Draft Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document

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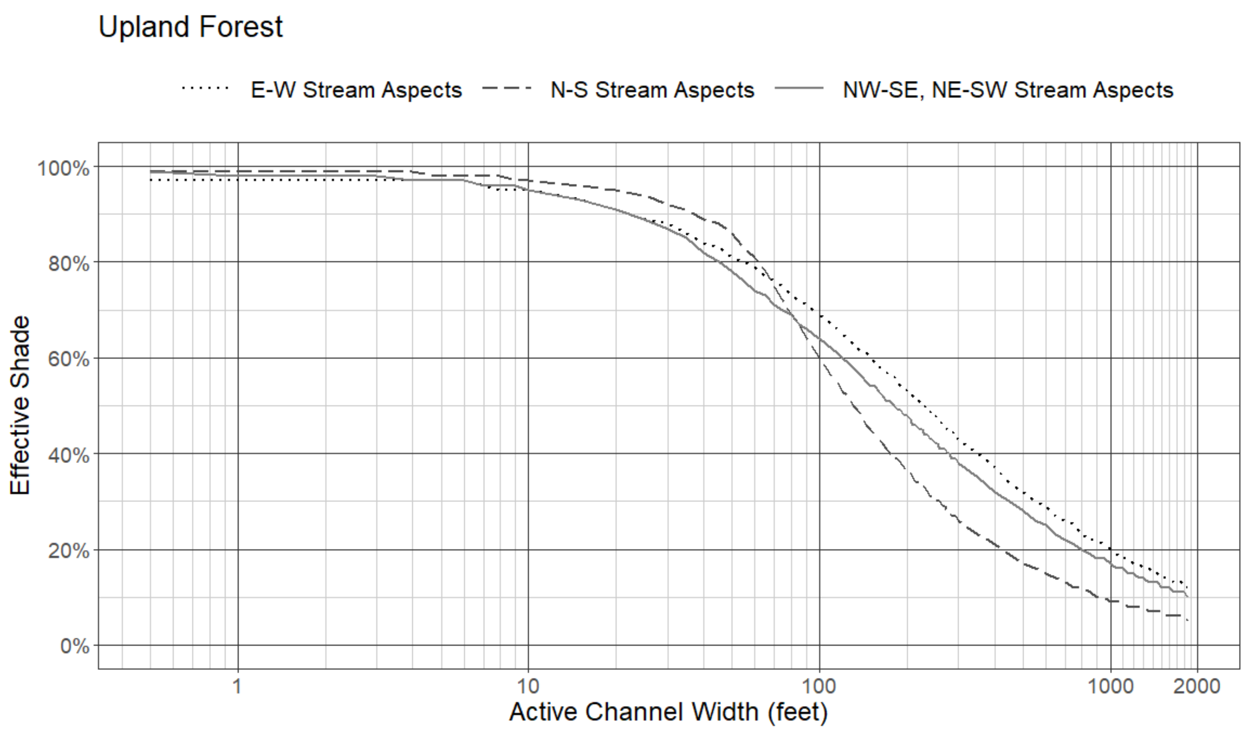

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1 Introduction

1.1 Document purpose and organization

This document provides comprehensive supporting information on technical analyses completed for the Total Maximum Daily Load and Water Quality Management Plan for addressing temperature impairments in the waters of the Willamette River Subbasins. This document provides explanations of TMDL concepts and analysis and support for conclusions and requirements included in the Willamette River Subbasins TMDL and WQMP, which are proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule [add OAR 340-042-0090(xx) post adoption].

This document is organized into sections with titles reflective of the TMDL elements required by OAR 340-042-0040(4) in the Willamette River Subbasins TMDL for temperature. This organization is intended to assist readers in readily accessing the information relied on for TMDL element-specific determinations.

1.2 Overview of TMDL elements

According to OAR 340-042-0030 Definitions (15): Total Maximum Daily Load means a written quantitative plan and analysis for attaining and maintaining water quality standards and includes the elements described in OAR 340-042-0040. Determinations on each element are presented in the Willamette River Subbasins TMDL for temperature. Technical and policy information supporting those determinations are presented in this report at the section headings that correspond to the TMDL elements for which complex analysis was undertaken.

In plain language, a TMDL is a water quality budget plan to ensure that the receiving water body can attain water quality standards that protect beneficial uses of the water. This budget calculates and assigns pollutant loads for discharges of point (end of pipe) and nonpoint (landscape) sources, in consideration of natural background levels, along with determination of a margin of safety and reserve capacity.

A margin of safety (MOS) takes into account the uncertainty in predicting how well pollutant reductions will result in meeting water quality standards and can be expressed either explicitly, as a portion of the allocations, or implicitly, by incorporating conservative assumptions into the analyses.

Reserve capacity (RC) sets aside some portion of the loading capacity for pollutant discharges that may result from future growth and new or expanded sources.

A key element of analysis is the amount of pollutant that a waterbody can receive and still meet the applicable water quality standard, and is referred to as the "loading capacity" (LC) of a waterbody. Because the loading capacity must not be exceeded by pollutant loads from all existing sources, plus the margin of safety and reserve capacity, it can be considered the maximum load. Hence, the loading capacity is often referred to as the TMDL. A loading capacity, or TMDL, is calculated on each assessment unit for each applicable temperature criteria in the TMDL project area. An assessment unit is a partition (segment) of the state's waterbodies (streams, river, lakes, estuaries, etc.) into manageable units. The Integrated Report makes assessment conclusions for each assessment unit.

Another key element of analysis is allocating portions of the loading capacity or TMDL to known sources. Allocations are quantified measures that assure water quality standards will be met and may distribute the pollutant loads between nonpoint and point sources. “Load allocations” are portions of the loading capacity that are attributed to: 1) nonpoint sources such as urban, agriculture, rural residential or forestry activities; and 2) natural background sources such as soils or wildlife. “Wasteload allocations” are portions of the total load that are allotted to point sources of pollution, such as permitted discharges from sewage treatment plants, industrial wastewater or stormwater. As noted above, allocations can also be reserved for future uses, termed “reserve capacity.”

This general TMDL concept is represented by the following equation:

TMDL = ∑Wasteload Allocations + ∑Load Allocations + Reserve Capacity + Margin of Safety

Together, these elements establish the pollutant loads necessary to meet the applicable water quality standards for impaired pollutants and protect beneficial uses.

2 TMDL location and scope

DEQ developed this TMDL to address all Category 5 listed assessment units impaired for temperature (identified in section 2.1) and to serve as a protection plan for all other assessment categories, including unimpaired and unassessed. The loading capacity and allocations, including surrogate measures, and implementation framework apply to all waters of the state as defined under ORS 468B.005(10), including all perennial and intermittent streams located in the Middle Fork Willamette Subbasin (HUC 17090001), Coast Fork Willamette Subbasin (HUC 17090002), Upper Willamette Subbasin (HUC 17090003), McKenzie Subbasin (HUC 17090004), North Santiam Subbasin (HUC 17090005), South Santiam Subbasin (HUC 17090006), Middle Willamette Subbasin (HUC 17090007), Molalla-Pudding Subbasin (HUC 17090009), Clackamas Subbasin (HUC 17090011), and Lower Willamette Subbasin (HUC 17090012). Waters excluded from the Willamette Subbasins TMDLs (Table 2-2) include the Willamette River, Multnomah Channel, and tributaries to the Willamette River downstream of the following dams: River Mill Dam, Detroit Dam, Foster Dam, Fern Ridge Dam, Dexter Dam, Fall Creek Dam, and Cottage Grove Dam. The temperature TMDLs also do not include the section of the Columbia River that flows through the Lower Willamette Subbasin (HUC 17090012).

The map in Figure 2-1 provides an overview of where the temperature TMDLs are applicable. Appendix D of the Willamette Subbasin Technical Support Document provides a list of all assessment units addressed by the TMDL.

The Willamette Subbasins are comprised of ten 8-digit hydrologic unit codes (HUC) (Table 2-1).

Table 2-1: The Willamette Subbasins.

HUC	Subbasin Name
17090001	Middle Fork Willamette

HUC	Subbasin Name
17090002	Coast Fork Willamette
17090003	Upper Willamette
17090004	McKenzie
17090005	North Santiam
17090006	South Santiam
17090007	Middle Willamette
17090009	Molalla-Pudding
17090011	Clackamas
17090012	Lower Willamette

Table 2-2: Waters not included in the Willamette Subbasins temperature TMDLs.

Waterbody	Extent
Willamette River	From the confluence of the Columbia River upstream to the confluence of Coast Fork of the Willamette and Middle Fork of the Willamette River.
Multnomah Channel	From the confluence of the Columbia River upstream to the Willamette River.
Clackamas River	From the confluence with the Willamette River upstream to River Mill Dam.
Santiam River	From the confluence with the Willamette River upstream to the confluence of the North and South Santiam Rivers.
North Santiam River	From the confluence with the Santiam River upstream to Detroit Dam.
South Santiam River	From the confluence with the Santiam River upstream to Foster Dam.
Long Tom River	From the confluence with the Willamette River upstream to Fern Ridge Dam.
Middle Fork Willamette River	From the confluence with the Willamette River upstream to Dexter Dam.
Fall Creek	From the confluence with the Middle Fork Willamette River upstream to Fall Creek Dam.
Coast Fork Willamette River	From the confluence with the Willamette River upstream to Cottage Grove Dam.
Row River	From the confluence with the Coast Fork Willamette River upstream to Dorena Dam.

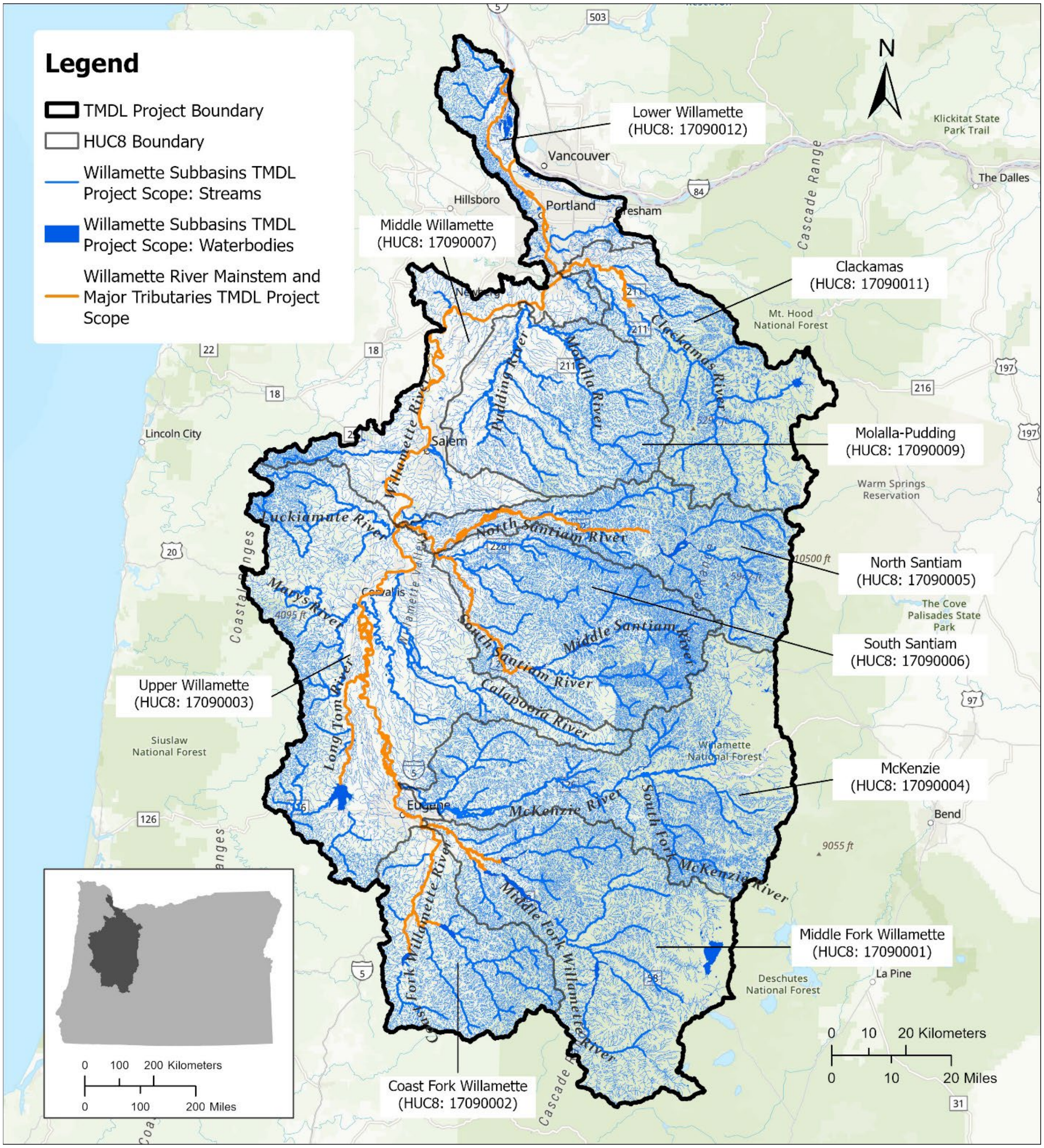


Figure 2-1: Willamette Subbasins temperature TMDLs project area overview.

2.1 Impaired waters

Table 2-3 through Table 2-12 present stream assessment units within the Willamette Subbasins that were listed as impaired for temperature on DEQ's 2022 Clean Water Act Section 303(d) List (as part of Oregon's Integrated Report), which was approved by the EPA on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean

Water Act. Assessment units listed in Category 5 (designated use is not supported or a water quality standard is not attained) require development of a TMDL. Locations of these listed segments are depicted in Figure 2-2.

Table 2-3: Middle Fork Willamette Subbasin (17090001) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000106_02_103722	Christy Creek	Spawning
OR_SR_1709000109_02_103736	Fall Creek	Year Round
OR_SR_1709000109_02_103736	Fall Creek	Spawning
OR_SR_1709000109_02_103737	Fall Creek	Year Round
OR_SR_1709000109_02_103737	Fall Creek	Spawning
OR_SR_1709000109_02_103743	Fall Creek	Year Round
OR_SR_1709000109_02_103743	Fall Creek	Spawning
OR_LK_1709000109_02_100701	Fall Creek Lake	Year Round
OR_SR_1709000109_02_103734	Hehe Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Spawning
OR_SR_1709000110_02_103749	Hills Creek	Year Round
OR_WS_170900010904_02_104219	HUC12 Name: Andy Creek-Fall Creek	Year Round
OR_WS_170900010502_02_104200	HUC12 Name: Buck Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010501_02_104199	HUC12 Name: Coal Creek	Year Round
OR_WS_170900010608_02_104210	HUC12 Name: Dartmouth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010701_02_104211	HUC12 Name: Deception Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010901_02_104216	HUC12 Name: Delp Creek-Fall Creek	Year Round
OR_WS_170900010703_02_104213	HUC12 Name: Dexter Reservoir-Middle Fork Willamette River	Year Round
OR_WS_170900010106_02_104190	HUC12 Name: Echo Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010607_02_104209	HUC12 Name: Eighth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010505_02_104202	HUC12 Name: Gray Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010702_02_104212	HUC12 Name: Lost Creek	Year Round
OR_WS_170900010202_02_104192	HUC12 Name: Lower Hills Creek	Year Round
OR_WS_170900010403_02_104198	HUC12 Name: Lower Salmon Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Spawning
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Year Round
OR_WS_170900010302_02_104194	HUC12 Name: Middle Salt Creek	Year Round
OR_WS_170900010503_02_104201	HUC12 Name: Packard Creek-Middle Fork Willamette	Year Round
OR_WS_170900010105_02_104189	HUC12 Name: Staley Creek	Year Round
OR_WS_170900010102_02_104186	HUC12 Name: Tumblebug Creek	Year Round
OR_WS_170900010402_02_104197	HUC12 Name: Upper Salmon Creek	Year Round
OR_WS_170900010905_02_104220	HUC12 Name: Winberry Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Spawning
OR_SR_1709000109_02_103742	Logan Creek	Year Round
OR_SR_1709000107_02_103727	Lost Creek	Year Round
OR_SR_1709000107_02_103727	Lost Creek	Spawning
OR_SR_1709000107_02_103728	Lost Creek	Year Round
OR_SR_1709000107_02_103728	Lost Creek	Spawning
OR_SR_1709000101_02_103713	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104579	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Year Round

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Spawning
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103723	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000109_02_103738	North Fork Winberry Creek	Year Round
OR_LK_1709000105_02_100684	Packard Creek	Year Round
OR_SR_1709000105_02_104578	Packard Creek	Year Round
OR_SR_1709000109_02_103741	Portland Creek	Year Round
OR_SR_1709000109_02_103744	Portland Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Spawning
OR_SR_1709000103_02_103716	Salt Creek	Year Round
OR_SR_1709000103_02_103716	Salt Creek	Spawning
OR_SR_1709000109_02_103745	South Fork Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Spawning

Table 2-4: Coast Fork Willamette Subbasin (17090002) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000202_02_103771	Brice Creek	Year Round
OR_SR_1709000203_02_104586	Coast Fork Willamette River	Year Round
OR_LK_1709000202_02_100705	Dorena Lake	Year Round
OR_WS_170900020401_02_104238	HUC12 Name: Hill Creek-Coast Fork Willamette River	Year Round
OR_WS_170900020204_02_104230	HUC12 Name: King Creek-Row River	Year Round
OR_WS_170900020203_02_104229	HUC12 Name: Sharps Creek	Year Round
OR_SR_1709000202_02_103765	Layng Creek	Year Round
OR_SR_1709000202_02_103756	Martin Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Spawning
OR_SR_1709000202_02_103761	Row River	Year Round
OR_SR_1709000202_02_103766	Row River	Year Round
OR_SR_1709000202_02_103755	Sharps Creek	Year Round
OR_SR_1709000202_02_103775	Sharps Creek	Year Round
OR_SR_1709000202_02_103776	Sharps Creek	Year Round

Table 2-5: Upper Willamette Subbasin (17090003) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000303_02_103815	Calapooia River	Year Round
OR_SR_1709000303_02_103815	Calapooia River	Spawning
OR_SR_1709000303_02_103816	Calapooia River	Year Round
OR_SR_1709000303_02_103816	Calapooia River	Spawning
OR_SR_1709000304_02_103821	Calapooia River	Year Round
OR_SR_1709000303_02_103819	Courtney Creek	Year Round
OR_SR_1709000301_02_103796	Coyote Creek	Year Round
OR_SR_1709000301_02_103790	Ferguson Creek	Year Round
OR_WS_170900030109_02_104251	HUC12 Name: Bear Creek-Long Tom River	Year Round
OR_WS_170900030510_02_104284	HUC12 Name: Berry Creek	Year Round
OR_WS_170900030302_02_104265	HUC12 Name: Bigs Creek-Calapooia River	Year Round
OR_WS_170900030603_02_104290	HUC12 Name: Flat Creek	Year Round
OR_WS_170900030204_02_104256	HUC12 Name: Greasy Creek	Year Round

Assessment Unit ID	Assessment Unit Name	Use Period
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Spawning
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Year Round
OR_WS_170900030505_02_104279	HUC12 Name: Jont Creek-Luckiamute River	Year Round
OR_WS_170900030402_02_104273	HUC12 Name: Lower Oak Creek	Year Round
OR_WS_170900030503_02_104277	HUC12 Name: Maxfield Creek-Luckiamute River	Year Round
OR_WS_170900030504_02_104278	HUC12 Name: Pedee Creek-Luckiamute River	Year Round
OR_SR_1709000305_02_103822	Little Luckiamute River	Year Round
OR_SR_1709000305_02_103829	Luckiamute River	Year Round
OR_SR_1709000302_02_103804	Marys River	Year Round
OR_SR_1709000302_02_103812	Marys River	Year Round
OR_SR_1709000302_02_103813	Marys River	Year Round
OR_SR_1709000305_02_103825	Miller Creek	Year Round
OR_SR_1709000302_02_103806	Muddy Creek	Year Round
OR_SR_1709000306_02_103838	Muddy Creek	Year Round
OR_SR_1709000305_02_103828	North Fork Pedee Creek	Year Round
OR_SR_1709000305_02_103833	Ritner Creek	Year Round
OR_SR_1709000305_02_103832	Soap Creek	Year Round
OR_SR_1709000305_02_103824	Teal Creek	Year Round

Table 2-6: McKenzie Subbasin (17090004) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000403_02_103865	Augusta Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Spawning
OR_SR_1709000406_02_103875	Cartwright Creek	Year Round
OR_SR_1709000406_02_103875	Cartwright Creek	Spawning
OR_SR_1709000407_02_103891	Cedar Creek	Year Round
OR_SR_1709000407_02_103891	Cedar Creek	Spawning
OR_SR_1709000407_02_103882	Deer Creek	Year Round
OR_SR_1709000407_02_103882	Deer Creek	Spawning
OR_SR_1709000403_02_103862	French Pete Creek	Year Round
OR_SR_1709000401_02_103855	Horse Creek	Year Round
OR_SR_1709000401_02_103856	Horse Creek	Year Round
OR_WS_170900040206_02_104310	HUC12 Name: Boulder Creek-McKenzie River	Year Round
OR_WS_170900040705_02_104336	HUC12 Name: Camp Creek	Year Round
OR_WS_170900040205_02_104309	HUC12 Name: Deer Creek	Year Round
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Spawning
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Year Round
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Spawning
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Year Round
OR_WS_170900040209_02_104313	HUC12 Name: Florence Creek-McKenzie River	Year Round
OR_WS_170900040202_02_104306	HUC12 Name: Hackleman Creek-McKenzie River	Year Round
OR_WS_170900040601_02_104327	HUC12 Name: Headwaters Mohawk River	Year Round
OR_WS_170900040204_02_104308	HUC12 Name: Kink Creek-McKenzie River	Year Round
OR_WS_170900040403_02_104324	HUC12 Name: Lower Blue River	Year Round
OR_WS_170900040105_02_104304	HUC12 Name: Lower Horse Creek	Year Round
OR_WS_170900040104_02_104303	HUC12 Name: Middle Horse Creek	Year Round
OR_WS_170900040304_02_104317	HUC12 Name: Rebel Creek-South Fork McKenzie River	Year Round
OR_WS_170900040602_02_104328	HUC12 Name: Shotgun Creek-Mohawk River	Year Round
OR_WS_170900040203_02_104307	HUC12 Name: Smith River	Year Round
OR_WS_170900040402_02_104323	HUC12 Name: Upper Blue River	Year Round
OR_SR_1709000404_02_104571	Lookout Creek	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Spawning

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000406_02_103879	McGowan Creek	Year Round
OR_SR_1709000406_02_103879	McGowan Creek	Spawning
OR_SR_1709000405_02_103866	McKenzie River	Year Round
OR_SR_1709000405_02_103866	McKenzie River	Spawning
OR_SR_1709000407_02_103884	McKenzie River	Year Round
OR_SR_1709000407_02_103884	McKenzie River	Spawning
OR_SR_1709000406_02_103873	Mill Creek	Year Round
OR_SR_1709000406_02_103874	Mill Creek	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Spawning
OR_SR_1709000406_02_103871	Mohawk River	Year Round
OR_SR_1709000406_02_103871	Mohawk River	Spawning
OR_SR_1709000406_02_103877	Mohawk River	Year Round
OR_SR_1709000406_02_103877	Mohawk River	Spawning
OR_SR_1709000405_02_103867	Quartz Creek	Year Round
OR_SR_1709000404_02_104576	Quentin Creek	Year Round
OR_SR_1709000406_02_103872	Shotgun Creek	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Spawning
OR_SR_1709000404_02_104574	Upper Blue River	Year Round
OR_SR_1709000404_02_104577	Upper Blue River	Year Round

Table 2-7: North Santiam Subbasin (17090005) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000506_02_103928	Bear Branch	Year Round
OR_SR_1709000503_02_103907	Blowout Creek	Year Round
OR_SR_1709000503_02_103909	Blowout Creek	Year Round
OR_SR_1709000502_02_103902	Boulder Creek	Year Round
OR_SR_1709000506_02_103926	Chehulpum Creek	Year Round
OR_SR_1709000505_02_103923	Elkhorn Creek	Year Round
OR_WS_170900050602_02_104360	HUC12 Name: Bear Branch-North Santiam River	Year Round
OR_WS_170900050203_02_104345	HUC12 Name: Marion Creek	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Spawning
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Year Round
OR_WS_170900050504_02_104563	HUC12 Name: Middle Little North Santiam River	Year Round
OR_WS_170900050301_02_104351	HUC12 Name: Upper Blowout Creek	Year Round
OR_WS_170900050503_02_104567	HUC12 Name: Upper Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Spawning
OR_SR_1709000506_02_103929	Stout Creek	Year Round

Table 2-8: South Santiam Subbasin (17090006) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000606_02_103973	Beaver Creek	Year Round
OR_SR_1709000607_02_103986	Bilyeu Creek	Year Round
OR_SR_1709000607_02_103989	Bilyeu Creek	Year Round
OR_SR_1709000602_02_103949	Canyon Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Spawning
OR_LK_1709000604_02_100772	Foster Lake	Year Round
OR_LK_1709000603_02_100771	Green Peter Lake	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Year Round

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000608_02_103993	Hamilton Creek	Spawning
OR_SR_1709000608_02_103996	Hamilton Creek	Year Round
OR_SR_1709000608_02_103996	Hamilton Creek	Spawning
OR_WS_170900060804_02_104398	HUC12 Name: Hamilton Creek	Year Round
OR_WS_170900060501_02_104384	HUC12 Name: Little Wiley Creek	Year Round
OR_WS_170900060705_02_104394	HUC12 Name: Lower Thomas Creek	Year Round
OR_SR_1709000602_02_103955	Latiwi Creek	Year Round
OR_SR_1709000608_02_103994	McDowell Creek	Year Round
OR_SR_1709000601_02_103934	Middle Santiam River	Year Round
OR_SR_1709000601_02_103936	Middle Santiam River	Year Round
OR_SR_1709000601_02_103938	Middle Santiam River	Year Round
OR_SR_1709000603_02_103965	Middle Santiam River	Year Round
OR_SR_1709000604_02_103969	Middle Santiam River	Spawning
OR_SR_1709000602_02_103954	Moose Creek	Year Round
OR_SR_1709000602_02_103954	Moose Creek	Spawning
OR_SR_1709000602_02_103941	Owl Creek	Year Round
OR_SR_1709000601_02_103935	Pyramid Creek	Year Round
OR_SR_1709000603_02_103957	Quartzville Creek	Year Round
OR_SR_1709000603_02_103960	Quartzville Creek	Year Round
OR_SR_1709000608_02_103997	Scott Creek	Year Round
OR_SR_1709000602_02_103953	Sheep Creek	Year Round
OR_SR_1709000602_02_103947	Soda Fork	Year Round
OR_SR_1709000607_02_103985	South Fork Neal Creek	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Spawning
OR_SR_1709000604_02_103968	South Santiam River	Year Round
OR_SR_1709000604_02_103968	South Santiam River	Spawning
OR_SR_1709000607_02_103988	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Spawning
OR_SR_1709000602_02_103942	Trout Creek	Year Round
OR_SR_1709000602_02_103948	Two Girls Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Spawning
OR_SR_1709000605_02_103972	Wiley Creek	Year Round
OR_SR_1709000605_02_103972	Wiley Creek	Spawning

Table 2-9: Middle Willamette Subbasin (17090007) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000704_02_104017	Abernethy Creek	Year Round
OR_SR_1709000704_02_104594	Abernethy Creek	Year Round
OR_WS_170900070306_02_104417	HUC12 Name: Chehalem Creek	Year Round
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Spawning
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Year Round
OR_WS_170900070303_02_104415	HUC12 Name: Glenn Creek-Willamette River	Year Round
OR_WS_170900070304_02_104599	HUC12 Name: Lambert Slough-Willamette River	Year Round
OR_WS_170900070204_02_104412	HUC12 Name: Lower Mill Creek	Year Round
OR_WS_170900070203_02_104411	HUC12 Name: McKinney Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Spawning
OR_SR_1709000703_02_104012	Pringle Creek	Year Round
OR_SR_1709000701_02_104591	Rickreall Creek	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Spawning

Table 2-10: Molalla-Pudding Subbasin (17090009) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709000901_02_104062	Abiqua Creek	Year Round
OR_SR_1709000902_02_104070	Butte Creek	Year Round
OR_SR_1709000902_02_104072	Butte Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Spawning
OR_WS_170900090303_02_104470	HUC12 Name: Bear Creek	Year Round
OR_WS_170900090204_02_104467	HUC12 Name: Brandy Creek-Pudding River	Year Round
OR_WS_170900090101_02_104454	HUC12 Name: Headwaters Pudding River	Year Round
OR_WS_170900090202_02_104465	HUC12 Name: Middle Butte Creek	Year Round
OR_WS_170900090403_02_104474	HUC12 Name: Pine Creek-Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Spawning
OR_SR_1709000901_02_104067	Pudding River	Year Round
OR_SR_1709000905_02_104088	Pudding River	Year Round
OR_SR_1709000901_02_104595	Silver Creek	Year Round
OR_SR_1709000901_02_104066	South Fork Silver Creek	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Spawning
OR_LK_1709000902_02_100830	Zollner Creek	Year Round

