardens (10856-ORDEQ)	22.83	Water Temperature	DEQ
Johnson Creek at SE Circle Avenue (28731-ORDEQ)	17.55	Water Temperature	DEQ
Johnson Creek at Pleasantville / 190th Ave. (11326-ORDEQ)	15.8	Water Temperature	DEQ
Johnson Creek at Regner Gage (11327-ORDEQ)	10.06	Water Temperature	USGS
Johnson Creek at Palmblad Road (11626-ORDEQ)	7.24	Water Temperature	DEQ
Johnson Creek at Short Road (28730-ORDEQ)	2.02	Water Temperature	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2003)

6.7 Johnson Creek Watershed (2019)

The Johnson Creek Watershed (2019) model is a shade model developed using Heat Source 9.0. The model will be developed by City of Portland Bureau of Environmental Services.

6.7.1 Model domain

The extent of the model domain is Johnson Creek and select tributaries from mouth to headwaters in the Lower Johnson Creek (170900120103) and Upper Johnson Creek (170900120101) subwatersheds. Tributaries include Badger Creek, Butler Creek, Clatsop Creek, Crystal Springs Creek, Deardorff Creek, Errol Creek, Frog Creek, Indian Creek, Jenne Creek, Kelley Creek, Mitchell Creek, Sunshine Creek, Veterans Creek, and Wahoo Creek. 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 25 meters. Outputs are generated every 25 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 25 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 purpose of the Johnson Creek Watershed (2019) shade model is to characterize solar radiation loading and the amount of effective shade. Effective shade is a surrogate for solar radiation loading caused by the disturbance or removal of near-stream vegetation. Other potential sources of thermal loading will not be evaluated by this model.

The majority land uses along the Johnson Creek Watershed (2019) are developed areas and forestry accounting for about 80 percent of the near-stream area. Table 21 summarizes all the land uses within 100 meters of the digitized Johnson Creek Watershed (2019) 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 21: Summary of land uses within 100 meters of the digitized Johnson Creek Watershed (2019) centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Developed, Low Intensity	855.8	22.8
Hay/Pasture	676.1	18
Developed, Open Space	675.2	18
Evergreen Forest	389.2	10.4
Developed, Medium Intensity	376.3	10
Woody Wetlands	262.4	7
Mixed Forest	203.5	5.4
Developed, High Intensity	149.2	4
Emergent Herbaceous Wetlands	72.9	1.9
Deciduous Forest	50.5	1.3
Shrub/Scrub	20.2	0.5
Cultivated Crops	12.5	0.3
Herbaceous	12.0	0.3

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, 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 22).

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 22 summarizes the potential designated management agencies and responsible persons along the Johnson Creek Watershed (2019) model extent.

Table 22: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Johnson Creek Watershed (2019) centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
City of Portland	1312.6	33.1
City of Gresham	650.6	16.4
Clackamas County	626.8	15.8
Oregon Department of Agriculture	568.7	14.3
Multnomah County	343.4	8.6
City of Milwaukie	199.6	5
Oregon Department of Forestry - Private Forestland	117.8	3
Oregon Department of Transportation	74.9	1.9
City of Happy Valley	56	1.4
Oregon Department of State Lands - Waterway	14.3	0.4
Union Pacific Railroad	3.5	0.1
TriMet	2.8	0.1
Oregon Pacific Railroad	<0.05	<0.05
U.S. Government	<0.05	<0.05

6.7.4 Time frame of simulation

The model period is July 01, 2019 to August 31, 2019.

6.7.5 Important assumptions

Model development for the Johnson Creek Watershed (2019) will be completed by City of Portland Bureau of Environmental Services. Model development assumptions are expected to be documented in the City of Portland final model report. DEQ will review the model and model assumptions and include or reference them in the TMDL. Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.7.6 Model inputs

The inputs to the model include LiDAR derived vegetation heights and stream position (latitude and longitude) derived from aerial imagery and LiDAR. The model is setup to assume no cloud cover. This is done to isolate the solar radiation flux blocked by vegetation and topography only.

6.7.7 Model calibration

Model calibration will be completed by the City of Portland Bureau of Environmental Services. DEQ and the City of Portland will coordinate and communicate on model development and quality assurance procedures outlined in this QAPP. The model will be calibrated primarily by comparing the model effective shade predictions to field measured effective shade values and making adjustments to canopy cover values as necessary. Canopy cover will be the primary calibration parameter. Field measurements of canopy cover collected with a densiometer by the City of Portland will be utilized during the calibration process to inform the range of values to consider. Other calibration parameters identified in Section 6.1.3 (landcover height and landcover overhang) will be determined directly from LiDAR with minimal adjustment. DEQ will review the model and model assumptions and recommend adjustments as necessary. The model and final calibration report will be made available to DEQ upon completion (COP BES personal communication August 2021).

6.8 Tryon Creek Watershed (2019)

The Tryon Creek Watershed (2019) model is a shade model developed using Heat Source 9.0. The model will be developed by City of Portland Bureau of Environmental Services.

6.8.1 Model domain

The extent of the model domain is Tryon Creek and select tributaries from mouth to headwaters in the Oswego Creek-Willamette River subwatershed (170900120104). Tributaries include Arnold Creek, Falling Creek, Nettle Creek, Park Creek, and multiple unnamed tributaries. 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 25 meters. Outputs are generated every 25 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 25 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

The primary purpose of the Tryon Creek Watershed (2019) shade model is to characterize solar radiation loading and the amount of effective shade. Effective shade is a surrogate for solar radiation loading caused by the disturbance or removal of near-stream vegetation. Other potential sources of thermal loading will not be evaluated by this model.

The majority land uses along the Tryon Creek Watershed (2019) are forestry and developed areas accounting for about 100 percent of the near-stream area. Table 23 summarizes all the land uses within 100 meters of the digitized Tryon Creek Watershed (2019) 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 23: Summary of land uses within 100 meters of the digitized Tryon Creek Watershed (2019) centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	323.1	28.8
Mixed Forest	278.2	24.8
Developed, Low Intensity	268.9	24
Developed, Open Space	153.5	13.7
Developed, Medium Intensity	64.0	5.7
Developed, High Intensity	11.8	1.1
Shrub/Scrub	8.2	0.7
Deciduous Forest	7.6	0.7
Hay/Pasture	3.3	0.3
Woody Wetlands	2.0	0.2

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, 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 24).

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 24 summarizes the potential designated management agencies and responsible persons along the Tryon Creek Watershed (2019) model extent.

Table 24: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Tryon Creek Watershed (2019) centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
City of Portland	814.4	67.9
City of Lake Oswego	285.6	23.8
Clackamas County	45.4	3.8
Oregon Department of Transportation	24.7	2.1
Oregon Parks and Recreation Department	7.3	0.6
Portland & Western Railroad	6.4	0.5
Willamette Shore Trolley	6.4	0.5
Multnomah County	4.6	0.4
Oregon Department of State Lands - Waterway	4	0.3
State of Oregon	<0.05	<0.05

6.8.4 Time frame of simulation

The model period is July 01, 2019 to August 31, 2019.

6.8.5 Important assumptions

Model development for the Tryon Creek Watershed (2019) will be completed by City of Portland Bureau of Environmental Services. Model development assumptions are expected to be documented in the City of Portland final model report. DEQ will review the model and model assumptions and include or reference them in the TMDL. Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.8.6 Model inputs

The inputs to the model include LiDAR derived vegetation heights and stream position (latitude and longitude) derived from aerial imagery and LiDAR. The model is setup to assume no cloud cover. This is done to isolate the solar radiation flux blocked by vegetation and topography only.

6.8.7 Model calibration

Model calibration will be completed by the City of Portland Bureau of Environmental Services. DEQ and the City of Portland will coordinate and communicate on model development and quality assurance procedures outlined in this QAPP. The model will be calibrated primarily by comparing the model effective shade predictions to field measured effective shade values and making adjustments to canopy cover values as necessary. Canopy cover will be the primary calibration parameter. Field measurements of canopy cover collected with a densiometer by the City of Portland will be utilized during the calibration process to inform the range of values to consider. Other calibration parameters identified in Section 6.1.3 (landcover height and landcover overhang) will be determined directly from LiDAR with minimal adjustment. DEQ will review the model and model assumptions and recommend adjustments as necessary. The model and final calibration report will be made available to DEQ upon completion (COP BES personal communication August 2021).

6.9 Tualatin Mountains (2019)

The Tualatin Mountains (2019) model is a shade model developed using Heat Source 9.0. The model will be developed by City of Portland Bureau of Environmental Services.

6.9.1 Model domain

The extent of the model domain is multiple streams on the west side of Tualatin Mountains that flow to the Willamette River in the Balch Creek-Willamette River subwatershed (170900120202) and to Multnomah Channel from the Multnomah Channel subwatershed (170900120305). Modeled streams include Balch Creek, Crestline Creek, Doane Creek, Dunthorpe Creek, Linnton Creek, Miller Creek, Munger Creek, Newton Creek, Rocking Chair Creek, Saltzman Creek, Stephens Creek, and multiple unnamed tributaries. 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 25 meters. Outputs are generated every 25 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 25 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

The primary purpose of the Tualatin Mountains (2019) shade model is to characterize solar radiation loading and the amount of effective shade. Effective shade is a surrogate for solar radiation loading caused by the disturbance or removal of near-stream vegetation. Other potential sources of thermal loading will not be evaluated by this model.

The majority land uses along the Tualatin Mountains (2019) are forestry and developed areas accounting for about 98 percent of the near-stream area. Table 25 summarizes all the land uses within 100 meters of the digitized Tualatin Mountains (2019) 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 25: Summary of land uses within 100 meters of the digitized Tualatin Mountains (2019) centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Mixed Forest	630.9	31.8
Evergreen Forest	528.0	26.6
Deciduous Forest	208.2	10.5
Developed, Open Space	159.0	8
Developed, Low Intensity	156.3	7.9
Developed, High Intensity	151.0	7.6
Developed, Medium Intensity	99.0	5
Emergent Herbaceous Wetlands	24.2	1.2
Hay/Pasture	12.5	0.6
Shrub/Scrub	6.9	0.3
Herbaceous	6.7	0.3
Woody Wetlands	3.8	0.2
Barren Land	0.2	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, 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 26).

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. summarizes the potential designated management agencies and responsible persons along the Tualatin Mountains (2019) model extent.

Table 26: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Tualatin Mountains (2019) centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
City of Portland	1648.4	81.1
Oregon Department of Forestry - Private Forestland	176.4	8.7
Multnomah County	131.1	6.4
Oregon Department of Transportation	53.3	2.6
Portland & Western Railroad	10.4	0.5
Oregon Department of State Lands - Waterway	6.2	0.3
Oregon Department of Agriculture	4.6	0.2
BNSF Railway	2.4	0.1
Port of Portland	0.2	<0.05

6.9.4 Time frame of simulation

The model period is July 01, 2019 to August 31, 2019.

6.9.5 Important assumptions

Model development for the Tualatin Mountains (2019) will be completed by City of Portland Bureau of Environmental Services. Model development assumptions are expected to be documented in the City of Portland final model report. DEQ will review the model and model assumptions and include or reference them in the TMDL. Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.9.6 Model inputs

The inputs to the model include LiDAR derived vegetation heights and stream position (latitude and longitude) derived from aerial imagery and LiDAR. The model is setup to assume no cloud cover. This is done to isolate the solar radiation flux blocked by vegetation and topography only.

6.9.7 Model calibration

Model calibration will be completed by the City of Portland Bureau of Environmental Services. DEQ and the City of Portland will coordinate and communicate on model development and quality assurance procedures outlined in this QAPP. The model will be calibrated primarily by comparing the model effective shade predictions to field measured effective shade values and making adjustments to canopy cover values as necessary. Canopy cover will be the primary calibration parameter. Field measurements of canopy cover collected with a densiometer by the City of Portland will be utilized during the calibration process to inform the range of values to consider. Other calibration parameters identified in Section 6.1.3 (landcover height and landcover overhang) will be determined directly from LiDAR with minimal adjustment. DEQ will review the model and model assumptions and recommend adjustments as necessary. The model and final calibration report will be made available to DEQ upon completion (COP BES personal communication August 2021).

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.

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

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 or because the management scenario is not applicable to the specific waterbody. 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 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.

10.2 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 Willamette 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.

10.3 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 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.

10.4 Restored stream flow

This scenario evaluates stream temperature response by changing permitted water withdrawals to instream flow. The stream temperature warming or cooling from keeping permitted water withdrawals as instream flow is evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to estimate restored stream flow will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Maintaining all currently permitted water withdrawals as instream flow in order to increase the thermal loading capacity and reduce stream warming.
- Model boundary and tributary flows will be set to reflect the additional instream flows.
- All other model inputs will be the same as the current condition model.

10.5 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.

10.6 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.

10.7 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.

10.8 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.

10.9 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.

11 Project organization

11.1 Project team/roles

Project roles and responsibilities are described in Table 27.

Table 27: The roles and responsibilities of each team member involved in the temperature TMDL replacement project.

Name	Position	Role and Responsibilities
Jennifer Wigal	Deputy 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 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

Name	Position	Role and Responsibilities
		Lead) 12. Coordinate team communication: Emails, SharePoint, shared drives 13. Closeout project and document lessons learned
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

Name	Position	Role and Responsibilities
		meetings 8. Respond to public comments
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
Andrea Matzke	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
Roxy Nayar	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 Lower Willamette and Clackamas Subbasins 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.

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 2022 with USEPA's final agency action approving or disapproving of the TMDL no later than January 15, 2024. 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 28.

Table 28: 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.

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17 Revision history

Table 29: QAPP revision history.

Revision	Date	Changes	Editor
1.0	12/09/2021	New QAPP	R. Michie

Appendix A Meteorology data summary

Table 30: Meteorological stations and data available in the National Climatic Data Center (NCDC) database in the Lower Willamette and Clackamas Subbasins.

Station ID	Station	Latitude/Longitude
10009634	PORTLAND TROUTDALE AIRPORT	45.55/-122.4
20016251	ESTACADA 24 SE	45.0833/-121.983
20016264	THREE LYNX	45.1333/-122.067
20016298	EAGLE CREEK 9 SE	45.2667/-122.2
20016299	ESTACADA 2 SE	45.2689/-122.319
20016347	CLACKAMAS 2 SE	45.4/-122.533
20016365	SYCAMORE JOHNSONCREEK	45.4778/-122.507
20016389	GRESHAM	45.5/-122.433
20016392	PORTLAND KGW TV	45.5181/-122.689
20016428	PORTLAND INTL AP	45.5958/-122.609
20016446	SAUVIES ISLAND	45.6583/-122.835
20016482	ST HELENS RFD	45.8606/-122.81
20016537	TROUTDALE SUBSTATION	45.5586/-122.403
30000080	PORTLAND NWSFO	45.5611/-122.538
30000722	SCAPPOOSE INDUSTRIAL AP	45.7728/-122.861
30001916	PORTLAND	45.715/-122.964
30015586	GRESHAM 2 SW	45.4803/-122.466
30019684	CLACKAMAS 1.9 NNE	45.4364/-122.544
30021262	PORTLAND 1.4 NE	45.5525/-122.635
30023021	PORTLAND 4.6 ENE	45.5548/-122.565
30027000	RALEIGH HILLS 3.1ESE	45.4642/-122.698
30027106	MILWAUKIE 1.3 WSW	45.438/-122.644
30027272	MILWAUKIE 2.1 W	45.4459/-122.663
30035686	PORTLAND 2.5 SE	45.5116/-122.62
30036881	OREGON CITY 2.2 NE	45.3706/-122.571
30040245	ST. HELENS 1 W	45.861/-122.831
30041874	LAKE OSWEGO 1.3 ESE	45.4059/-122.672
30048290	PORTLAND 0.8 ENE	45.5416/-122.64
30050028	WARREN 1 SW	45.8153/-122.857
30050530	WEST LINN 1 NW	45.3778/-122.646
30051837	BORING 1 E	45.4231/-122.372

Station ID	Station	Latitude/Longitude
30052275	SANDY 1.7 SSW	45.3751/-122.274
30054101	ESTACADA 4.8 SW	45.2435/-122.405
30057853	JENNINGS LODGE 0.2 SW	45.3907/-122.617
30060592	MILWAUKIE 1.6 E	45.4486/-122.586
30060605	PORTLAND 7 SW	45.4681/-122.681
30062316	SANDY 0.9 SE	45.3894/-122.254
30062775	PORTLAND 2.1 SE	45.5136/-122.631
30063543	ESTACADA 3 WNW	45.3108/-122.39
30072236	PORTLAND 2.6 NW	45.5631/-122.698
30074619	CLACKAMAS LAKE	45.1/-121.75
30074663	RED BOX OREGON	45.0275/-121.921
30074969	PEAVINE RIDGE	45.04/-121.93
30075548	WANDERER’S PEAK OREGON	45.1094/-122.195
30076284	EAGLE CREEK OREGON	45.3686/-122.331
30078482	MILWAUKIE 0.5 SE	45.4395/-122.611
30078527	DAMASCUS 2.4 WSW	45.4012/-122.503
30079083	LAKE OSWEGO 0.7 SE	45.406/-122.688
30079163	SANDY 1.0 WSW	45.3927/-122.284
30079884	SCAPPOOSE 6.9 NNW	45.8342/-122.96
30081010	SCAPPOOSE 0.7 S	45.7409/-122.882
30083050	ST. HELENS 3.5 NW	45.8941/-122.866
30083095	PORTLAND 2.1 E	45.5382/-122.613
30083652	SCAPPOOSE 1.9 NW	45.7733/-122.903
30084309	PORTLAND 4.9 SSW	45.4534/-122.698
30084384	LAKE OSWEGO 1.2 NW	45.4226/-122.717
30084568	PORTLAND 4.8 S	45.4545/-122.678
30084722	PORTLAND 2.4 N	45.5734/-122.662
30090676	HAPPY VALLEY 1.7ESE	45.434/-122.504
30094359	PORTLAND 5.7 SSW	45.4462/-122.719
30094422	MILWAUKIE 0.9 NNE	45.4558/-122.614
30094777	ESTACADA 5.2 WNW	45.3321/-122.425
30094841	PORTLAND 2.3 SW	45.52/-122.695
30094962	LAKE OSWEGO 0.6 N	45.4209/-122.7
30101493	BORING 0.6 WSW	45.4276/-122.365
30101703	PORTLAND 4.0 ESE	45.5225/-122.578
30102589	MILWAUKIE 2.9 S	45.4025/-122.614
30103182	PORTLAND 5.2 ESE	45.5061/-122.559