Table 2-11: Clackamas Subbasin (17090011) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_SR_1709001104_02_104154	Clackamas River	Year Round
OR_SR_1709001104_02_104154	Clackamas River	Spawning
OR_SR_1709001104_02_104155	Clackamas River	Year Round
OR_SR_1709001104_02_104155	Clackamas River	Spawning
OR_SR_1709001101_02_104142	Collawash River	Year Round
OR_SR_1709001101_02_104142	Collawash River	Spawning
OR_SR_1709001101_02_104144	Collawash River	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Spawning
OR_SR_1709001104_02_104156	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Spawning
OR_WS_170900110406_02_104539	HUC12 Name: Helion Creek-Clackamas River	Year Round
OR_WS_170900110405_02_104538	HUC12 Name: North Fork Clackamas River	Year Round
OR_WS_170900110402_02_104535	HUC12 Name: Roaring River	Year Round
OR_WS_170900110607_02_104549	HUC12 Name: Rock Creek-Clackamas River	Year Round
OR_WS_170900110501_02_104540	HUC12 Name: Upper Eagle Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Spawning
OR_SR_1709001104_02_104152	North Fork Clackamas River	Year Round
OR_SR_1709001105_02_104165	North Fork Eagle Creek	Year Round
OR_SR_1709001104_02_104160	Roaring River	Spawning
OR_SR_1709001104_02_104157	Trout Creek	Year Round

Table 2-12: Lower Willamette Subbasin (17090012) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit ID	Assessment Unit Name	Use Period
OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Year Round

Assessment Unit ID	Assessment Unit Name	Use Period
OR_WS_170900120201_02_104554.1	HUC12 Name: Columbia Slough (Lower)	Year Round
OR_WS_170900120201_02_104554.2	HUC12 Name: Columbia Slough (Upper)	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Spawning
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Year Round
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Spawning
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Year Round
OR_WS_170900120301_02_104557	HUC12 Name: South Scappoose Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Year Round
OR_SR_1709001201_02_104170	Johnson Creek	Year Round
OR_SR_1709001201_02_104170	Johnson Creek	Spawning
OR_SR_1709001203_02_104176	Milton Creek	Year Round
OR_SR_1709001203_02_104176	Milton Creek	Spawning
OR_SR_1709001203_02_104179	North Scappoose Creek	Year Round
OR_SR_1709001203_02_104179	North Scappoose Creek	Spawning
OR_SR_1709001203_02_104180	South Scappoose Creek	Year Round
OR_SR_1709001203_02_104180	South Scappoose Creek	Spawning

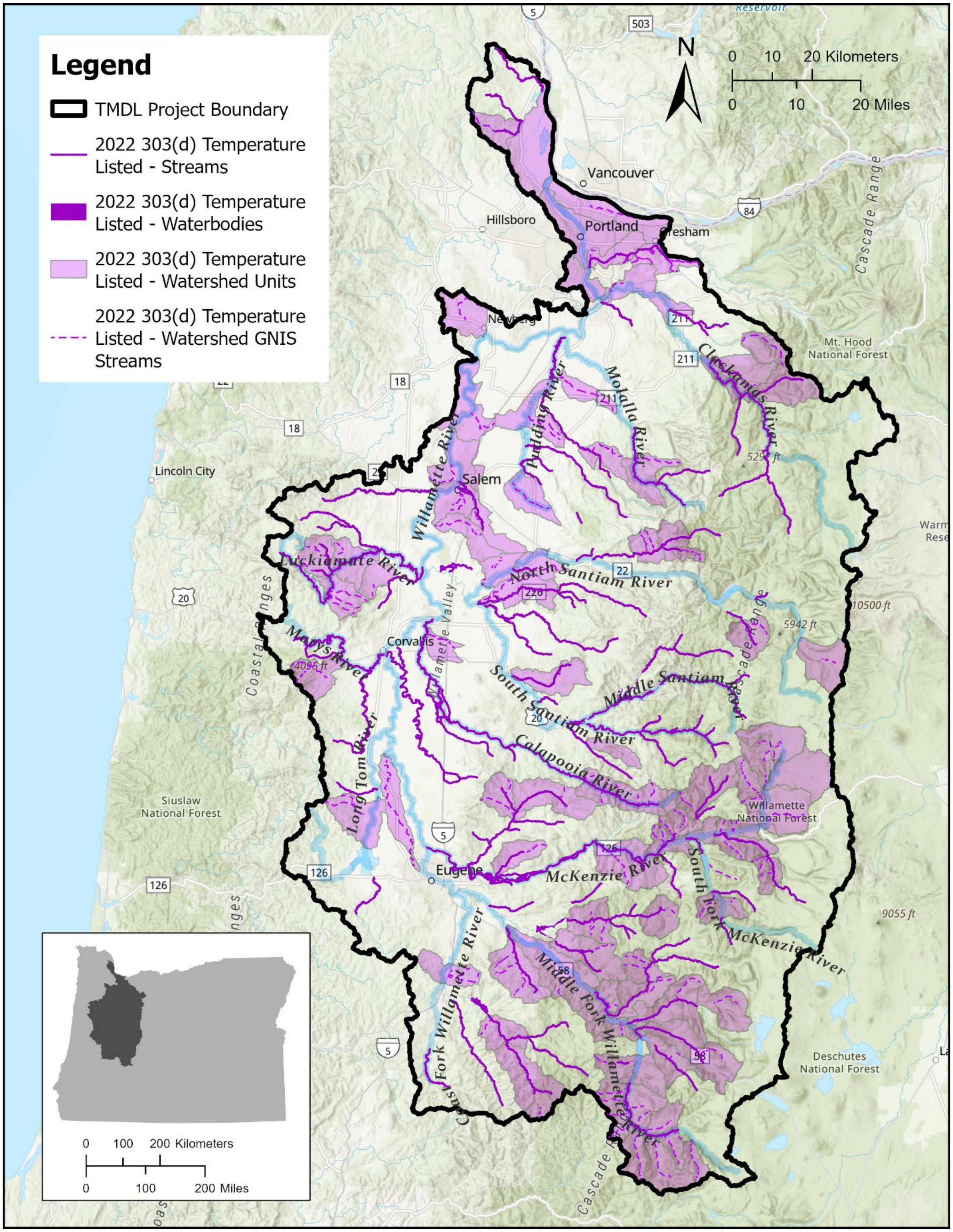


Figure 2-2: Willamette Subbasins category 5 temperature impairments on the 2022 Integrated Report.

2.2 Climate

The Willamette Basin has a temperate maritime climate with mild, wet winters and warm, dry summers. According to PRISM normals of annual conditions over the past 30 years (1991-2020), the average annual precipitation in the Willamette Basin ranges from around 985 mm (38") in the lower elevations of the Willamette Valley to over 4,160 mm (160") in the higher elevations of the Cascade Range (PRISM Climate Group, 2022) (Figure 2-3). The highest precipitation levels are typically seen during the winter months, with November to January being the wettest months. In contrast, the summer months are generally drier, with July and August being the driest months of the year.

In terms of temperature, the PRISM normals show that the average annual temperature in the Willamette Basin is around 15.3°C (59.6°F). However, temperatures can vary greatly depending on elevation and the time of year. The average annual maximum temperatures in the Willamette Basin range from 2.7°C (37°F) in the Willamette Valley to about 18°C (64°F) at the Cascade Range (Figure 2-4). The summer months are typically warm, with average temperatures of 26°C (78.8°F) in July and August. On the other hand, the winter months are cooler, with average temperatures of 6°C (42.8°F) in December and January.

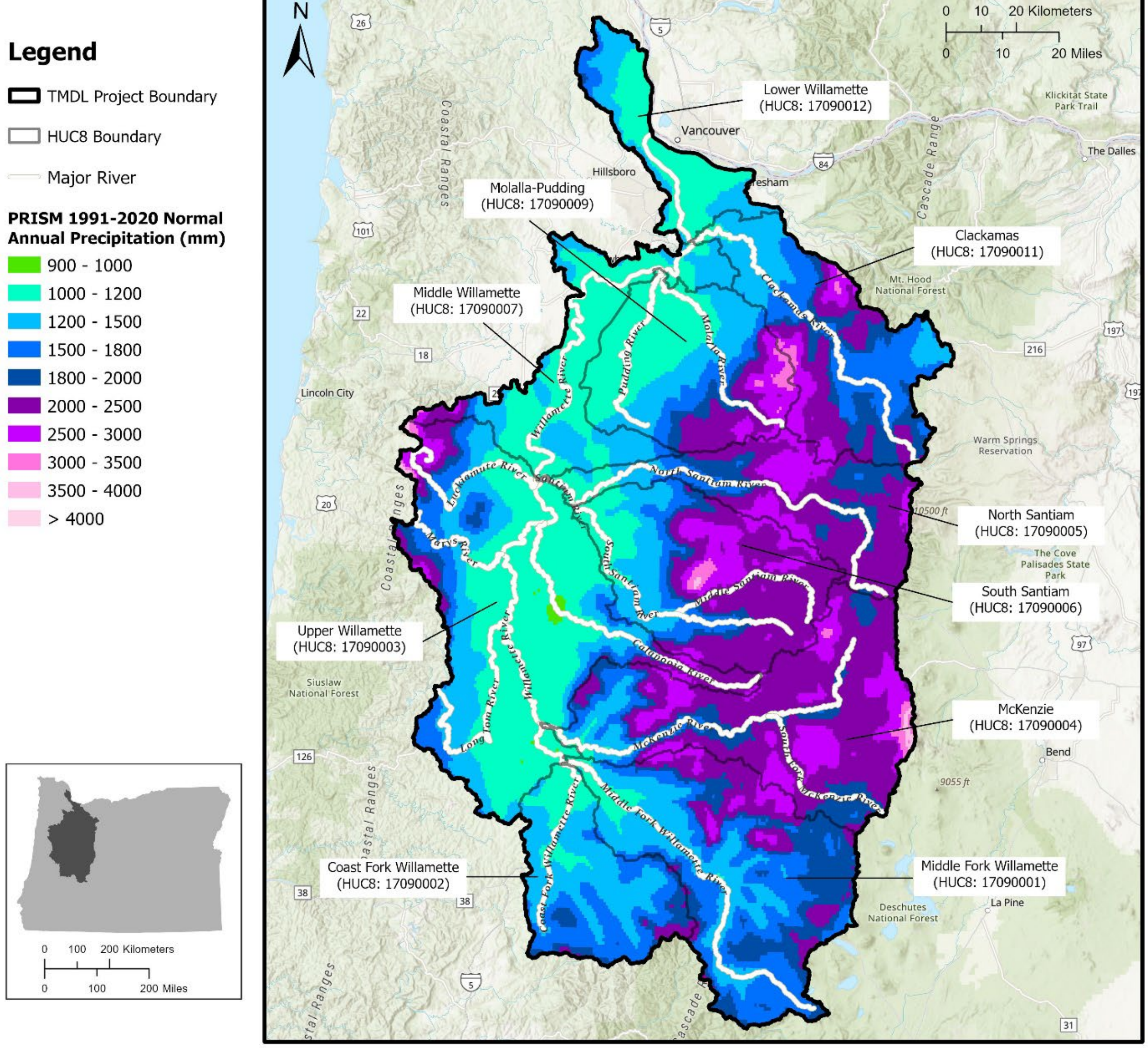


Figure 2-3: PRISM 1991-2020 Normal Annual Precipitation in the Willamette Subbasins temperature TMDL project area (Data Source: PRISM Climate Group, 2022).

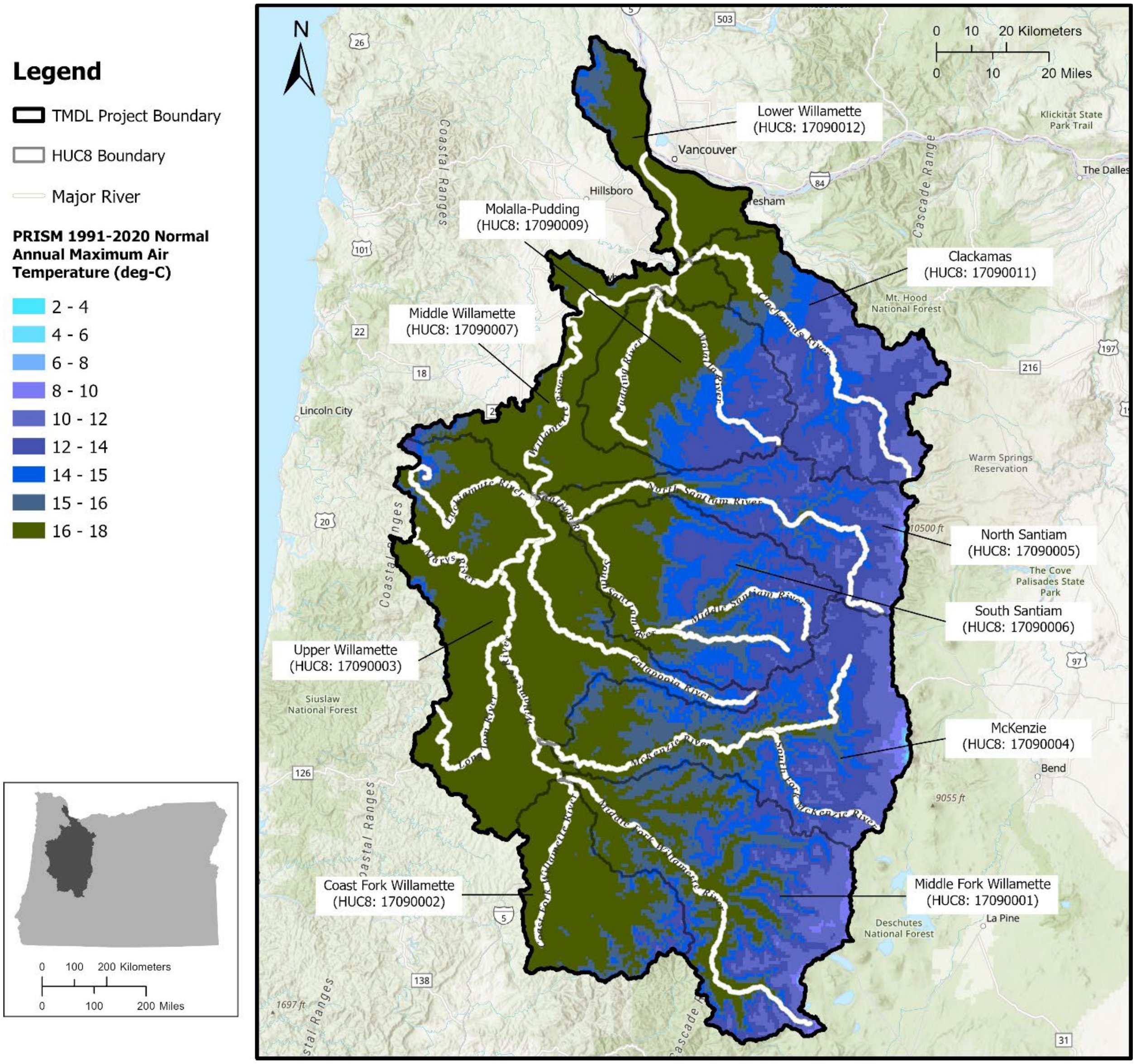


Figure 2-4: PRISM 1991-2020 Normal Annual Maximum Air Temperature in the Willamette Subbasins temperature TMDL project area (Data Source: PRISM Climate Group, 2022).

2.3 Hydrology

The Willamette Basin drains approximately 29,785 km^2 (11,500 mi^2) in northwestern Oregon between the Cascade and Coast Ranges. The Willamette River is formed by the confluence of two major tributaries, the Coast Fork Willamette River and the Middle Fork Willamette River. The Coast Fork originates in the foothills of the Cascade Mountains, while the Middle Fork originates in the high Cascades. These two rivers merge near the city of Eugene to form the Willamette River, which then travels about 187 miles before flowing into the Columbia River at River Mile 101, at Portland.

The Willamette Basin includes numerous major tributaries, including the Coast Fork Willamette River, the Middle Fork Willamette River, the McKenzie River, the Long Tom River, the Calapooia River, the Santiam River, and the Clackamas River. The Willamette River mainstem and lower reaches of major tributaries downstream from dams are not included in this TMDL; instead, they are covered by the Willamette River Mainstem and Major Tributaries TMDL.

The Willamette Basin also has many smaller tributaries. These include, but are not limited to, the Pudding River, Molalla River, Little North Santiam River, Luckiamute River, Marys River, Long Tom River upstream of Fern Ridge, and Mohawk River, which are covered in this TMDL.

Dams and reservoirs have a significant influence on the hydrology of the Willamette Basin. The U.S. Army Corps of Engineers (USACE) constructed a series of 11 dams with reservoirs and 2 re-regulating dams on major tributaries in the basin between 1941 and 1969, known as the Willamette Valley Project (Table 2-13). USACE operates the Willamette Valley Project based on the purposes authorized by Congress with the Flood Control Act of 1938. Flood control is the highest priority of the Willamette Project, but other purposes include flow augmentation for navigation, irrigation, hydroelectric power production, fisheries, recreation, and water quality. The project provides the capacity of seasonal storage of nearly 1.6 million acre-feet of water and a production capacity of 2,100 megawatts (MW) of electric power (USACE, 2019).

In addition to these large federal dams, there are Portland General Electric’s (PGE) dams and reservoirs on the Clackamas River, Eugene Water and Electric Board (EWEB) operated projects in the McKenzie Subbasin, and over 350 smaller dams and reservoirs throughout the basin that are operated by local irrigation districts, municipalities, and private companies.

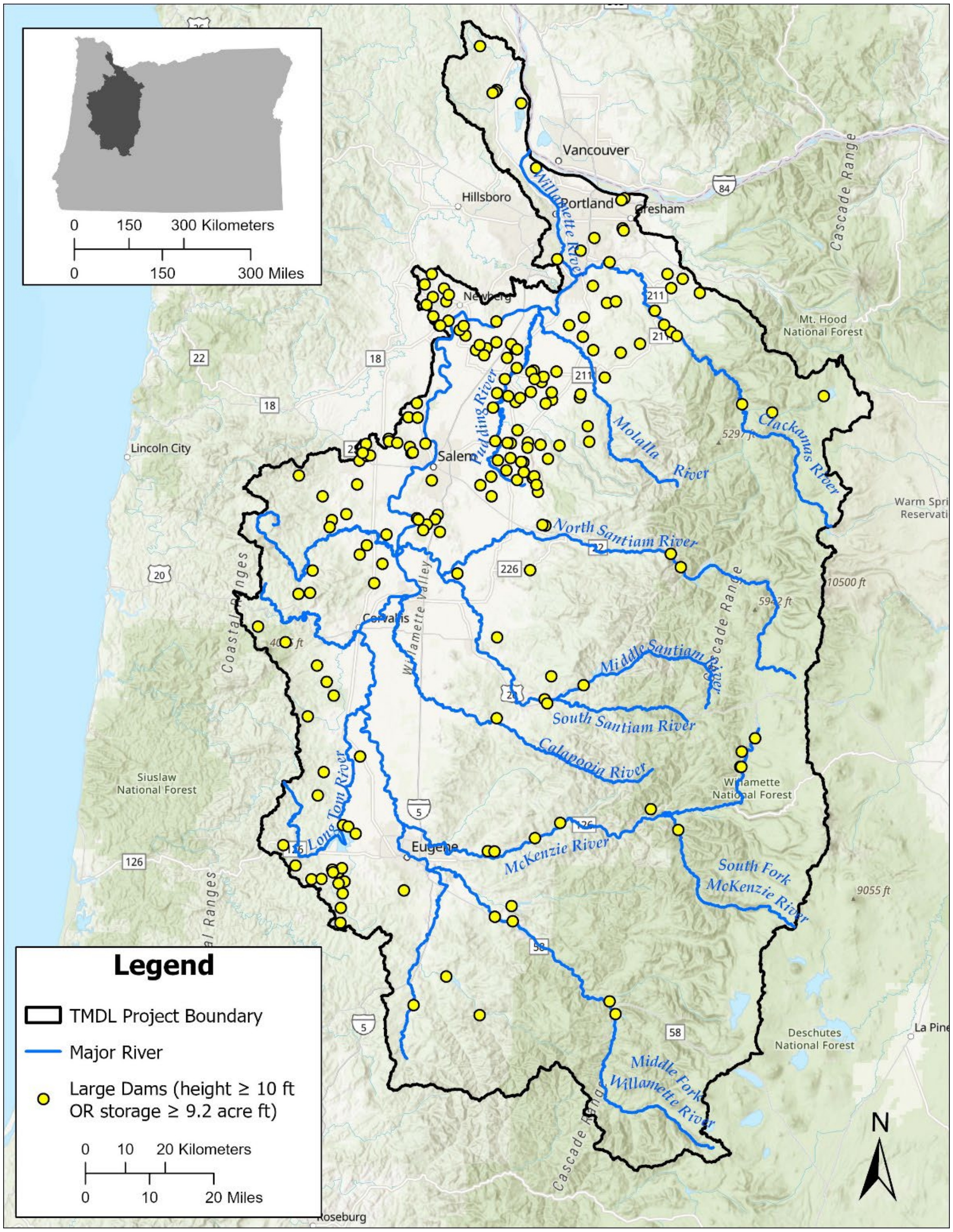


Figure 2-5: Large dams located within the Willamette Subbasins temperature TMDL project area.

Table 2-13: Summary of USACE dams and reservoirs in the Willamette Basin.

Dam & Reservoir	Tributary Location	Year Complete	Total Storage in acre-feet	Summary Storage	# of Rec Areas	Power Generators	Drawdown Priority
Blue River	Blue River	1969	89,500	78,800	3	None	3rd
Cottage Grove	Coast Fork Willamette River	1942	32,900	28,700	5	None	5th

Dam & Reservoir	Tributary Location	Year Complete	Total Storage in acre-feet	Summary Storage	# of Rec Areas	Power Generators	Drawdown Priority
Fern Ridge	Long Tom River	1941	116,800	93,900	5	None	Last
Dexter	MF Willamette River	1954	NA, Reregulating	NA	2	1	NA
Lookout Point	MF Willamette River	1954	455,800	324,200	6	3	1st
Hills Creek	MF Willamette River	1961	355,500	194,000	5	2	4th
Fall Creek	MF Willamette River	1966	125,000	108,200	5	None	5th
Green Peter	Middle Santiam River	1968	428,100	249,900	3	2	5th
Big Cliff	North Santiam River	1953	NA, Reregulating	NA	None	1	NA
Detroit	North Santiam River	1953	455,100	281,000	7	2	Last
Dorena	Row River	1949	77,600	65,000	5	None	5th
Cougar	SF McKenzie River	1963	219,000	143,900	6	2	2nd
Foster	South Santiam River	1968	60,700	24,800	6	2	Last

Figure 2-5 shows the locations of large dams within the Willamette Subbasins temperature TMDL project area. This subset of dams was downloaded from two sources: the National Inventory of Dams website (a repository maintained by USACE), and the Oregon Water Resources Department website (a repository listing only dams regulated by the State of Oregon). The 202 dams shown in the figure either meet or exceed ten feet in height or have storage capacities meeting or exceeding 9.2 acre-feet. They serve a variety of purposes, including but not limited to flood risk reduction, irrigation, water supply, hydroelectric power, recreation, and habitats for fish and wildlife. These dams are owned and operated by federal and local governments, state agencies, private entities, and public utilities. The first of these dams to be constructed was the Faraday Forebay dam, a PGE-owned dam for which construction was completed in 1907. The most recent dam to be constructed was the Sullivan Pond 3 dam near Lebanon, which was completed in 2009.

2.4 Land Use

Forestry, agriculture and urban uses dominate land use in the Willamette Subbasins TMDL project area, which is summarized in Table 2-14 and Figure 2-6 based on the 2019 National Land Cover Database (Dewitz and USGS, 2021). The majority of the basin is forestry, accounting for about 68% of the land in the basin. Forests are mainly located from the higher elevations to the foothills of the Coast and Cascade mountain ranges. These forests are primarily composed of Douglas fir and other conifers, and provide important habitat for a variety of wildlife, including salmon and steelhead. The land cover of the lower elevations of the basin is more heavily influenced by agriculture and urbanization. Agricultural land covers about 19% of the basin, including pasture and crops. Urban areas are prominent, with a total of 75 cities, including the three largest cities in the state (Portland, Eugene, and Salem). According to the 2010 census data, more than two million individuals, which accounts for over 50% of Oregon's overall population, reside in the Willamette Basin.

Table 2-14: Summary of land uses in the Willamette Subbasins TMDL project area based on the 2019 National Land Cover Database.

2019 NLCD Land Cover	Acres	Percent of Total Area
Evergreen Forest	3723099.4	58.30
Hay/Pasture	817292.4	12.80
Cultivated Crops	404290.1	6.30
Shrub/Scrub	346706.4	5.40
Mixed Forest	197931.8	3.10
Herbaceous	165112.3	2.60
Developed, Low Intensity	156196.8	2.40
Developed, Open Space	142817.1	2.20
Developed, Medium Intensity	130316.7	2.00
Open Water	75347.9	1.20
Woody Wetlands	63695.8	1.00
Developed, High Intensity	55271.5	0.90
Emergent Herbaceous Wetlands	54148.8	0.80
Barren Land	31091.2	0.50
Deciduous Forest	25684.6	0.40
Perennial Snow/Ice	2126.5	0.03

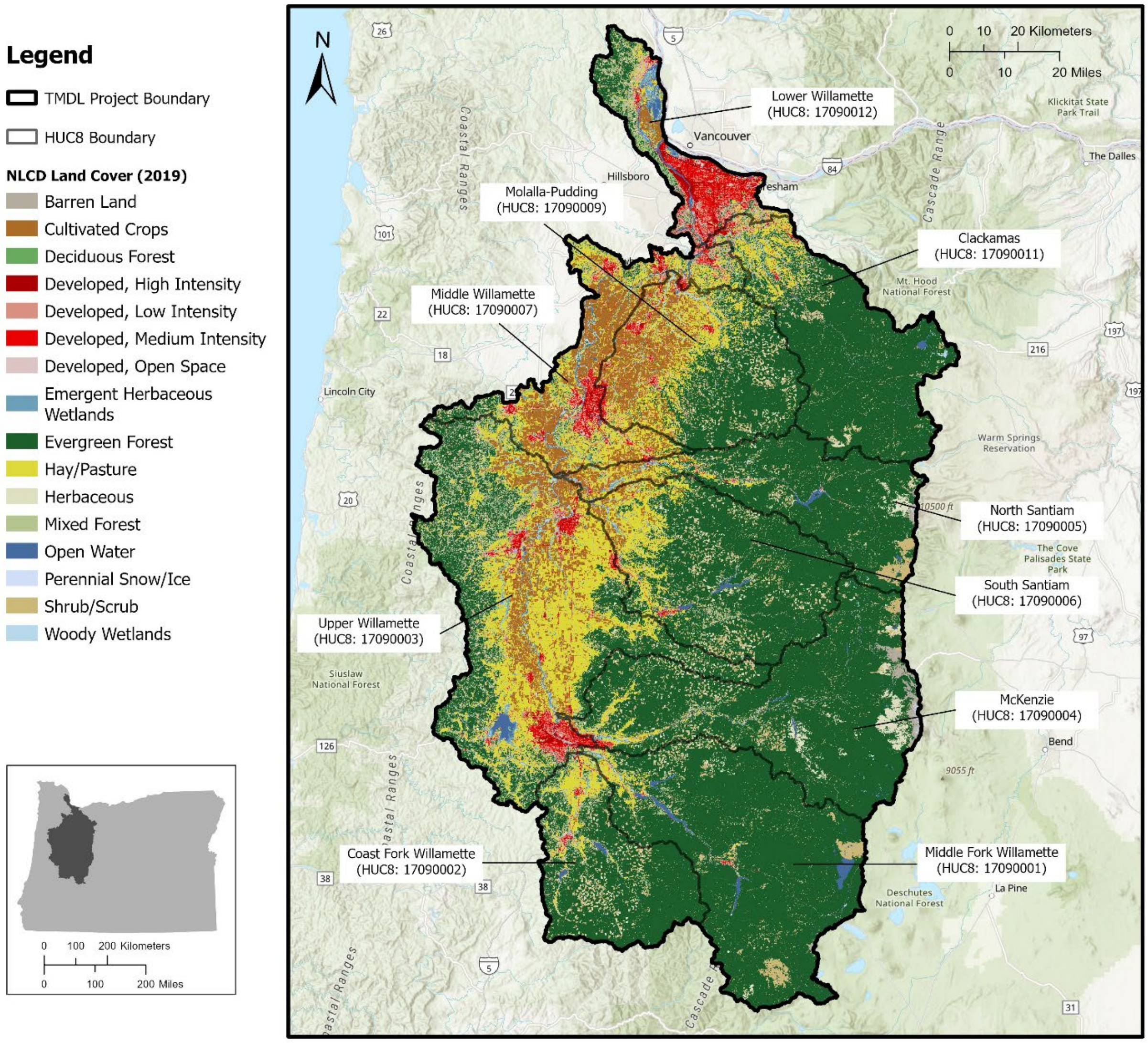


Figure 2-6: Land uses in the Willamette Subbasins TMDL project area based on the 2019 National Land Cover Database. (*Note: Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.)*

2.5 Land Ownership and Jurisdiction

The Willamette Subbasins TMDL project area is a complex landscape with a variety of landowners and jurisdictions (Figure 2-7). Land ownership and jurisdiction was determined using the Designated Management Agency (DMA) GIS data described in Section 2.2 of the modeling report (Technical Support Document Appendix A). Land ownership within the subbasins includes private individuals, corporations, state and federal agencies, and tribal governments. Private individuals and corporations own the majority of the land in the basin, accounting for about 56%, particularly in the Willamette Valley where agriculture and urbanization are more prevalent. Federal agencies, such as the U.S. Forest Service and the Bureau of Land Management, own and manage those portions of forested lands, accounting for about 34.4% and 5.5% of the basin, respectively. The Oregon Department of Forestry manages about 27% of the land in the basin, including both private and public lands. Tribal governments also have important land ownership and management roles within the basin. The Confederated Tribes of Warm Springs has land holdings within the basin and has treaty rights to fish and hunt in the area.

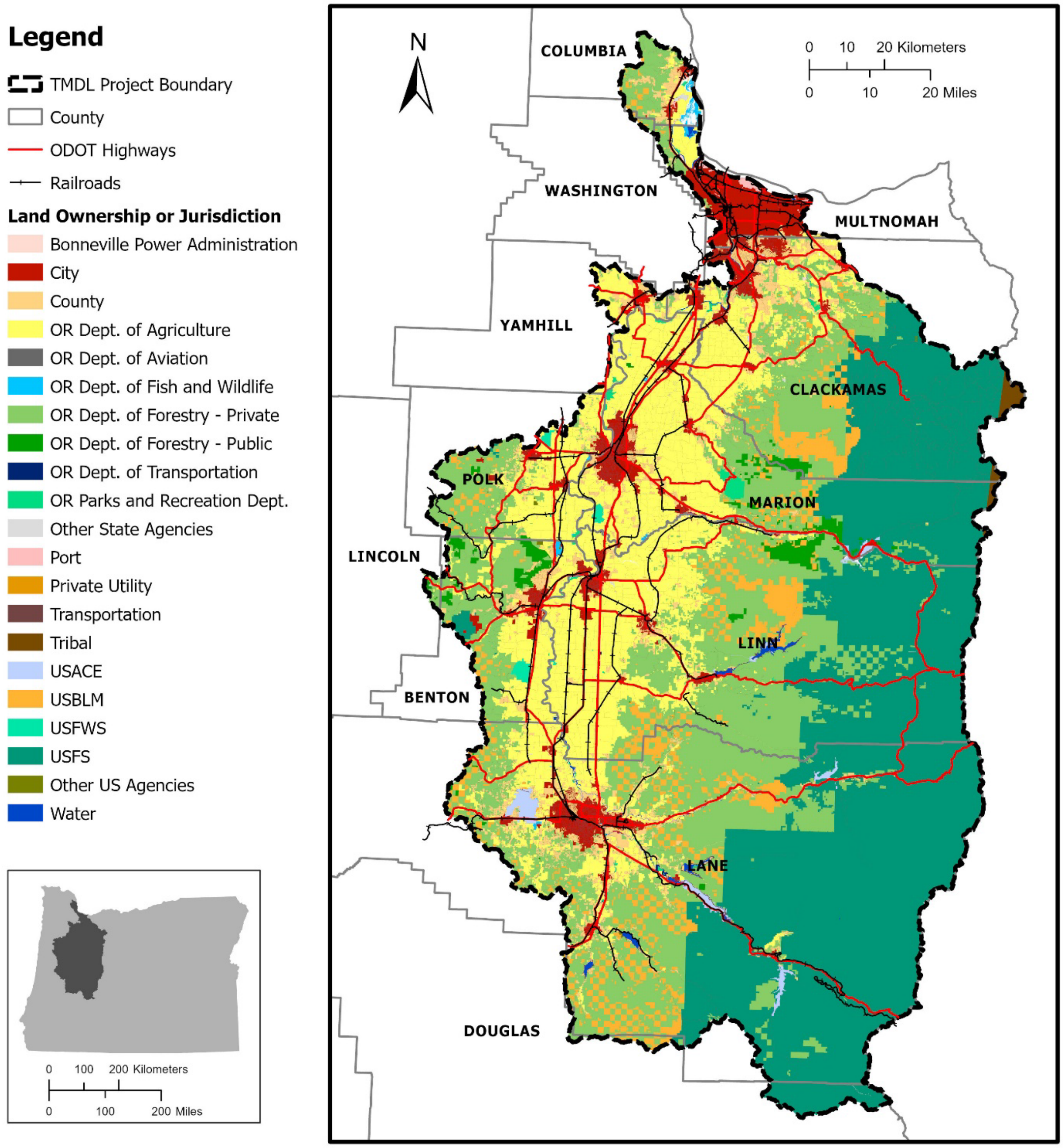


Figure 2-7: Land ownership and jurisdiction in the Willamette Subbasins temperature TMDL project area.

3 Pollutant identification

Temperature is the water quality parameter of concern, but heat or thermal loading, is the pollutant of concern causing impairment. Heat caused by human activities are of particular 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 also result in water temperature change for a defined amount of heat exchange.

$$\Delta Tw = \frac{\Delta Heat}{Density \times Specific\ Heat \times \Delta Volume}$$

The pollutants addressed by these temperature TMDLs are heat or thermal loads, with surrogate measures of effective shade.

EPA regulations (40 CFR 130.2(i)) and OAR 340-042-0040(O)(5)(b) allow for TMDLs to utilize other appropriate measures (or surrogate measures). Surrogate measures are defined in OAR 340-042-0030(14) as “substitute methods or parameters used in a TMDL to represent pollutants.” In accordance with OAR 340-042-0040(5)(b), DEQ used effective shade as a surrogate measure for thermal loading caused by solar radiation. Effective shade is the percent of the daily solar radiation flux blocked by vegetation and topography. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint load allocations for this temperature TMDL.

4 Temperature water quality standards and beneficial uses

EQC issued, and EPA approved, numeric and narrative water quality standards to protect designated *beneficial use*s in the Willamette (Oregon Administrative Rules OAR 340–041–0344 - 0350, November 2003), and antidegradation policies to protect overall water quality. Table 4-1 specifies the designated beneficial uses in the Willamette Subbasins surface water.

Table 4-1: Designated beneficial uses in the Willamette Subbasins as identified in OAR 340-041-0340 Table 340A.

Beneficial Uses	All waterbodies
Public Domestic Water Supply	X
Private Domestic Water Supply	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Fish and Aquatic Life	X
Wildlife and Hunting	X
Fishing	X

Beneficial Uses	All waterbodies
Boating	X
Water Contact Recreation	X
Aesthetic Quality	X
Hydro Power	X
Commercial Navigation & Transportation	

Water quality criteria have been set at a level to protect the most sensitive beneficial uses. These TMDLs are designed such that meeting water quality standards for the most sensitive beneficial uses will be protective of all other uses. Fish and aquatic life are the most sensitive beneficial use for temperature. Oregon's water temperature criteria use salmonids' life cycles as indicators. If temperatures are protective of these indicator species, other species will share in this protection. The locations and periods of criteria applicability are determined from designated fish use maps in rule at OAR 340-041-0340 Figure 340A and Figure 340B. The maps from the rule have been reproduced and shown in Figure 4-1 and Figure 4-2. Figure 4-1 shows various designated fish uses and applicable criteria, while Figure 4-2 shows salmon and steelhead spawning use designation, based on the National Hydrography Dataset (NHD).

The temperature water quality standards for the Willamette Subbasins are based on the rolling seven-day average daily maximum (7DADM) and include the following numeric criteria:

- Salmon and steelhead spawning: 13.0°C (55.4°F) (OAR 340-041-0028(4)(a))
- Core cold water habitat: 16.0°C (60.8°F) (OAR 340-041-0028(4)(b))
- Salmon and trout rearing and migration: 18.0°C (64.4°F) (OAR 340-041-0028(4)(c))
- Salmon and steelhead migration corridors: 20.0°C (68.0°F) (OAR 340-041-0028(4)(d))
- Bull trout spawning and juvenile rearing: 12°C (53.6°F) (OAR 340-041-0028(4)(f))

The following narrative temperature water quality standards and other rule provisions also apply in the Willamette Subbasins:

- Cool Water Species (OAR 340-041-0028(9))
- Human use allowance (OAR 340-041-0028(12)(b))
- Minimum duties (OAR 340-041-0028(12)(a))
- Natural Lakes (OAR 340-041-0028(6))
- Protecting cold water (OAR 340-041-0028(11))
- The three basin rule: Clackamas, McKenzie, and North Santiam (OAR 340-041-0350)
- Antidegradation (OAR 340-041-0004)

Details of each rule are described in the sections that follow.

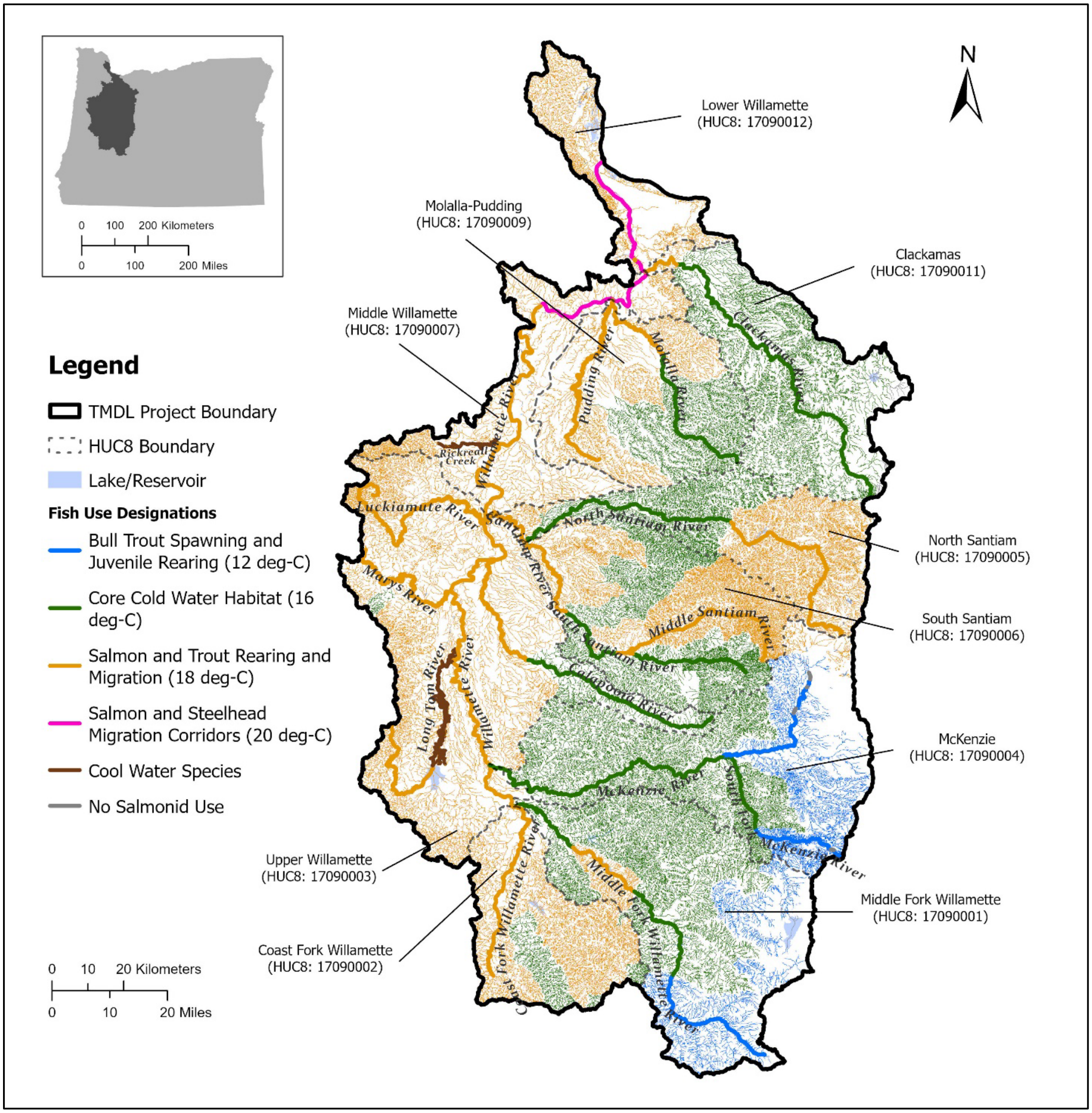


Figure 4-1: Fish use designations in the Willamette Subbasins TMDL project area.

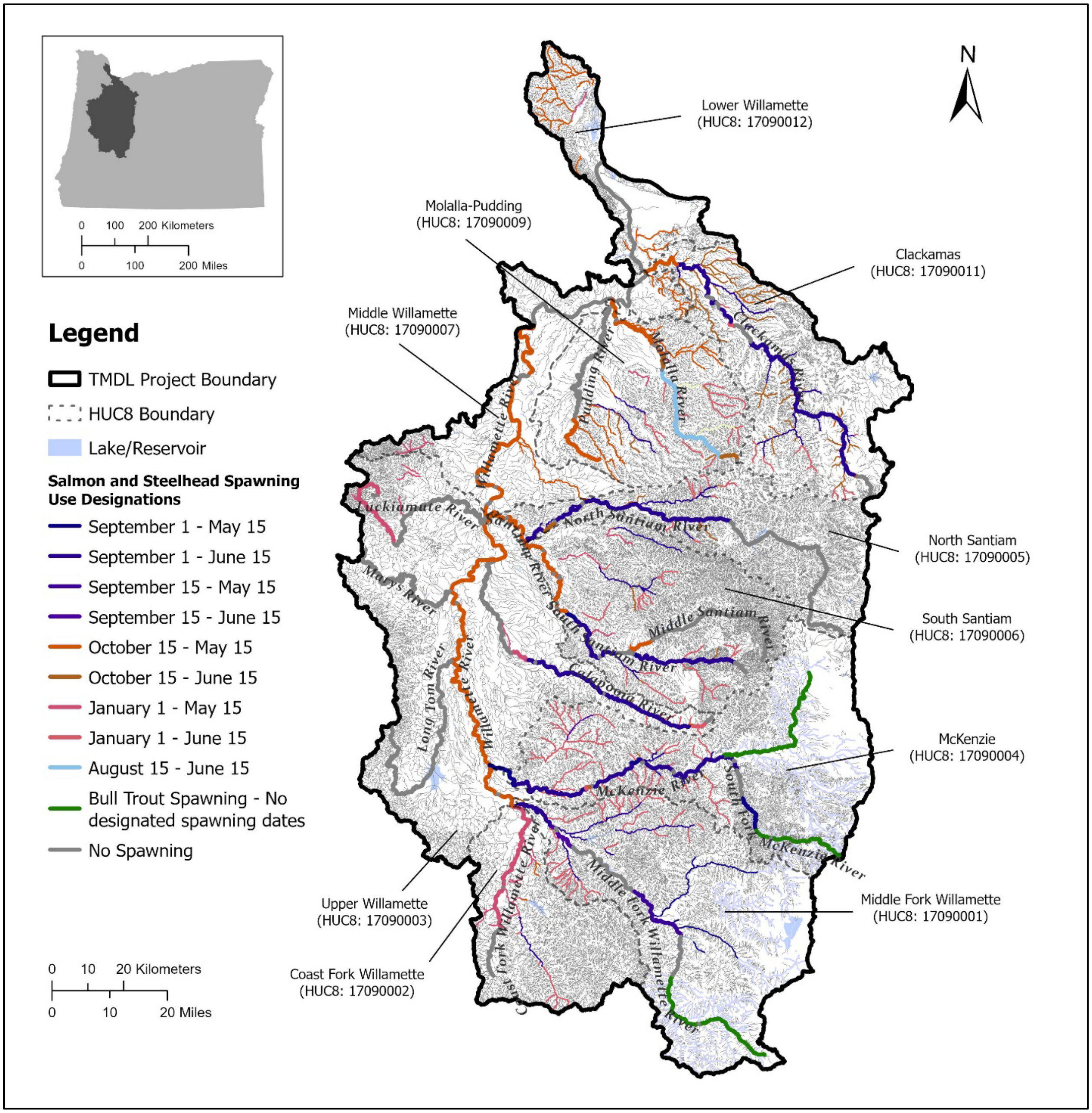


Figure 4-2: Salmon and steelhead spawning use designations in the Willamette Subbasins TMDL project area.

4.1 Salmon and steelhead spawning use

OAR 340-041-0028(4)(a). Waters that have been designated as having salmon and steelhead spawning use are identified in rule at OAR 340-041-0340 Figure 340B and shown in Figure 4-2. During the spawning period, these waters may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) expressed as a seven-day average of daily maximum temperature (7DADM).

4.2 Core cold water habitat use

OAR 340-041-0028(4)(b). Waters that have been designated as having core cold water habitat use are identified in OAR 340-041-0340 Figure 340A and shown in Figure 4-1. These waters may not exceed 16.0 degrees Celsius (60.8 degrees Fahrenheit) expressed as a seven-day average of the daily maximum temperature (7DADM).

4.3 Salmon and trout rearing and migration

OAR 340-041-0028(4)(c). Waters that have been designated as having salmon and trout rearing and migration use are identified in OAR 340-041-0340 Figure 340A and shown in Figure 4-1. These waters may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit) expressed as a seven-day average of the daily maximum temperature (7DADM).

4.4 Bull trout spawning and juvenile rearing

OAR 340-041-0028(4)(f). Waters that have been designated as having salmon and trout rearing and migration use are identified in OAR 340-041-0340 Figure 340A and shown in Figure 4-1. These waters may not exceed 12.0 degrees Celsius (53.6 degrees Fahrenheit) expressed as a seven-day average of the daily maximum temperature (7DADM).

In addition, the rule states that below Carmen Reservoir on the Upper McKenzie River, there may be no more than a 0.3 degrees Celsius (0.5 Fahrenheit) increase between the water temperature immediately upstream of the reservoir and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0 degrees Celsius (48 degrees Fahrenheit) or greater, and no more than a 1.0 degree Celsius (1.8 degrees Fahrenheit) increase when the seven-day-average stream temperature is less than 9 degrees Celsius.

4.5 Human use allowance

Oregon water quality standards have provisions for human use (OAR 340-041-0028(12)(b)). The human use allowance is an insignificant addition of heat (0.3 degrees Celsius) authorized in waters that exceed the applicable temperature criteria. Following a temperature TMDL, or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable biological criterion after complete mixing in the waterbody, and at the point of maximum impact. The rationale behind selection of 0.3 deg-C for the human use allowance and how DEQ implements this portion of the standard can be found in DEQ (2003) and the Temperature IMD (DEQ 2008a).

4.6 Natural lakes

OAR 340-041-0028(6). Natural lakes may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of a natural lake is the same as its natural thermal condition.

4.7 Cool water species

The narrative cool water species criterion in rule at OAR 340-041-0028(9)(a) states that “No increase in temperature is allowed that would reasonably be expected to impair cool water species.” Under the Clean Water Act, states must designate the uses of a waterbody and provide water quality for the protection and propagation of fish, shellfish, and wildlife, where attainable (40 CFR 131.10(j)). Rickreall Creek (Middle Willamette Subbasin) is the only waterbody designated for the subcategory cool water species use in the Willamette Subbasins. The designation applies from the mouth at the confluence of the Willamette River (river mile 0) to the east end of Dallas City Park at approximately river mile 14. This reach of Rickreall Creek is hereafter referred to as “the lower reach”. The Long Tom River below Fern Ridge Reservoir (Upper Willamette Subbasin) is also designated for cool water use, but this reach of the Long Tom River is not addressed by the Willamette Subbasins TMDL.

DEQ uses a stepwise approach to implement this narrative standard (DEQ 2008). The Department bases its evaluations on the best available information and professional judgment. Pertinent information includes: the species present and their thermal requirements, physical characteristics of the water body, current ambient temperatures and the magnitude, duration and frequency of the proposed temperature increase.

DEQ followed the procedures of the Water Quality Standard Implementation IMD to implement the narrative provision of the Cool Water Species narrative criterion. First, DEQ considered if it would be reasonable to apply the Redband & Lahontan Cutthroat Trout criterion of 20 degrees Celsius plus the 0.3 degrees Celsius human use allowance to the reach. The rationale, as outlined in DEQ’s temperature water quality standard implementation IMD (DEQ, 2008) is that a target temperature based on 20 degrees Celsius will not impair cool water species, which have more tolerance of warm temperatures than trout. This approach was rejected because 20 degrees Celsius does not appear to be attainable (see section 4.7.3) and, as discussed later in this section, there are periods when winter steelhead are migrating in lower Rickreall Creek, which require temperatures less than 20 degrees Celsius. Instead, DEQ determined what cool water species are present in Rickreall Creek and identified a target temperature based on the thermal tolerance information available for those species. A temperature target was also identified for the peak periods when winter steelhead are migrating.

4.7.1 Rickreall Creek temperatures

Continuous temperature data (Figure 4-3) and instantaneous (grab) data (Figure 4-4, Figure 4-5) are available on lower Rickreall Creek. The data show temperatures peak in July and August and exceed 18° Celsius from May 15 to September 30 near the mouth of the creek (Figure 4-3), and into October near the midpoint of the lower reach (Figure 4-5). Temperatures exceed 20° Celsius from July through the end of September. The plots include the selected lower Rickreall Creek temperature target (Section 4.7.4) for comparison.

DEQ has not modeled the background temperatures of lower reach of Rickreall Creek so an estimate of possible background temperature was derived using a nearby stream that was modeled. This provides a useful estimate of the range of potential temperature reductions possible in Rickreall Creek and to evaluate if a target temperature based on 20 degrees Celsius is attainable, as outlined in DEQ's temperature water quality standard implementation IMD (DEQ, 2008).

The Luckiamute River watershed is a tributary of the Willamette River, approximately 60 miles long, that drains the eastern Coast Range mountains with an outlet on the Willamette Valley floor. The mouth of the Luckiamute River is approximately 20 river miles south of the mouth of Rickreall Creek along the Willamette River. DEQ estimated the background temperatures of the nearby Luckiamute River as part of the Willamette Subbasins TMDL. See Technical Support Document Appendix A for more details. A temperature reduction refers to the decrease in 7-day average daily maximum temperatures from full restoration of streamside vegetation in a system free of dam and reservoir operations.

Thermal pollutant sources identified for the Luckiamute River include lack of sufficient shade-producing streamside vegetation, and background sources. Along the Luckiamute River model extent, lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9%, corresponding to daily maximum water temperature increases of 3.56 deg-C at the point of maximum impact at model kilometer 42.8 (~ river mile 26) and 0.34 deg-C at the mouth. The Luckiamute background model suggests temperature reductions of approximately 3.5 to 0.3 degrees Celsius are possible depending on the position of a site along the watershed. The temperature reductions suggested by the Luckiamute background model at the mouth, indicate that a 20 degrees Celsius temperature target may not be attainable in the lower reach of Rickreall Creek.

Figure 4-3: Distribution of 7DADM temperatures from continuously monitored temperature data from DEQ monitoring site 11102 (approximate river mile 0.9). The cool water species narrative temperature targets are shown as dashed lines. The yellow shading indicates time periods were some 7DADM values exceeded the temperature target.

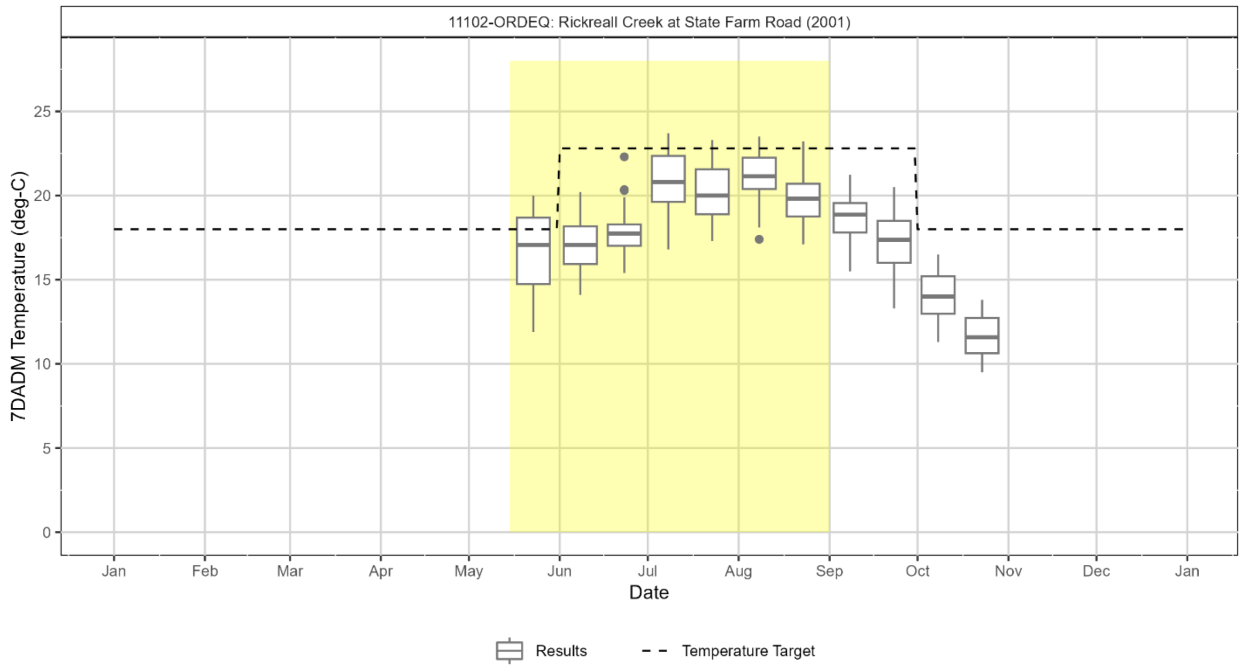


Figure 4-4: Distribution of temperatures from single sample grab data at DEQ monitoring site 10364 (approximate river mile 2.2) from 2003-2011. The cool water species narrative temperature targets are shown as dashed lines.

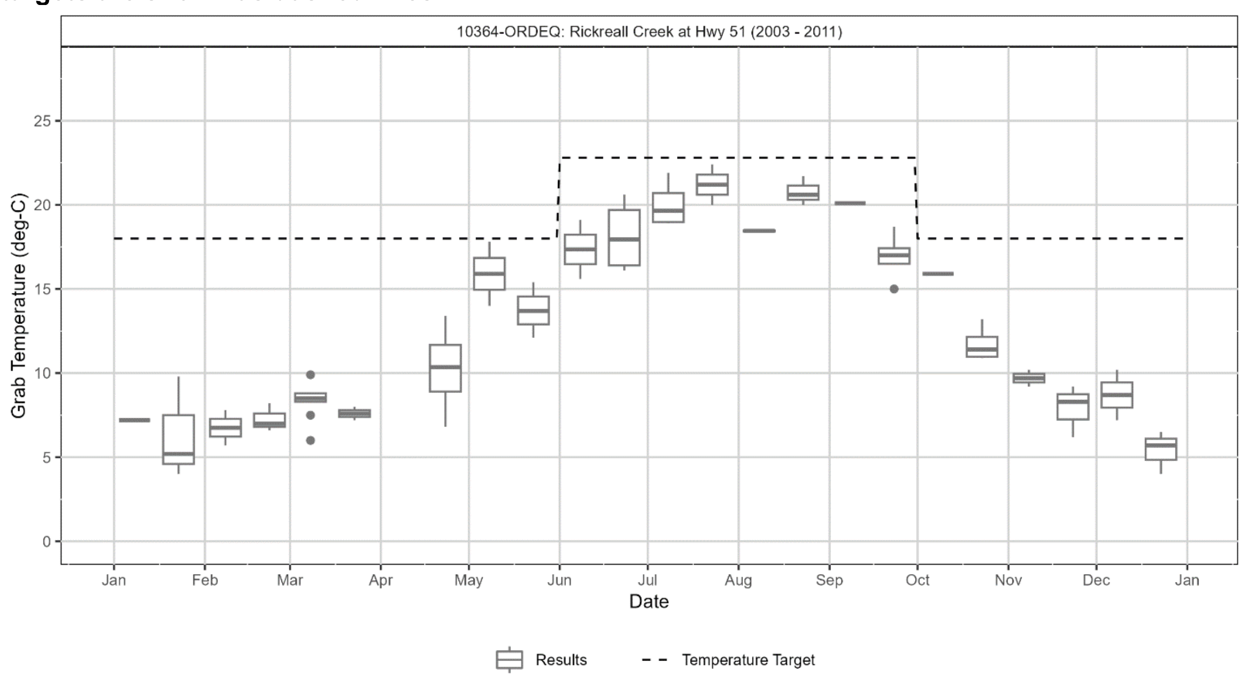
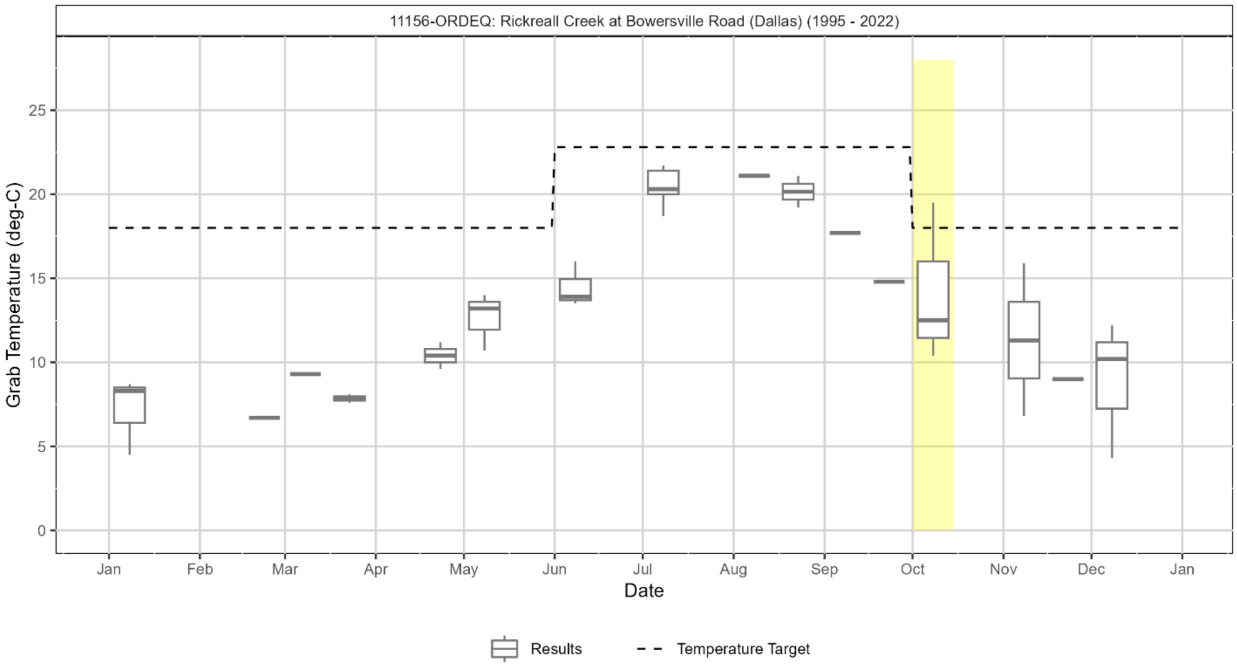


Figure 4-5: Distribution of temperatures from grab data collected at DEQ monitoring site 11156 (approximate river mile 10.7) from 1995-2022. The cool water species narrative temperature targets

are shown as dashed lines. The yellow shading indicates time periods where some grab temperature exceeded the temperature target.