Station ID	Station	Latitude/Longitude
30103186	LAKE OSWEGO 1.4 NNW	45.4304/-122.708
30103590	PORTLAND 9.8 ESE	45.4774/-122.486
30103931	WEST LINN 0.7 NW	45.3749/-122.649
30103982	PORTLAND 4.1 NW	45.5772/-122.719
30107512	PORTLAND 2.8 E	45.5425/-122.599
30108628	FAIRVIEW 1.8 SW	45.5293/-122.462
30111653	LAKE OSWEGO 1.5 N	45.4344/-122.699
30111769	PORTLAND 5.8 S	45.4393/-122.696
30111991	PORTLAND 7.7 E	45.5294/-122.498
30112174	PORTLAND 2.8 ENE	45.5474/-122.6
30112336	PORTLAND 3.2 SE	45.5063/-122.609
30112568	PORTLAND 4.7 NW	45.5817/-122.731
30119313	LAKE OSWEGO 1.4 NNE	45.4299/-122.685
30120615	DAMASCUS 3.9 NE	45.45/-122.394
30120779	PORTLAND 5.9 NW	45.5981/-122.745
30120849	MILWAUKIE 0.6 SSW	45.4362/-122.624
30121024	PORTLAND 2.6 ESE	45.5202/-122.609
30121095	CLACKAMAS 1.9 W	45.4105/-122.592
30121409	DAMASCUS 0.9 WNW	45.4224/-122.476
30121777	LAKE OSWEGO 2.0 NNW	45.4389/-122.714
30122797	PORTLAND 2.0 N	45.5678/-122.658
30122949	ESTACADA 5.4 WNW	45.3326/-122.428
30123648	PORTLAND 6.9 E	45.5515/-122.515
30125233	HAZELWOOD 2.1 S	45.4868/-122.521

Table 31: Meteorological stations and data, including air temperature, precipitation, relative humidity, wind speed and wind direction, available in the MesoWest database in the Lower Willamette and Clackamas Subbasins.

Station ID	Station	Latitude/Longitude
1945P	STAR LAB CRESTON KENILWORTH	45.4951/-122.639
1946P	PSU STAR LAB ROSE CITY PARK	45.5441/-122.596
1948P	STAR LAB HOMESTEAD NEIGHBORHOOD	45.5002/-122.693
1950P	STAR LAB - HILLSDALE	45.4769/-122.684
1956P	MARION COURT APARTMENTS	45.5119/-122.63
1961P	RED FOX HILLS	45.4306/-122.678
1973P	PSU STAR LAB EDGEWATER	45.5821/-122.747
1975P	PSU STAR LAB CULLY	45.5582/-122.606

Station ID	Station	Latitude/Longitude
1983P	IRVINGTON NE 12TH & TILLAMOOK	45.5372/-122.653
1985P	MILLER	45.5794/-122.708
1986P	BYUKI PROJECT	45.4926/-122.64
1990P	PSU STAR LAB SEL	45.4968/-122.603
1991P	NORTH MIDWAY AVE.	45.5923/-122.736
2018P	NW DISTRICT 2343	45.5327/-122.7
2026P	KU’ALE HEIGHTS MILWAUKIE - OR	45.432/-122.637
2032P	EDGEWOOD OUTSIDE	45.5043/-122.699
2039P	UPPER MULTNOMAH VILLAGE	45.474/-122.705
2049P	NE GLISAN	45.5264/-122.625
2053P	GH TILLAMOOK ROW	45.5376/-122.667
2058P	N VANCOUVER	45.5542/-122.668
2059P	CARPENTER FAM	45.5747/-122.698
2060P	JAN’S AIR	45.5763/-122.667
2065P	SOUTH TABOR	45.5046/-122.595
2067P	PPR WASHINGTON PARK SOUTH	45.5102/-122.717
2072P	LEWIS & CLARK COLLEGE	45.4519/-122.673
2073P	MIRABELLA	45.4977/-122.67
2087P	BENSON 4	45.5266/-122.651
2088P	BENSON 3	45.5273/-122.652
2090P	BENSON 1	45.5278/-122.651
2091P	BENSON 2	45.5278/-122.652
2112P	36TH & SE WOODWARD	45.5017/-122.626
2698P	FAIRVIEW - OR	45.5336/-122.436
2778P	2240 SE 24TH AVE	45.5065/-122.641
3008P	CONCORDIA	45.5296/-122.646
3600P	LIGHTHOUSE	45.5654/-122.669
3722P	SOUTH WOODSTOCK	45.4631/-122.625
3951P	SOUTH BURLINGAME	45.4663/-122.683
4087P	SHARKTANK	45.5399/-122.618
A3796	PORTLAND - SAUVIE ISLAND	45.7685/-122.772
A3805	PORTLAND - SE LAFAYETTE	45.4966/-122.603
A3810	PORTLAND NEAR ROAD	45.3992/-122.746
A4685	PORTLAND CULLY HELENSVIEW SCHOOL	45.5622/-122.576
A4730	GRESHAM CENTENNIAL HS	45.4962/-122.483
A4751	PORTLAND JEFFERSON HIGH SCHOOL	45.5609/-122.672

Station ID	Station	Latitude/Longitude
A4779	ESTACADA CLACKAMAS RIVER ELEMENTARY SCHOOL	45.2914/-122.333
AP477	KC7ZPO MILWAUKIE	45.4123/-122.638
AR683	W7FAA GLADSTONE	45.4017/-122.6
AS192	WH6KO ST HELENS	45.8543/-122.819
AS252	KE7FUZ PORTLAND	45.5488/-122.619
AS864	N4AEN PORTLAND	45.492/-122.512
AT954	K7JDK PORTLAND	45.454/-122.694
AU650	KA7IKB-2 WEST LINN	45.3923/-122.655
AU675	N7XAH DAMASCUS	45.4408/-122.404
AU774	KC7CDD PORTLAND	45.581/-122.731
AU998	KC6RZW-10 MILWAUKIE	45.4052/-122.584
AV511	KI7RM-1 MILWAUKIE	45.4355/-122.624
AV691	KK7DS HAPPY VALLEY	45.4597/-122.516
BPTRO	TROUTDALE	45.5583/-122.402
C1183	CW1183 MILWAUKIE	45.413/-122.638
C1657	CW1657 EAGLE CREEK	45.3492/-122.36
C1753	CW1753 PORTLAND	45.5075/-122.731
C2936	CW2936 PORTLAND	45.5029/-122.523
C3580	CW3580 MULTNOMAH VILLAGE	45.465/-122.709
C3798	CW3798 PORTLAND	45.5072/-122.593
C3812	CW3812 LAKE OSWEGO	45.4097/-122.669
C5276	CW5276 HILLSBORO	45.6187/-122.865
C5317	CW5317 GRESHAM	45.4817/-122.426
C5646	CW5646 PORTLAND	45.4422/-122.719
C7021	CW7021 PORTLAND	45.4748/-122.616
C7295	CW7295 ST. HELENS	45.8592/-122.848
C8730	CW8730 DAMASCUS	45.4083/-122.5
C9252	CW9252 ESTACADA	45.2981/-122.288
C9374	CW9374 GRESHAM	45.4917/-122.452
C9430	CW9430 GRESHAM	45.4667/-122.417
C9538	CW9538 DAMASCUS	45.4319/-122.427
C9796	CW9796 PORTLAND	45.5475/-122.653
COOPDIXO3	DIXIE MOUNTAIN	45.7/-122.93
COOPEAGO3	EAGLE CRK FISH HATCHERY	45.27/-122.2
COOPFADO3	P.G.E. RAFADAY POWERHOUSE	45.27/-122.32
COOPPDX	INTERNATIONAL AIRPORT	45.59/-122.6

Station ID	Station	Latitude/Longitude
COOPPGWO3	KGW-TV	45.52/-122.69
COOPPQR	PORTLAND, OR	45.56/-122.54
COOPTLYO3	CLACKAMAS RVR ABV THREE LYNX CRK	45.12/-122.07
COOPTRTO3	BPA TROUTDALE SUBSTATION	45.56/-122.4
D0228	DW0228 EAGLE CREEK	45.3487/-122.362
D0380	DW0380 SANDY	45.3461/-122.199
D1612	DW1612 SCAPPOOSE	45.8353/-122.972
D1732	DW1732 PORTLAND	45.5158/-122.592
D2682	DW2682 PORTLAND	45.5/-122.633
D2889	DW2889 WEST LINN	45.3843/-122.656
D3557	DW3557 PORTLAND	45.4842/-122.69
D3762	DW3762 PORTLAND	45.4915/-122.599
D4360	DW4360 PORTLAND	45.4957/-122.62
D4702	DW4702 GRESHAM	45.3/-122.2
D4839	DW4839 HAPPY VALLEY	45.4521/-122.546
D4869	DW4869 BORING	45.4415/-122.366
D5310	DW5310 HAPPY VALLEY	45.46/-122.508
D5318	DW5318 SE PORTLAND	45.4685/-122.593
D5586	DW5586 BEAVERCREEK	45.2448/-122.435
D6016	DW6016 MILWAUKIE	45.4508/-122.605
D6132	DW6132 PORTLAND	45.5344/-122.512
D7564	DW7564 ESTACADA	45.2332/-122.354
D8151	DW8151 GRESHAM	45.5217/-122.46
D8818	DW8818 DAMASCUS	45.4301/-122.419
D9191	DW9191 PORTLAND	45.5197/-122.632
D9370	DW9370 PORTLAND	45.5862/-122.712
DIXO3	DIXIE MTN	45.7147/-122.964
E0191	EW0191 PORTLAND	45.4901/-122.562
E1091	EW1091 PORTLAND	45.493/-122.508
E1617	EW1617 PORTLAND	45.5183/-122.61
E1914	EW1914 PORTLAND	45.5373/-122.653
E2024	EW2024 PORTLAND	45.5978/-122.732
E2235	EW2235 TROUTDALE	45.4526/-122.525
E2298	EW2298 PORTLAND	45.5047/-122.67
E2601	EW2601 WEST LINN	45.392/-122.655
E2839	EW2839 DAMASCUS	45.4/-122.45
E2880	EW2880 GRESHAM	45.4895/-122.435

Station ID	Station	Latitude/Longitude
E3007	EW3007 HAPPY VALLEY	45.4509/-122.544
E4438	EW4438 PORTLAND	45.5398/-122.526
E5093	EW5093 PORTLAND	45.5302/-122.701
E5214	EW5214 HAPPY VALLEY	45.4338/-122.504
E6165	EW6165 HAPPY VALLEY	45.4/-122.5
E6567	EW6567 PORTLAND	45.7066/-122.868
E7517	EW7517 PORTLAND	45.5217/-122.585
E8319	EW8319 MILWAUKIE	45.4563/-122.605
E8380	EW8380 PUYALLUP	45.4595/-122.514
E9240	EW9240 GRESHAM	45.5075/-122.432
E9637	EW9637 ST HELENS	45.8542/-122.819
ESTO3	CLACKAMAS RIVER NEAR ESTACADA 1NNW	45.3/-122.353
F2157	FW2157 PORTLAND	45.5068/-122.645
F2727	FW2727 OREGON CITY	45.4458/-122.544
F4240	FW4240 PORTLAND	45.5327/-122.546
F4241	FW4241 PORTLAND	45.4787/-122.527
F4242	FW4242 PORTLAND	45.5132/-122.524
F4243	FW4243 PORTLAND	45.501/-122.537
F4628	FW4628 PORTLAND	45.4147/-122.616
F4655	FW4655 PORTLAND	45.478/-122.563
F5278	FW5278 PORTLAND	45.5117/-122.618
F6402	FW6402 CLACKAMAS	45.4142/-122.516
F7062	FW7062 HAPPY VALLEY	45.4342/-122.555
F7953	FW7953 PORTLAND	45.5132/-122.636
FADO3	RAIN GAGE AT P.G.E. FARADAY POWERHOUSE NEAR ESTACADA	45.2689/-122.317
HYD03	ARLETA SCHOOL	45.4862/-122.596
HYD04	ASTOR ELEMENTARY SCHOOL	45.5789/-122.73
HYD05	BEAUMONT SCHOOL	45.5487/-122.621
HYD07	CASCADE PCC	45.5636/-122.674
HYD08	CHILDREN’S MUSEUM	45.5086/-122.718
HYD09	COLLINS VIEW	45.4541/-122.684
HYD10	COLUMBIA IPS	45.5948/-122.717
HYD11	COTTRELL SCHOOL	45.4538/-122.289
HYD16	GRESHAM FIRE DEPT.	45.5076/-122.437
HYD18	HARNEY	45.4623/-122.643
HYD21	KELLY SCHOOL	45.4729/-122.57

Station ID	Station	Latitude/Longitude
HYD25	METRO LEARNING CENTER	45.5268/-122.693
HYD26	MT. TABOR MAINTENANCE YARD	45.5057/-122.597
HYD27	MULTNOMAH	45.5127/-122.66
HYD28	OPEN MEADOWS SCHOOL	45.578/-122.7
HYD30	PLEASANT VALLEY SCHOOL	45.4648/-122.48
HYD32	POST OFFICE	45.5839/-122.583
HYD36	SUNNYSIDE SCHOOL	45.5146/-122.629
HYD43	VERNON SCHOOL	45.5624/-122.644
HYD44	WPCL	45.5857/-122.76
HYD45	YEON	45.5462/-122.71
KCMO3	KELLOGG CREEK NEAR MILWAUKIE 1SE	45.4317/-122.628
KPQR	PORTLAND - NWS WFO	45.5606/-122.538
KSPB	SCAPPOOSE INDUSTRIAL AIRPARK	45.7691/-122.864
KTTD	PORTLAND, PORTLAND-TROUTDALE AIRPORT	45.5511/-122.409
NS066	EAGLE CREEK	45.3689/-122.331
OD163	I84 EB AT I205 MP5.62	45.5316/-122.568
OD164	US26 AT SYLVAN MP71.32	45.5084/-122.736
OD166	JOHNSON CREEK BLVD AT HUNTER BLUFF CL CNTY	45.4561/-122.563
OD173	WALLY ROAD RADIO TOWER BORING CL CNTY	45.4342/-122.39
OD178	I5 SB AT MARINE DR MP307.3	45.6037/-122.683
ODT10	I405 SB AT FREMONT BRIDGE (WEST END) MP3.14	45.5368/-122.684
ODT11	FREMONT BRIDGE EAST (I-405 MP 3)	45.5391/-122.681
ODT12	US26 EB AT ZOO BRIDGE MP72.3	45.5069/-122.719
ODT14	I205 NB AT DIVISION ST RAMP MP19.61	45.5025/-122.565
ODT87	US26 EB AT SANDY MAINT MP21.65	45.4137/-122.311
ODT95	US30 WB AT BOAT BASIN RD MP16.58	45.6954/-122.871
TDEOR	TROUTDALE OR	45.55/-122.39
TT378	PRAWS 11	44.9067/-121.806
UR057	PRKPLC	45.3791/-122.581

Appendix B Continuous stream temperature data summary

Table 32: Continuous temperature monitoring stations in the Lower Willamette and Clackamas Subbasins currently available in public databases and DEQ files.