4.7.2 Rickreall Creek cool water species

DEQ reviewed the ODFW fish habitat distribution database and life stage timing tables for the Rickreall Creek watershed (ODFW 2023) and consulted with the ODFW district biologist about the fish species in the lower reach. Based on this information, DEQ determined the resident cool water species that may be present in Rickreall Creek downstream of Dallas include Speckled dace (Rhinichthys osculus), Redside shiner (Richardsonius balteatus), Largescale sucker (Catostomus macrocheilus), Prickly sculpin (Cottus asper), and Pacific lamprey (Entosphenus tridentatus). The exact timing of cool water species use of Lower Rickreall Creek is not fully understood but multiple cool water species have been observed in the reach from April to November (Chastain et al 2002). ODFW's information also show that adult and juvenile winter steelhead (Oncorhynchus mykiss) migrate through Lower Rickreall Creek. The peak migration period in ODFW's timing tables is February 15th through May 31 (ODFW 2023).

A review of available studies evaluating the temperature tolerance of the cool species present in Lower Rickreall Creek was completed in order to identify a target temperature to implement the cool water species narrative rule. We found temperature tolerance studies for all species except Largescale sucker. A summary of the studies follows.

Carveth et al (2006) reported four endpoint thermal maxima for Speckled dace collected from Arizona rivers. The lowest temperature of all the endpoints reported is the initial loss of equilibrium (ILOE) at 34.7 degree Celsius (95% confidence interval of 0.4 degree Celsius) for fishes acclimated to 25 degree Celsius waters. Other endpoints reported are summarized in Table 4-2.

Beitinger et al (2000) conducted a review and summarized the results of several temperature tolerances studies of multiple North American freshwater species. For Speckled dace, a study by Castleberry and Cech (1993) reported a loss of equilibrium at 32.4 degrees Celsius with a standard deviation of 1.90 degrees Celsius. The acclimation temperature was 20 degrees Celsius (Table 4-2).

John (1964) reported the ultimate incipient upper lethal temperature for Speckled dace is about 33 degrees Celsius for young fish and 32 degrees Celsius for older fish (Table 4-2). The fish were not acclimated for this study.

Black (1953) evaluated the temperature tolerance for some freshwater fish found in the Okanagan Lakes in British Columbia, Canada. The upper lethal temperatures, defined as the temperature at which 50 percent of the fish died in 24 hours, was 24.1 degrees Celsius for Prickly sculpin and 27.6 degrees Celsius for Redside shiner. All fish survived after 24 hours at treatment temperatures of 22.8 degrees Celsius for both species. No fish survived after 24 hours at treatment temperatures of 26.5 and 30.3 degrees Celsius for Prickly sculpin and Redside shiner, respectively (Table 4-2).

Whitesel and Uh (2023) reported the ultimate incipient upper lethal temperature after 7 days for larval Pacific lamprey was 28.3 degrees Celsius based on the time to death and 30.2 degrees Celsius based on the percent mortality approach (Table 4-2). In experiments of direct acute exposure, larval were acclimated to different temperatures ranging from 19.8 to 23.3 degrees Celsius for 7-9 days and then placed in various treatment temperatures. The LT50 was calculated, which is the number of hours at which 50% of the larval survived. The LT50 was 1 hour or less at treatment temperatures ranging from 31.1 to 33.4 degrees Celsius. The LT50 ranged from 43.1 to 80.5 hours in treatment temperatures of 29 to 29.3 degrees Celsius. In experiments of acclimated chronic exposure over a 30 day period, 100% of the larval survived in the treatment temperatures of constant exposure ranging from 21 to 27 degree Celsius. No larval survived in constant treatment temperatures of 30 and 33 degrees Celsius over the 30 day period.

Table 4-2: Temperature tolerance endpoints for cool water species as reported in literature reviewed by DEQ.

Species	Acclimation Temperature (deg-C)	Endpoint	Endpoint Temperature (deg-C)	Source
Speckled dace (Rhinichthys osculus)	20	Initial loss of equilibrium	32.4 ± 1.90	Castleberry and Cech (1993) via Beitinger et al (2000)
	25	Initial loss of equilibrium	34.4 ± 0.4	Carveth et al (2006)
		Final loss of equilibrium	34.4 ± 0.4	
		Flaring opercula	35.9 ± 0.2	
		Death	36.0 ± 0.4	
	30	Initial loss of equilibrium	35.8 ± 0.6	
		Final loss of equilibrium	36.9 ± 0.1	
		Flaring opercula	37.0 ± 0.1	
		Death	36.9 ± 0.3	
	NA	Ultimate incipient upper lethal temperature	33 (young fish) 32 (old fish)	John (1964)
Redside shiner (Richardsonius balteatus)	14	100% survival after 24 hours	22.8	Black (1953)
		50% survival after 24 hours	27.6	
		No survival after 24 hours	30.3	
Prickly sculpin (Cottus asper)	18–19	100% survival after 24 hours	22.8	
		50% survival after 24 hours	24.1	
		No survival after 24 hours	26.5	
Pacific lamprey (Entosphenus tridentatus)		Ultimate incipient upper lethal temperature (7 days) based on time to death	28.3	Whitesel and Uh (2023)
		Ultimate incipient upper lethal temperature (7 days) based on percent mortality	30.2	

Based on review of available temperature tolerance studies, Prickly sculpin are the most temperature sensitive cool water species. Black (1953) reported the upper lethal temperature as 24.1 degrees Celsius. The upper lethal temperature was based on 50% survival after 24 hours of exposure to various treatment temperatures. Other endpoints reported for Prickly sculpin include the treatment temperature at which all fish survived after 24 hours (22.8 degrees Celsius) and the treatment temperatures with no survival after 24 hours (26.5 degrees Celsius).

These results indicate that Prickly sculpin have a narrow temperature margin between complete survival and the point at which half the population died (1.3 degrees Celsius). This was taken into consideration when setting the target temperature. Exposure to water temperatures greater than 24.1 degrees for just a few hours will likely not cause significant harm, but it is unclear if exposure for just a few hours a day over the course of 7 or more days would have a similar impact as a constant 24 hour exposure. Due to this uncertainty, DEQ selected the more protective endpoint (22.8 degrees Celsius) expressed as the instream seven-day average maximum temperature target plus an insignificant addition of heat for human use equal to 0.3 degrees Celsius. This target will limit the exposure time to temperatures that would result in impairment to Prickly sculpin. This target applies from June 1 through September 30. The following section will explain when the cool water species applies versus when salmonid species uses apply.

4.7.3 Rickreall Creek salmonid uses

Rickreall Creek also provides habitat for cold water salmonid species, including steelhead trout (Oncorhynchus mykiss) and Coastal Cutthroat trout (Oncorhynchus clarkii). Various life stages are present in the watershed at certain times of year (ODFW, 2023). The following timing tables are for the entire Rickreall Creek basin. The lower reach is not spawning or egg incubation habitat and trout use is absent or limited during the warmer months.

Table 4-3: Anadromous salmonid species use in Rickreall Creek (Source: ODFW 2003[1])

Rickreall Cr - Anadromous Species												
Waterway ID: MidWill18												
Life Stage/Activity/Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Upstream Adult Migration												
Winter Steelhead												
Adult Spawning												
Winter Steelhead												
Adult Holding												
Winter Steelhead												
Egg Incubation through Fry Emergence												
Winter Steelhead												
Juvenile Rearing												
Winter Steelhead												
Downstream Juvenile Migration												
Winter Steelhead												

Represents periods of peak use based on professional opinion, survey data, or other inforr

Represents lesser level of use based on professional opinion,survey data, or other informa

Represents periods of presence OR uniformly distributed level of use

Table 4-4: Resident salmonid species use of Rickreall Creek (Source: ODFW, 2003[1])

[1] ODFW Fish Life Stage Timing Tables https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=42654.xml

Rickreall Cr - Non-Anadromous Species												
Waterway ID: MidWill18												
Life Stage/Activity/Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Fluvial or Adfluvial Migration												
Cutthroat Trout - Resident												
Adult Spawning												
Cutthroat Trout - Resident												
Adult/Sub-Adult Rearing												
Cutthroat Trout - Resident												
Egg Incubation through Fry Emergence												
Cutthroat Trout - Resident												
Juvenile Rearing												
Cutthroat Trout - Resident												
Juvenile/Sub-Adult Migration												
Cutthroat Trout - Resident												

Represents periods of peak use based on professional opinion, survey data, or other inforr

Represents lesser level of use based on professional opinion,survey data, or other informa

Represents periods of presence OR uniformly distributed level of use

From the ODFW timing tables it is not clear what timing of use is specific to the lower reach versus within the watershed as a whole. The prime rearing habitat is likely upstream of the City of Dallas. Data on abundance of cold water species in the lower reach relative to the other waters of the Rickreall Creek watershed is limited. ODFW provided DEQ with some supplemental studies of fish presence in the Rickreall Creek Watershed.

A detailed survey of fish presence for multiple cool and cold-water species was conducted in Rickreall Creek in 2002 (Chastain et al. 2002). The authors sampled nine sites on the main stem of Rickreall Creek from river mile 0.56 to 28[2] monthly for a year, from April 2001–March 2002. Four of the sites sampled (Sites #1-4) are within and representative of the lower reach (Figure 4-3). A fifth site (Site #5) is located at or above the endpoint of the lower reach in Dallas City Park, and therefore is not representative of the lower reach. The authors found the Rickreall Creek watershed has a relatively intact native fish community, and that sites #1-4 were dominated by cool water species (Chastain et al. 2002, Figure 2a).

No anadromous salmonid species were detected at site #1, near the mouth of Rickreall Creek, at any time of year (Figure 4-4). Coho, Chinook, and steelhead salmon were detected at sites #2-4 sporadically between October 1 and May 31 (Figure 4-5 through Figure 4-8). Resident Cutthroat trout were detected sporadically between September 1 and April, but never in consecutive months except for Site #4 (Figure 4-7). One detection of Cutthroat trout occurred in July at site #3 (Figure 4-6). The total number of Cutthroat captured at site #3 and site #4 appears to be less than 10 individuals for the entire year (Chastain et al. 2002, Figure 7g).

In contrast, at site #6, approximately 2 stream miles upstream of Dallas City Park in the portion of Rickreall Creek designated for Salmon and Trout Rearing and Migration use, and expected to be more prime rearing habitat, anadromous salmon or resident Cutthroat trout were detected every month of the year. This suggests a low level or only sporadic use of the lower reach by cold water salmonid species, namely Cutthroat trout only, between June and October, consistent with the designated use of Cool Water Species.

Chapman et al. (c. 2003) also conducted a bi-weekly snorkel survey within the lower reach at Villwok's Ford (approximate river mile 7.7) from May – September 2003. This site is identical to site #3 sampled by Chastain et al in 2002. They did not detect any anadromous salmon species, including juvenile steelhead, at the site between May and September. Cutthroat trout were detected downstream of the ford in May, July, August and September, but only sporadically upstream of the ford one week of May and one week of June (Table 4-5). No counts of individuals detected were included in the study. The authors indicate that the ford is not a barrier to Cutthroat trout passage. Chastain et al did not find Cutthroat trout at the same site during the same months in 2002, suggesting only low or sporadic levels of use by Cutthroat in the summer.

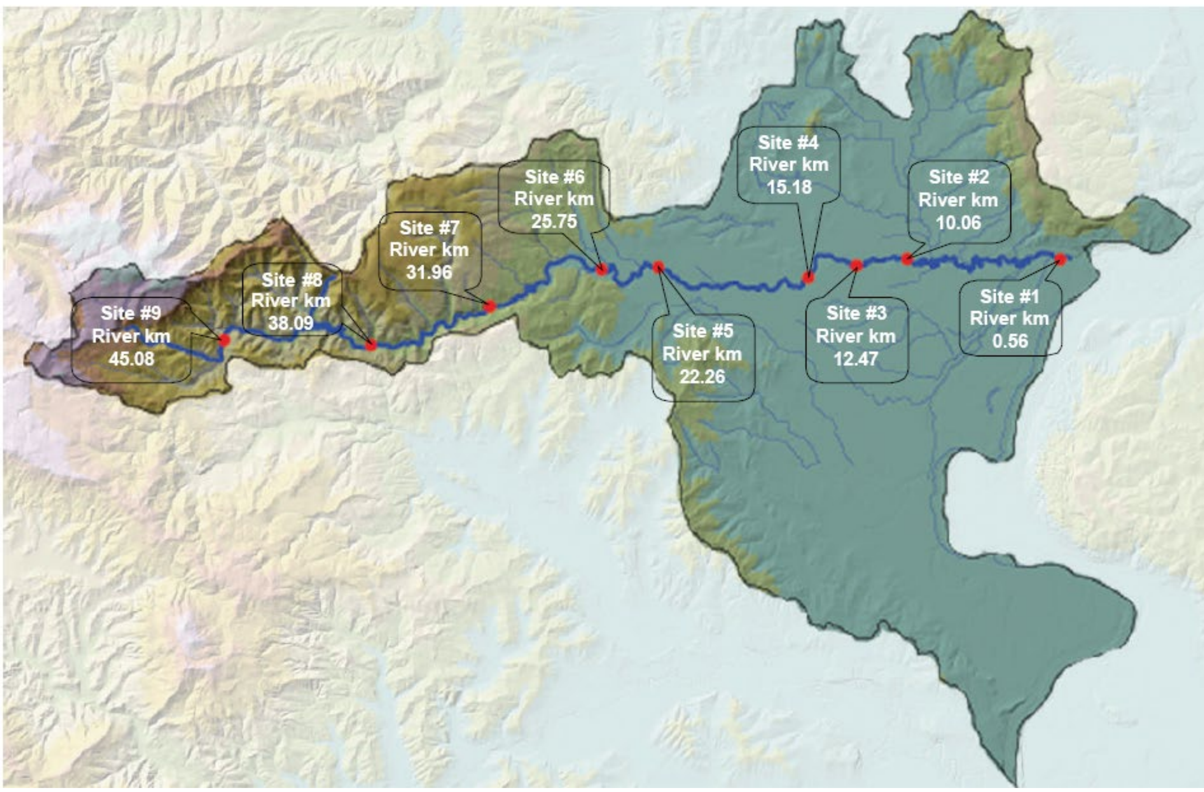


Figure 4-6: Sampling sites on the Rickreall Creek mainstem (from Chastain et al. 2002) Reaches below Site #5 are designated for cool water use.

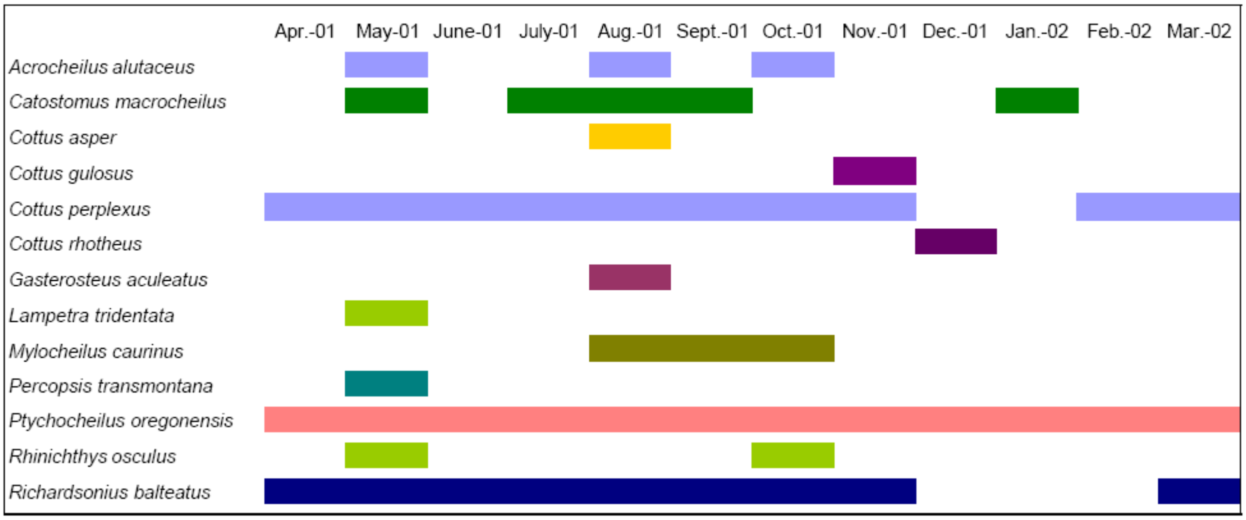


Figure 4-7: Temporal distribution of fish species encountered at approx. river mile 0.3 (Site #1) April 2001 – March 2002 (Chastain et al. 2002, Figure 3a). All species detected at this site are cool water species.

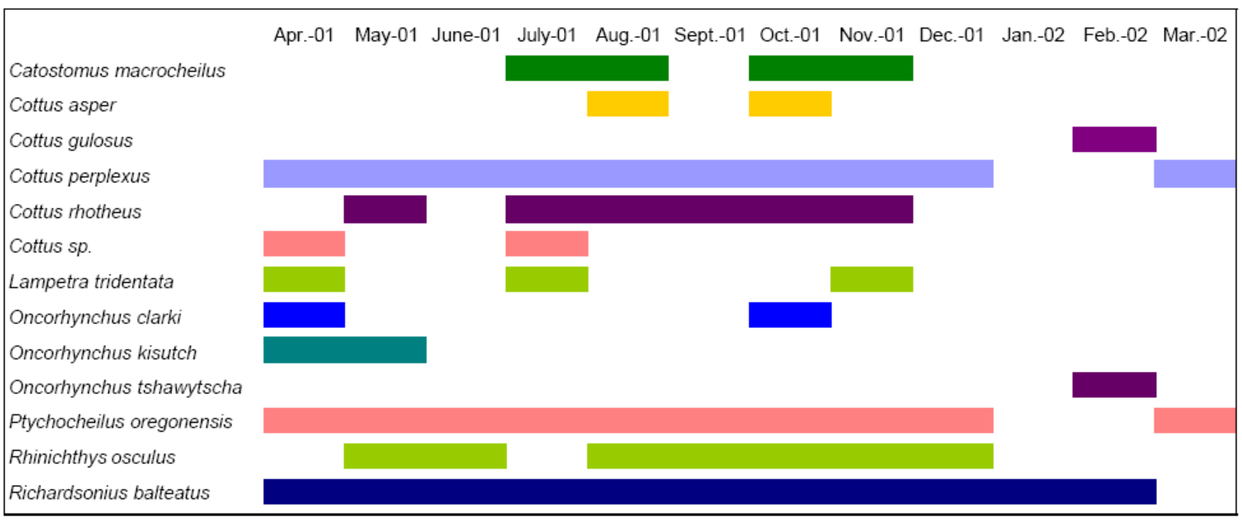


Figure 4-8: Temporal distribution of fish species encountered at approx. river mile 6.3 (Site #2) April 2001 – March 2002 (Chastain et al. 2002, Figure 3b). The salmonid species detected include: cutthroat trout (O. clarkii), Coho salmon (O. kisutch), and Chinook salmon (O. tshawytscha).

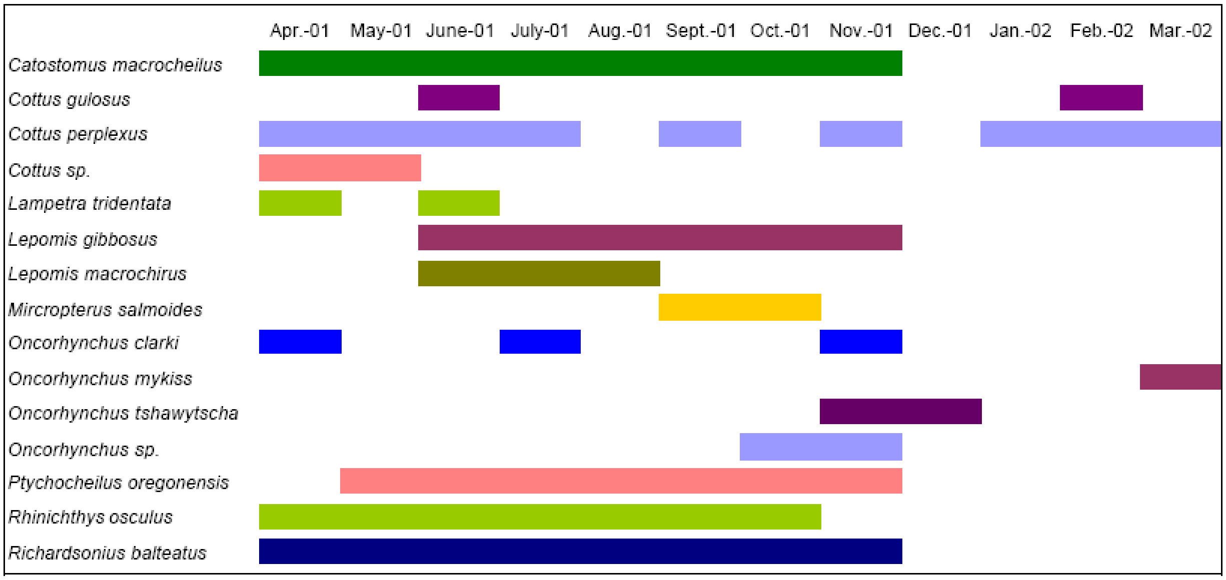


Figure 4-9: Temporal distribution of fish species encountered at approx. river mile 7.7 (Site #3) April 2001 – March 2002 (Chastain et al. 2002, Figure 3c). The salmonid species detected include: cutthroat trout (O. clarkii), steelhead/rainbow trout (O. mykiss), Coho salmon (O. kisutch), and Chinook salmon (O. tshawytscha).

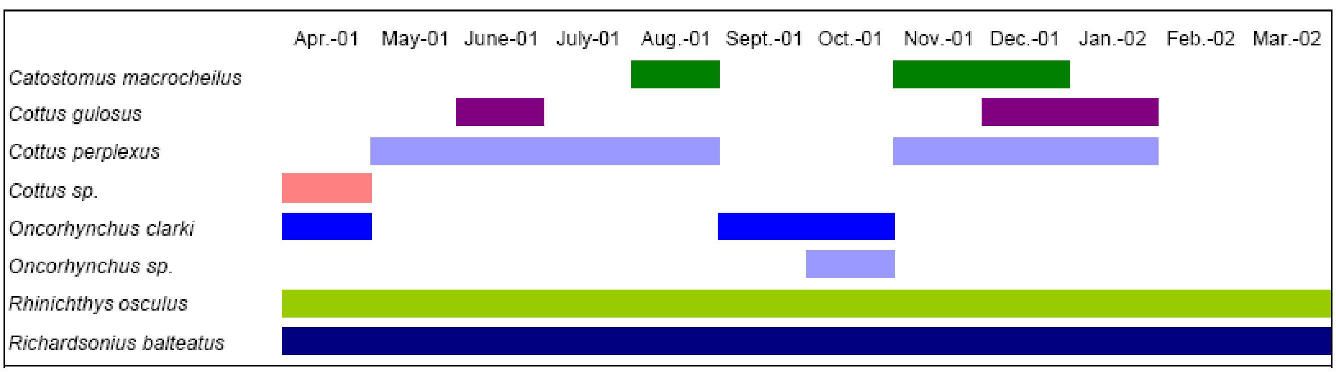


Figure 4-10: Temporal distribution of fish species encountered at approx. river mile 9.8 (Site #4) April 2001 – March 2002 (Chastain et al. 2002, Figure 3d). The salmonid species detected include: cutthroat trout (O. clarkii) and another salmonid (Onchorhynchus spp).

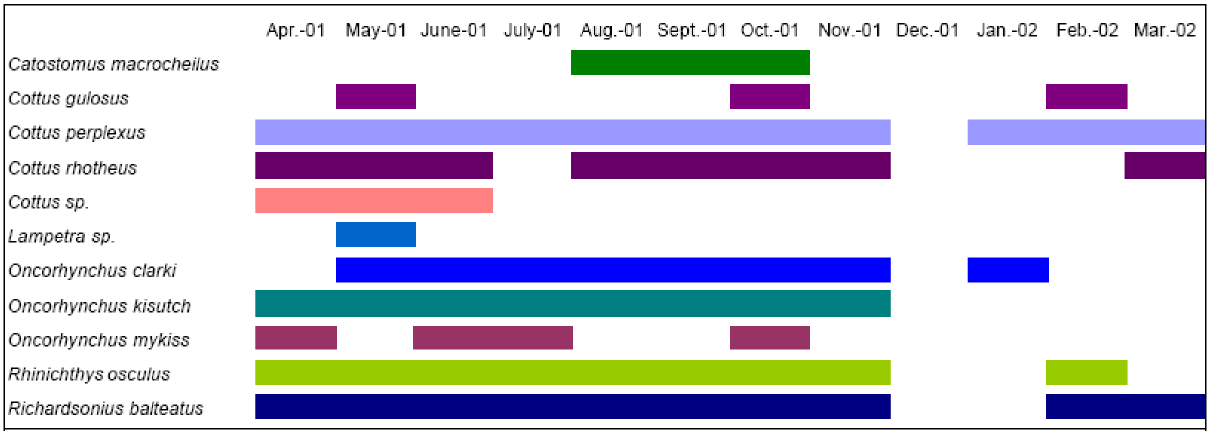


Figure 4-11: Temporal distribution of fish species encountered upstream of the lower reach for comparison, at approx. river mile 16 (Site #6) April 2001 – March 2002 (Chastain et al. 2002, Figure 3f).

Table 4-5: Species observed downstream and upstream of Villwok's Ford approximately river mile 12 (May – September 2003). (Chapman et al. undated, Table 10).

	Downstream of ford							
Species	**May 23**	**June 1**	**June 6**	**June 27**	**July 12**	**July 26**	**Aug. 18**	**Sept. 6**
Ptychocheilus oregonensis	No	Yes	No	Yes	Yes	Yes	Yes	No
Lepomis spp.	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Oncorhynchus clarki	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Catostomus machrocheilus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lampetra tridentata	No	Yes	No	No	No	No	No	No
	Upstream of ford							
Ptychocheilus oregonensis	No	No	No	No	No	No	Yes	No
Lepomis spp.	No	No	No	No	No	No	No	No
Oncorhynchus clarki	Yes	No	No	No	No	Yes	No	No
Catostomus machrocheilus	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Lampetra tridentata	No	No	No	No	No	No	No	No

4.7.4 Rickreall Creek temperature target

To protect the adult winter steelhead (Oncorhynchus mykiss), Coho salmon, and Chinook salmon that may be migrating through the lower reach of Rickreall Creek, and juvenile winter steelhead or Coastal Cutthroat trout (Oncorhynchus clarkii) that may be rearing within the lower reach, DEQ will rely upon the 18.0 degrees Celsius target temperature established to protect salmon and trout rearing and migration uses suggested by EPA guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)). DEQ will apply the 18 degrees Celsius target plus the 0.3 degrees Celsius human use allowance from October 1 to May 31. This target temperature will also protect cool water fish.

To protect Prickly sculpin (Cottus asper), the most temperature sensitive cool water species in lower Rickreall Creek, DEQ will apply a temperature target of 22.8 degree Celsius. DEQ will apply the 22.8 degrees Celsius target plus the 0.3 degrees Celsius human use allowance from June 1 to September 30. Warming from anthropogenic sources shall be limited to a cumulative increase of no greater than 0.3 degrees Celsius above the temperature targets after complete mixing in the water body, and at the point of maximum impact. A summary of the temperature targets is presented in Table 4-6.

If 7-day average daily maximum temperatures trend to always being cooler than both of these temperature targets year-round, the protecting cold water criterion shall be applied with the 0.3 degree human use allowance based on an increase above the cooler ambient temperature.