Station ID	Station	Latitude/Longitude	Organization
10853-ORDEQ	Johnson Creek at 92nd Avenue near Flavel	45.4678/-122.568	DEQ
10856-ORDEQ	Johnson Creek at SE 122nd Avenue (Portland)	45.4737/-122.536	DEQ
11201-ORDEQ	Columbia Slough at Landfill Road	45.6107/-122.755	DEQ
11321-ORDEQ	Johnson Creek at SE 17th Avenue (Portland)	45.4467/-122.643	DEQ
11323-ORDEQ	Johnson Creek at 45th Avenue Footbridge	45.4617/-122.616	DEQ
11326-ORDEQ	Johnson Creek at Pleasantville / 190th Ave.	45.488/-122.468	DEQ
11329-ORDEQ	Crystal Springs Creek	45.4615/-122.642	DEQ
11626-ORDEQ	Johnson Creek at Palmblad Road	45.4728/-122.403	DEQ
12032-ORDEQ	Mitchell Creek at SE 162nd (downstream of trailer park)	45.4602/-122.497	DEQ
23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30	45.7711/-122.879	DEQ
28728-ORDEQ	Johnson Creek at SE 327th Avenue	45.4605/-122.326	DEQ
28729-ORDEQ	Johnson Creek at Revenue Road	45.4617/-122.337	DEQ
28730-ORDEQ	Johnson Creek at Short Road	45.4627/-122.358	DEQ
28731-ORDEQ	Johnson Creek at SE Circle Avenue	45.4864/-122.488	DEQ
28732-ORDEQ	Johnson Creek at Bell Road and Johnson Creek Blvd	45.4556/-122.593	DEQ
28818-ORDEQ	Blue Lake (Multnomah Co) Fishing Dock	45.5539/-122.447	DEQ
30319-ORDEQ	Kink Creek	45.0576/-121.949	DEQ
30437-ORDEQ	Clear Creek at mouth (tributary to Clackamas River at River Mile 8.2)	45.3927/-122.495	DEQ
30438-ORDEQ	Deep Creek at mouth (tributary to Clackamas River at River Mile 12.2)	45.3899/-122.432	DEQ
30440-ORDEQ	Eagle Creek at mouth (tributary to Clackamas River at River Mile 16.7)	45.3533/-122.382	DEQ
30442-ORDEQ	Estacada Lake near spillway (PGE site)	45.2766/-122.323	DEQ

Station ID	Station	Latitude/Longitude	Organization
30624-ORDEQ	Hot Springs Fork Collawash	44.8884/-122.142	DEQ
30625-ORDEQ	Doris Creek (Clackamas)	44.917/-122.166	DEQ
31075-ORDEQ	Portland Cully Helensview	45.5625/-122.575	DEQ
31354-ORDEQ	Whetstone Creek tributary	44.8819/-122.17	DEQ
31382-ORDEQ	Tryon Creek	45.4314/-122.673	DEQ
31387-ORDEQ	Elk Lake Creek lower	44.8899/-122.008	DEQ
31405-ORDEQ	Milton Creek upper	45.8899/-122.924	DEQ
31483-ORDEQ	Squirrel Creek	44.8481/-121.821	DEQ
31484-ORDEQ	Slow Creek (Clackamas)	44.9004/-121.775	DEQ
33477-ORDEQ	Willamette River tributary at River Mile 0.3	45.4687/-122.68	DEQ
33491-ORDEQ	McNulty Creek	45.8458/-122.831	DEQ
33494-ORDEQ	Tickle Creek tributary near Sandy	45.4095/-122.285	DEQ
33517-ORDEQ	Columbia Slough	45.5882/-122.643	DEQ
33518-ORDEQ	Miller Creek	45.6076/-122.817	DEQ
33524-ORDEQ	Columbia Slough	45.5882/-122.68	DEQ
34203-ORDEQ	Milton Creek 0.2 miles US of Old Portland Rd (Scappoose Bay)	45.8507/-122.818	DEQ
34207-ORDEQ	Scappoose Creek 0.5 miles US of West Lane Rd	45.7761/-122.871	DEQ
34209-ORDEQ	Scappoose Bay at Marker #3 (Multnomah, Columbia)	45.8295/-122.829	DEQ
37339-ORDEQ	Johnson Creek at SE 307th Ave., Gresham, OR	45.4608/-122.347	DEQ
37346-ORDEQ	Johnson Creek Tributary just east of 307th & Orient St.	45.4607/-122.345	DEQ
37348-ORDEQ	Badger Creek at Telford Rd. north of Haley	45.445/-122.385	DEQ
37356-ORDEQ	Clatsop Creek at mouth (at confl. w/Kelly Cr.)	45.4702/-122.496	DEQ
37365-ORDEQ	Errol Springs Creek at mouth off SE 42nd St. (T-23)	45.4635/-122.618	DEQ
37371-ORDEQ	Kelley Creek at Richey Road (T-30)	45.4659/-122.477	DEQ
37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)	45.4668/-122.491	DEQ
37375-ORDEQ	Unnamed Johnson Creek Tributary at SE 287th St., betwn. Stone & Wheeler Rds. (T-36)	45.4589/-122.368	DEQ
37376-ORDEQ	Spring Creek at mouth, outlet to Johnson Creek near Hwy. 224 (T-37)	45.4487/-122.643	DEQ

Station ID	Station	Latitude/Longitude	Organization
37377-ORDEQ	Spring Creek at Harrison Road, Milwaukie, OR	45.446/-122.64	DEQ
37378-ORDEQ	Sunshine Creek at SE Rugg Road, east of sharp bend	45.4599/-122.403	DEQ
37379-ORDEQ	Sunshine Creek at Sunshine Valley Road, just east of SE 242nd St.	45.4468/-122.413	DEQ
37380-ORDEQ	Sunshine Creek, North Fork, at SE 242nd St. no. of Sunshine Valley Road	45.4472/-122.414	DEQ
37384-ORDEQ	veterans & Cottonwood Creeks at confl. w/Johnson Creek, east of I-205	45.4687/-122.565	DEQ
37385-ORDEQ	Wheeler Creek at Wheeler Road	45.458/-122.352	DEQ
37543-ORDEQ	Butler Creek at SW Towle Ave and SW Butler Road (T-48)	45.4699/-122.447	DEQ
37599-ORDEQ	Scappoose Cr North Fork at Alder Cr	45.822/-122.946	DEQ
38667-ORDEQ	Badger Cr	45.4562/-122.383	DEQ
38668-ORDEQ	Johnson Cr Below d/s Circle Ave Bridge	45.482/-122.492	DEQ
38670-ORDEQ	Johnson Cr in Schweizer Beaver Dam Pond	45.4786/-122.496	DEQ
38673-ORDEQ	Mitchell Cr above Centennial School Pond	45.4646/-122.491	DEQ
38674-ORDEQ	Johnson Cr abv Trib at EB 224 on ramp	45.4492/-122.643	DEQ
38675-ORDEQ	Johnson Cr below Trib at SB 99E exit to EB hwy 224	45.4485/-122.643	DEQ
38676-ORDEQ	Kelley Cr above Clatsop Cr	45.4702/-122.495	DEQ
38677-ORDEQ	Sunshine Cr W Fk at SE Borges Rd (Trib to Johnson Cr)	45.4495/-122.421	DEQ
38678-ORDEQ	Johnson Cr Trib at Mouth nr SE Stone Rd	45.4619/-122.373	DEQ
38680-ORDEQ	Wahoo Cr blw SE Flavel St (Johnson Cr Trib)	45.4688/-122.528	DEQ
38681-ORDEQ	Kelley Cr at SE 190th Dr	45.4659/-122.467	DEQ
38755-ORDEQ	Spring Creek u/s of Portland Waldorf School in Milwaukie	45.4462/-122.638	DEQ
38756-ORDEQ	Badger Cr off Telford Rd West of SE 282nd Ave and Hwy 26 intersection	45.4522/-122.38	DEQ
38757-ORDEQ	East Fork Sunshine Cr Johnson Cr Trib at Sunshine Valley Rd nr SE 250th Pl	45.4432/-122.406	DEQ
38759-ORDEQ	Johnson Cr Trib Deardorff Cr at Mouth	45.4712/-122.525	DEQ
39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road	45.8506/-122.814	DEQ

Station ID	Station	Latitude/Longitude	Organization
39204-ORDEQ	Johnson Creek near mouth at spring inlet	45.4452/-122.643	DEQ
40237-ORDEQ	Upper sunshine Creek at SE Tillstrom Rd	45.44/-122.421	DEQ
40239-ORDEQ	Johnson Creek DS from Harrison St outfall	45.4449/-122.643	DEQ
40313-ORDEQ	South Scappoose 160 m above Scappoose Venonia Hwy	45.7625/-122.88	DEQ
40316-ORDEQ	Milton Creek 85 m below W Kappler Rd	45.8641/-122.887	DEQ
40317-ORDEQ	South Scappoose Creek 129 m above Otto Miller Rd	45.7448/-122.961	DEQ
40620-ORDEQ	Bear Creek	45.3278/-122.279	DEQ
40621-ORDEQ	South Fork Eagle Creek	45.2836/-122.15	DEQ
40961-ORDEQ	Wheeler Creek downstream of large pond north of Wheeler Rd	45.4598/-122.352	DEQ
40962-ORDEQ	Hogan Creek upstream end of first inline pond	45.4663/-122.429	DEQ
40963-ORDEQ	Hogan Creek in between pond 1 and pond 2	45.4676/-122.425	DEQ
40964-ORDEQ	Hogan Creek South of Butler Rd	45.4683/-122.423	DEQ
40965-ORDEQ	Butler Creek upstream of pond on HOA property	45.4777/-122.457	DEQ
40966-ORDEQ	Butler Creek downstream of pond on HOA property	45.4781/-122.458	DEQ
40967-ORDEQ	Kelley Creek upstream of first inline pond	45.4656/-122.472	DEQ
40968-ORDEQ	Kelley Creek downstream of first inline pond	45.4654/-122.473	DEQ
40969-ORDEQ	Kelley Creek upstream of inline pond South of Foster Rd	45.4689/-122.492	DEQ
40970-ORDEQ	Kelley Creek Downstream of 2nd inline pond S of Foster Rd	45.4696/-122.493	DEQ
40971-ORDEQ	Crystal Springs Creek downstream of pond at base of fish ladder	45.4824/-122.633	DEQ
40972-ORDEQ	Crystal Springs Creek 300 ft downstream	45.4823/-122.633	DEQ
40973-ORDEQ	Johnson Creek upstream of pond east of SE Cottrell Rd	45.4621/-122.304	DEQ
40974-ORDEQ	Johnson Creek downstream of pond east of SE Cottrell Rd	45.4623/-122.305	DEQ
COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road	45.4639/-122.393	City of Gresham

Station ID	Station	Latitude/Longitude	Organization
COG_BearMouth	Bear Creek at mouth	45.4778/-122.458	City of Gresham
COG_BotefMouth	Botefuhr Creek at mouth	45.4757/-122.409	City of Gresham
COG_BrigatHogan	Brigman Creek at Hogan Road	45.4662/-122.414	City of Gresham
COG_BrigDSMeade	Brigman Creek downstream of Meade Property	45.4737/-122.405	City of Gresham
COG_BrigUSMeade	Brigman Creek upstream of Meade property	45.4723/-122.405	City of Gresham
COG_BUC1	Butler Creek upstream of Mawrcrest Pond	45.4754/-122.456	City of Gresham
COG_BUC2	Butler Creek downstream of Mawrcrest Pond and upstream of Marpol Pond	45.4776/-122.456	City of Gresham
COG_BUC3	Butler Creek downstream of Marpol Pond and upstream of Binford Lake	45.4813/-122.461	City of Gresham
COG_BUC4	Butler Creek downstream of Binford Lake	45.4859/-122.462	City of Gresham
COG_ButlerDSBinf	Butler Creek close downstream of Binford Lake	45.4842/-122.461	City of Gresham
COG_ButlerMouth	Butler Creek at 14th Street mouth	45.4865/-122.462	City of Gresham
COG_ButUSBear	Butler Creek above Bear Creek	45.4782/-122.458	City of Gresham
COG_CedarMouth	Cedar Creek at mouth	45.4841/-122.418	City of Gresham
COG_ChastatTowle	Chastain Creek at mouth	45.4864/-122.448	City of Gresham
COG_EFButat27th	East Fork of Butler Creek at 27th Avenue	45.4769/-122.455	City of Gresham
COG_Fairv@Birdsd	Fairview Creek at Birdsdale Road	45.5087/-122.455	City of Gresham
COG_Fairv@Glisan	Fairview Creek at Glisan Road	45.5277/-122.449	City of Gresham
COG_FairvatBirdsd	Fairview Creek at Birdsdale Road	45.5087/-122.455	City of Gresham
COG_FairvatDivision	Fairview Creek at Division Street	45.5049/-122.46	City of Gresham
COG_FairvatGlisan	Fairview Creek at Glisan Road	45.5277/-122.449	City of Gresham
COG_FCI0	Fairview Creek at Eastman Parkway	45.5456/-122.436	City of Gresham

Station ID	Station	Latitude/Longitude	Organization
COG_FCI1	Fairview Creek at Stark Street	45.5211/-122.451	City of Gresham
COG_HeineyMouth	Heiney Creek at mouth	45.488/-122.454	City of Gresham
COG_HogDSCedarLk	Hogan Creek downstream of Cedar Lake	45.4791/-122.418	City of Gresham
COG_HogDSGolf	Hogan Creek downstream of Persimmon Golf Course	45.4688/-122.422	City of Gresham
COG_HogMouth	Hogan Creek at mouth	45.4812/-122.418	City of Gresham
COG_HogTrib	Hogan Creek at small tributary	45.4805/-122.418	City of Gresham
COG_HogUSCedarLk	Hogan Creek upstream of Cedar Lake	45.4766/-122.416	City of Gresham
COG_HogUSGolf	Hogan Creek upstream of Persimmon Golf Course	45.4661/-122.429	City of Gresham
COG_ICJ31	Johnson Creek at Gresham Woods	45.4881/-122.454	City of Gresham
COG_IJC26	Johnson Creek at Hogan Road	45.4809/-122.415	City of Gresham
COG_IJC29	Kelley Creek at Brookside development	45.4662/-122.455	City of Gresham
COG_IJC35	Johnson Creek at Powell Loop	45.488/-122.468	City of Gresham
COG_IJC39	Johnson Creek downstream of Nechakokee Creek downstream of Liberty beaver dam (JoDSBeavDamE)	45.4849/-122.421	City of Gresham
COG_IJC41	Johnson Creek at Highland Road	45.4869/-122.476	City of Gresham
COG_IJC49	East Fork of Butler Creek at Willow Parkway	45.4751/-122.451	City of Gresham
COG_IJC53	Johnson Creek downstream of Brigman Creek	45.4746/-122.405	City of Gresham
COG_IJC72	Johnson Creek at Pleasant View Drive	45.4879/-122.468	City of Gresham
COG_IJC990	Butler Creek at Towle/Butler Road	45.4698/-122.447	City of Gresham
COG_IJC992	Brigman Creek at 247th Ave	45.4701/-122.408	City of Gresham
COG_IJC993	Chastain Creek upstream of the pond	45.4842/-122.445	City of Gresham

Station ID	Station	Latitude/Longitude	Organization
COG_JCI1	Johnson Creek at Jenne Road	45.4866/-122.485	City of Gresham
COG_JCI2	Johnson Creek at Palmblad Road	45.473/-122.403	City of Gresham
COG_JenneMouth	Jenne Creek at mouth	45.4734/-122.496	City of Gresham
COG_JoDSBeavDamB	Johnson Creek at Main City Park downstream of beaver dam	45.4959/-122.43	City of Gresham
COG_JoDSBeavDamC	Johnson Creek at 7th Street downstream of beaver dam	45.4954/-122.439	City of Gresham
COG_JoDSBeavDamD	Johnson Creek at Palmblad Road downstream of beaver dam	45.4728/-122.403	City of Gresham
COG_JoDSBeavDamF	Johnson Creek at Roberts property downstream of beaver dam	45.4653/-122.395	City of Gresham
COG_JohnatAmble	Johnson Creek at Ambleside	45.4782/-122.412	City of Gresham
COG_JohnatGrWood	Johnson Creek at Gresham Woods	45.4882/-122.464	City of Gresham
COG_JohnatMCP	Johnson Creek at Main City Park	45.4959/-122.431	City of Gresham
COG_JohnatTelf	Johnson Creek at Telford Road	45.4643/-122.393	City of Gresham
COG_JoUSBeavDamB	Johnson Creek at Main City Park upstream of beaver dam	45.4952/-122.429	City of Gresham
COG_JoUSBeavDamC	Johnson Creek at 7th Street upstream of beaver dam	45.4953/-122.436	City of Gresham
COG_JoUSBeavDamD	Johnson Creek at Palmblad Road upstream of beaver dam	45.4723/-122.402	City of Gresham
COG_JoUSBeavDamE	Johnson Creek at Liberty upstream of beaver dam	45.4829/-122.417	City of Gresham
COG_JoUSBeavDamF	Johnson Creek at Roberts property upstream of beaver dam	45.4643/-122.393	City of Gresham
COG_KelleyatRich	Kelley Creek at Richey Road	45.4661/-122.477	City of Gresham
COG_KelleyDS190	Kelley Creek downstream of 190th Ave	45.4658/-122.467	City of Gresham
COG_KelleyUS190	Kelley Creek upstream of 190th Ave	45.4661/-122.466	City of Gresham
COG_KI1	Kelley Creek at Pleasant Valley Grange	45.468/-122.487	City of Gresham
COG_KI2	Kelley Creek at Rodlun Road	45.4635/-122.452	City of Gresham