The mixing zone and thermal plume limitations in OAR 340-041-0053 (2)(E)(d) will provide further protections against potential migration blockages and acute thermal impacts. The TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

Table 4-6: Summary of temperature targets implementing the cool water species narrative in lower Rickreall Creek.

Time period	7DADM Temperature Target (deg-C)	Most Temperature Sensitive Species
June 1 – September 30	22.8 + 0.3 HUA	Prickly sculpin (Cottus asper)
October 1 – May 31	18.0 + 0.3 HUA	Winter steelhead (Oncorhynchus mykiss)

4.8 Three basin rule: Clackamas, McKenzie, and North Santiam

The three basin rule OAR 340-41-0350 applies to the waters of the Clackamas River Subbasin (17090011), The McKenzie River subbasin (17090004) above the Hayden Bridge (River mile 15), and the North Santiam Subbasin (17090005). The rule prohibits new or increased waste discharges with some exceptions.

4.9 Protecting cold water

The "protecting cold water" criterion in OAR 340-041-0028(11) applies to waters of the state that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based criteria. With some exceptions, these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the colder water ambient temperature. This applies to all anthropogenic sources taken together at the point of maximum impact where salmon, steelhead or bull trout are present. A summary of how DEQ implements this portion of the standard can be found in the protecting cold water IMD (DEQ 2011) and the Temperature IMD (DEQ 2008a).

4.10 Statewide narrative criteria

Statewide narrative criteria at OAR 340-041-0007(1) apply to all waters of the state. The highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.

5 Seasonal variation and critical period for temperature

Per OAR 340-042-0040(4)(j) and 40 Code of Federal Regulation130.7(c)(1), TMDLs must identify any seasonal variation and the critical condition or period of each pollutant, if applicable.

DEQ reviewed available temperature data to determine seasonal temperature variation and the critical period. The critical period is based on when seven-day average daily maximum stream temperatures (7DADM) exceed the applicable temperature criteria.

Figure 5-1 through Figure 5-28 show box-and-whisker plots (boxplots) of the seasonal variation of 7DADM temperatures and the critical period at select monitoring locations identified as having category 5 temperature impairments on the 2022 Integrated Report. When multiple monitoring sites were available, the sites with multiple years of data were selected. Temperature data were grouped by the first and second half of each month. The month was split on the 15th with the first group including all results measured on the 1st through the 14th day and the second group including all results measured on the 15th through the end of the month. The boxplots are Tukey style boxplots with the middle line representing the median and ends of the box representing the temperature range between the first and third quartiles (25th – 75th percentile). The whiskers extend to values no further than 1.5 times the interquartile 7DADM temperature range (1.5 times the difference between 25th and 75th percentiles). The points represent individual 7DADM temperatures values beyond 1.5 times the interquartile range. The dashed line corresponds to the applicable temperature criteria. The shaded yellow area identifies the period when 7DADM temperatures exceeded the appliable temperature criteria.

The plots show that maximum stream temperatures typically occur in July or August. This period usually coincides with the lowest annual stream flows, maximum solar radiation fluxes, and warmest ambient air temperature conditions. The warmest median 7DADM temperatures were observed in the Middle Willamette. Monitoring data at Clagget Creek at Mainline Drive in the Middle Willamette Subbasin (Figure 5-15) show the median 7DADM temperature from 2013 to 2019 was close to 25 degrees from July 1 to September 1.

The period of temperature criteria exceedance varies based on monitoring location. Monitoring locations in the Johnson Creek Watershed had the longest periods of exceedance. Near the mouth of Crystal Springs, 7DADM temperatures exceeded the applicable criteria approximately February 15 through November 15 (Figure 5-6). Exceedances occurred approximately March 1 through November 15 in Johnson Creek near Milwaukie (Figure 5-7). At other monitoring sites the earliest exceedances occurred in March (McKenzie Subbasin Figure 5-12), or April (Lower Willamette Subbasin Figure 5-8, Middle Willamette Subbasin Figure 5-16) and the latest occurred at the end of December (South Santiam Subbasin Figure 5-24).

DEQ uses the critical period to determine when allocations apply. In setting this period, DEQ relied upon monitoring sites with the longest period of exceedance. When downstream monitoring sites have longer exceedance periods relative to upstream waters, the longer period is used as the critical period for upstream waterbodies. This is a margin of safety to ensure warming of upstream waters does not contribute to downstream exceedances.

Based on review of available temperature data, the overall critical period is May 1 through October 31 on all waterbodies in the Clackamas, Coast Fork Willamette, Middle Willamette, Middle Fork Willamette, Molalla-Pudding, North Santiam, and Upper Willamette Subbasins. For waterbodies tributary to the McKenzie River in the McKenzie Subbasin, the critical period is March 15 through November 15. The McKenzie River critical period is May 1 through October 31. For waterbodies in the South Santiam Subbasin, the critical period is May 1 through November 30. The critical period is April 1 through October 31 for waterbodies located in the Lower Willamette Subbasin except those within the Johnson Creek Watershed (HUC 1709001201). For waterbodies within the Johnson Creek Watershed, the critical period is February 15 through November 15. Allocations presented in the TMDL apply during these periods.

Table 5-1: Water temperature monitoring locations and periods used to determine seasonal temperature variation and critical periods for the Willamette Subbasins.

Monitoring Location ID	Monitoring Location	Monitoring Period	Number of 7DADM values
14162200	BLUE RIVER AT BLUE RIVER, OR	01/01/02 - 12/31/22	7592
10896-ORDEQ	Butte Creek at Hwy 211	07/04/02 - 08/16/06	386
14164550	CAMP CRK AT CAMP CRK RD BRIDGE, NR SPRINGFIELD, OR	07/18/17 - 12/31/22	1912
14164700	CEDAR CREEK AT SPRINGFIELD, OR	07/17/17 - 12/31/22	1972
CGT1	Claggett Creek at Mainline Dr NE	05/08/13 - 10/11/19	923
14211546	CRYSTAL SPRINGS CREEK AT MOUTH AT PORTLAND, OR	12/12/02 - 12/18/12	3490
40073-ORDEQ	Ferguson Creek 0.1 miles upstream of Eber Creek confluence	05/21/17 - 10/28/20	638
40088-ORDEQ	Ferguson Ck 270 Meters DS SFK Mouth	05/21/17 - 10/28/20	638
40089-ORDEQ	Ferguson CK 0.1 Miles DS of Territorial RD	05/21/17 - 10/28/20	638
MHNF-039	Fish Creek temp monitoring	07/30/09 - 06/02/20	1173
14211550	JOHNSON CREEK AT MILWAUKIE, OR	01/01/02 - 12/31/22	7584
14182500	LITTLE NORTH SANTIAM RIVER NEAR MEHAMA, OR	01/01/02 - 12/31/22	5546
14164900	McKENZIE RIVER ABV HAYDEN BR, AT SPRINGFIELD,OR	07/01/09 - 12/31/22	4920
14186200	MIDDLE SANTIAM R BLW GREEN PETER DAM NR FOSTER, OR	10/30/07 - 12/31/22	5222
35917-ORDEQ	Mill Creek at North Salem High School	02/14/07 - 12/31/07	201
39130-ORDEQ	Milton Cr DS of Old Portland Rd on Boise Cascade side of road	07/04/17 - 11/02/21	1035
23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30	07/05/17 - 10/05/21	1013
11102-ORDEQ	Rickreall Creek at State Farm Road	05/22/01 - 10/23/01	149
14154500	ROW RIVER ABOVE PITCHER CREEK, NEAR DORENA, OR	08/13/09 - 12/31/22	4589

Monitoring Location ID	Monitoring Location	Monitoring Period	Number of 7DADM values
UmpNF-069	Row River above Sharps Creek LTWT	06/24/04 - 09/24/19	1337
WNF-099	SalmonCreek_Mouth_LTWT	07/15/09 - 10/09/19	800
WNF-100	SaltCreek_Mouth_LTWT	07/01/08 - 10/04/17	416
UmpNF-072	Sharps Creek at the Mouth LTWT	06/24/04 - 09/24/19	1291
UmpNF-073	Sharps Creek at the Quarry LTWT	06/24/04 - 09/26/17	1181
31879-ORDEQ	Silver Creek at Silverton, OR	07/09/02 - 09/22/05	428
14185000	SOUTH SANTIAM RIVER BELOW CASCADIA, OR	11/05/08 - 12/31/22	5088
40313-ORDEQ	South Scappoose 160 m above Scappoose Vernonia Hwy	07/05/17 - 09/20/21	1055
14181750	ROCK CREEK NEAR MILL CITY, OR	10/07/05 - 01/04/09	1170

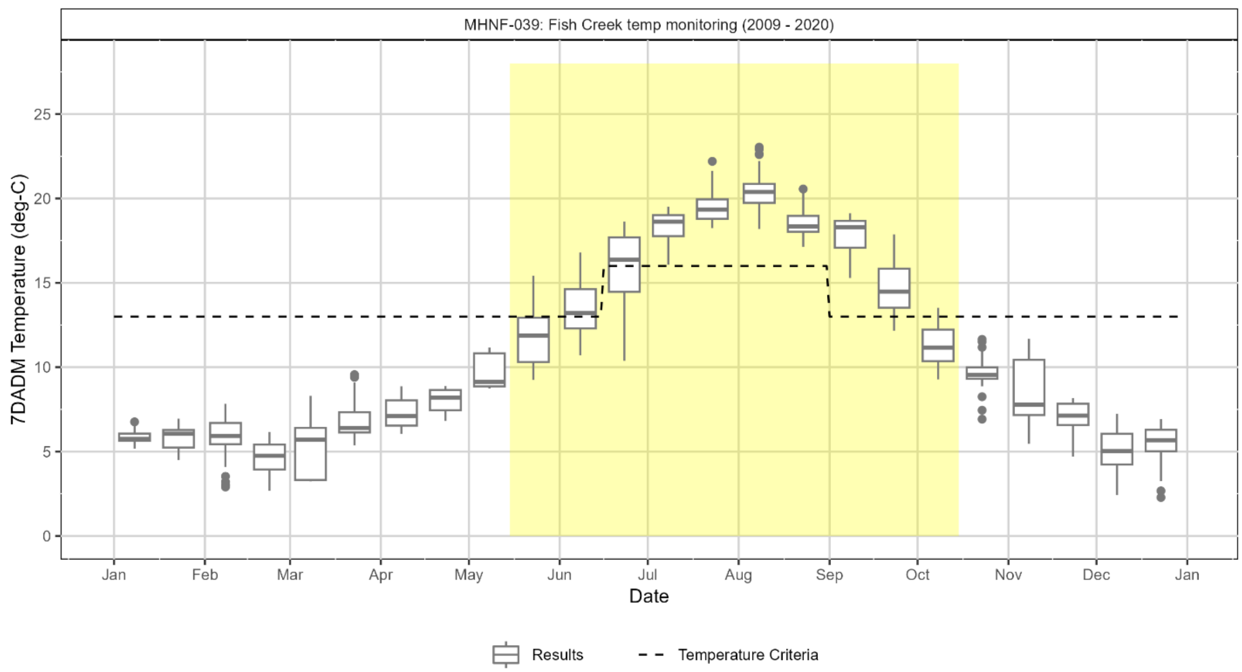


Figure 5-1: Seasonal variation and critical period at the Fish Creek temperature monitoring site in the Clackamas Subbasin.

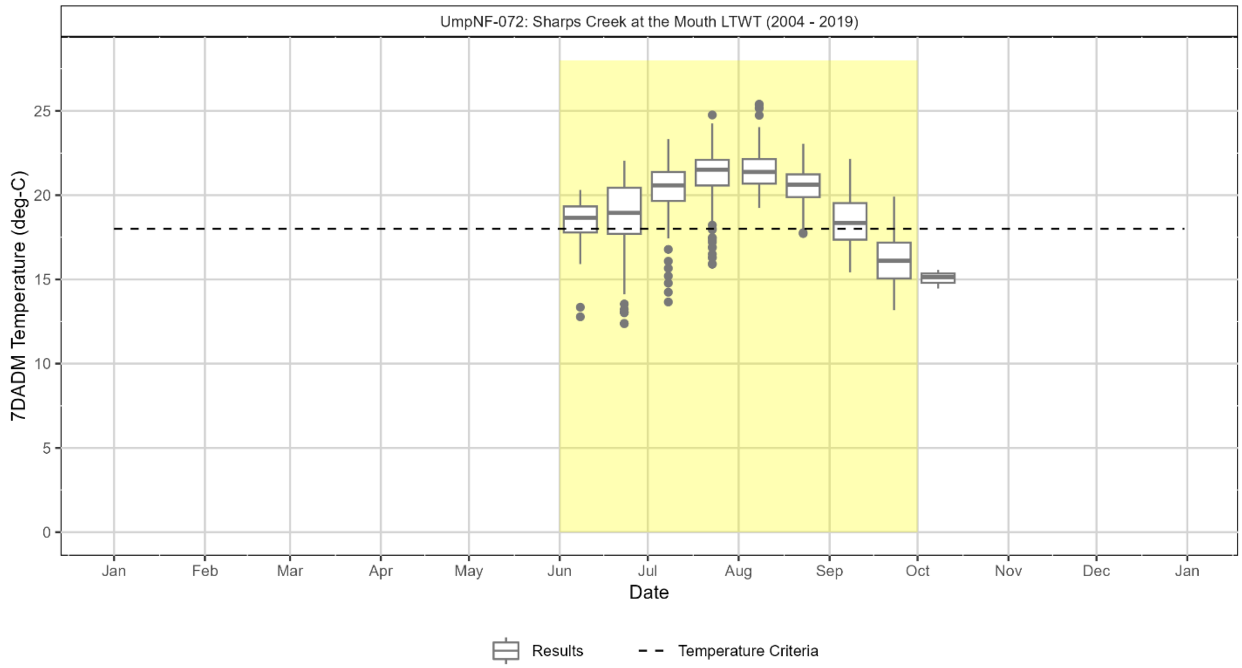


Figure 5-2: Seasonal variation and critical period at the Sharps Creek at mouth temperature monitoring site in the Coast Fork Willamette Subbasin.

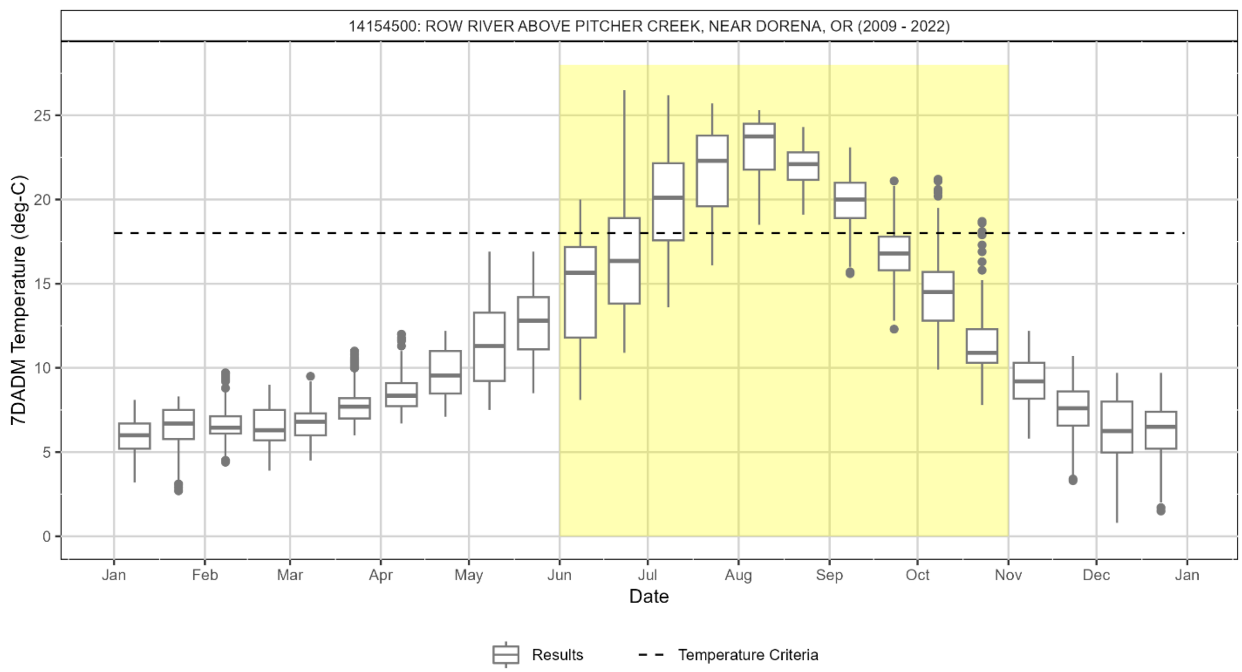


Figure 5-3: Seasonal variation and critical period at the Row River above Pitcher Creek temperature monitoring site in the Coast Fork Willamette Subbasin.

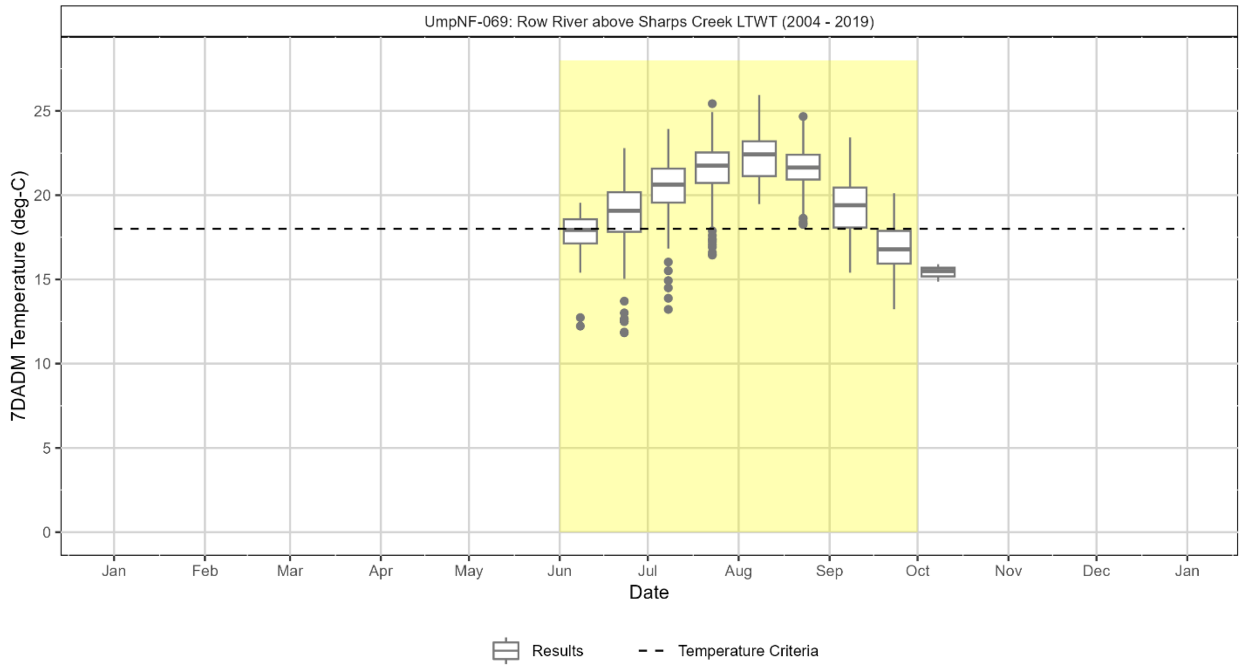


Figure 5-4: Seasonal variation and critical period at the Row River above Sharps Creek temperature monitoring site in the Coast Fork Willamette Subbasin.

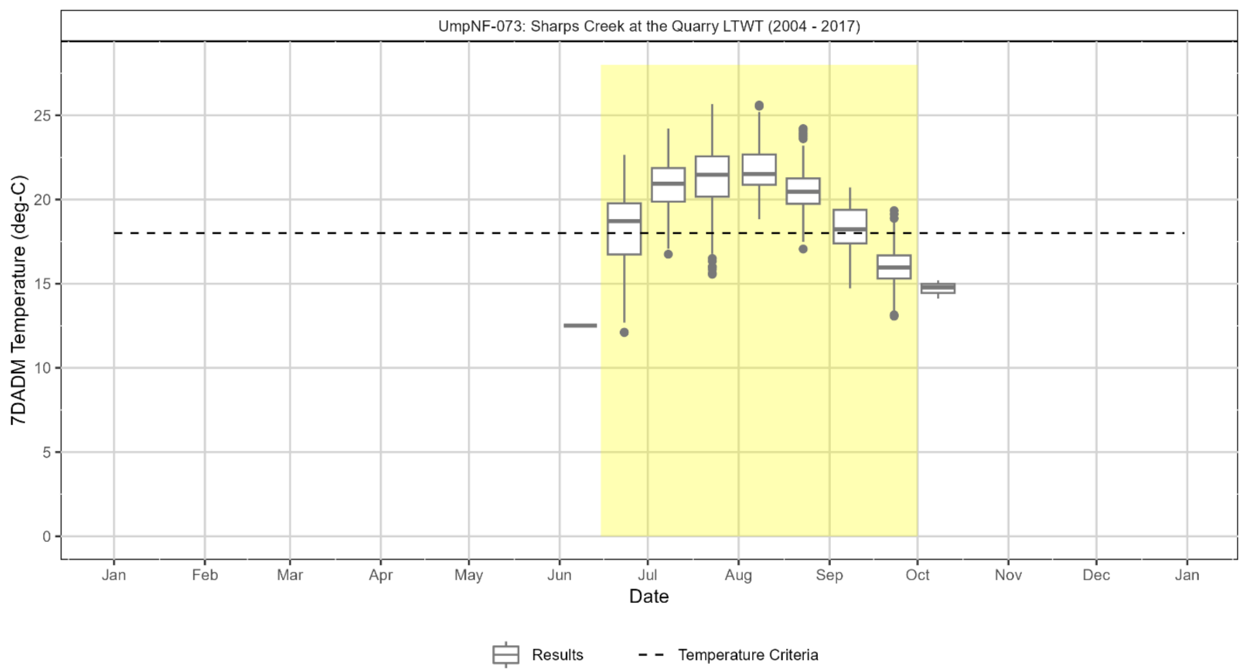


Figure 5-5: Seasonal variation and critical period at the Sharps Creek at quarry temperature monitoring site in the Coast Fork Willamette Subbasin.

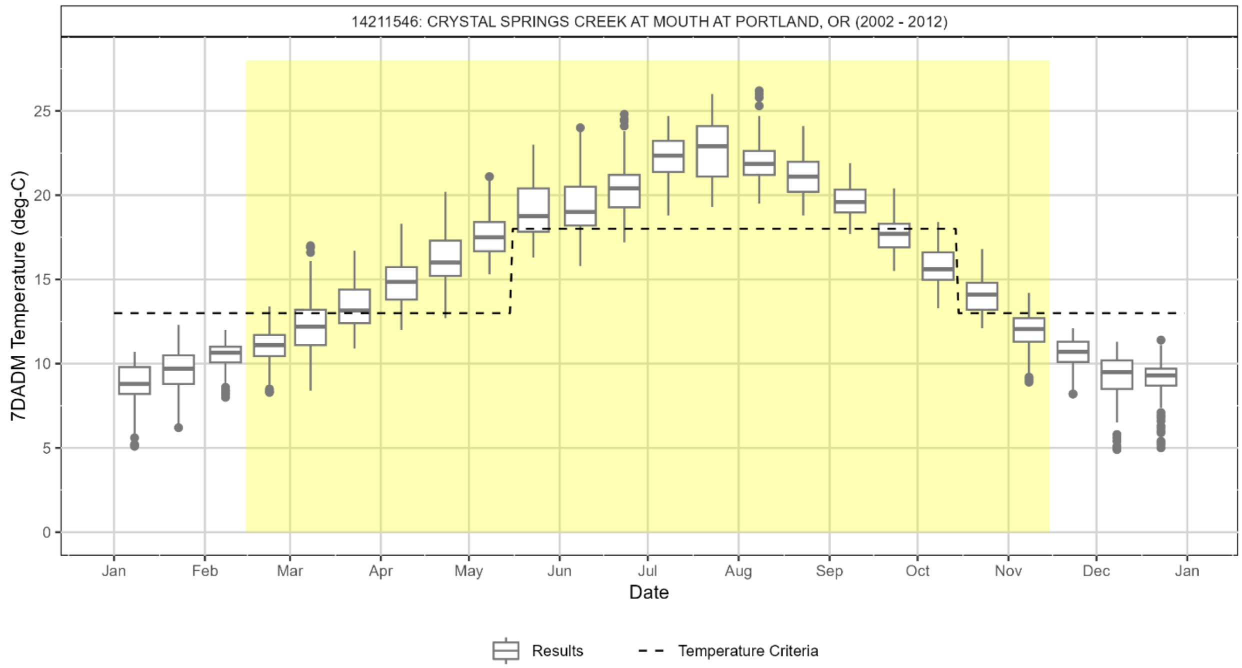


Figure 5-6: Seasonal variation and critical period at the Crystal Springs at mouth temperature monitoring site in the Johnson Creek Watershed (HUC 1709001201).

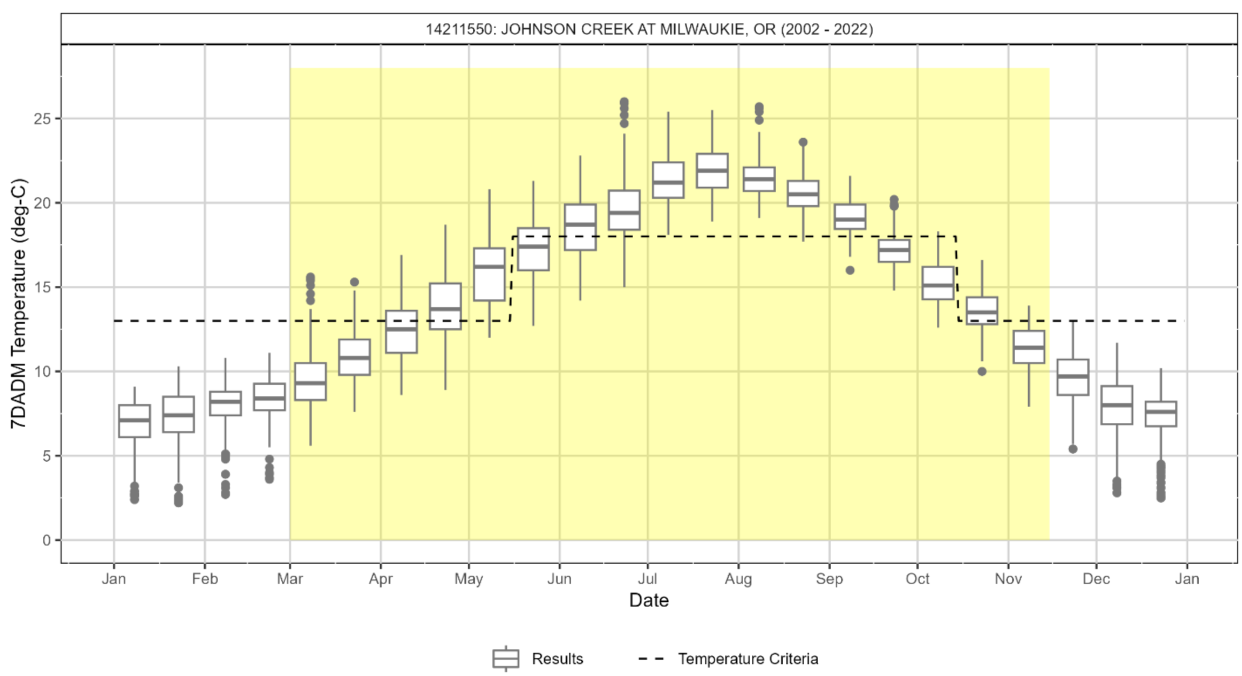


Figure 5-7: Seasonal variation and critical period at the Johnson Creek at Milwaukie temperature monitoring site in the Johnson Creek Watershed (HUC 1709001201).

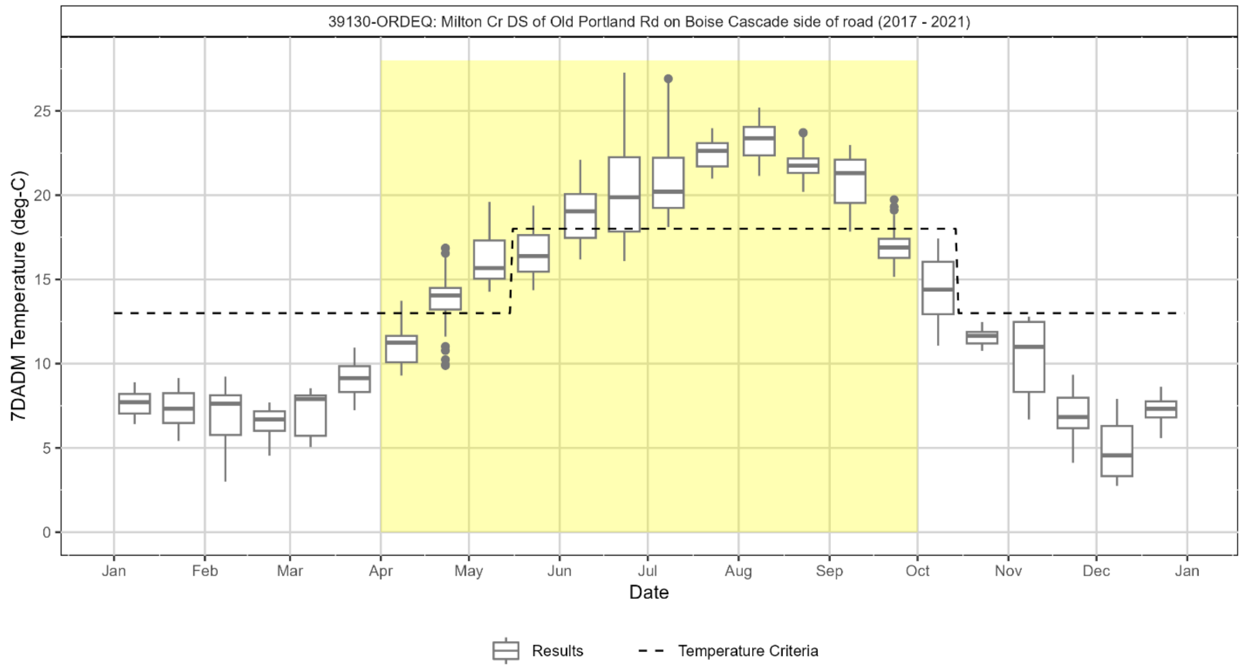


Figure 5-8: Seasonal variation and critical period at the Milton Creek upstream of Old Portland Road temperature monitoring site in the Lower Willamette Subbasin.

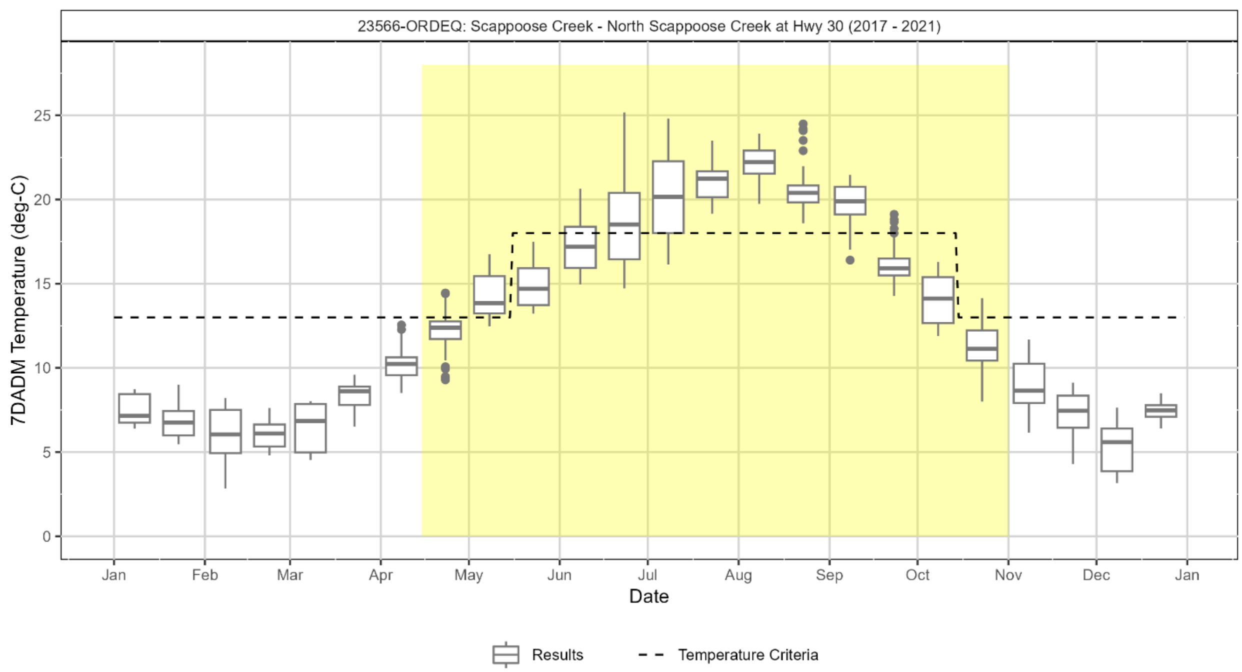


Figure 5-9: Seasonal variation and critical period at the North Scappoose Creek at Highway 30 temperature monitoring site in the Lower Willamette Subbasin.

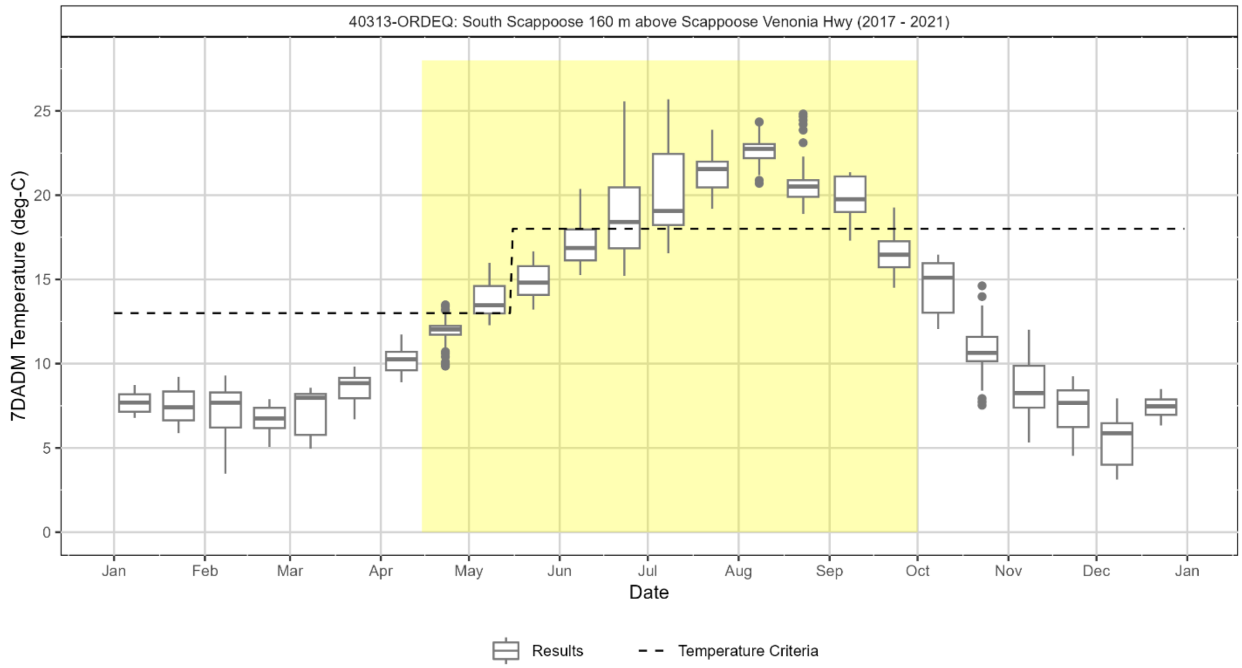


Figure 5-10: Seasonal variation and critical period at the South Scappoose Creek above Vernonia Highway temperature monitoring site in the Lower Willamette Subbasin.

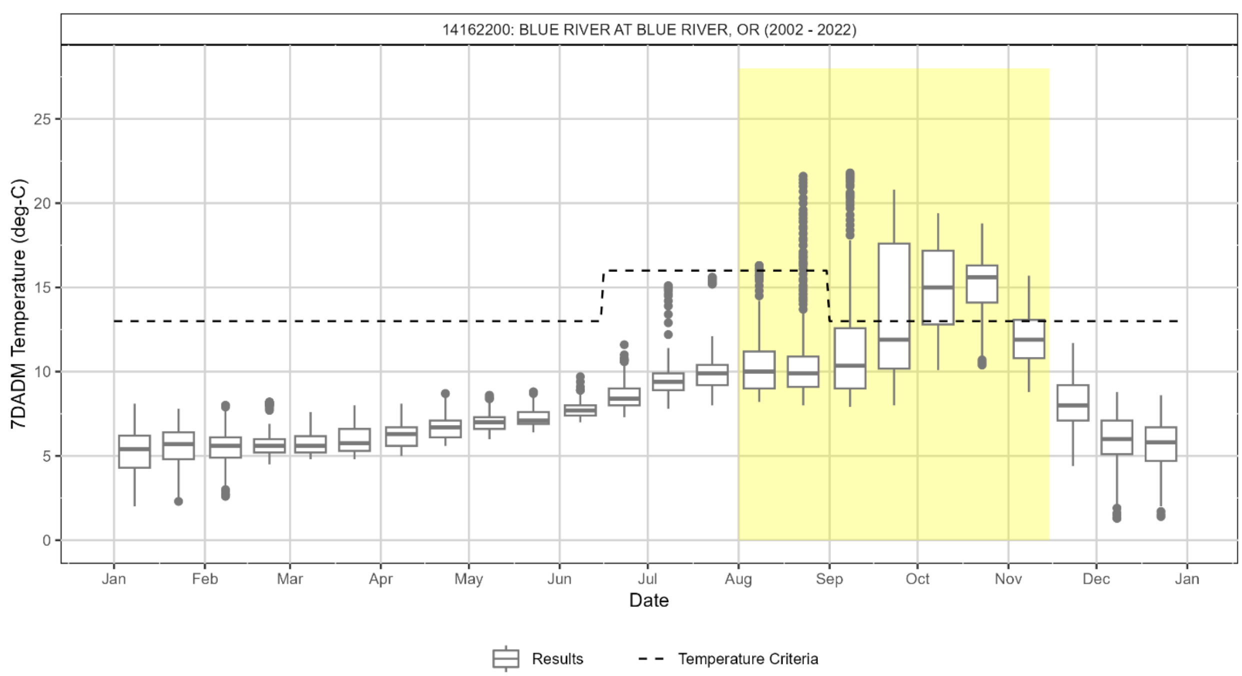


Figure 5-11: Seasonal variation and critical period at the Blue River at Blue River, Oregon temperature monitoring site in the McKenzie Subbasin.

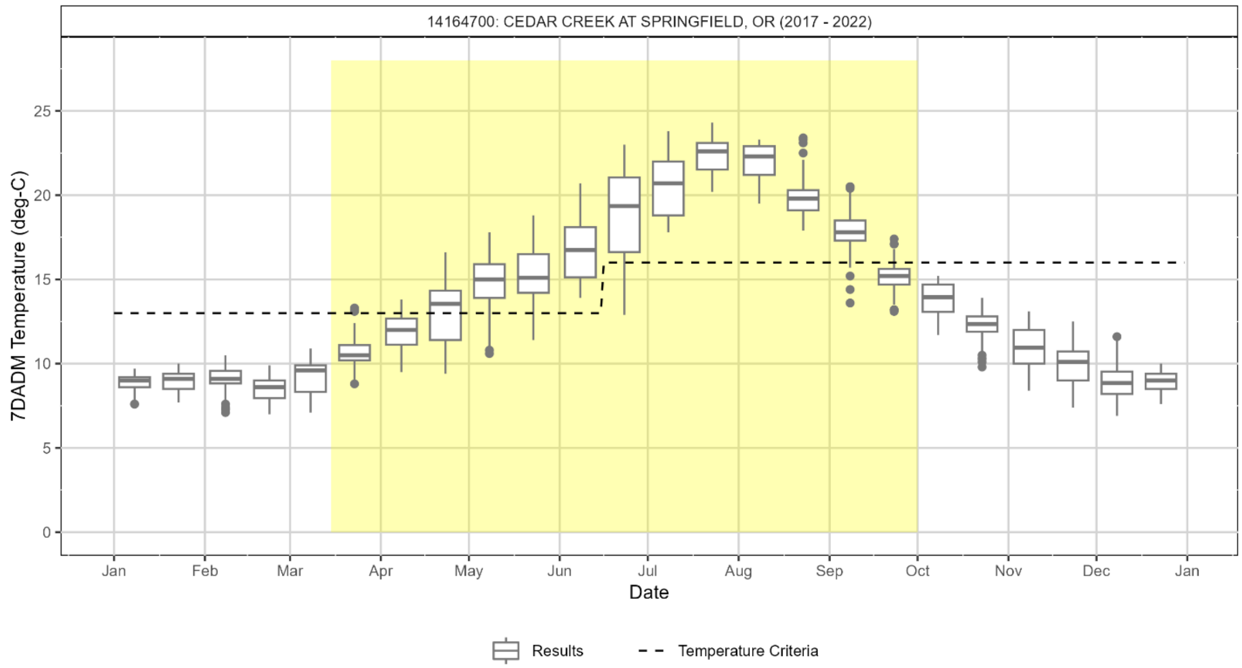


Figure 5-12: Seasonal variation and critical period at the Cedar Creek at Springfield, Oregon temperature monitoring site in the McKenzie Subbasin.

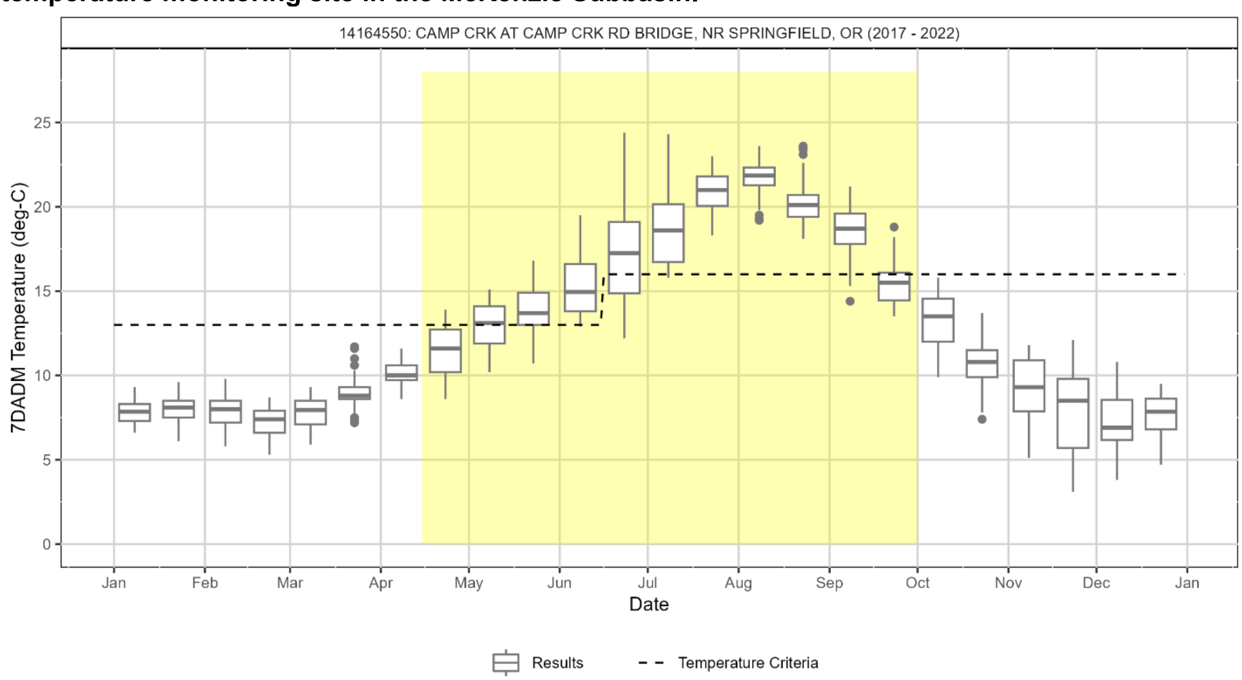


Figure 5-13: Seasonal variation and critical period at the Camp Creek at Camp Creek Road Bridge temperature monitoring site in the McKenzie Subbasin.

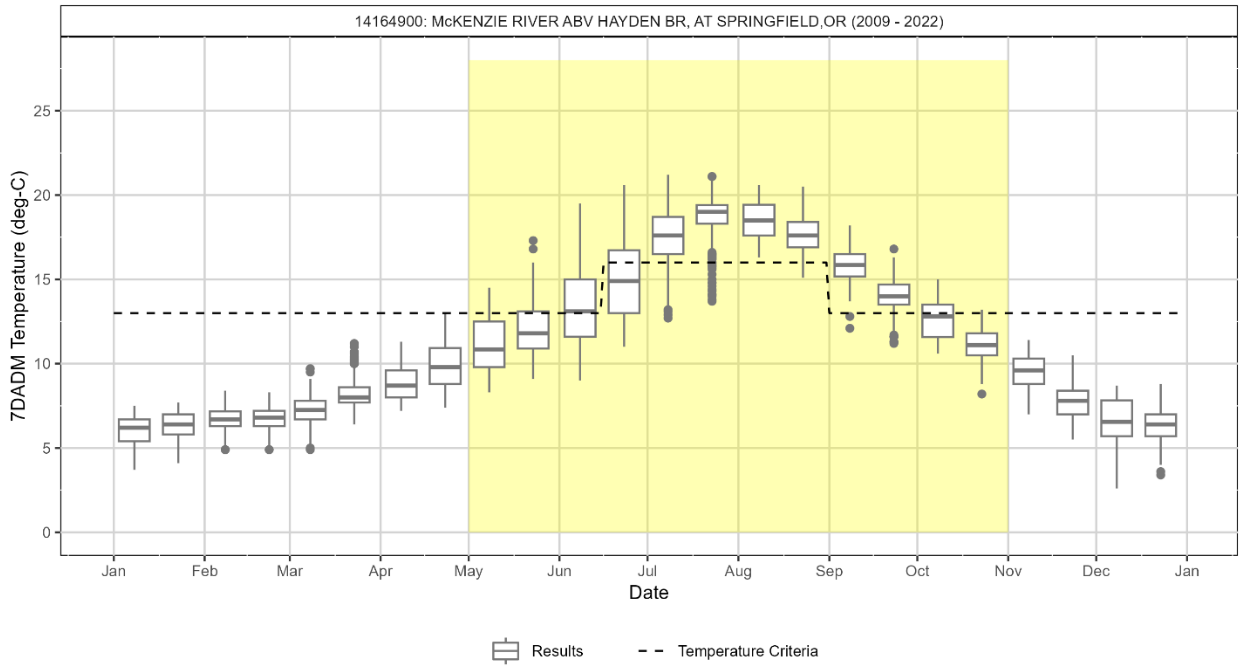


Figure 5-14: Seasonal variation and critical period at the McKenzie River above Hayden Bridge temperature monitoring site in the McKenzie Subbasin.

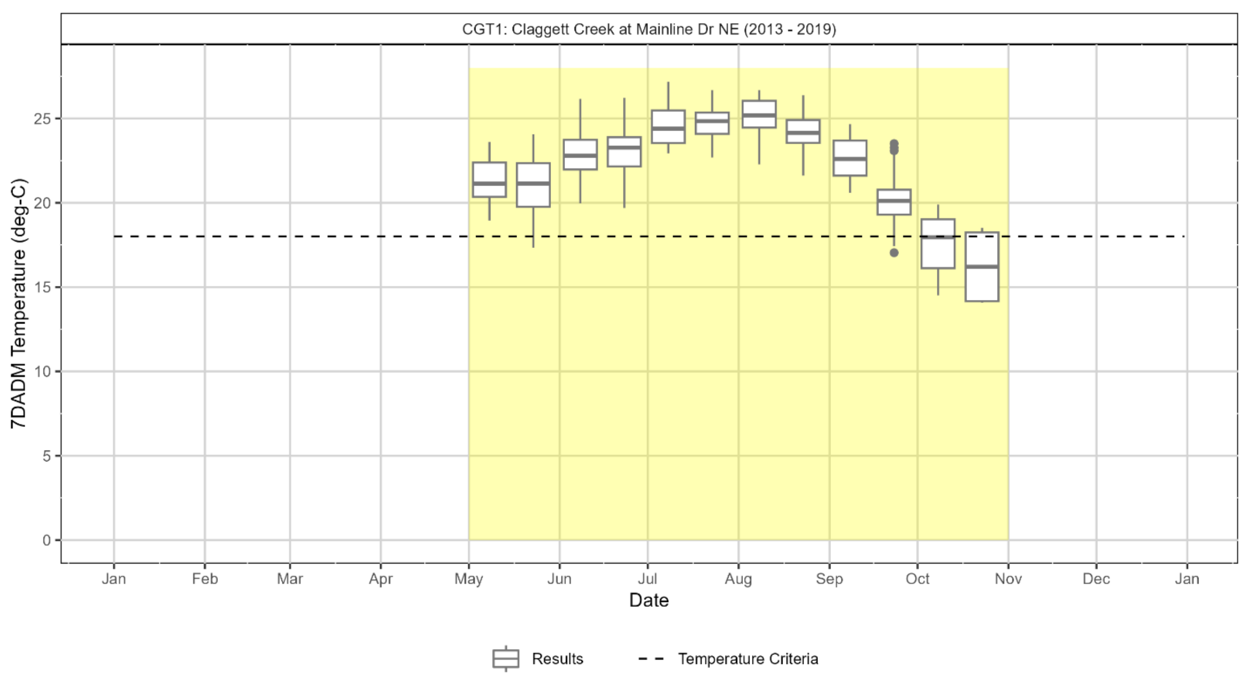


Figure 5-15: Seasonal variation and critical period at the Claggett Creek at Mainline Drive temperature monitoring site in the Middle Willamette Subbasin.

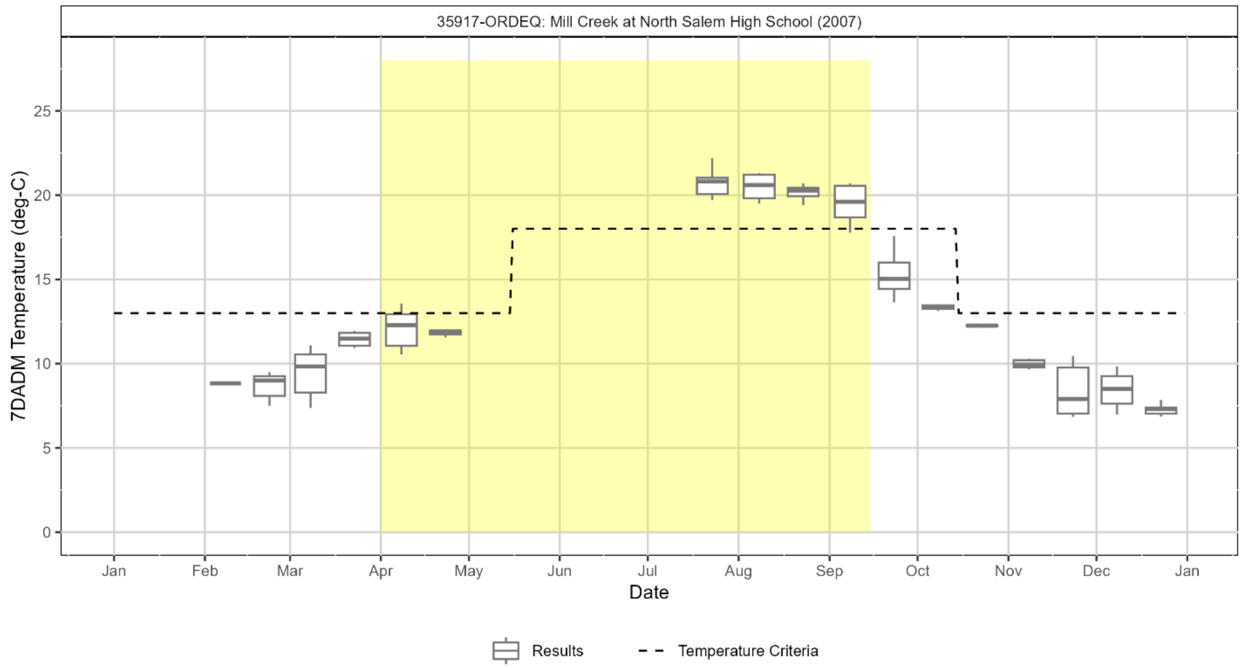


Figure 5-16: Seasonal variation and critical period at the Mill Creek at North Salem High School temperature monitoring site in the Middle Willamette Subbasin.

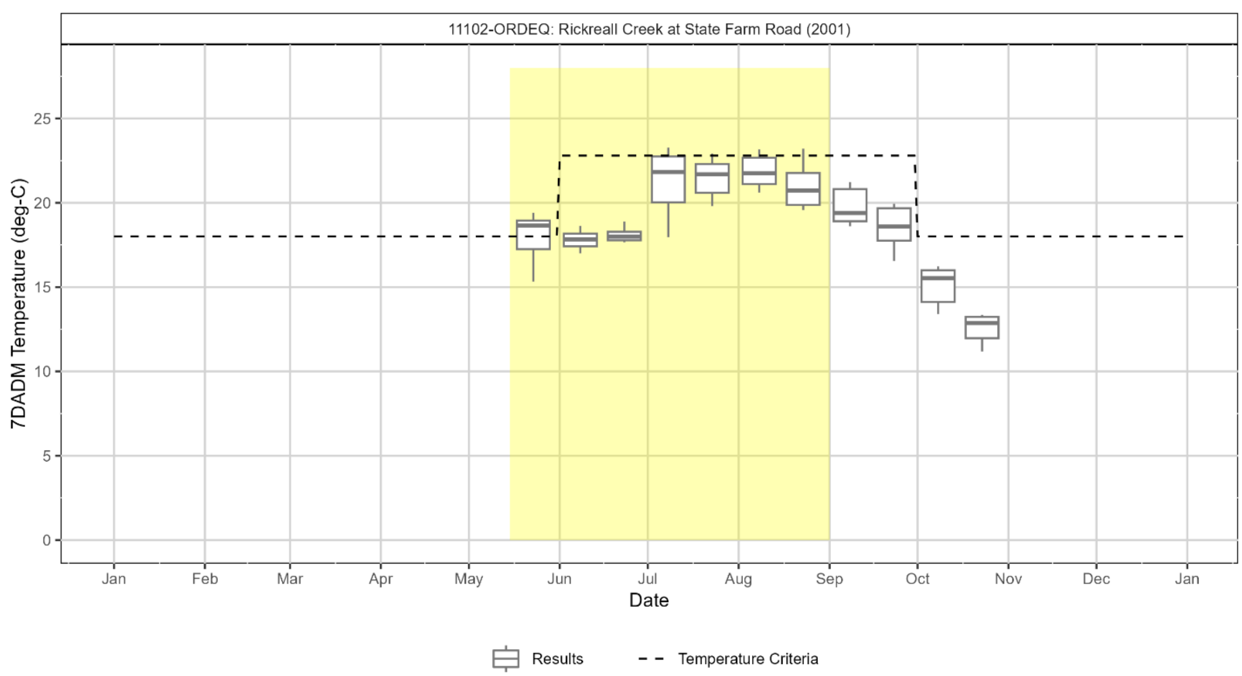


Figure 5-17: Seasonal variation and critical period at the Rickreall Creek at State Farm Road temperature monitoring site in the Middle Willamette Subbasin.

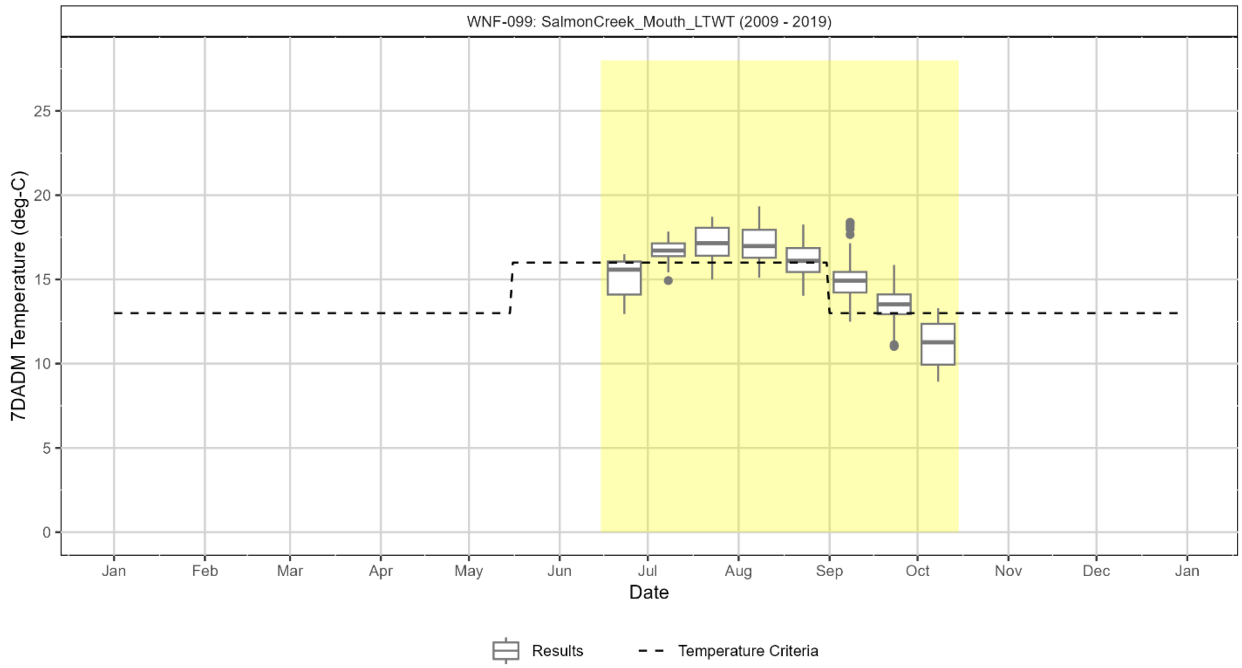


Figure 5-18: Seasonal variation and critical period at the Salmon Creek at mouth temperature monitoring site in the Middle Fork Willamette Subbasin.