Station ID	Station	Latitude/Longitude	Organization
COG_MeadowMouth	Meadow Creek at mouth	45.4855/-122.424	City of Gresham
COG_MillerMouth	Miller Creek at mouth	45.4935/-122.429	City of Gresham
COG_NechakoMouth	Nechacokee Creek at mouth	45.4839/-122.42	City of Gresham
COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road	45.4665/-122.395	City of Gresham
COG_ThomMouth	Thom Creek at mouth	45.4902/-122.425	City of Gresham
COG_ThompsMouth	Thompson Creek at mouth	45.4963/-122.43	City of Gresham
No Station ID	Errol Spring		City of Portland Parks & Recreation
EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge	45.4619/-122.373	EMSWCD
EMSWCD_JCD	Johnson Creek Mainstem downstream of Short Rd.	45.4632/-122.36	EMSWCD
EMSWCD_JCG	Johnson Creek Mainstem head waters at Surface Nursery	45.458/-122.295	EMSWCD
EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.	45.4693/-122.368	EMSWCD
EMSWCD_Johnson_Collins	Johnson Creek Mainstem downstream of Cottrell Rd.	45.4627/-122.308	EMSWCD
P0012	Tributary to Stevens Creek downstream of SW Custer St	45.4687/-122.679	Portland Environmental Services
P0016	Kelley Creek near SE Foster and Richey Rd	45.4667/-122.482	Portland Environmental Services
P0017	Elrod Slough downstream of Columbia River Correctional Institution	45.5885/-122.64	Portland Environmental Services
P0060	Veteran’s Creek at SE 101st Ave South of Mt. Scott Blvd	45.4643/-122.56	Portland Environmental Services
P0080	Upper Columbia Slough downstream of NE 185th Ave	45.5493/-122.478	Portland Environmental Services

Station ID	Station	Latitude/Longitude	Organization
P0124	Johnson Creek off SE Barbara Welch Rd near SE Foster Rd	45.4755/-122.516	Portland Environmental Services
P0129	Upper Columbia Slough Between 148th and 158th Ave	45.5573/-122.508	Portland Environmental Services
P0144	Nettle Creek East from Andrews Rd on Iron Mountain Trail	45.4292/-122.677	Portland Environmental Services
P0188	Johnson Creek downstream of SE 110th Dr	45.4739/-122.55	Portland Environmental Services
P0208	Tryon Creek off North Creek Trail South of SW Boones Ferry Rd	45.4446/-122.683	Portland Environmental Services
P0250	Balch Creek upstream of Lower Macleay Park	45.5323/-122.717	Portland Environmental Services
P0272	Johnson Creek upstream of SE 174th Ave	45.4866/-122.482	Portland Environmental Services
P0316	Veteran’s Creek downstream of Lincoln Memorial Cemetery Pond	45.4601/-122.552	Portland Environmental Services
P0337	Lower Columbia Slough downstream of Vancouver Bridge	45.5866/-122.671	Portland Environmental Services
P0352	Johnson Creek upstream of SE Stanley Ave	45.4558/-122.603	Portland Environmental Services
P0444	Johnson Creek upstream of SW Pleasant View Dr	45.4882/-122.464	Portland Environmental Services
P0524	Stephens Creek at Confluence with Willamette River	45.4688/-122.67	Portland Environmental Services
P0526	Tributary to Balch Creek at NW Thompson Rd upstream of Cornell Rd	45.5376/-122.739	Portland Environmental Services
P0529	Middle Columbia Slough across from Oregon Air National Guard	45.5744/-122.593	Portland Environmental Services

Station ID	Station	Latitude/Longitude	Organization
P0544	Johnson Creek downstream of SE Ochoco St	45.4582/-122.642	Portland Environmental Services
P0592	Tributary to Tryon Creek downstream of Red Fox Bridge	45.4365/-122.675	Portland Environmental Services
P0633	Newton Creek downstream of Newton Trail	45.6073/-122.797	Portland Environmental Services
P0705	Middle Columbia Slough upstream of Whitaker Slough Confluence	45.5789/-122.617	Portland Environmental Services
P0720	Riverview Tributary to Willamette River North of Lewis and Clark College	45.4534/-122.669	Portland Environmental Services
P0754	Falling Creek near SW Jonathan Ct	45.4565/-122.708	Portland Environmental Services
P0762	Balch Creek off Wildwood Trail near Stone House	45.5277/-122.726	Portland Environmental Services
P0800	Tributary to Willamette River upstream of Riverview Pump Station	45.4534/-122.663	Portland Environmental Services
P0828	Tributary to Johnson Creek along SE Deardorff Rd near covered bridge	45.471/-122.525	Portland Environmental Services
P0892	Johnson creek upstream of SE 100th Ave	45.4742/-122.56	Portland Environmental Services
P0961	Middle Columbia Slough upstream of NE 21st Ave	45.58/-122.641	Portland Environmental Services
P1020	Kelley Creek downstream of SE 159th Dr	45.4772/-122.499	Portland Environmental Services
P1104	Upper Columbia Slough downstream of NE 185th Ave	45.5488/-122.474	Portland Environmental Services
P1184	Johnson Creek at Eastside Plating 1,2,3	45.463/-122.636	Portland Environmental Services

Station ID	Station	Latitude/Longitude	Organization
P1212	Johnson Creek at Brookside Wetland	45.475/-122.547	Portland Environmental Services
P1292	Crystal Springs at 2215 SE Miller St	45.4669/-122.642	Portland Environmental Services
P1312	Riverview Tributary to Willamette River South of Lewis and Clark College	45.4495/-122.665	Portland Environmental Services
P1360	Wilkes Creek at NE 154th Ave	45.548/-122.504	Portland Environmental Services
P1376	Johnson Creek downstream of SE Bell Ave	45.4553/-122.594	Portland Environmental Services
P1404	Johnson Creek downstream of Leach Botanical Gardens	45.474/-122.537	Portland Environmental Services
P1473	Whitaker Slough near confluence with Middle Columbia Slough	45.5775/-122.62	Portland Environmental Services
P1593	Miller Creek downstream of Wildwood Trail	45.6122/-122.812	Portland Environmental Services
P1612	Johnson Creek near Errol Creek confluence	45.4634/-122.618	Portland Environmental Services
P1744	Riverview Tributary to Willamette River South of Riverview Cemetery	45.4595/-122.671	Portland Environmental Services
P1769	Miller Creek upstream of HWY 30	45.6168/-122.809	Portland Environmental Services
P1781	Lower Columbia Slough at Kelley Point Park	45.6417/-122.766	Portland Environmental Services
P1857	Upper Columbia Slough downstream of Big Four Corners	45.5553/-122.49	Portland Environmental Services
P1865	Lower Columbia Slough downstream of St. Johns Landfill Bridge	45.6131/-122.759	Portland Environmental Services

Station ID	Station	Latitude/Longitude	Organization
P1872	Nettle Creek West of Iron Mountain Bridge	45.4296/-122.675	Portland Environmental Services
P1916	Veteran's Creek near 9908 SE Mt. Scott Blvd	45.4658/-122.562	Portland Environmental Services
P1936	Tributary to Arnold Creek at Boones Ferry Rd	45.4486/-122.687	Portland Environmental Services
P2000	Tryon Creek downstream of High Bridge	45.4404/-122.68	Portland Environmental Services
P2113	Middle Columbia Slough downstream of NE 92nd Dr	45.5663/-122.569	Portland Environmental Services
P2185	Rocking Chair Creek downstream of Leif Erikson Dr	45.5569/-122.751	Portland Environmental Services
P2208	Johnson Creek at Brookside Apartments	45.459/-122.613	Portland Environmental Services
P2318	Upper Balch Creek at NW Cornell Rd and 53rd Ave	45.5296/-122.734	Portland Environmental Services
P2320	Johnson Creek downstream of SE Jenne Rd (SE 174th Ave)	45.4825/-122.492	Portland Environmental Services
P2377	Lower Columbia Slough downstream of N. Portland Rd	45.6032/-122.73	Portland Environmental Services
P2384	Tributary to Tryon Creek upstream of Cedar Trail	45.4349/-122.68	Portland Environmental Services
P2400	Johnson Creek upstream of SE Bell Ave	45.4565/-122.59	Portland Environmental Services
TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)	45.4469/-122.687	Portland Environmental Services
VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	45.585/-122.668	Portland Environmental Services
MHNF-001	0605 Poop Creek Temperature	44.9868/-121.839	USFS

Station ID	Station	Latitude/Longitude	Organization
MHNF-002	060600001_Unnamed_LTWT	45.2086/-122.24	USFS
MHNF-003	060600002_Oscar_Cr_LTWT	45.1542/-122.241	USFS
MHNF-004	060600003Unnamed_Cr_LTWT	45.1767/-122.171	USFS
MHNF-005	060600004_Clear_Creek	45.1574/-122.283	USFS
MHNF-006	060600005_Clear_Creek	45.1381/-122.296	USFS
MHNF-008	060600007_Helion Creek	45.1513/-122.176	USFS
MHNF-009	060600008_Unnamed_Cr	45.175/-122.185	USFS
MHNF-013	Berry Cr. R6 Water Temp. Monitor	44.8546/-121.896	USFS
MHNF-014	Butte Cr. R6 Water Temp Monitor	45.0811/-122.009	USFS
MHNF-018	Clackamas at Oak Grove Powerhouse	45.1291/-122.079	USFS
MHNF-019	Clackamas below Oak Grove Powerhouse	45.1315/-122.078	USFS
MHNF-020	Clackamas upstream North Fork Reservoir	45.213/-122.233	USFS
MHNF-021	Clackamas upstream Oak Grove confluence	45.0724/-122.051	USFS
MHNF-022	Clackamas upstream Oak Grove Powerhouse	45.1257/-122.079	USFS
MHNF-026	Collawash above HSF water temperature site	44.9828/-122.063	USFS
MHNF-027	Collawash below HSF water temperature site	44.9874/-122.066	USFS
MHNF-030	Dry_Creek_R6	45.2092/-122.148	USFS
MHNF-031	Eagle Cr at Forest Boundary_LTWT	45.2979/-122.127	USFS
MHNF-032	Eagle Cr at Wilderness Boundary_LTWT	45.2984/-122.097	USFS
MHNF-033	Eagle Creek HOBO temperature site	45.2987/-122.112	USFS
MHNF-039	Fish Creek temp monitoring	45.1526/-122.154	USFS
MHNF-044	Hot Springs Fork water temperature site	44.9854/-122.068	USFS
MHNF-045	Kelley Cr. R6 Temp Monitor	45.0692/-121.965	USFS
MHNF-055	Lowe_Cr_R6_Water_Temp	44.9579/-121.929	USFS
MHNF-061	Mouth_Collawash_Temp_Data	45.0319/-122.061	USFS
MHNF-063	Nohorn at mouth water temperature site	44.9531/-122.173	USFS
MHNF-064	Nohorn at Skin water temperature site	44.9449/-122.197	USFS
MHNF-065	North Fork Eagle Creek HOBO Temperature	45.3089/-122.084	USFS
MHNF-068	Oak Grove below Harriet Lake	45.0747/-121.97	USFS
MHNF-069	Oak Grove below Timothy Lake	45.1127/-121.811	USFS

Station ID	Station	Latitude/Longitude	Organization
MHNF-070	Oak Grove Fork Temp	45.0749/-122.053	USFS
MHNF-071	Oak Grove Fork Water Temperature Monitor	45.075/-122.053	USFS
MHNF-073	Pnk Cr. Water Temp Monitor	44.9778/-122.096	USFS
MHNF-088	Unnamed Trib Water temperature Monitor	45.0342/-121.961	USFS
MHNF-090	Upper Collawash water temperature site	44.8963/-122.006	USFS
MHNF-093	Wolf_Cr_Trib R6 Water Temp	45.0098/-121.892	USFS
MHNF-094	Wolf_Cr_Trib R6 Water Temp(A)	45.0093/-121.897	USFS
MHNF-095	WT_Clackamas_R_at_4650Br	45.0167/-121.921	USFS
MHNF-096	WT_Exact_Spot_Unk_Clakamas_R_at_4690Jct	44.8912/-121.879	USFS
MHNF-097	WT_Exact_Spot_Unk_Rhododendron_Cr	44.9451/-121.89	USFS
MHNF-101	NFk_ClackamasR_LTWT	45.217/-122.21	USFS
MHNF-102	WhiskyCr_LTWT	45.212/-122.158	USFS
MHNF-103	WinslowCr_LTWT	45.203/-122.149	USFS
MHNF-104	BoyerCr_LTWT	45.2035/-122.148	USFS
MHNF-105	CalicoCr_WT_060605	45.067/-122.165	USFS
MHNF-111	DogCr_WT	45.145/-122.136	USFS
MHNF-113	FirstCr_LTWT_0605	45.122/-122.163	USFS
MHNF-115	LTWT_Monitoring_RoaringR	45.1594/-122.116	USFS
MHNF-118	OregonFishWilife_temps	45.1149/-122.074	USFS
MHNF-121	WashCr_LTWT_0605	45.0747/-122.179	USFS
MHNF-122	WT_BigCreek	45.0572/-122.11	USFS
MHNF-123	WT_TroutCr	45.038/-122.078	USFS
11327-ORDEQ	Johnson Creek at Regner Gage	45.4867/-122.421	USGS
14209710	Clackamas River At Carter Bridge, Near Estacada,OR	45.1671/-122.156	USGS
14211400	Johnson Creek At Regner Road, At Gresham, OR	45.4865/-122.422	USGS
14211499	Kelley Creek At Se 159th Drive At Portland, OR	45.4768/-122.498	USGS
14211500	Johnson Creek At Sycamore, OR	45.4775/-122.508	USGS
14211542	Crystal Springs Creek At Bybee St, Portland, OR	45.474/-122.642	USGS
14211546	Crystal Springs Creek At Mouth At Portland, OR	45.4607/-122.643	USGS
14211550	Johnson Creek At Milwaukie, OR	45.4529/-122.643	USGS

Station ID	Station	Latitude/Longitude	Organization
28804-ORDEQ	Johnson Creek at Milwaukie Gage	45.453/-122.643	USGS

Table 33: Summary of existing temperature data in the Lower Willamette and Clackamas Subbasins. Columns Jan – Dec indicate the number of daily maximum temperature results in each month. Data from the DEQ files 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
1998	14211500	Johnson Creek At Sycamore, OR				3	31	30	31	29	30	31	28	28
1998	14211542	Crystal Springs Creek At Bybee St, Portland, OR							14	29	30	31	30	31
1998	14211546	Crystal Springs Creek At Mouth At Portland, OR							12	31	30	31	30	31
1998	14211550	Johnson Creek At Milwaukie, OR					25	30	31	31	30	31	27	31
1998	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					31	30	31	31	30	27		
1999	14211400	Johnson Creek At Regner Road, At Gresham, OR	12	28	31	30	31	30	31	31	30	31	30	31
1999	14211500	Johnson Creek At Sycamore, OR	31	25	31	30	31	30	31	31	30	31	30	31
1999	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				4	31	1	19	31	30	31	4	
2000	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	7	19
2000	14211499	Kelley Creek At Se 159th Drive At Portland, OR	3	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
2000	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	29	31	30	31	30	31	31	30			
2000	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	30437-ORDEQ	Clear Creek at mouth (tributary to Clackamas River at River Mile 8.2)					9	30	31	31	30	31	30	31
2000	30438-ORDEQ	Deep Creek at mouth (tributary to Clackamas River at River Mile 12.2)						2	31	31	21			
2000	30440-ORDEQ	Eagle Creek at mouth (tributary to Clackamas River at River Mile 16.7)					9	30	31	31	30	31	30	31
2000	30442-ORDEQ	Estacada Lake near spillway (PGE site)					8	30	25		9	31	7	
2000	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)						9	31	31	30	31	6	
2001	11201-ORDEQ	Columbia Slough at Landfill Road						9	31	20	22	31		
2001	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211542	Crystal Springs Creek At Bybee St, Portland, 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	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	30437-ORDEQ	Clear Creek at mouth (tributary to Clackamas River at River Mile 8.2)	31	28	31	30	31	29	31	31	30	25		
2001	30438-ORDEQ	Deep Creek at mouth (tributary to Clackamas River at River Mile 12.2)				11	31	29	31	31	30	25		
2001	30440-ORDEQ	Eagle Creek at mouth (tributary to Clackamas River at River Mile 16.7)	31	28	31	30	31	29	31	31	30	25		
2001	30442-ORDEQ	Estacada Lake near spillway (PGE site)	31	28	31	30	31	29	31	31	30	26		
2001	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					25	4	30	6		31	5	
2002	10856-ORDEQ	Johnson Creek at SE 122nd Avenue (Portland)					2	30	29					
2002	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211546	Crystal Springs Creek At Mouth At Portland, OR												26
2002	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	28818-ORDEQ	Blue Lake (Multnomah Co) Fishing Dock						25	31	31	30	30		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	31075-ORDEQ	Portland Cully Helensview						9	31	31	26			
2002	40620-ORDEQ	Bear Creek							22	31	9			
2002	40621-ORDEQ	South Fork Eagle Creek						2	31	31	19			
2002	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					26	30	31	31	9	31	4	
2003	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	30319-ORDEQ	Kink Creek						2						
2003	30624-ORDEQ	Hot Springs Fork Collawash					3	29		11	30	19		
2003	30625-ORDEQ	Doris Creek (Clackamas)					3	30	31	17				
2003	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					27	30	31	31	30	31	3	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	14211400	Johnson Creek At Regner Road, At Gresham, OR	30	29	31	30	31	30	31	31	30	31	30	31
2004	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	22	31	30	31	30	31
2004	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	31354-ORDEQ	Whetstone Creek tributary							24	31	30	10		
2004	31382-ORDEQ	Tryon Creek						8	31	31	26			
2004	31387-ORDEQ	Elk Lake Creek lower							23	31	30	14		
2004	31405-ORDEQ	Milton Creek upper							25	31	22			
2004	31483-ORDEQ	Squirrel Creek						21	20					
2004	31484-ORDEQ	Slow Creek (Clackamas)						21	31	31	30	11		
2004	MHNF-031	Eagle Cr at Forest Boundary_LTWT							29	31	30	18		
2004	MHNF-032	Eagle Cr at Wilderness Boundary_LTWT							29	31	30	18		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					22	30	31	31	30	31	1	
2005	14209710	Clackamas River At Carter Bridge, Near Estacada,OR				14	31	26	29	31	30	31	30	31
2005	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	34209-ORDEQ	Scappoose Bay at Marker #3 (Multnomah, Columbia)											29	31
2005	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					30	30	31	31	30	31	7	
2006	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	28	31	23	31	30	31
2006	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211500	Johnson Creek At Sycamore, 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	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	30	28	31
2006	33477-ORDEQ	Willamette River tributary at River Mile 0.3							19	31	30	1		
2006	33491-ORDEQ	McNulty Creek							21	4	19	1		
2006	33494-ORDEQ	Tickle Creek tributary near Sandy							20	31	30	2		
2006	33517-ORDEQ	Columbia Slough							20	31	30	2		
2006	33518-ORDEQ	Miller Creek							21	31	30	1		
2006	33524-ORDEQ	Columbia Slough							20	13				
2006	34203-ORDEQ	Milton Creek 0.2 miles US of Old Portland Rd (Scappoose Bay)			16	30	31	30	31	31	30	30		
2006	34207-ORDEQ	Scappoose Creek 0.5 miles US of West Lane Rd				20	31	30	31	31	30	30		
2006	34209-ORDEQ	Scappoose Bay at Marker #3 (Multnomah, Columbia)	31	28	31	30	31	30	31	31	30	30		
2006	MHNF-031	Eagle Cr at Forest Boundary_LTWT					18	30	31	31	30	3		
2006	MHNF-032	Eagle Cr at Wilderness Boundary_LTWT					18	30	6					

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	MHNF-121	WashCr_LTWT_0605							7	31	27			
2006	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					22	30	31	31	30	31	1	
2007	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	30	30	31	30	31
2007	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	30	30	31	30	31
2007	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	MHNF-031	Eagle Cr at Forest Boundary_LTWT						1	31	31	30	21		
2007	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					24	30	31	31	30	31	7	
2008	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	29	15	30	31	30	31	31	30	31	30	31
2008	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	27	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	29	31	30	31	30	31	31	30	31	30	10
2008	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	29	31	30	31	30	31	31	29			
2008	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	COG_FCI0	Fairview Creek at Eastman Parkway							16	31	29			
2008	COG_FCI1	Fairview Creek at Stark Street							16	31	29			
2008	COG_HogDSCedarLk	Hogan Creek downstream of Cedar Lake							20	31	30	12		
2008	COG_HogUSCedarLk	Hogan Creek upstream of Cedar Lake							20	31	30	12		
2008	COG_JCI1	Johnson Creek at Jenne Road							16	31	29			
2008	COG_JCI2	Johnson Creek at Palmblad Road							16	31	29			
2008	COG_KI1	Kelley Creek at Pleasant Valley Grange							16	31	29			
2008	COG_KI2	Kelley Creek at Rodlun Road							16	31	29			
2008	MHNF-031	Eagle Cr at Forest Boundary_LTWT						11	31	31	30	14		
2008	MHNF-032	Eagle Cr at Wilderness Boundary_LTWT						11	31	31	30	14		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					30	30	31	31	30	29		
2009	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	30	30	31
2009	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211542	Crystal Springs Creek At Bybee St, Portland, OR	10	28	31	30	31	30	31	31	30	31	30	31
2009	14211546	Crystal Springs Creek At Mouth At Portland, OR	10	28	31	30	31	30	31	31	30	31	30	31
2009	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road					15	30	31	31	30	31	2	
2009	COG_ButlerMouth	Butler Creek at 14th Street mouth					12	30	31	31	30	31	2	
2009	COG_FCI0	Fairview Creek at Eastman Parkway									1	31		
2009	COG_FCI1	Fairview Creek at Stark Street					12	30	31	31	30	31		
2009	COG_HogDSCedarLk	Hogan Creek downstream of Cedar Lake					12	30	31	31	30	31		
2009	COG_HogMouth	Hogan Creek at mouth					12	30	31	31	30	31	2	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	COG_JCI1	Johnson Creek at Jenne Road					12	30	31	31	30	31	2	
2009	COG_JCI2	Johnson Creek at Palmblad Road					12	30	31	31	30	31	2	
2009	COG_JohnatTelf	Johnson Creek at Telford Road					15	30	31	31	30	31	2	
2009	COG_KI1	Kelley Creek at Pleasant Valley Grange					12	30	31	31	30	31	2	
2009	COG_KI2	Kelley Creek at Rodlun Road					12	30	31	31	30	31	2	
2009	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road					15	30	31	31	30	31	2	
2009	MHNF-031	Eagle Cr at Forest Boundary_LTWT						19	31	31	28			
2009	MHNF-039	Fish Creek temp monitoring							8	31	30	18		
2009	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				1	31	30	31	31	30			
2010	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	26	31	30	31	31	30	31	30	31
2010	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211542	Crystal Springs Creek At Bybee St, Portland, 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
2010	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge							2	31	30	28		
2010	MHNF-073	Pnk Cr. Water Temp Monitor						8	31	31	26			
2010	MHNF-095	WT_Clackamas_R_at_4650Br							18	31	29			
2010	MHNF-096	WT_Exact_Spot_Unk_Clakamas_R_at_4690Jct							18	31	29			
2010	MHNF-097	WT_Exact_Spot_Unk_Rhododendron_Cr							18	31	29			
2010	P0017	Elrod Slough downstream of Columbia River Correctional Institution							10	31	30	31	30	8
2010	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					22	30	31	31	30	31	23	
2011	11321-ORDEQ	Johnson Creek at SE 17th Avenue (Portland)								27	30	5		
2011	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	30	29	28	30	22	31	30	31	30	31
2011	14211500	Johnson Creek At Sycamore, 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	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	31	28	31
2011	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	28	31	30	31	30	31	31	19		28	31
2011	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	29	27
2011	28729-ORDEQ	Johnson Creek at Revenue Road								26	30	3		
2011	37348-ORDEQ	Badger Creek at Telford Rd. north of Haley								26				
2011	37379-ORDEQ	Sunshine Creek at Sunshine Valley Road, just east of SE 242nd St.								26	30	3		
2011	37380-ORDEQ	Sunshine Creek, North Fork, at SE 242nd St. no. of Sunshine Valley Road								26	30	3		
2011	37384-ORDEQ	veterans & Cottonwood Creeks at confl. w/Johnson Creek, east of I-205								12	30	3		
2011	37543-ORDEQ	Butler Creek at SW Towle Ave and SW Butler Road (T-48)								26	30	3		
2011	38674-ORDEQ	Johnson Cr abv Trib at EB 224 on ramp								26	26	3		
2011	38759-ORDEQ	Johnson Cr Trib Deardorff Cr at Mouth								11				
2011	39204-ORDEQ	Johnson Creek near mouth at spring inlet								27	30	5		
2011	COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road					13	30	31	31	30	24		
2011	COG_ButlerDSBinf	Butler Creek close downstream of Binford Lake					6	30	31	31	30	24		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	COG_FairvatGlisan	Fairview Creek at Glisan Road					6	30	31	31	30	24		
2011	COG_FCI1	Fairview Creek at Stark Street					6	30	31	31	30	24		
2011	COG_JCI1	Johnson Creek at Jenne Road					6	30	31	31	30	24		
2011	COG_JCI2	Johnson Creek at Palmblad Road					6	30	31	31	30	24		
2011	COG_JohnatTelf	Johnson Creek at Telford Road					13	30	31	31	30	24		
2011	COG_KI1	Kelley Creek at Pleasant Valley Grange					6	30	31	31	30	24		
2011	COG_KI2	Kelley Creek at Rodlun Road					6	30	31	31	30	24		
2011	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road					13	30	31	31	30	24		
2011	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					6	30	31	31	30	19		
2011	MHNF-013	Berry Cr. R6 Water Temp. Monitor						9	31	31	30	4		
2011	MHNF-014	Butte Cr. R6 Water Temp Monitor						9	31	31	30	4		
2011	MHNF-045	Kelley Cr. R6 Temp Monitor						9	31	31	30	4		
2011	P0444	Johnson Creek upstream of SW Pleasant View Dr						28	31	31	30	18		
2011	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				6	31	30	31	31	30	25		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)										21	28	4
2012	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	29	31	30	31	22	31
2012	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211546	Crystal Springs Creek At Mouth At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	18
2012	14211550	Johnson Creek At Milwaukie, OR	31	25	31	30	31	30	31	31	30	31	30	31
2012	37339-ORDEQ	Johnson Creek at SE 307th Ave., Gresham, OR						17	31	31	30	22		
2012	37346-ORDEQ	Johnson Creek Tributary just east of 307th & Orient St.						17	31	31	30	22		
2012	37356-ORDEQ	Clatsop Creek at mouth (at confl. w/Kelly Cr.)						17	31	14		19	7	
2012	37365-ORDEQ	Errol Springs Creek at mouth off SE 42nd St. (T-23)						17	31	31	30	31	7	
2012	37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)						8	31	31	30	31	7	
2012	37375-ORDEQ	Unnamed Johnson Creek Tributary at SE 287th St., betwn. Stone & Wheeler Rds. (T-36)						17	31	31	30	31	7	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	37377-ORDEQ	Spring Creek at Harrison Road, Milwaukie, OR						25	31	31	30	31	5	
2012	37379-ORDEQ	Sunshine Creek at Sunshine Valley Road, just east of SE 242nd St.						17	31	31	30	31	7	
2012	37380-ORDEQ	Sunshine Creek, North Fork, at SE 242nd St. no. of Sunshine Valley Road						17	31	31	30	31	7	
2012	37384-ORDEQ	veterans & Cottonwood Creeks at confl. w/Johnson Creek, east of I-205						17	31	31	30	31	7	
2012	38755-ORDEQ	Spring Creek u/s of Portland Waldorf School in Milwaukie						25	31	31	30	31	5	
2012	38759-ORDEQ	Johnson Cr Trib Deardorff Cr at Mouth						8	31	26		17	7	
2012	COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road						25	31	31	30	31	3	
2012	COG_BotefMouth	Botefuhr Creek at mouth						25	31	31	30	31	3	
2012	COG_CedarMouth	Cedar Creek at mouth						25	31	31	30	15	1	
2012	COG_ChastatTowle	Chastain Creek at mouth						25	31	31	30	11		
2012	COG_FairvatGlisan	Fairview Creek at Glisan Road						23	31	31	30	31	3	
2012	COG_HeineyMouth	Heiney Creek at mouth						25	31	31	30	31	3	
2012	COG_HogMouth	Hogan Creek at mouth						25	31	31	30	31	3	
2012	COG_JenneMouth	Jenne Creek at mouth						23	31	31	30	31	3	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	COG_JohnatAmble	Johnson Creek at Ambleside						25	31	31	30	31	3	
2012	COG_JohnatGrWood	Johnson Creek at Gresham Woods						25	31	31	30	31	3	
2012	COG_JohnatMCP	Johnson Creek at Main City Park						25	31	31	30	31	3	
2012	COG_JohnatTelf	Johnson Creek at Telford Road						25	31	31	30	31	3	
2012	COG_MeadowMouth	Meadow Creek at mouth						25	31	10		17	3	
2012	COG_MillerMouth	Miller Creek at mouth						25	31	31	30	31	3	
2012	COG_NechakoMouth	Nechacokee Creek at mouth						25	31	31	30	31	3	
2012	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road						25	31	23		17	3	
2012	COG_ThomMouth	Thom Creek at mouth						25	31	31	30	31	3	
2012	COG_ThompsMouth	Thompson Creek at mouth							28	28	30	11		
2012	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					7	30	31	31	30	24		
2012	P0800	Tributary to Willamette River upstream of Riverview Pump Station					22	30	31	21	30	23		
2012	P1104	Upper Columbia Slough downstream of NE 185th Ave						23	31	31	30	25		
2012	P1781	Lower Columbia Slough at Kelley Point Park							29	17	3	22		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				6	31	30	31	31	30	23		
2012	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	27	10	29	31	8				28	30	31
2013	12032-ORDEQ	Mitchell Creek at SE 162nd (downstream of trailer park)						13	31	31	30	22		
2013	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	6			30	31
2013	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211542	Crystal Springs Creek At Bybee St, Portland, OR	31	28	31	30	31	30	31	31	30	16		
2013	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	37356-ORDEQ	Clatsop Creek at mouth (at confl. w/Kelly Cr.)						24	31	31	30	22		
2013	37365-ORDEQ	Errol Springs Creek at mouth off SE 42nd St. (T-23)							28	31	30	3		
2013	37371-ORDEQ	Kelley Creek at Richey Road (T-30)						17	31	31	30	22		
2013	37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)							28	31	30	3		
2013	37380-ORDEQ	Sunshine Creek, North Fork, at SE 242nd St. no. of Sunshine Valley Road						18	31	31	30	7		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	38673-ORDEQ	Mitchell Cr above Centennial School Pond							28	31	30	3		
2013	38676-ORDEQ	Kelley Cr above Clatsop Cr						24	31	31	30	22		
2013	38677-ORDEQ	Sunshine Cr W Fk at SE Borges Rd (Trib to Johnson Cr)						18	31	31	30	7		
2013	38678-ORDEQ	Johnson Cr Trib at Mouth nr SE Stone Rd						18	31	31	30	16		
2013	38680-ORDEQ	Wahoo Cr blw SE Flavel St (Johnson Cr Trib)							28	31	30	3		
2013	38681-ORDEQ	Kelley Cr at SE 190th Dr						17	31	31	30	31	30	16
2013	COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road						29	31	31	30	24		
2013	COG_BearMouth	Bear Creek at mouth						29	31	31	30	24		
2013	COG_BUC3	Butler Creek downstream of Marpol Pond and upstream of Binford Lake						29	31	31	30	24		
2013	COG_ButlerDSBinf	Butler Creek close downstream of Binford Lake						29	31	31	30	24		
2013	COG_ButlerMouth	Butler Creek at 14th Street mouth						29	31	31	30	24		
2013	COG_ButUSBear	Butler Creek above Bear Creek						29	31	31	30	24		
2013	COG_EFButat27th	East Fork of Butler Creek at 27th Avenue						29	31	31	30	24		
2013	COG_FairvatBirdsd	Fairview Creek at Birdsdale Road						29	31	31	30	24		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	COG_FairvatDivision	Fairview Creek at Division Street						8	31	31	30	24		
2013	COG_FairvatGlisan	Fairview Creek at Glisan Road						29	31	31	30	24		
2013	COG_FCI0	Fairview Creek at Eastman Parkway			5	30	31	30	31	31	30	28		
2013	COG_FCI1	Fairview Creek at Stark Street						29	31	31	30	24		
2013	COG_HogDSGolf	Hogan Creek downstream of Persimmon Golf Course						29	31	31	30	24		
2013	COG_HogMouth	Hogan Creek at mouth						29	31	31	30	24		
2013	COG_IJC49	East Fork of Butler Creek at Willow Parkway						29	31	31	30	24		
2013	COG_IJC990	Butler Creek at Towle/Butler Road						29	31	31	30	24		
2013	COG_JCI1	Johnson Creek at Jenne Road						29	31	31	30	24		
2013	COG_JCI2	Johnson Creek at Palmblad Road			5	30	31	30	31	31	30	28		
2013	COG_JenneMouth	Jenne Creek at mouth						29	31	31	30	24		
2013	COG_KI1	Kelley Creek at Pleasant Valley Grange			5	30	31	30	31	31	30	28		
2013	COG_KI2	Kelley Creek at Rodlun Road			5	30	31	30	31	31	30	28		
2013	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road						29	31	31	30	24		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					15	30	31	31	30	16		
2013	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.					15	30	31	31	30	16		
2013	MHNF-018	Clackamas at Oak Grove Powerhouse					22	29	30	30	29	17		
2013	MHNF-019	Clackamas below Oak Grove Powerhouse					22	29	30	30	5			
2013	MHNF-020	Clackamas upstream North Fork Reservoir					21	28	29	29	28	27		
2013	MHNF-021	Clackamas upstream Oak Grove confluence					22	29	30	30	29	9		
2013	MHNF-022	Clackamas upstream Oak Grove Powerhouse					22	29	30	30	29	9		
2013	MHNF-068	Oak Grove below Harriet Lake					22	29	30	30	29	9		
2013	MHNF-069	Oak Grove below Timothy Lake					22	29	30	30	29	9		
2013	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				8	31	30	31	31	30	29		
2013	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	30	30	31	18				1	25	1
2014	12032-ORDEQ	Mitchell Creek at SE 162nd (downstream of trailer park)						19	31	31	30	31	10	
2014	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	29	31	31	30	31	30	31
2014	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	30	29	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	30	30	31	31	30	31	24	31
2014	14211500	Johnson Creek At Sycamore, OR	31	26	31	30	31	30	31	31	28	31	30	31
2014	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	28	31	30	31
2014	28728-ORDEQ	Johnson Creek at SE 327th Avenue						25	31	31	30	22		
2014	37339-ORDEQ	Johnson Creek at SE 307th Ave., Gresham, OR						25	31	31	30	22		
2014	37348-ORDEQ	Badger Creek at Telford Rd. north of Haley						27	31	31	30	22		
2014	37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)						19	31	31	30	27		
2014	37378-ORDEQ	Sunshine Creek at SE Rugg Road, east of sharp bend						19	31	31	30	22		
2014	38673-ORDEQ	Mitchell Cr above Centennial School Pond						19	31	31	30	31	10	
2014	38677-ORDEQ	Sunshine Cr W Fk at SE Borges Rd (Trib to Johnson Cr)						19	31	9				
2014	38756-ORDEQ	Badger Cr off Telford Rd West of SE 282nd Ave and Hwy 26 intersection						27	31	31	30	22		
2014	38757-ORDEQ	East Fork Sunshine Cr Johnson Cr Trib at Sunshine Valley Rd nr SE 250th Pl						27	31	31	30	31	2	
2014	COG_BadgeratTelf	Badger Creek (a.k.a McDonald) at Telford Road					21	30	31	31	30	26		
2014	COG_ButlerMouth	Butler Creek at 14th Street mouth					21	30	31	31	30	26		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	COG_FairvatBirdsd	Fairview Creek at Birdsdale Road					21	30	31	31	30	26		
2014	COG_FairvatDivision	Fairview Creek at Division Street					21	30	31	31	30	26		
2014	COG_FairvatGlisan	Fairview Creek at Glisan Road					21	30	31	31	30	26		
2014	COG_FCI0	Fairview Creek at Eastman Parkway					21	30	30	31	30	26		
2014	COG_FCI1	Fairview Creek at Stark Street					21	30	31	31	30	26		
2014	COG_HogMouth	Hogan Creek at mouth					21	30	31	31	30	26		
2014	COG_JCI1	Johnson Creek at Jenne Road					21	30	31	31	30	26		
2014	COG_JCI2	Johnson Creek at Palmblad Road					21	30	31	31	30	26		
2014	COG_JohnatTelf	Johnson Creek at Telford Road					21	30	31	31	30	26		
2014	COG_KelleyDS190	Kelley Creek downstream of 190th Ave					21	30	31	31	30	26		
2014	COG_KI1	Kelley Creek at Pleasant Valley Grange					21	30	31	31	30	26		
2014	COG_KI2	Kelley Creek at Rodlun Road					21	30	31	31	30	26		
2014	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road					21	30	31	31	30	26		
2014	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					8	30	31	31	30	8		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.					8	30	31	31	30	8		
2014	MHNF-002	060600001_Unnamed_LTWT							15	31	30	31	2	
2014	MHNF-003	060600002_Oscar_Cr_LTWT							1	31	30	27		
2014	MHNF-004	060600003Unnamed_Cr_LTWT							9	31	30	31	4	
2014	MHNF-005	060600004_Clear_Creek							15	31	30	27		
2014	MHNF-006	060600005_Clear_Creek							15	31	30	31	5	
2014	MHNF-008	060600007_Helion Creek							15	31	30	31	4	
2014	MHNF-009	060600008_Unnamed_Cr							9	31	30	31	4	
2014	MHNF-018	Clackamas at Oak Grove Powerhouse					22	29	16	17	30	6		
2014	MHNF-019	Clackamas below Oak Grove Powerhouse					23	30	31	31	30	6		
2014	MHNF-020	Clackamas upstream North Fork Reservoir					23	30	31	31	30	9		
2014	MHNF-021	Clackamas upstream Oak Grove confluence					23	30	31	31	30	6		
2014	MHNF-022	Clackamas upstream Oak Grove Powerhouse					22	28	28	29	28	6		
2014	MHNF-031	Eagle Cr at Forest Boundary_LTWT						18	31	31	17			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	MHNF-065	North Fork Eagle Creek HOBO Temperature						17	31	31	17			
2014	MHNF-068	Oak Grove below Harriet Lake					23	29	30	13				
2014	MHNF-069	Oak Grove below Timothy Lake					23	29	30	30	8			
2014	MHNF-070	Oak Grove Fork Temp					23	29	30	30	29	6		
2014	MHNF-071	Oak Grove Fork Water Temperature Monitor							31	31	30	15		
2014	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				1	31	30	31	31	30	16		
2014	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	31	30	31	6				30	30	31
2015	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	29
2015	14211400	Johnson Creek At Regner Road, At Gresham, OR	25	28	29	30	31	30	31	31	30	31	30	31
2015	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211500	Johnson Creek At Sycamore, OR	31	28	30	30	31	30	31	31	30	31	30	31
2015	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	28728-ORDEQ	Johnson Creek at SE 327th Avenue						20	31	31	30	26		
2015	37339-ORDEQ	Johnson Creek at SE 307th Ave., Gresham, OR						20	31	31	30	26		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	37348-ORDEQ	Badger Creek at Telford Rd. north of Haley						20	31	31				
2015	37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)						20	31	31	30	26		
2015	37378-ORDEQ	Sunshine Creek at SE Rugg Road, east of sharp bend						20	31	31	30	26		
2015	38673-ORDEQ	Mitchell Cr above Centennial School Pond						20	31	31	30	26		
2015	38677-ORDEQ	Sunshine Cr W Fk at SE Borges Rd (Trib to Johnson Cr)						20	31	31	30	26		
2015	38756-ORDEQ	Badger Cr off Telford Rd West of SE 282nd Ave and Hwy 26 intersection						20	31	31	30	26		
2015	38757-ORDEQ	East Fork Sunshine Cr Johnson Cr Trib at Sunshine Valley Rd nr SE 250th Pl						20	31	31	30	26		
2015	COG_BrigatHogan	Brigman Creek at Hogan Road					9	30	31	31	30	19		
2015	COG_BrigDSMeade	Brigman Creek downstream of Meade Property					9	30	31	31	30	19		
2015	COG_BrigUSMeade	Brigman Creek upstream of Meade property					9	30	31	31	30	19		
2015	COG_BUC1	Butler Creek upstream of Mawrcrest Pond										3	29	31
2015	COG_BUC2	Butler Creek downstream of Mawrcrest Pond and upstream of Marpol Pond										3	29	31
2015	COG_BUC3	Butler Creek downstream of Marpol Pond and upstream of Binford Lake										3	29	31
2015	COG_BUC4	Butler Creek downstream of Binford Lake										3	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	COG_ButlerMouth	Butler Creek at 14th Street mouth					9	30	31	31	30	19		
2015	COG_FairvatDivision	Fairview Creek at Division Street					9	30	31	31	30	19		
2015	COG_FairvatGlisan	Fairview Creek at Glisan Road					9	30	31	31	30	19		
2015	COG_FCI0	Fairview Creek at Eastman Parkway					9	30	31	31	30	19		
2015	COG_HogMouth	Hogan Creek at mouth					9	30	31	31	30	19		
2015	COG_HogTrib	Hogan Creek at small tributary					9	30	31	31	30	19		
2015	COG_HogUSCedarLk	Hogan Creek upstream of Cedar Lake					9	30	31	31	30	19		
2015	COG_HogUSGolf	Hogan Creek upstream of Persimmon Golf Course					9	30	31	31	30	19		
2015	COG_IJC29	Kelley Creek at Brookside development					9	30	31	31	30	19		
2015	COG_JCI1	Johnson Creek at Jenne Road					9	30	31	31	30	19		
2015	COG_JCI2	Johnson Creek at Palmblad Road					9	30	31	31	30	19		
2015	COG_JohnatTelf	Johnson Creek at Telford Road					9	30	31	31	30	19		
2015	COG_KelleyatRich	Kelley Creek at Richey Road					9	30	31	31	30	19		
2015	COG_KelleyUS190	Kelley Creek upstream of 190th Ave					9	30	31	31	30	19		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	COG_KI1	Kelley Creek at Pleasant Valley Grange					9	30	31	31	30	19		
2015	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road					9	30	31	31	30	19		
2015	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					12	30	31	31	30	12		
2015	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.					12	30	31	31	30	12		
2015	MHNF-001	0605 Poop Creek Temperature						15	31	31	20			
2015	MHNF-018	Clackamas at Oak Grove Powerhouse					18	30	31	31	30	13		
2015	MHNF-019	Clackamas below Oak Grove Powerhouse					18	30	31	31	30	13		
2015	MHNF-020	Clackamas upstream North Fork Reservoir					18	30	31	31	30	12		
2015	MHNF-021	Clackamas upstream Oak Grove confluence					18	30	31	31	30	13		
2015	MHNF-022	Clackamas upstream Oak Grove Powerhouse					18	29	31	31	14			
2015	MHNF-026	Collawash above HSF water temperature site						4	31	31	1			
2015	MHNF-027	Collawash below HSF water temperature site						4	31	31	1			
2015	MHNF-033	Eagle Creek HOBO temperature site							23	31	2			
2015	MHNF-055	Lowe_Cr_R6_Water_Temp						13	31	31	29			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	MHNF-065	North Fork Eagle Creek HOBO Temperature							23	31	2			
2015	MHNF-068	Oak Grove below Harriet Lake					18	30	31	31	30	13		
2015	MHNF-069	Oak Grove below Timothy Lake					18	30	31	31	30	13		
2015	MHNF-070	Oak Grove Fork Temp					18	30	31	31	30	13		
2015	MHNF-088	Unnamed Trib Water temperature Monitor						19	31	31	20			
2015	MHNF-090	Upper Collawash water temperature site						4	31	31	1			
2015	MHNF-093	Wolf_Cr_Trib R6 Water Temp						19	31	31	20			
2015	MHNF-094	Wolf_Cr_Trib R6 Water Temp(A)						7	31	31	20			
2015	P0444	Johnson Creek upstream of SW Pleasant View Dr					25	30	31	31	30	31	30	1
2015	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				1	31	30	31	31	30	31	9	
2015	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	31	16							13	16
2016	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	24	29	31	30	31	30	31	31	30	31	30	31
2016	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	27	28	31	30	31	31	28	31	30	31
2016	14211499	Kelley Creek At Se 159th Drive At Portland, OR	29	29	31	30	31	22	24	5	10	30	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	37372-ORDEQ	Mitchell Creek at Old Race Track (T-32)					27	30	31	31	30	31	9	
2016	38667-ORDEQ	Badger Cr					27	30	31	31	30	31	9	
2016	38668-ORDEQ	Johnson Cr Below d/s Circle Ave Bridge					13	30	31	31	30	31	9	
2016	38670-ORDEQ	Johnson Cr in Schweizer Beaver Dam Pond					27	30	11			26	9	
2016	38673-ORDEQ	Mitchell Cr above Centennial School Pond					27	30	31	31	30	31	9	
2016	38674-ORDEQ	Johnson Cr abv Trib at EB 224 on ramp					27	30	31	31	30	31	9	
2016	38675-ORDEQ	Johnson Cr below Trib at SB 99E exit to EB hwy 224					27	30	31	31	30	31	9	
2016	COG_BrigDSMeade	Brigman Creek downstream of Meade Property					24	30	31	31	30	31	3	
2016	COG_BrigUSMeade	Brigman Creek upstream of Meade property					24	30	31	31	30	31	3	
2016	COG_BUC1	Butler Creek upstream of Mawrcrest Pond	31	29	30	30	31	30	24	31	30	31	26	
2016	COG_BUC2	Butler Creek downstream of Mawrcrest Pond and upstream of Marpol Pond	31	29	30	30	31	30	30	31	30	31	26	
2016	COG_BUC3	Butler Creek downstream of Marpol Pond and upstream of Binford Lake	23	29	30	30	31	30	30	31	30	31	26	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	COG_BUC4	Butler Creek downstream of Binford Lake	31	29	30	30	31	30	30	31	30	31	26	
2016	COG_FairvatBirdsd	Fairview Creek at Birdsdale Road					24	30	31	31	30	31	3	
2016	COG_FairvatDivision	Fairview Creek at Division Street					24	30	31	31	30	31	3	
2016	COG_FairvatGlisan	Fairview Creek at Glisan Road					24	30	31	31	30	31	3	
2016	COG_FCI0	Fairview Creek at Eastman Parkway					24	30	31	31	30	31	3	
2016	COG_FCI1	Fairview Creek at Stark Street					24	30	31	31	30	31	3	
2016	COG_HogDSCedarLk	Hogan Creek downstream of Cedar Lake					24	30	31	31	30	31	3	
2016	COG_HogDSGolf	Hogan Creek downstream of Persimmon Golf Course					24	30	31	31	30	31	3	
2016	COG_HogUSCedarLk	Hogan Creek upstream of Cedar Lake					24	30	31	31	30	31	3	
2016	COG_HogUSGolf	Hogan Creek upstream of Persimmon Golf Course					24	30	31	31	30	31	3	
2016	COG_IJC39	Johnson Creek downstream of Nechakokee Creek downstream of Liberty beaver dam (JoDSBeavDamE)					24	30	31	31	30	31	3	
2016	COG_IJC41	Johnson Creek at Highland Road					24	30	31	31	30	31	3	
2016	COG_IJC53	Johnson Creek downstream of Brigman Creek					24	30	31	31	30	31	3	
2016	COG_JCI2	Johnson Creek at Palmblad Road					24	30	31	31	30	31	3	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	COG_JoDSBeavDamF	Johnson Creek at Roberts property downstream of beaver dam					18	30	31	31	30	31	3	
2016	COG_JoUSBeavDamE	Johnson Creek at Liberty upstream of beaver dam					18	30	31	31	30	31	3	
2016	COG_JoUSBeavDamF	Johnson Creek at Roberts property upstream of beaver dam					18	30	31	31	30	31	3	
2016	COG_KelleyDS190	Kelley Creek downstream of 190th Ave					24	30	31	31	30	31	26	
2016	COG_KelleyUS190	Kelley Creek upstream of 190th Ave					24	30	31	31	30	31	3	
2016	COG_KI1	Kelley Creek at Pleasant Valley Grange										6	26	
2016	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					19	30	31	31	30	10		
2016	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.					19	30	31	31	30	10		
2016	MHNF-018	Clackamas at Oak Grove Powerhouse					18	29	30	30	29	10		
2016	MHNF-019	Clackamas below Oak Grove Powerhouse					18	29	30	30	29	10		
2016	MHNF-020	Clackamas upstream North Fork Reservoir						8	30	30	8			
2016	MHNF-021	Clackamas upstream Oak Grove confluence					17	28	28	29	28	10		
2016	MHNF-022	Clackamas upstream Oak Grove Powerhouse					18	7	26	30	29	10		
2016	MHNF-026	Collawash above HSF water temperature site						21	31	31				