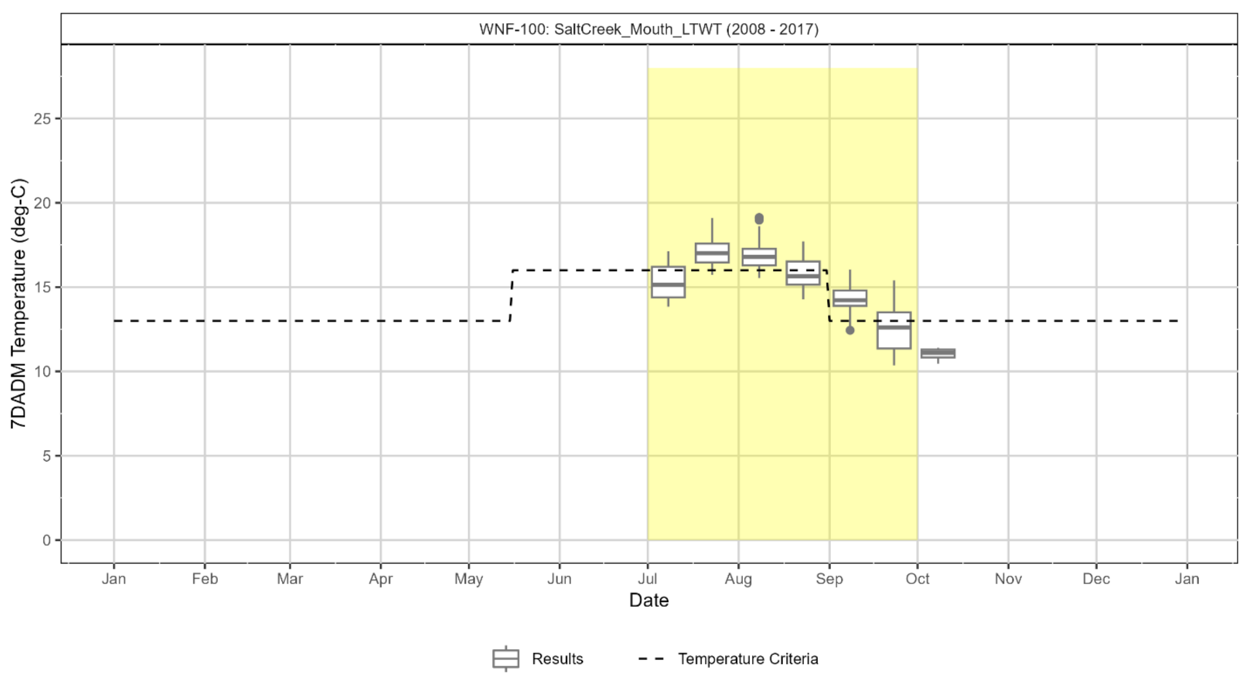


Figure 5-19: Seasonal variation and critical period at the Salt Creek at mouth temperature monitoring site in the Middle Fork Willamette Subbasin.

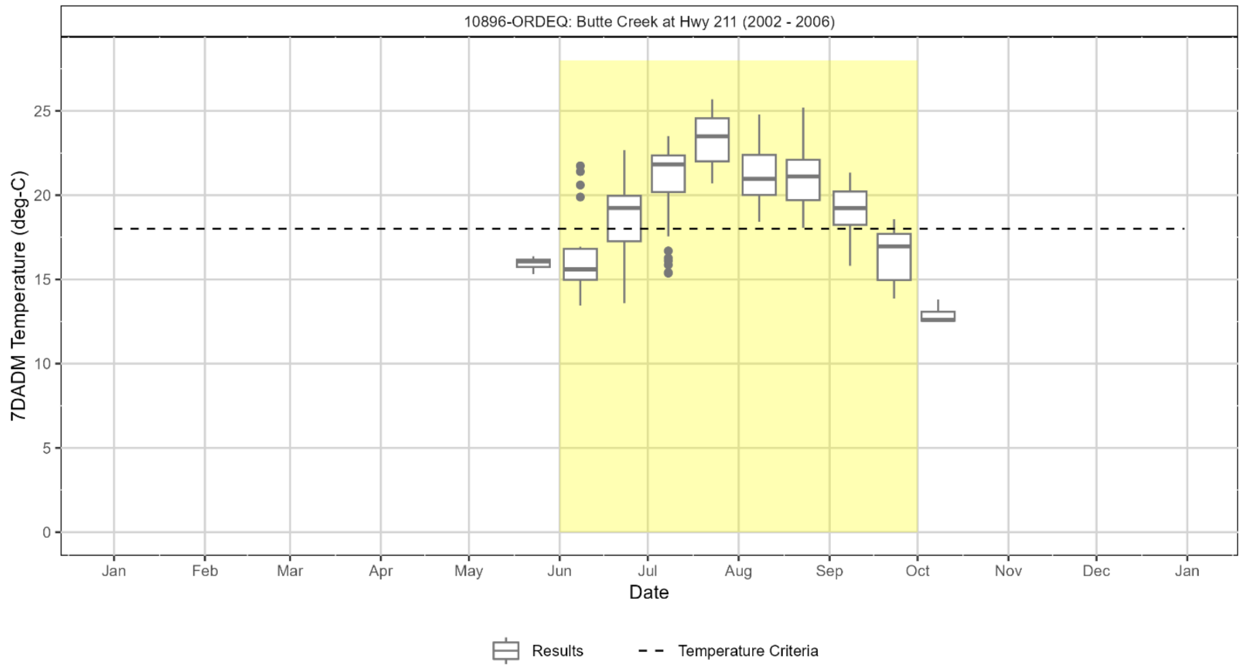


Figure 5-20: Seasonal variation and critical period at the Butte Creek at Highway 211 temperature monitoring site in the Molalla-Pudding Subbasin.

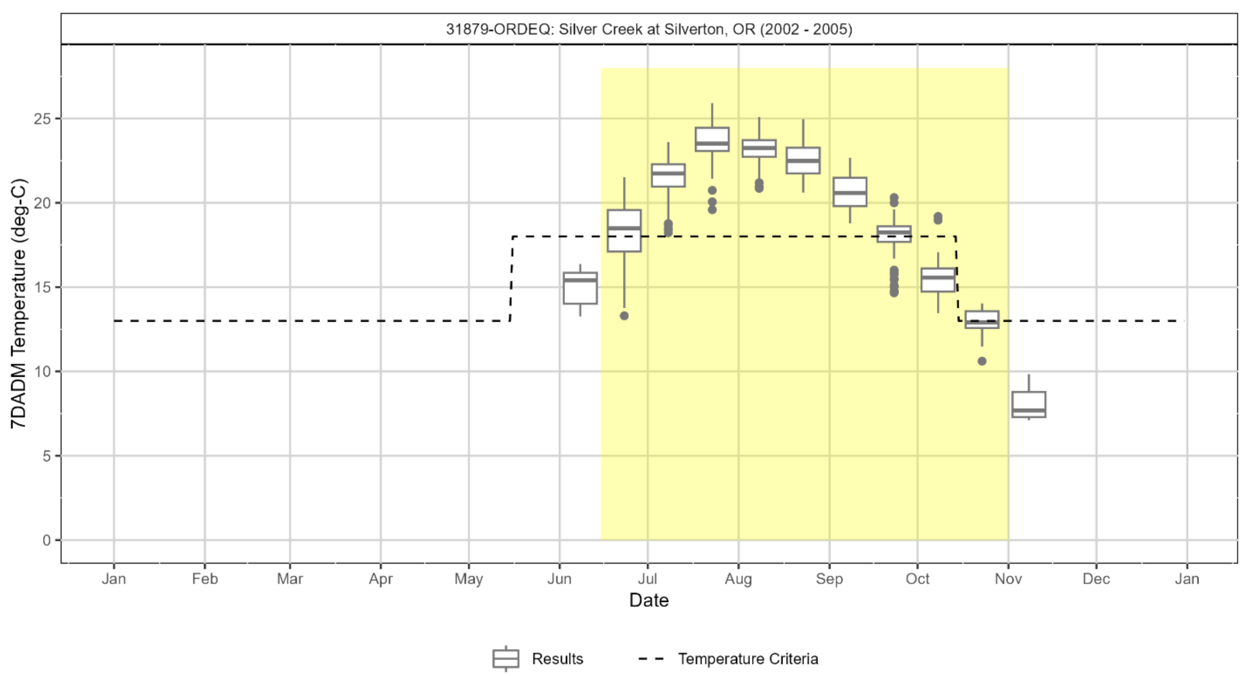


Figure 5-21: Seasonal variation and critical period at the Silver Creek at Silverton, Oregon temperature monitoring site in the Molalla-Pudding Subbasin.

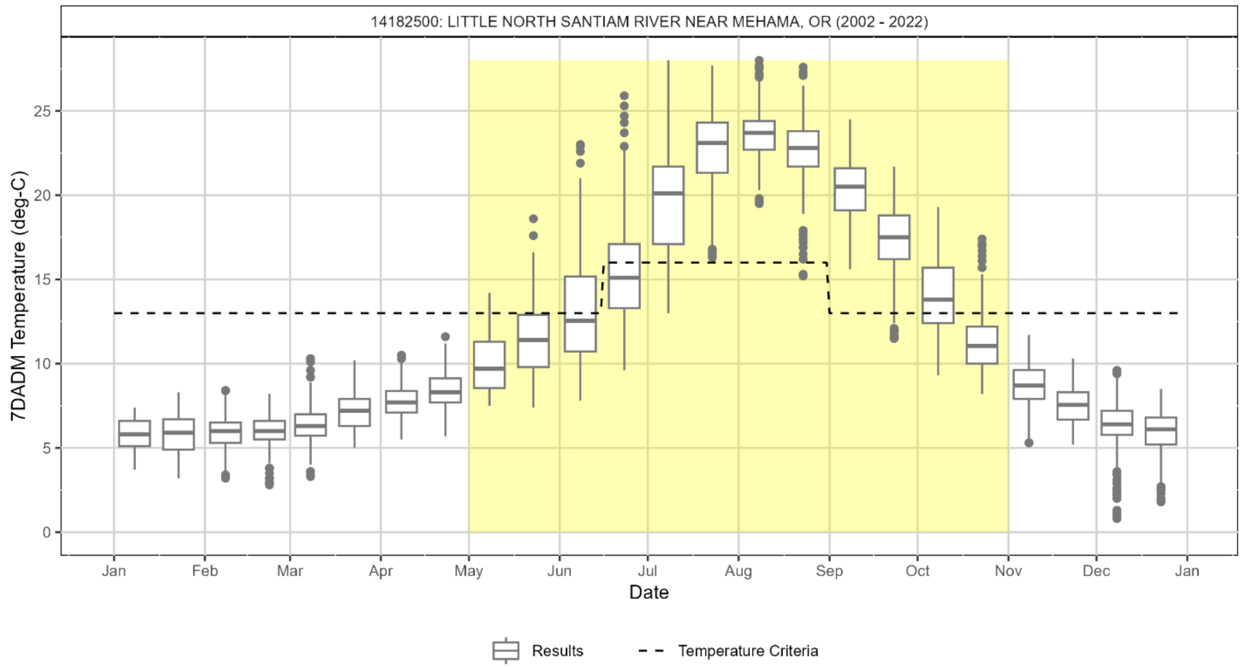


Figure 5-22: Seasonal variation and critical period at the Little North Santiam River near Mehama, Oregon temperature monitoring site in the North Santiam Subbasin.

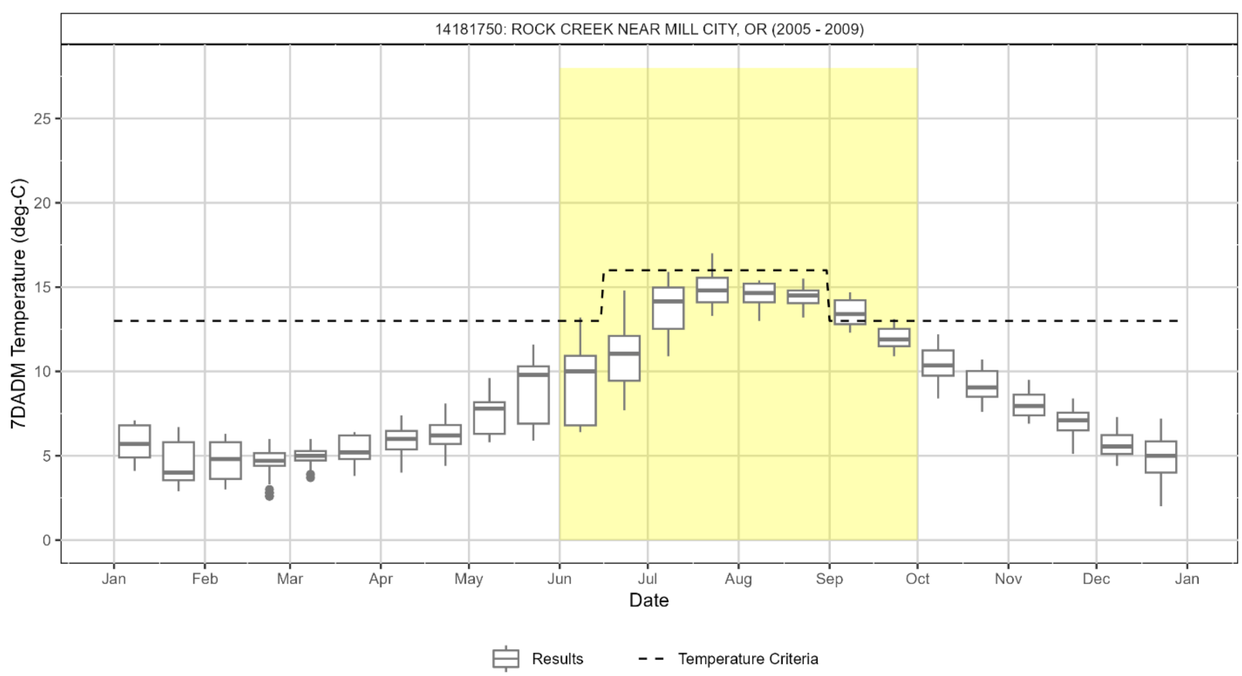


Figure 5-23: Seasonal variation and critical period at the Rock Creek near Mill City, Oregon monitoring site in the North Santiam Subbasin.

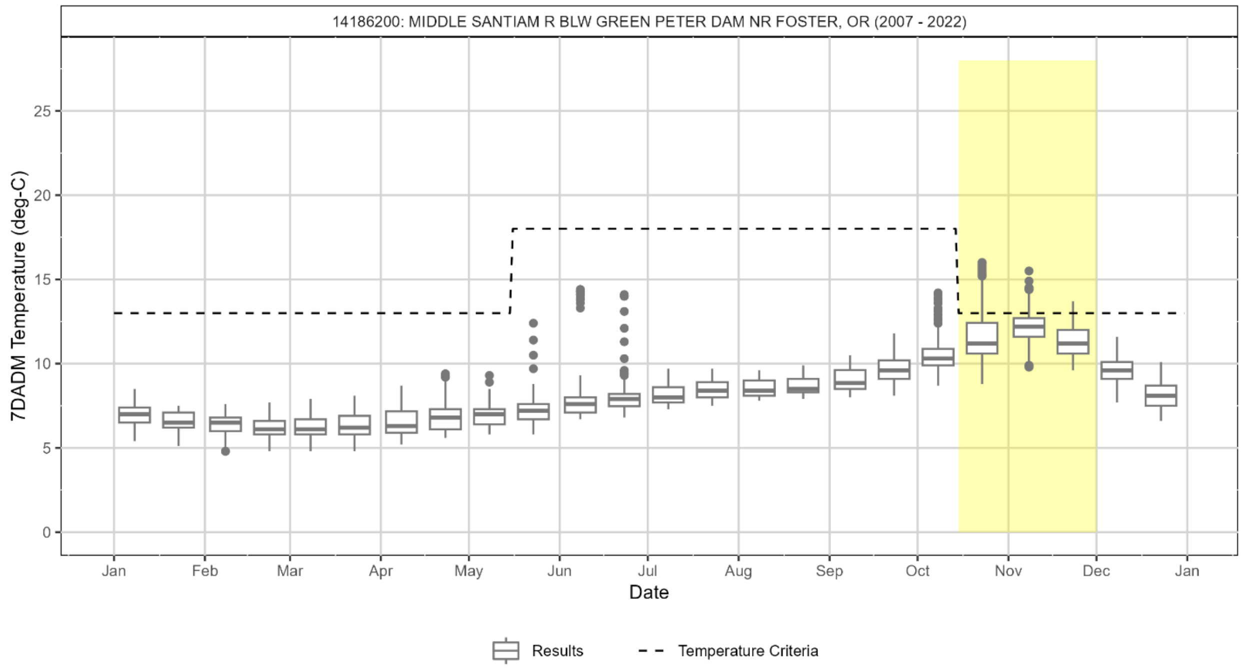


Figure 5-24: Seasonal variation and critical period at the Middle Santiam River below Green Peter Dam monitoring site in the South Santiam Subbasin.

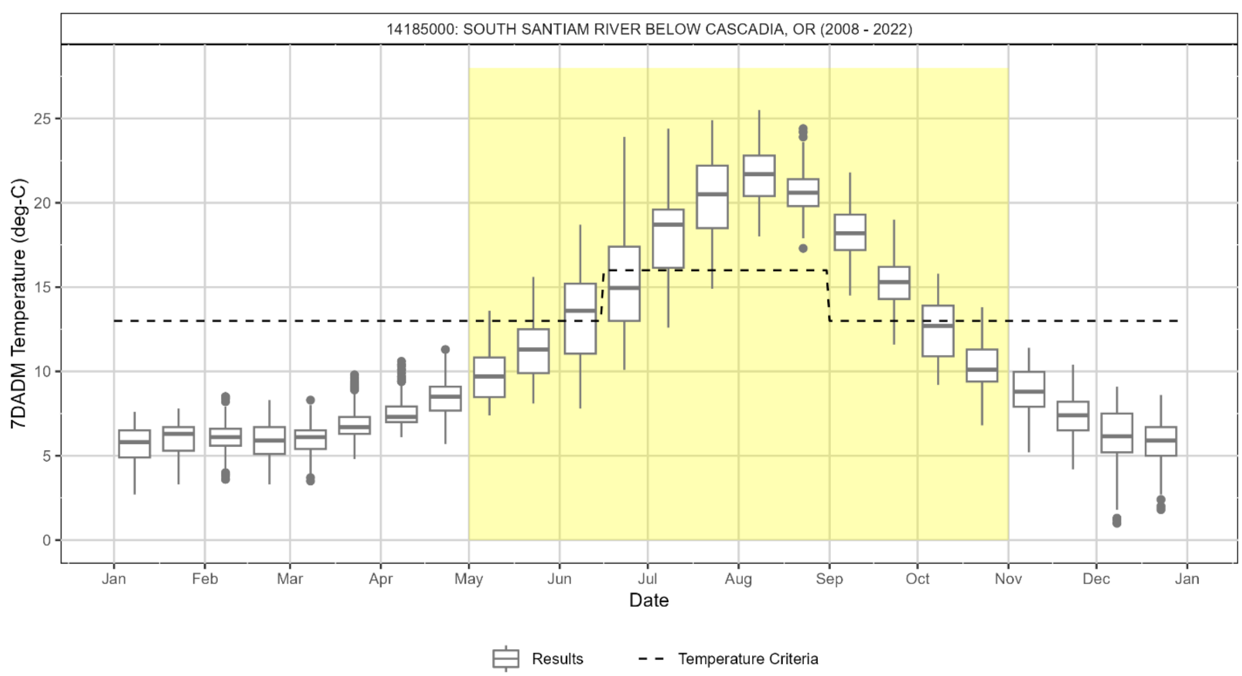


Figure 5-25: Seasonal variation and critical period at the South Santiam River below Cascadia, Oregon monitoring site in the South Santiam Subbasin.

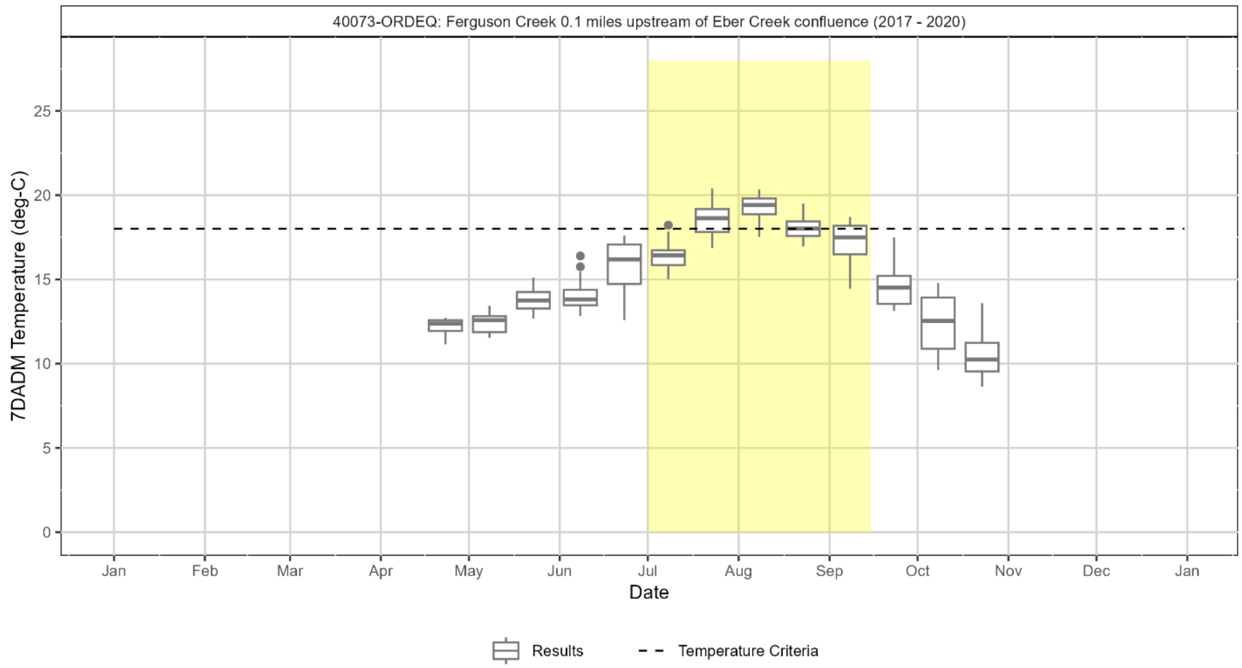


Figure 5-26: Seasonal variation and critical period at the Ferguson Creek upstream of Eber Creek confluence temperature monitoring site in the Upper Willamette Subbasin.

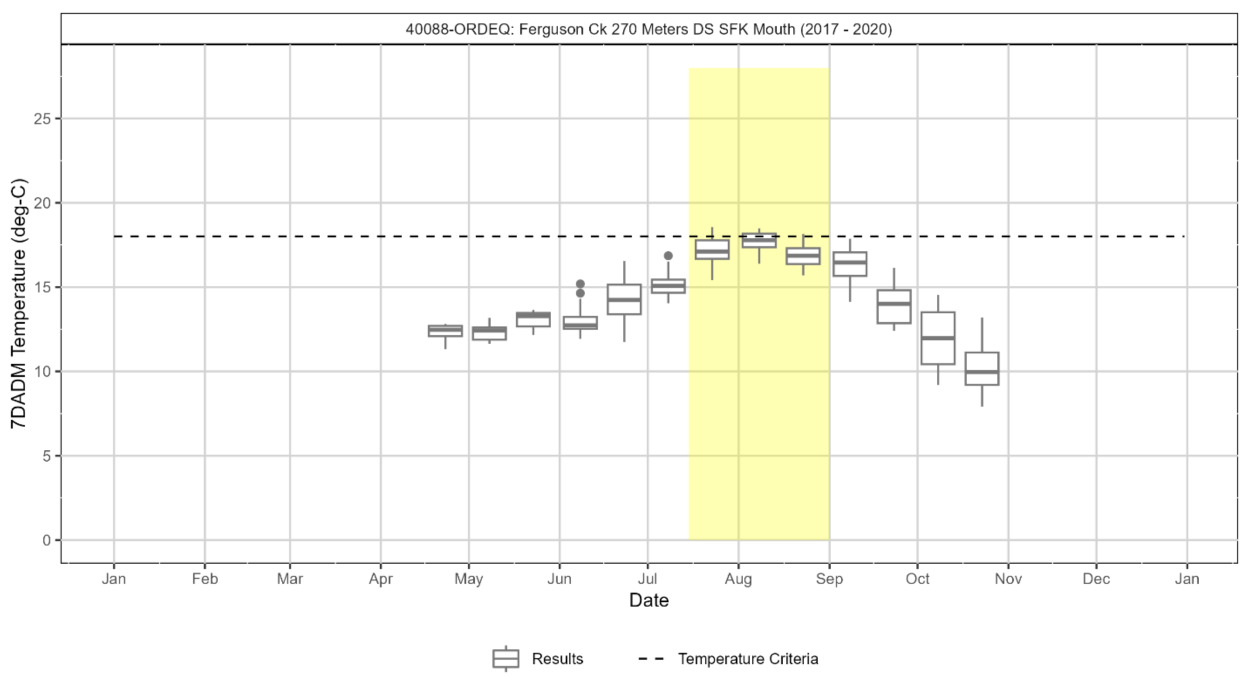


Figure 5-27: Seasonal variation and critical period at the Ferguson Creek downstream of South Fork Ferguson Creek temperature monitoring site in the Upper Willamette Subbasin.

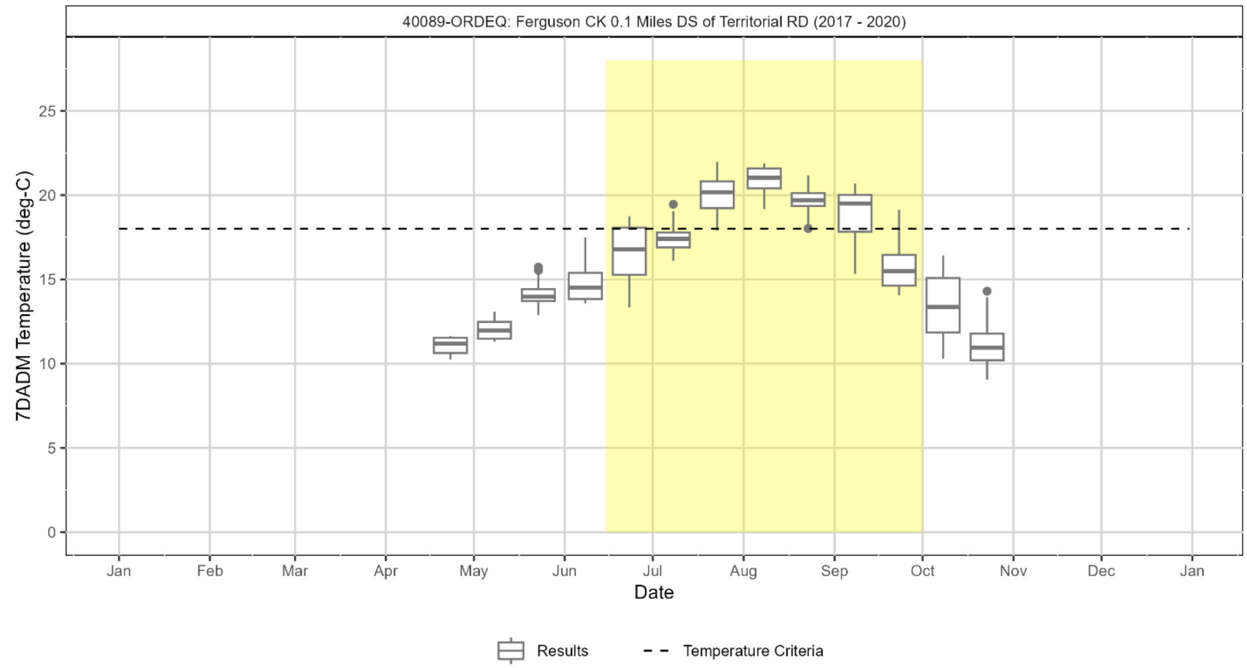


Figure 5-28: Seasonal variation and critical period at the Ferguson Creek downstream of Territorial Road temperature monitoring site in the Upper Willamette Subbasin.

6 Temperature water quality data evaluation and analyses

A critical TMDL element is water quality data evaluation and analysis to the extent that existing data allow. To understand the water quality impairment, assess potential pollutant sources, and evaluate the ability of various management scenarios in achieving the TMDL and applicable temperature water quality standards, the analysis requires a predictive component. DEQ uses models to evaluate potential stream warming sources and, to the extent existing data allow, their current and TMDL allocation pollutant loads. Heat Source and CE-QUAL-W2 models were used in this effort and are described in Appendices A-B of this document.

6.1 Analysis overview

The analysis framework needs for this project included the abilities to predict/evaluate hourly:

1. Stream temperatures spanning months at ≤500m longitudinal resolution.
2. Solar radiation fluxes and daily effective shade at ≤200m longitudinal resolution.
3. Stream temperature responses due to changes in:
    a. Streamside vegetation,
    b. Water withdrawals and upstream tributaries’ stream flow,
    c. Channel morphology,
    d. Effluent temperature and flow discharge from NPDES permitted facilities.