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	MHNF-027	Collawash below HSF water temperature site						21	31	19				
2016	MHNF-033	Eagle Creek HOBO temperature site				3	31	30	31	31				
2016	MHNF-044	Hot Springs Fork water temperature site						21	31	31				
2016	MHNF-063	Nohorn at mouth water temperature site						21	31	31				
2016	MHNF-064	Nohorn at Skin water temperature site						21	31	31				
2016	MHNF-065	North Fork Eagle Creek HOBO Temperature				3	31	30	31	31				
2016	MHNF-068	Oak Grove below Harriet Lake					18	29	30	30	29	10		
2016	MHNF-069	Oak Grove below Timothy Lake					18	29	30	30	29	20		
2016	MHNF-070	Oak Grove Fork Temp					18	29	30	30	29	10		
2016	MHNF-090	Upper Collawash water temperature site						21	31	31				
2016	P0316	Veteran's Creek downstream of Lincoln Memorial Cemetery Pond							5	31	30	31	29	
2016	P0337	Lower Columbia Slough downstream of Vancouver Bridge					7	30	31	31	30	31	10	
2016	P0800	Tributary to Willamette River upstream of Riverview Pump Station					22	30	31	31	30	31	1	
2016	P1104	Upper Columbia Slough downstream of NE 185th Ave					7	30	31	31	30	31	9	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	P1184	Johnson Creek at Eastside Plating 1,2,3					27	30	31	31	30	31	14	
2016	P1212	Johnson Creek at Brookside Wetland					27	30	31	31	30	31	14	
2016	P1292	Crystal Springs at 2215 SE Miller St					27	30	31	31	30	31	16	
2016	P1312	Riverview Tributary to Willamette River South of Lewis and Clark College					22	30	31	16				
2016	P1360	Wilkes Creek at NE 154th Ave					1	30	31	31	6			
2016	P1376	Johnson Creek downstream of SE Bell Ave					27	30	31	31	30	31	14	
2016	P1404	Johnson Creek downstream of Leach Botanical Gardens					27	30	31	31	30	31	14	
2016	P1473	Whitaker Slough near confluence with Middle Columbia Slough					1	30	31	31	30	31	10	
2016	P1593	Miller Creek downstream of Wildwood Trail								29	30	31	9	
2016	P1872	Nettle Creek West of Iron Mountain Bridge					1	30	31	31	30	31	1	
2016	P1916	Veteran's Creek near 9908 SE Mt. Scott Blvd								15	30	31	29	
2016	P2000	Tryon Creek downstream of High Bridge					1	30	31	31	30	31	1	
2016	P2384	Tributary to Tryon Creek upstream of Cedar Trail						11	31	31	30	31	1	
2016	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				2	31	30	31	31	30	31	1	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)		28	31	30	25					13	30	31
2017	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211400	Johnson Creek At Regner Road, At Gresham, OR	30	28	31	30	31	30	31	31	30	31	30	31
2017	14211499	Kelley Creek At Se 159th Drive At Portland, OR	26	28	31	30	31	30	31	31	30	31	30	31
2017	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	18	31	31	30	31	30	31
2017	23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30						1	31	31	30	10		
2017	37376-ORDEQ	Spring Creek at mouth, outlet to Johnson Creek near Hwy. 224 (T-37)					13	30	31	31	30	15		
2017	37599-ORDEQ	Scappoose Cr North Fork at Alder Cr						1	31	31	30	11		
2017	38674-ORDEQ	Johnson Cr abv Trib at EB 224 on ramp					13	30	31	30	30	16		
2017	38675-ORDEQ	Johnson Cr below Trib at SB 99E exit to EB hwy 224					13	30	31	31	30	17		
2017	39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road						2	31	31	30	10		
2017	39204-ORDEQ	Johnson Creek near mouth at spring inlet								7	30	15		
2017	40237-ORDEQ	Upper sunshine Creek at SE Tillstrom Rd					15	30	31	31	30	15		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	40239-ORDEQ	Johnson Creek DS from Harrison St outfall								7	30	15		
2017	40313-ORDEQ	South Scappoose 160 m above Scappoose Venonia Hwy						1	31	31	30	10		
2017	40316-ORDEQ	Milton Creek 85 m below W Kappler Rd						1	31	31	30	11		
2017	40317-ORDEQ	South Scappoose Creek 129 m above Otto Miller Rd						1	31	31	30	11		
2017	COG_BrigUSMeade	Brigman Creek upstream of Meade property					18	30	31	31	25			
2017	COG_BUC1	Butler Creek upstream of Mawrcrest Pond						19	31	31	30	31	1	
2017	COG_BUC2	Butler Creek downstream of Mawrcrest Pond and upstream of Marpol Pond						21	31	31	30	31	1	
2017	COG_BUC3	Butler Creek downstream of Marpol Pond and upstream of Binford Lake						21	31	31	19	31	1	
2017	COG_BUC4	Butler Creek downstream of Binford Lake						21	31	31	30	31	1	
2017	COG_FairvatBirdsd	Fairview Creek at Birdsdale Road					18	30	31	31	30	3		
2017	COG_FairvatDivision	Fairview Creek at Division Street					18	30	31	31	30	3		
2017	COG_FairvatGlisan	Fairview Creek at Glisan Road					18	30	31	31	30	9		
2017	COG_FCI0	Fairview Creek at Eastman Parkway					18	30	31	31	30	3		
2017	COG_FCI1	Fairview Creek at Stark Street					18	30	31	31	30	3		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	COG_IJC29	Kelley Creek at Brookside development					18	30	31	31	25			
2017	COG_IJC72	Johnson Creek at Pleasant View Drive					18	30	31	31	25			
2017	COG_JCI2	Johnson Creek at Palmblad Road					18	30	31	31	25			
2017	COG_JoDSBeavDamD	Johnson Creek at Palmblad Road downstream of beaver dam					18	30	31	31	25			
2017	COG_JoUSBeavDamD	Johnson Creek at Palmblad Road upstream of beaver dam					18	30	31	31	25			
2017	COG_KelleyDS190	Kelley Creek downstream of 190th Ave						21	31	31	30	17		
2017	COG_KelleyUS190	Kelley Creek upstream of 190th Ave					18	30	31	31	25			
2017	COG_KI1	Kelley Creek at Pleasant Valley Grange						21	31	31	30	31	1	
2017	COG_KI2	Kelley Creek at Rodlun Road						21	31	31	30	29		
2017	COG_NFJoatMouth	North Fork of Johnson Creek mouth at Telford Road					16	30	31	31	25			
2017	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge					8	30	31	31	30	10		
2017	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.					8	30	31	31	30	10		
2017	EMSWCD_Johnson_Collins	Johnson Creek Mainstem downstream of Cottrell Rd.					8	30	31	31	30	10		
2017	MHNF-018	Clackamas at Oak Grove Powerhouse					20	30	28	22				

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	MHNF-019	Clackamas below Oak Grove Powerhouse					19	10	29	22				
2017	MHNF-020	Clackamas upstream North Fork Reservoir					19	24	29	22				
2017	MHNF-021	Clackamas upstream Oak Grove confluence					20	29	30	22				
2017	MHNF-022	Clackamas upstream Oak Grove Powerhouse					20	29	30	22				
2017	MHNF-027	Collawash below HSF water temperature site					7	30	31	31	29			
2017	MHNF-030	Dry_Creek_R6					14	30	31	31	30	23		
2017	MHNF-032	Eagle Cr at Wilderness Boundary_LTWT					7	30	31	31	25			
2017	MHNF-033	Eagle Creek HOBO temperature site					6	30	31	31	25			
2017	MHNF-039	Fish Creek temp monitoring					8	40*	45*	62*	54*	21	29	31
2017	MHNF-044	Hot Springs Fork water temperature site					7	30	31	31	30			
2017	MHNF-061	Mouth_Collawash_Temp_Data					7	30	5					
2017	MHNF-065	North Fork Eagle Creek HOBO Temperature					4	30	31	31	25			
2017	MHNF-068	Oak Grove below Harriet Lake						11	30	22				
2017	MHNF-069	Oak Grove below Timothy Lake					20	29	30	21				

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	MHNF-070	Oak Grove Fork Temp					20	29	30	22				
2017	MHNF-090	Upper Collawash water temperature site					7	30	31	31	29			
2017	MHNF-101	NFk_ClackamasR_LTWT				24	31	30	31	31	30	15		
2017	MHNF-102	WhiskyCr_LTWT					16	30	31	31	30	23		
2017	MHNF-103	WinslowCr_LTWT					14	30	31	31	30	23		
2017	MHNF-104	BoyerCr_LTWT					13	30	31	31	30	23		
2017	MHNF-115	LTWT_Monitoring_RoaringR						24	31	31	30	17		
2017	MHNF-118	OregonFishWilife_temps										13	29	31
2017	P1612	Johnson Creek near Errol Creek confluence					8	30	31	31	30	31	7	
2017	P1744	Riverview Tributary to Willamette River South of Riverview Cemetery					9	30	31	31	30	31	22	
2017	P1769	Miller Creek upstream of HWY 30					6	22			29	31	22	
2017	P1857	Upper Columbia Slough downstream of Big Four Corners							15	31	6			
2017	P1865	Lower Columbia Slough downstream of St. Johns Landfill Bridge					3	29						
2017	P1936	Tributary to Arnold Creek at Boones Ferry Rd					9	30	31	8				

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	P2113	Middle Columbia Slough downstream of NE 92nd Dr					2	30	31	31	25			
2017	P2185	Rocking Chair Creek downstream of Leif Erikson Dr					6	30	26	23	30	31	22	
2017	P2208	Johnson Creek at Brookside Apartments					8	30	31	31	30	31	7	
2017	P2318	Upper Balch Creek at NW Cornell Rd and 53rd Ave					9	30	31	31	30	31	22	
2017	P2320	Johnson Creek downstream of SE Jenne Rd (SE 174th Ave)								22	30	31	7	
2017	P2377	Lower Columbia Slough downstream of N. Portland Rd					2	30	31	24	28	20	3	
2017	P2400	Johnson Creek upstream of SE Bell Ave					8	30	31	31	30	23		
2017	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				4	31	30	31	31	30	31	2	
2017	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	31	30	31						15	31
2018	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	30	30	31	30	31
2018	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211550	Johnson Creek At Milwaukie, 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	23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30									25	31	30	30
2018	37385-ORDEQ	Wheeler Creek at Wheeler Road						26	11	31	30	7		
2018	37599-ORDEQ	Scappoose Cr North Fork at Alder Cr									25	31	30	31
2018	39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road									25	31	30	31
2018	40313-ORDEQ	South Scappoose 160 m above Scappoose Venonia Hwy										21	30	30
2018	40316-ORDEQ	Milton Creek 85 m below W Kappler Rd									25	31	30	31
2018	40317-ORDEQ	South Scappoose Creek 129 m above Otto Miller Rd									25	9	22	31
2018	40961-ORDEQ	Wheeler Creek downstream of large pond north of Wheeler Rd						26	31	31	30	7		
2018	40962-ORDEQ	Hogan Creek upstream end of first inline pond						4	31	31	30	7		
2018	40963-ORDEQ	Hogan Creek in between pond 1 and pond 2								3	30	7		
2018	40964-ORDEQ	Hogan Creek South of Butler Rd							1	31	30	7		
2018	40965-ORDEQ	Butler Creek upstream of pond on HOA property						11	31	31	30	7		
2018	40966-ORDEQ	Butler Creek downstream of pond on HOA property						11	31	31	30	7		
2018	40967-ORDEQ	Kelley Creek upstream of first inline pond						25	31	31	30	7		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	40968-ORDEQ	Kelley Creek downstream of first inline pond								31	30	7		
2018	40969-ORDEQ	Kelley Creek upstream of inline pond South of Foster Rd						25	31	31	30	17		
2018	40970-ORDEQ	Kelley Creek Downstream of 2nd inline pond S of Foster Rd						25	31	31	30	17		
2018	40971-ORDEQ	Crystal Springs Creek downstream of pond at base of fish ladder							20	31	30	22		
2018	40972-ORDEQ	Crystal Springs Creek 300 ft downstream							20	31	30	22		
2018	40973-ORDEQ	Johnson Creek upstream of pond east of SE Cottrell Rd						26	31	31	30	7		
2018	40974-ORDEQ	Johnson Creek downstream of pond east of SE Cottrell Rd						26	31	31	30	7		
2018	COG_BUC1	Butler Creek upstream of Mawrcrest Pond				17	31	30	31	31	30	31	23	
2018	COG_BUC2	Butler Creek downstream of Mawrcrest Pond and upstream of Marpol Pond				17	31	30	31	31	30	31	23	
2018	COG_JoDSBeavDamB	Johnson Creek at Main City Park downstream of beaver dam							10	31	30	8		
2018	COG_JoDSBeavDamC	Johnson Creek at 7th Street downstream of beaver dam							10	31	30	8		
2018	COG_JoUSBeavDamB	Johnson Creek at Main City Park upstream of beaver dam							10	31	30	8		
2018	COG_JoUSBeavDamC	Johnson Creek at 7th Street upstream of beaver dam							10	31	30	8		
2018	COG_KI1	Kelley Creek at Pleasant Valley Grange										1	24	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	EMSWCD_JCG	Johnson Creek Mainstem head waters at Surface Nursery				5	31	30	31	31	30	15		
2018	EMSWCD_Johnson_Collins	Johnson Creek Mainstem downstream of Cottrell Rd.				5	31	30	31	31	30	14		
2018	MHNF-018	Clackamas at Oak Grove Powerhouse					4	30	31	31	30	15		
2018	MHNF-020	Clackamas upstream North Fork Reservoir					1	30	31	22				
2018	MHNF-021	Clackamas upstream Oak Grove confluence					8	30	31	31	30	16		
2018	MHNF-022	Clackamas upstream Oak Grove Powerhouse					4	30	31	31	30	16		
2018	MHNF-033	Eagle Creek HOBO temperature site						29	31	31	10			
2018	MHNF-039	Fish Creek temp monitoring	31	28	30	21	15	30	31	31	30	31	29	31
2018	MHNF-065	North Fork Eagle Creek HOBO Temperature						29	31	31	10			
2018	MHNF-118	OregonFishWilife_temps	31	28	30	30	31	30	31	31	12			
2018	P0012	Tributary to Stevens Creek downstream of SW Custer St					30	30	31	31	30	31	16	
2018	P0016	Kelley Creek near SE Foster and Richey Rd						19	31	31	30	31	30	31
2018	P0060	Veteran’s Creek at SE 101st Ave South of Mt. Scott Blvd					30	30	31	31	27			
2018	P0080	Upper Columbia Slough downstream of NE 185th Ave							2	31	30	31	30	12

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	P0124	Johnson Creek off SE Barbara Welch Rd near SE Foster Rd					30	30	31	31	30	31	15	
2018	P0129	Upper Columbia Slough Between 148th and 158th Ave							1	31	30	30	30	12
2018	P0144	Nettle Creek East from Andrews Rd on Iron Mountain Trail					30	30	31	31	30	31	16	
2018	P0188	Johnson Creek downstream of SE 110th Dr					30	30	31	31	30	31	15	
2018	P0208	Tryon Creek off North Creek Trail South of SW Boones Ferry Rd					30	30	31	31	30	31	16	
2018	P0250	Balch Creek upstream of Lower Macleay Park					30	30	31	31	30	31	30	31
2018	P0272	Johnson Creek upstream of SE 174th Ave					30	30	31	31	30	31	15	
2018	P0352	Johnson Creek upstream of SE Stanley Ave					30	30	31	31	30	31	16	
2018	P0524	Stephens Creek at Confluence with Willamette River					30	30	31	31	12	27	16	
2018	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)					31	30	31	31	30	31	28	
2018	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	31	30	31							14
2019	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	30	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30	31	28	30	30	30	30	31	31	4		24	10
2019	37599-ORDEQ	Scappoose Cr North Fork at Alder Cr	30	28	30	30	30	29	9	31	30	31	29	10
2019	39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road	31	28	30	29	31	30	31	31	4		24	31
2019	40313-ORDEQ	South Scappoose 160 m above Scappoose Venonia Hwy	31	28	30	30	30	30	31	31	3	22	29	31
2019	40316-ORDEQ	Milton Creek 85 m below W Kappler Rd	31	28	30	30	30	30	31	31	3		24	31
2019	40317-ORDEQ	South Scappoose Creek 129 m above Otto Miller Rd	31	28	30	30	30	30	31	31	3	22	29	10
2019	COG_BrigatHogan	Brigman Creek at Hogan Road				12	31	30	31	31	30			
2019	COG_BrigDSMeade	Brigman Creek downstream of Meade Property				12	31	30	31	31	30			
2019	COG_BrigUSMeade	Brigman Creek upstream of Meade property				12	31	30	31	31	30			
2019	COG_FairvatBirdsd	Fairview Creek at Birdsdale Road				12	31	30	31	31	30			
2019	COG_FairvatGlisan	Fairview Creek at Glisan Road				12	31	30	31	31	30			
2019	COG_FCI0	Fairview Creek at Eastman Parkway				12	31	30	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	COG_FCI1	Fairview Creek at Stark Street				12	31	30	31	31	30			
2019	COG_ICJ31	Johnson Creek at Gresham Woods					30	30	31	31	30			
2019	COG_IJC26	Johnson Creek at Hogan Road					30	30	31	31	30			
2019	COG_IJC29	Kelley Creek at Brookside development				12	31	30	31	31	30			
2019	COG_IJC35	Johnson Creek at Powell Loop					30	30	31	31	30			
2019	COG_IJC992	Brigman Creek at 247th Ave				12	31	30	31	31	30			
2019	COG_JCI1	Johnson Creek at Jenne Road					30	30	31	31	30			
2019	EMSWCD_JCC	Johnson Creek Mainstem at 282nd Ave bridge				7	31	30	31	31	30	9		
2019	EMSWCD_JCD	Johnson Creek Mainstem downstream of Short Rd.				7	31	30	31	31	30	9		
2019	EMSWCD_JCG	Johnson Creek Mainstem head waters at Surface Nursery				7	31	30	31	31	30	9		
2019	EMSWCD_JCJ	Johnson Creek North Fork South of SE Ruth Ln.				7	31	30	31	31	30	9		
2019	EMSWCD_Johnson_Collins	Johnson Creek Mainstem downstream of Cottrell Rd.				7	31	30	31	31	30	9		
2019	MHNF-033	Eagle Creek HOBO temperature site					16	30	31	31	20			
2019	MHNF-039	Fish Creek temp monitoring	31	28	30	8	17	30	31	31	30	31	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	MHNF-065	North Fork Eagle Creek HOBO Temperature					16	30	31	31	21			
2019	MHNF-105	CalicoCr_WT_060605							20	31	30			
2019	MHNF-111	DogCr_WT							8	31	30	1		
2019	MHNF-113	FirstCr_LTWT_0605							20	31	30			
2019	MHNF-115	LTWT_Monitoring_RoaringR					17	30	31	31	19	31	29	31
2019	MHNF-122	WT_BigCreek						2	31	31	24			
2019	MHNF-123	WT_TroutCr							7	31	24			
2019	P0444	Johnson Creek upstream of SW Pleasant View Dr					10	30	31	31	30	31	7	
2019	P0526	Tributary to Balch Creek at NW Thompson Rd upstream of Cornell Rd					30	30	31	31	30	31	5	
2019	P0529	Middle Columbia Slough across from Oregon Air National Guard					2	30	31	31	8			
2019	P0544	Johnson Creek downstream of SE Ochoco St					30	30	31	31	30	31	7	
2019	P0592	Tributary to Tryon Creek downstream of Red Fox Bridge					19	30	31	31	30	31	4	
2019	P0633	Newton Creek downstream of Newton Trail					6	26	31	31	30	31	7	
2019	P0705	Middle Columbia Slough upstream of Whitaker Slough Confluence									12	31	14	

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	P0720	Riverview Tributary to Willamette River North of Lewis and Clark College					19	30	31	31	30	31	4	
2019	P0754	Falling Creek near SW Jonathan Ct					19	30	31	31	30	31	5	
2019	P0762	Balch Creek off Wildwood Trail near Stone House					30	30	31	31	30	31	5	
2019	P0828	Tributary to Johnson Creek along SE Deardorff Rd near covered bridge										25	7	
2019	P0892	Johnson creek upstream of SE 100th Ave					10	30	31	31	30	31	25	
2019	P0961	Middle Columbia Slough upstream of NE 21st Ave					2	30	31	31	30	31	14	
2019	P1020	Kelley Creek downstream of SE 159th Dr					10	30	31	31	30	31	7	
2019	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				15	31	30	31	31	30	31	5	
2019	VNB	N Vancouver St Bridge (Main Channel - Columbia Slough)	31	28	30	30	31							
2020	14209710	Clackamas River At Carter Bridge, Near Estacada,OR	31	29	31	30	31	30	31	31	30	31	15	23
2020	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211550	Johnson Creek At Milwaukie, 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
2020	23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30			11	30	31	30	30	31	30	6		
2020	37599-ORDEQ	Scappoose Cr North Fork at Alder Cr			11	30	31	30	31	31	30	6		
2020	39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road	31	29	30	30	31	30	31	31	30	6		
2020	40313-ORDEQ	South Scappoose 160 m above Scappoose Venonia Hwy	31	29	30	30	30	30	31	5	27	6		
2020	40316-ORDEQ	Milton Creek 85 m below W Kappler Rd	31	29	30	30	19							
2020	40317-ORDEQ	South Scappoose Creek 129 m above Otto Miller Rd			11	30	31	30	31	31	30	6		
2020	COG_Fairv@Birdsd	Fairview Creek at Birdsdale Road					31	29	31	31	30	20		
2020	COG_Fairv@Glisan	Fairview Creek at Glisan Road					31	29	31	31	30	20		
2020	COG_FCI0	Fairview Creek at Eastman Parkway					31	29	31	31	30	20		
2020	COG_FCI1	Fairview Creek at Stark Street					31	29	31	31	30	20		
2020	COG_IJC39	Johnson Creek downstream of Nechakokee Creek downstream of Liberty beaver dam (JoDSBeavDamE)					31	29	31	31	30	20		
2020	COG_IJC41	Johnson Creek at Highland Road					31	29	31	31	30	20		
2020	COG_IJC53	Johnson Creek downstream of Brigman Creek					31	29	31	31	30	20		
2020	COG_IJC990	Butler Creek at Towle/Butler Road					31	29	31	31	30	20		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	COG_IJC993	Chastain Creek upstream of the pond					31	29	31	31	30	20		
2020	COG_JCI1	Johnson Creek at Jenne Road					31	29	31	31	30	20		
2020	COG_JCI2	Johnson Creek at Palmblad Road					31	29	31	31	30	20		
2020	MHNF-039	Fish Creek temp monitoring	31	29	30	30	31	1						
2020	MHNF-115	LTWT_Monitoring_RoaringR	31	9										
2020	P0800	Tributary to Willamette River upstream of Riverview Pump Station							11	31	30	31	12	
2020	P1104	Upper Columbia Slough downstream of NE 185th Ave					18	30	31	31	30	31	30	21
2020	P1184	Johnson Creek at Eastside Plating 1,2,3					25	30	31	31	30	31	30	7
2020	P1212	Johnson Creek at Brookside Wetland					25	30	31	31	30	31	30	7
2020	P1292	Crystal Springs at 2215 SE Miller St					25	30	2					
2020	P1376	Johnson Creek downstream of SE Bell Ave					25	30	31	31	30	31	30	7
2020	P1404	Johnson Creek downstream of Leach Botanical Gardens					25	30	31	31	30	20		
2020	P1593	Miller Creek downstream of Wildwood Trail					20	30	31	31	30	31	30	2
2020	P1872	Nettle Creek West of Iron Mountain Bridge					11	30	31	31	30	31	30	2

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	P1916	Veteran’s Creek near 9908 SE Mt. Scott Blvd					25	30	31	31	30	31	30	7
2020	P2000	Tryon Creek downstream of High Bridge					11	30	31	31	30	31	30	2
2020	P2384	Tributary to Tryon Creek upstream of Cedar Trail					8	30	31	31	30	31	12	
2020	TC-4	Tryon Creek at 10750 SW Boones Ferry Rd (Downstream of Culvert)				3	31	30	31	3		26	9	

* 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 34: Continuous flow measurements available from the USGS flow gaging stations in the Lower Willamette and Clackamas Subbasins.

Station ID	Station	Latitude/Longitude
14208700	Oak Grove Fork Near Government Camp, OR	45.11373/-121.8151
14209000	Oak Grove Fork Above Powerplant Intake, OR.	45.07123/-121.9406
14209250	Oak Grove Fork At Ripplebrook Campground, OR	45.07981/-122.0429
14209500	Clackamas River Above Three Lynx Creek, OR	45.12484/-122.0734
14209700	Fish Creek Near Three Lynx, OR	45.14762/-122.1531
14211315	Tryon Creek Near Lake Oswego, OR	45.43067/-122.6737
14211400	Johnson Creek At Regner Road, At Gresham, OR	45.48651/-122.4218
14211499	Kelley Creek At Se 159th Drive At Portland, OR	45.47679/-122.4984
14211500	Johnson Creek At Sycamore, OR	45.47746/-122.508
14211550	Johnson Creek At Milwaukie, OR	45.4529/-122.6431
14211814	Fairview Creek At Glisan St Near Gresham, OR	45.52762/-122.4487
14211818	Buffalo Slough At Ne 33rd Ave, Portland, OR	45.57659/-122.6331

Table 35: Instantaneous flow measurements made by DEQ in the Lower Willamette and Clackamas Subbasins.

Station ID	Station	Date	Time	Flow (cfs)	Latitude/Longitude
28728-ORDEQ	Johnson Creek at SE 327th Avenue	2002-07-29	10:40	0.42	45.4605/-122.326
28729-ORDEQ	Johnson Creek at Revenue Road	2002-07-29	11:00	1.01	45.4617/-122.337
11326-ORDEQ	Johnson Creek at Pleasantville / 190th Ave.	2002-07-29	14:30	1.09	45.488/-122.468
10856-ORDEQ	Johnson Creek at SE 122nd Avenue (Portland)	2002-07-30	09:45	2.08	45.4737/-122.536
28732-ORDEQ	Johnson Creek at Bell Road and Johnson Creek Blvd	2002-07-30	11:33	1.38	45.4556/-122.593
11329-ORDEQ	Crystal Springs Creek at Johnson Creek Park	2002-07-30	12:50	8.87	45.4613/-122.642

Table 36: Summary of existing flow data in the Lower Willamette and Clackamas Subbasins. 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	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1990	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1991	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1992	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
1992	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14209700	Fish Creek Near Three Lynx, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14211500	Johnson Creek At Sycamore, 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
1992	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14211814	Fairview Creek At Glisan St Near Gresham, OR					31	30	31	31	30	31	30	31
1993	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1993	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1994	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14208700	Oak Grove Fork Near Government Camp, 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
1995	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1995	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1996	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
1996	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14209700	Fish Creek Near Three Lynx, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
1997	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1997	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14211500	Johnson Creek At Sycamore, 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
1997	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1998	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14211400	Johnson Creek At Regner Road, At Gresham, OR		3	31	30	31	30	31	31	30	31	30	31
1998	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1999	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14211550	Johnson Creek At Milwaukie, 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
1999	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2000	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2000	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14209700	Fish Creek Near Three Lynx, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211499	Kelley Creek At Se 159th Drive At Portland, OR			21	30	31	30	31	31	30	31	30	31
2000	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2001	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2001	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211315	Tryon Creek Near Lake Oswego, OR								31	30	31	30	31
2001	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211499	Kelley Creek At Se 159th Drive At Portland, 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	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2002	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2003	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211315	Tryon Creek Near Lake Oswego, 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	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14211818	Buffalo Slough At Ne 33rd Ave, Portland, OR								24	30	12		
2004	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2004	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14209700	Fish Creek Near Three Lynx, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211315	Tryon Creek Near Lake Oswego, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14211818	Buffalo Slough At Ne 33rd Ave, Portland, OR			9	30	31	30	31	31	29			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2005	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2006	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14209700	Fish Creek Near Three Lynx, OR	31	28	31	30	31	30	31	31	30	22		
2006	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211499	Kelley Creek At Se 159th Drive At Portland, 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	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2007	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2008	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2008	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211315	Tryon Creek Near Lake Oswego, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211400	Johnson Creek At Regner Road, At Gresham, 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
2008	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2009	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2009	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2010	14209250	Oak Grove Fork At Ripplebrook Campground, OR										31	30	31
2010	14209500	Clackamas River Above Three Lynx Creek, 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
2010	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2011	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2012	14208700	Oak Grove Fork Near Government Camp, 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	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2012	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211315	Tryon Creek Near Lake Oswego, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2013	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2013	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211500	Johnson Creek At Sycamore, 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
2013	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2014	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	29
2014	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2015	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211315	Tryon Creek Near Lake Oswego, 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	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2016	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2016	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211315	Tryon Creek Near Lake Oswego, OR	31	29	31	30	30	30	31	31	30	31	30	31
2016	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2017	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14209000	Oak Grove Fork Above Powerplant Intake, 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
2017	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2018	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14211550	Johnson Creek At Milwaukie, 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	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14208700	Oak Grove Fork Near Government Camp, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2019	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14209500	Clackamas River Above Three Lynx Creek, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211315	Tryon Creek Near Lake Oswego, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211500	Johnson Creek At Sycamore, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211550	Johnson Creek At Milwaukie, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	28	31	30	31	30	31	31	30	31	30	31
2020	14208700	Oak Grove Fork Near Government Camp, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14209000	Oak Grove Fork Above Powerplant Intake, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2020	14209250	Oak Grove Fork At Ripplebrook Campground, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14209500	Clackamas River Above Three Lynx Creek, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211315	Tryon Creek Near Lake Oswego, 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
2020	14211400	Johnson Creek At Regner Road, At Gresham, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211499	Kelley Creek At Se 159th Drive At Portland, OR	31	29	31	30	31	30	31	31	30	31	30	30
2020	14211500	Johnson Creek At Sycamore, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211550	Johnson Creek At Milwaukie, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14211814	Fairview Creek At Glisan St Near Gresham, OR	31	29	31	30	31	30	31	31	29	29	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 340-041-0340 Figure 340A.

20. Salmon and Steelhead spawning use extent and period depicted in OAR 340-041-0340 Figure 340B.

Appendix E Columbia Slough model updates

DEQ recommends the existing Columbia Slough CE-QUAL-W2 model (Wells and Berger, 1995; Berger and Wells, 2005) be updated and recalibrated before it can be used to simulate current water temperature conditions. DEQ investigated, to the extent that time allowed, some of the model setup changes required for recalibration. This summary is not exhaustive and should be treated as a starting point. Key model configuration changes investigated include the setup of pumps, culverts, and weirs. Table 37 displays how various pumps were configured in the 1992 model calibration (Berger and Wells, 2005) and the pumping capacity in 2019 based on information presented in the MCDD Drainage Master Plan (Brown and Caldwell, 2019). Table 38 show how culvert conditions were configured in the 1992 calibration and known updates that are needed to represent culvert condition in 2021. Culvert status was based on information presented in CSWC, 2013 and City of Portland project 1135 plans (summarized in DEQ, 2006). DEQ also reviewed aerial imagery and google street view to further evaluate the presence of open span bridges. Dimensions and elevations for replacement culverts #27 - #30 are based on the 1135 project plans configured in the 2006 TMDL model scenario #2 “Current Conditions + improvements”. The “as built” dimensions should be confirmed. There are a number of other culverts configured in the model that still need review. These are noted in Table 38. Table 39 shows how various weirs were configured in the 1992 calibration and the 2021 status.

Table 37: 1992 pump capacity (Berger and Wells, 2005) and 2019 pump capacity (MCCD, 2019).

Location	Pump #	1992 Pump Capacity (cfs)	2019 Pump Capacity (cfs)
MCDD #1	1	90	58
MCDD #1	2	82	122
MCDD #1	3	111	51
MCDD #1	4	85	122
MCDD #1	5	98	58
MCDD #4	1	45	122
MCDD #4	2	45	122
MCDD #4	3	65	122
MCDD #4	4	65	122

Table 38: Culvert conditions in 1992 at locations simulated in the existing Columbia Slough CE-QUAL-W2 model (Berger and Wells, 2005) and the 2021 status.

Model Culvert #	Location	1992 Culvert Type	1992 Diameter (in)	1992 Invert Elevation (feet)	1992 Length (feet)	2021 Culvert Status
1	82nd	CMP	148	22	205	needs review
2	122nd	CMP	144	2.53/2.53	108	needs review
3	Mid-Dike	CMP	60	2.62/1.59	315	needs review

Model Culvert #	Location	1992 Culvert Type	1992 Diameter (in)	1992 Invert Elevation (feet)	1992 Length (feet)	2021 Culvert Status
4	Mid-Dike	CMP	60	2.50/1.59	316	needs review
5	148th	CMP	84	4.01/4.03	100	open span bridge
6	148th	CMP	96	2.62/1.72	100	open span bridge
7	158th	CMP	96	2.87/2.55	120	open span bridge
8	158th	CMP	96	3.43/2.85	120	open span bridge
9	185th	CMP	54	5.71/5.60	60	open span bridge
10	185th	CMP	72	5.71/5.60	50	open span bridge
11	Agricultural Crossing	CONCRETE	36	7.07/7.13	41	open span bridge
12	Agricultural Crossing	CONCRETE	36	5.96/6.32	42	open span bridge
13	Agricultural Crossing	CONCRETE	36	5.95/5.82	42	open span bridge
14	33rd	CMP	48	5.89/5.12	121	open span bridge #109g (CSWC, 2013)
15	Broadmore G.C. #1	CMP	48	4.92/5.07	40	open span bridge #109a (CSWC, 2013)
16	Broadmore G.C. #2	CMP	36	6.30/5.78	56	open span bridge #109b (CSWC, 2013)
17	47th	CMP	36	7.10/6.50	64	open span bridge
18	47th	CMP	36	4.51/3.64	69	open span bridge
19	47th	CMP	48	2.06/3.16	62	open span bridge
20	Private Road	CSP-CMP (half & half)	60	5.30/5.29	35	open span bridge #109f (CSWC, 2013)
21	63rd	CMP	72	3.39/2.82	54	needs review
22	Alderwood Road	CMP	60	4.42/3.62	125	needs review
23	Colwood G.C. #1	CSP	48	6.13/6.34	30	open span bridge #109d (CSWC, 2013)
24	Colwood G.C. #2	CSP	48	5.63/6.17	24	open span bridge #109e (CSWC, 2013)
25	78th.	CMP	48	3.64/3.12	120	needs review
26	82nd	CMP	48	4.53/4.66	220	needs review

Model Culvert #	Location	1992 Culvert Type	1992 Diameter (in)	1992 Invert Elevation (feet)	1992 Length (feet)	2021 Culvert Status
27	8800 Marx	CMP	48	6.85/6.85	122	Replaced with single RCP (same as #28) 60 in diameter, 6.29/6.41 feet invert elevation, 120 foot length
28	8800 Marx	CMP	48	6.73/7.07	122	Replaced with single RCP (same as #27) 60 in diameter, 6.29/6.41 feet invert elevation, 120 foot length
29	92nd	CMP	48	5.68/6.41	65	Replaced with box (same as #29), 6’x3’, 7.07/7.08 feet invert elevation, 71 foot length
30	92nd	CMP	48	6.24/6.08	71	Replaced with box (same as #29), 6’x3’, 7.07/7.08 feet invert elevation, 71 foot length
31	I205	CMP	42	5.89/7.19	604	needs review
32	105th	CMP	42	7.08/7.21	84	needs review
33	117th	CMP	48	5.49/5.50	50	needs review
34	117th	CMP	48	5.49/5.50	50	needs review
35	122nd	CMP	48	5.34/5.05	108	needs review
36	122nd	CMP	48	5.24/5.05	108	needs review
37	112th	Elliptical CMP	29 x 42	6.1/5.7	50	open span bridge #109c (CSWC, 2013)

Table 39: Weir conditions in 1992 at locations simulated in the existing Columbia Slough CE-QUAL-W2 model (Berger and Wells, 2005) and 2021 status.

Model Weir #	Location	1992 Type	1992 Length (m)	1992 Elevation (meters above MSL)	1992 Equation Q=cms, H=head (m)	2021 Review
1	East Whitaker Pond	Sharp-crested	0.610	1.829	Q = 1.11H^(3/2)	needs review
2	Outlet to Prison Pond at NE 112th	Broad-crested	3.048	2.65	Q = 5.20H^(3/2)	needs review
3	MCDD #1 gravity gates	Sharp-crested	12.200	Adjustable	Q = 23.4H^(3/2)	needs review
4	Outlet of Bybee Lake into North Slough	Sharp-crested	3.050	2.2	Q = 5.58H^(3/2)	Removed
5	Outlet of Fairview Lake into Upper Slough	Sharp-crested or Broad-crested	6.096	3.414 with weir plates, 1.829 without	Q = 11.16H^(3/2) with weir plates, Q = 27.00H^(3/2) without	needs review