Figure 6-1 provides an overview of the type of analyses completed for this TMDL. Water quality models were used to support analysis on many streams. These models have specific input and calibration data requirements. Data types and how they supported the TMDL analysis are summarized in Figure 6-1 and are described more fully in Appendix A, Appendix B and Appendix J. All data are available to the public with a public records request.

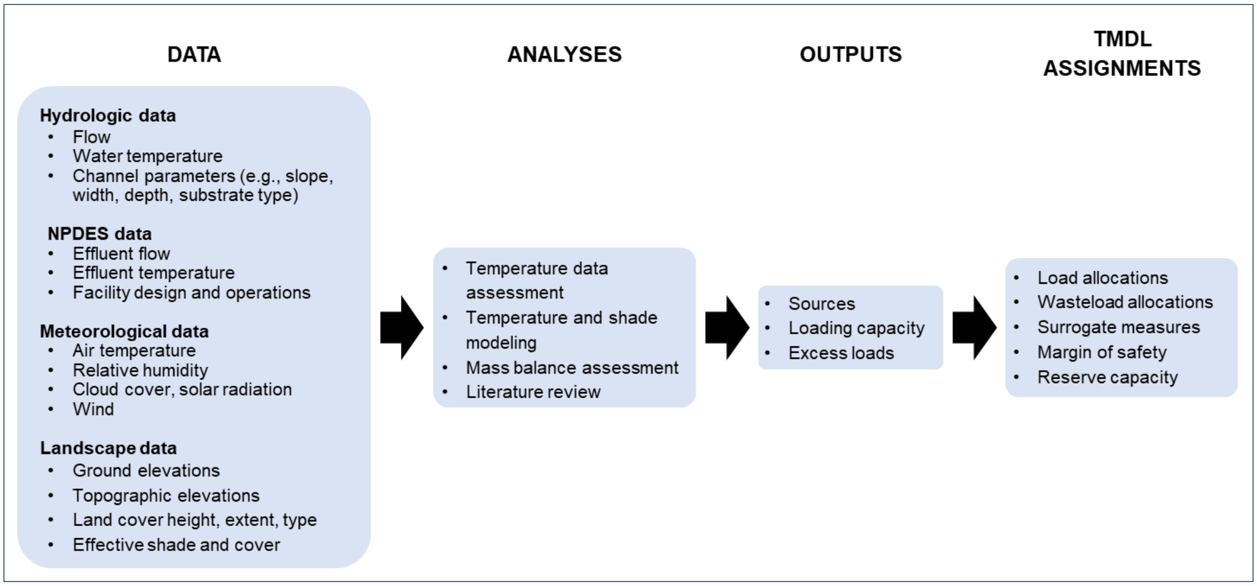


Figure 6-1: Willamette Subbasins temperature analysis overview.

6.2 Data overview

As illustrated in Figure 6-1, data for numerous hydrologic, meteorologic, and landscape/ geographic parameters within the spatial and temporal boundaries of the TMDL are required to conduct effective analysis for TMDL development. Section 2 of Appendix B to this document describes these parameters, their applications in this TMDL development, and provides information on the specific datasets and sources utilized for this effort. All data are available upon request.

Table 6-1: Data types used in the Willamette River Subbasins Temperature TMDL modeling.

Data Source Type	Dataset Types	Data Sources
Field-acquired	• Continuous stream temperature • Stream flow rate: continuous & instantaneous • Point source discharge temperatures & flows	DEQ Ambient Water Quality Monitoring System (AWQMS); USGS National Water Information System (NWIS); DEQ data solicitation responses; NPDES Discharge Monitoring Reports
GIS and/or remotely sensed	• 3-ft Digital Elevation Model (DEM) • Light Detection and Ranging (LiDAR) • Aerial imagery: Digital Orthophoto Quads (DOQs) • Thermal Infrared Radiometry (TIR) temperature data	Oregon Department of Geology and Mineral Industries (DOGAMI); Oregon LiDAR Consortium (OLC); Watershed Sciences, Inc.
Derived from above data types via: (a) quantitative methods or (b) proxy substitution (for	• Stream position, channel width, channel bottom width, elevation, gradient • Topographic shade angles • Land cover mapping • Tributary flows & temperatures	DEMs, LiDAR, DOQs (for stream morphology, land cover, topography, & geography); USGS StreamStats, historical data, proxy site data, estimated

certain tributary flows & temps.)		data (for tributary flows & temperatures if direct monitoring data were unavailable)

6.3 Model setup and application overview

As described in the Technical Support Document model report appendices (Appendix A, Appendix B, and Appendix J), DEQ and partners set up and calibrated temperature and shade models for numerous streams in the Willamette Subbasins (Figure 6-2). Temperature models were developed for:

- Johnson Creek (Lower Willamette Subbasin)
- Molalla River (Molalla-Pudding Subbasin)
- Pudding River (Molalla-Pudding Subbasin)
- Little North Santiam River (North Santiam Subbasin)
- Thomas Creek (South Santiam Subbasin)
- Crabtree Creek (South Santiam Subbasin)
- Luckiamute River (Upper Willamette Subbasin)
- Mohawk River (McKenzie Subbasin)
- McKenzie River (McKenzie Subbasin)
- Coyote Creek (Upper Willamette Subbasin)
- Mosby Creek (Coast Fork Willamette Subbasin)

Shade models were developed for:

- Select streams in the Lower Willamette Subbasin including Columbia Slough, Tryon Creek, and Johnson Creek Watersheds, and streams that flow to the Willamette River and Multnomah Channel on the west side of the Tualatin Mountains in the Balch Creek-Willamette River subwatershed (170900120202) and Multnomah Channel subwatershed (170900120305)
- Streams in the Southern portion of the Willamette Basin where LiDAR data were available.

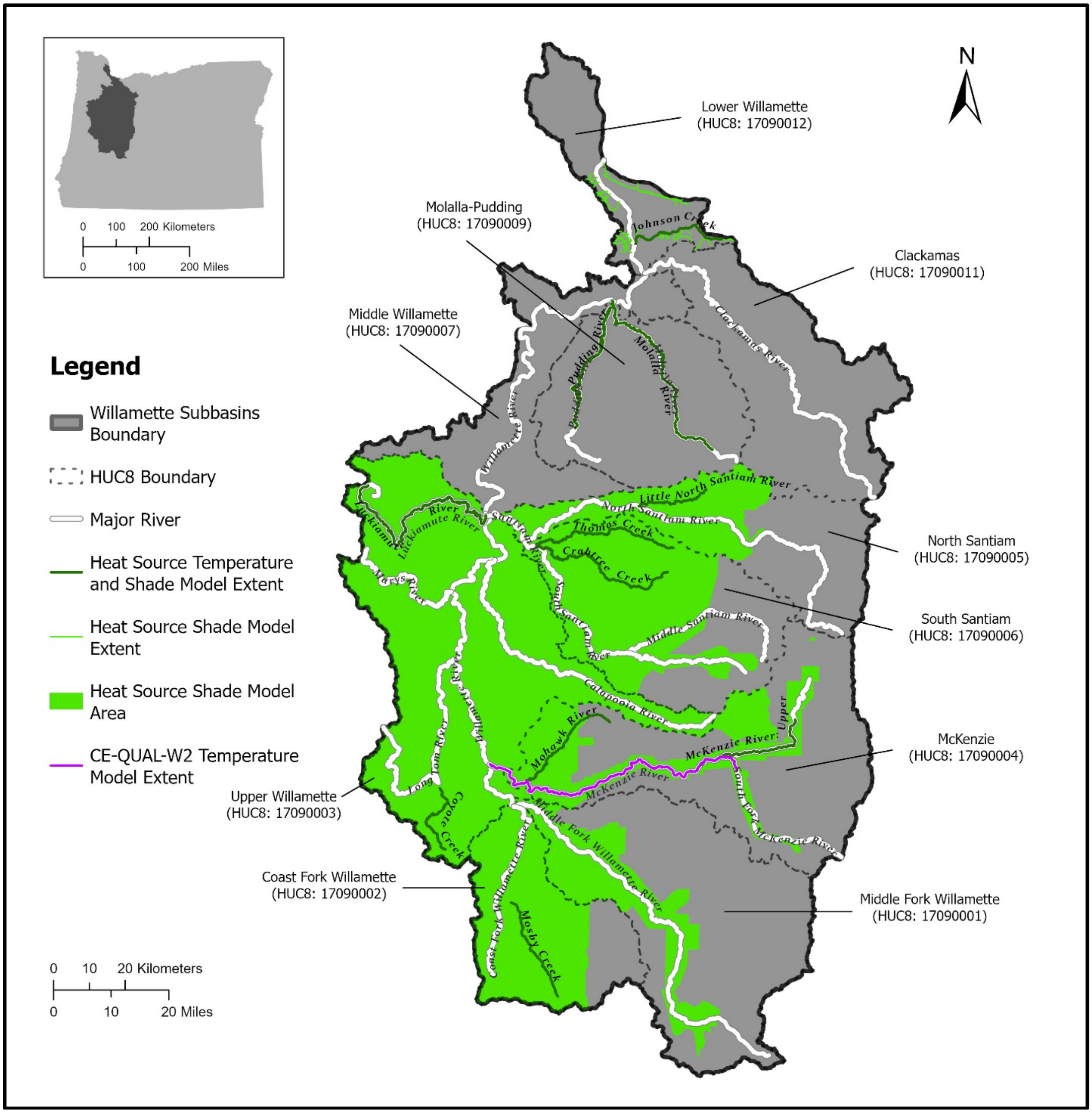


Figure 6-2: Overview of TMDL project area and model extents.

The setup and calibration for these models was completed by DEQ for the Willamette Basin TMDL and WQMP (DEQ, 2006) and Molalla-Pudding Subbasin TMDL (DEQ, 2008). During development, the models were adjusted iteratively until acceptable goodness-of-fit was achieved relative to the observed current conditions. DEQ did not make adjustments to the original calibrated temperature models with the exception of a minor correction to the meteorological inputs on Johnson Creek. The Heat Source shade models and the CE-QUAL-W2 temperature model on the lower McKenzie River are new to this TMDL and were not available for the 2006 TMDL. DEQ and City of Portland developed the shade models. USGS developed the calibrated McKenzie River CE-QUAL-W2 model (Stratton et al, 2022).

Adjustments were made to the various model scenarios developed for the 2006 and 2008 TMDL with some new scenarios developed. The adjustments were principally focused on updating point source effluent discharge inputs based on more recent data, adding new sources, removing sources no longer discharging, and assessment of various management scenarios such as changes in riparian conditions and water withdrawal rates.

The results of these models were used in tandem with applicable temperature criteria to complete a source assessment and cumulative effects analysis, determine TMDL allocations and surrogate measures that attain the applicable temperature criteria, and develop information that will support TMDL implementation and development of the TMDL Water Quality Management Plan. It was not possible to model all waters with a temperature listing, so the determination of sources and source categories is principally based on the findings from the streams that were modelled or were assessed using available data. Results from the modeled reaches and reaches with available data are relevant in the larger watershed context.

A summary of the source assessment finding can be found in Section 7. The detailed model calibration and scenario results are provided in the Technical Support Document model report appendices (Appendix A, Appendix B, and Appendix J).

6.4 The 7Q10 low-flow statistic

The “7Q10” is a summary low-flow statistic equal to the lowest seven-day average flow that occurs once every ten years (on average). For the Willamette River Subbasins temperature TMDL, estimated 7Q10s were used to calculate numeric loading capacities and allocations. DEQ calculated annual 7Q10s for temperature-impaired streams in the Willamette River Subbasins (Table 6-2), and for the receiving waterbodies that have NPDES permitted discharges with a wasteload allocation (Table 6-3).

The 7Q10 estimates were based on the following approaches:

1) If sufficient daily mean flow data from USGS or OWRD gaging stations were available for a given waterbody, 7Q10 estimates were calculated using these data. Available flow data were retrieved for up to a 30-year period (October 1, 1992 to September 31, 2022). DEQ relied on quality control protocols implemented by USGS and OWRD. Only data with a result status of “Approved” (USGS) or “Published” (OWRD) were included in 7Q10 calculations. 7Q10s were calculated by the method of EPA’s DFLOW program (Rossman, 1990), which computes extreme design flows using the log-Pearson Type III probability distribution. A minimum of 10 years of flow data were used with some exceptions. For ungaged locations, if there were sufficient gage data from confluent streams, 7Q10s were estimated from (a) the sum of daily mean flows (for upstream gages), or (b) the difference of mean daily flows (for downstream gages), prior to application of the DFLOW procedure.

2) If insufficient daily mean flow data from USGS and OWRD stream flow gaging stations were available, the web-based tool StreamStats (USGS, 2019) was used to estimate 7Q10s. Details of StreamStats are described below.

3) 7Q10s calculated and reported elsewhere (e.g., consultant studies, water quality permits, TMDLs) may have been used. In such cases, DEQ relied on the source’s data quality.

4) For tidally influenced streams, DEQ reviewed each situation and made 7Q10 estimates based on the best available data from the relevant gaging stations. Methods are described for each case.

StreamStats version 4 is a web-based geographic information system (GIS) application developed by the USGS (https://streamstats.usgs.gov/ss/). StreamStats has a map-based interface that allows the user to determine drainage area delineations, basin characteristics, and estimates of stream flow statistics for user-selected locations along available streams. The program also provides users with access to stream monitoring data by selecting USGS data-collection stations in the map application and providing access to flow statistics and other information for the stations. StreamStats provides estimates of various stream flow statistics for user-selected sites by solving site-specific regression equations. The regression equations were developed through a process, known as regionalization, which involves use of regression analysis to relate stream flow statistics computed for a group of selected stream gages (usually within a state) to basin characteristics measured for the stream gages. Basin characteristics are used to obtain estimates of the stream flow statistics for ungaged sites.

StreamStats regression equations for Oregon were developed by Cooper (2005) and Risley et al. (2008). These equations were based on basin characteristics and flow statistics (e.g., historical percentile flow-exceedance values and annual and monthly 7Q10). Flow statistics were computed at 466 gaging stations across Oregon and proximal out-of-states areas. This study area was divided into 10 regions based on ecological, topographic, geologic, hydrologic, and climatic criteria. StreamStats includes 910 annual and monthly regression equations to estimate 7Q10s for ungaged stream sites in the 10 aforementioned regions. These equations were developed for unregulated streams (without major dams, constructed reservoirs, catchment development, or significant diversions/withdrawals). If the equations are applied to ungaged streams subject to such influences, the resultant estimates may require adjustment to approximate actual flows.

The StreamStats user selects a stream location of interest and the program estimates the associated drainage area and summary flow statistics. For this TMDL, DEQ's procedure specified that selected stream locations should be the most downstream location on each stream for which DEQ required flow estimates; the exception was if DEQ required 7Q10 estimates for NPDES permitted point source receiving waters, in which case the selected stream location was immediately upstream of the point source outfall. StreamStats also estimates basin characteristics for the selected catchment, including drainage area, mean annual precipitation, mean slope, and climatic characteristics (Cooper, 2005; Risley et al., 2008). If estimates are outside suggested parameter ranges, the warning message "extrapolated with uncertainty" appears in the StreamStats report.

Table 6-2: The 7Q10 low-flow estimates for modeled temperature-impaired rivers in the Willamette River Subbasins.

Assessment Unit Name	Assessment Unit ID	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Coyote Creek	OR_SR_1709000301_02_103796	5.9	StreamStats	44.052, -123.269	
Crabtree Creek	OR_SR_1709000606_02_103978	25.4	StreamStats	44.673, -122.946	
Johnson Creek	OR_SR_1709001201_02_104170	11.3	USGS: 14211550	45.453, -122.643	1992-10-01 ~ 2020-11-08
Little North Santiam River	OR_SR_1709000505_02_104564	21.1	USGS: 14182500	44.792, -122.579	1992-10-01 ~ 2021-10-19

Assessment Unit Name	Assessment Unit ID	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Luckiamute River	OR_SR_1709000305_02_103829	16.3	USGS: 14190500	44.783, -123.235	1992-10-01 ~ 2022-09-30
McKenzie River	OR_SR_1709000405_02_103866	740	StreamStats	44.111, -122.422	
McKenzie River	OR_SR_1709000407_02_103884	975.1	USGS: 14163900	44.069, -122.771	1992-10-01 ~ 2021-11-29
Mohawk River	OR_SR_1709000406_02_103870	4.26	StreamStats	44.191, -122.84	
Mohawk River	OR_SR_1709000406_02_103871	15.9	USGS: 14165000	44.093, -122.957	1992-10-01 ~ 2020-10-15
Mohawk River	OR_SR_1709000406_02_103877	3.04	StreamStats	44.213, -122.827	
Molalla River	OR_SR_1709000904_02_104086	38.1	StreamStats	45.083, -122.488	
Mosby Creek	OR_SR_1709000201_02_103752	10.7	StreamStats	43.779, -123.011	
Pudding River	OR_SR_1709000901_02_104067	3.13	StreamStats	45, -122.842	
Pudding River	OR_SR_1709000905_02_104088	10.1	USGS: 14202000	45.233, -122.75	1993-06-21 ~ 2021-10-26
South Fork McKenzie River	OR_SR_1709000403_02_104590	219	USGS: 14159500	44.135, -122.248	2002-10-01 ~ 2021-09-30
Thomas Creek	OR_SR_1709000607_02_103988	6.8	USGS: 14188800	44.712, -122.77	2002-10-01 ~ 2021-10-13
Thomas Creek	OR_SR_1709000607_02_103991	12.5	StreamStats	44.713, -122.719	

Table 6-3: The 7Q10 low-flow estimates for NPDES permitted discharges receiving a numeric wasteload allocation in this TMDL.

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Albany Water Treatment Plant (66584)	Calapooia River	24	StreamStats	44.635, -123.114	
Alpine Community (100101)	Muddy Creek	0.446	StreamStats	44.33, -123.352	
Americold Logistics, LLC (87663)	Claggett Creek	0	StreamStats	44.976, -123.001	
Arclin (16037)	28th Street Canal	0	StreamStats	44.058, -122.986	
Arclin (81714)	Columbia Slough	0	USGS: 14211820	45.639, -122.763	1992-10-01 ~ 2022-09-30
ATI Albany Operations (64300)	Oak Creek	1.38	StreamStats	44.602, -123.107	
Aumsville STP (4475)	Beaver Creek	0.659	StreamStats	44.852, -122.872	
Aurora STP (110020)	Pudding River	10.1	USGS: 14202000	45.233, -122.75	1993-06-21 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Blount Oregon Cutting Systems Division (63545)	Minthorne Creek	0	StreamStats	45.436, -122.612	
Boeing of Portland - Fabrication Division (9269)	Osburn Creek	0	StreamStats	45.541, -122.446	
Brownsville STP (11770)	Calapooia River	14.4	StreamStats	44.396, -122.998	
Coburg Wastewater Treatment Plant (115851)	Muddy Creek	0	StreamStats	44.152, -123.058	
Coffin Butte Landfill (104176)	Roadside ditch to Soap Creek tributary	0	StreamStats	44.698, -123.23	
Columbia Helicopters (100541)	Unnamed Stream RM 1.8 (Trib to Pudding River)	0	Assumed zero	45.278, -122.733	
Corvallis Rock Creek WTP (20160)	Marys River	0	StreamStats	44.51, -123.456	
Creswell STP (20927)	Camas Swale Creek	0	StreamStats	43.928, -123.037	
Dallas STP (22546)	Rickreall Creek	4.2	StreamStats	44.92, -123.258	
Dallas WTP (22550)	Rickreall Creek	3.3	StreamStats	44.928, -123.363	
Duraflake (97047)	Murder Creek	0	StreamStats	44.664, -123.066	
Estacada STP (27866)	River Mill Reservoir	317	StreamStats	45.296, -122.347	
EWEB Carmen-Smith (28393)	McKenzie River Outfall 001A/B	146	StreamStats	44.2878, 122.0350	
EWEB Carmen-Smith (28393)	McKenzie River Outfall 002A/B	497.5	USGS: 14158850	44.268, -122.05	1992-10-01 ~ 2022-09-30
Falls City STP (28830)	Little Luckiamute River	5.34	StreamStats	44.865, -123.43	
Forrest Paint Co. (100684)	Amazon Creek	0	StreamStats	44.046, -123.128	
Foster Farms (97246)	Camas Swale Creek	0	StreamStats	43.93, -123.027	
Fujimi Corporation - SW Commerce Circle (107178)	Coffee Lake Creek	0	StreamStats	45.338, -122.779	
Georgia-Pacific Chemicals LLC (32864)	Amazon Creek	0	StreamStats	44.121, -123.19	
Gervais STP (33060)	Pudding River	33	StreamStats	45.108, -122.839	
GP Millersburg Resin Plant (32650)	Murder Creek	0	StreamStats	44.661, -123.069	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Halsey STP (36320)	Muddy Creek	4.99	StreamStats	44.383, -123.136	
Holiday Plaza (108298)	Unknown				
Hubbard STP (40494)	Mill Creek	0	StreamStats	45.186, -122.814	
Hull-Oakes Lumber Co. (107228)	Oliver Creek	0	StreamStats	44.36, -123.412	
International Paper Springfield Paper Mill (96244)	McKenzie River	Annual: 1538.4	USGS: 14164900	44.070, -122.966	1910-06-30 ~ 2023-02-04
		Spring Spawning (Apr. 1-June 15): 2459.4			
		Fall Spawning (Sep. 1-Oct. 15): 1630.2			
	Outfall 003 - Storm Ditch near 42nd St.	0	StreamStats. Discharge point is not well represented on StreamStats network. Used nearest location on Q Street Canal	44.0623, -123.0069	
J.H. Baxter & Co., Inc. (6553)	Amazon Diversion Canal	0.597	StreamStats	44.062, -123.196	
JLR, LLC (32536)	Pudding River	6.7	USGS: 14201340	45.151, -122.804	1997-10-01 ~ 2022-09-30
Junction City STP (44509)	Flat Creek	0	StreamStats	44.218, -123.23	
Kingsford Manufacturing Company - Springfield Plant (46000)	Patterson Slough	0	StreamStats	44.062, -123.063	
Knoll Terrace Mhc (46990)	Mountain View Creek	0	StreamStats	44.625, -123.227	
Lakewood Utilities, Ltd (96110)	Mill Creek	0	StreamStats	45.206, -122.789	
Lane Community College (48854)	Russel Creek	0	StreamStats	44.009, -123.037	
Lowell STP (51447)	Dexter Reservoir (20 feet from penstock)	998.4	USGS Gage 14150000. Assumed flow in the penstock as measured by USGS gage defined flow available for mixing.	43.946, -122.837	1992-10-01 ~ 2022-09-30
Malarkey Roofing (52638)	Columbia Slough	0	StreamStats	45.593, -122.699	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Mcfarland Cascade Pole & Lumber Co (54370)	Storm Ditch to Amazon Creek	0	StreamStats	44.092, -123.198	
Miller Paint Company (103774)		0	StreamStats	45.562, -122.53	
Molalla Municipal Water Treatment Plant (109846)	Molalla River	55.5	StreamStats	45.129, -122.54	
Molalla STP (57613)	Molalla River	55.8	StreamStats	45.15, -122.544	
Mt. Angel STP (58707)	Pudding River	31.6	StreamStats	45.067, -122.828	
Murphy Veneer, Foster Division (97070)	Wiley Creek	4.2	USGS: 14187000	44.372, -122.623	1992-10-01 ~ 2022-09-30
Norpac Foods- Plant #1, Stayton (84820)	Salem Ditch	0	StreamStats	44.799, -122.806	
Norpac Foods - Brooks Plant No. 5 (84791)	Fitzpatrick Creek	0	StreamStats	45.056, -122.955	
Oakridge STP (62886)	Middle Fork Willamette River	449.8	USGS: 14148000 - 14147500	43.801, -122.561	1987-10-01 ~ 1994- 09-30
ODC - Oregon State Penitentiary (109727)	Mill Creek	6.53	StreamStats	44.931, -123.007	
ODFW - Leaburg Hatchery (64490)	McKenzie River	Annual: 923.3 Spring Spawning (Apr. 1-June15): 994.5 Fall Spawning (Sep. 1-Oct. 15): 965.2	USGS: 14163150	44.135, -122.610	1989-10-01~2021-10-27
ODFW - Marion Forks Hatchery (64495)	Horn Creek	6.3	DEQ permit renewal fact sheet, Appendix D. (DEQ, 2022)	44.135, -122.610	
ODFW – McKenzie River Hatchery (64500)	McKenzie River	Annual: 923.3 Spring Spawning (Apr. 1-June15): 994.5 Fall Spawning (Sep. 1-Oct. 15): 965.2	USGS: 14163150	44.115, -122.635	1989-10-01~2021-10-27

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
ODFW - Roaring River Hatchery (64525)	Roaring River	0.523	StreamStats	44.627, -122.719	
ODFW - Willamette Fish Hatchery (64585)	Salmon Creek	110	StreamStats	43.748, -122.444	
Owens-Brockway Glass Container Plant (65610)		0	StreamStats	45.563, -122.564	
PCC Structurals, Inc. - (71920)	Mount Scott Creek	0	StreamStats	45.427, -122.569	
Philomath WTP (100048)	Marys River	6.6	USGS: 14171000	44.525, -123.334	2000-10-01 ~ 2022-09-30
Philomath WWTP (103468)	Marys River	6.6	USGS: 14171000	44.525, -123.334	2000-10-01 ~ 2022-09-30
Portland International Airport (107220)	Columbia Slough	0	StreamStats	45.575, -122.604	
RSG Forest Products - Liberal (72596)	Molalla River	0	StreamStats	45.191, -122.592	
Sandy WWTP (78615)	Tickle Creek	0.195	StreamStats	45.405, -122.347	
SCIO STP (79633)	Thomas Creek	6.8	USGS: 14188800	44.712, -122.77	2002-10-01 ~ 2022-09-30
Seneca Sawmill Company (80207)	Ditch to A-1 Amazon Channel	0	StreamStats	44.116, -123.174	
SFPP, L.P. (103159)	Flat Creek	0	StreamStats	44.092, -123.149	
Sherman Bros. Trucking (36646)	Little Muddy Creek	0.194	StreamStats	44.285, -123.06	
Silverton STP (81395)	Silver Creek	14	StreamStats	45.008, -122.803	
Spinnaker II Office Building (110603)	Unknown				
Sundance Lumber Company, Inc. (107401)	Stream without a name	0	StreamStats	44.053, -122.981	
Sunstone Circuits (26788)	Milk Creek	10.5	Using 7Q10 reported in 2008 TMDL		
Tangent STP (87425)	Calapooia River	20.3	StreamStats	44.553, -123.147	
Timberlake STP (90948)	Clackamas River	254	StreamStats	45.087, -122.065	
USFW - Eagle Creek National Fish Hatchery (91035)	Eagle Creek	21.3	StreamStats	45.278, -122.196	
Veneta STP (92762)	Long Tom River	6.3	USGS: 14166500	44.05, -123.426	1992-10-01 ~ 2022-09-30
Ventura Foods, LLC (103832)		0	StreamStats	45.567, -122.57	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
WES (Boring STP) (16592)	North Fork Deep Creek	0.65	Clackamas County reports the estimated North Fork Deep Creek 7Q10 flow (0.65 cfs) in the temperature management plan for the Boring WWTP (DEQ, 2006).		
Westfir STP (94805)	N Fk Middle Fk Willamette R	174	StreamStats	43.759, -122.522	
Willamette Leadership Academy (34040)	Wild Hog Creek	0	StreamStats	43.991, -123.007	
Woodburn WWTP (98815)	Pudding River	6.7	USGS: 14201340	45.151, -122.804	1997-10-01 ~ 2022-09-30

7 Pollutant sources and load contributions

A key element of TMDL development is a complete, comprehensive source assessment for the relevant water quality pollutant(s). This includes identification of all relevant point and nonpoint sources to the impaired waterbody, characterization/quantification of their pollutant load contributions, determination of seasonal variation, and delineation of periods when applicable temperature criteria are exceeded at various locations, to the extent that existing data allow. The TMDL report and its appendices describe the significant thermal pollutant sources identified within the Willamette Subbasins temperature TMDL area and the data sources that DEQ utilized for TMDL modeling.

7.1 Point sources

Individual and general NPDES permittees were identified as significant sources of thermal loading to streams in the Willamette Subbasins.

7.1.1 Individual NPDES permitted point sources

There are 64 domestic or industrial individual NPDES permitted point source discharges within the Willamette Subbasins identified as potential sources of thermal load (Table 7-1). There also are 20 individual Municipal Separate Storm Sewer System (MS4) NPDES permittees identified as potential sources of thermal load (Table 7-2).

Table 7-1: Individual NPDES permitted point source discharges that contribute thermal loads to Willamette Subbasins streams at a frequency and magnitude to cause exceedances to the temperature standard.

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name	River mile
Alpine Community	NPDES-DOM-Db	100101	OR0032387	Muddy Creek	25.6
Arclin	NPDES-IW-B16	16037	OR0021857	Patterson Slough	1.8
Arclin	NPDES-IW-B10	81714	OR0000892	Columbia Slough	6
ATI Albany Operations	NPDES-IW-B08	64300	OR0001716	Oak Creek	1.6
Aumsville STP	NPDES-DOM-Db	4475	OR0022721	Beaver Creek	2.5
Aurora STP	NPDES-DOM-Db	110020	OR0043991	Pudding River	8.8
Blount Oregon Cutting Systems Division	NPDES-IW-B16	63545	OR0032298	Mount Scott Creek	0.9
Boeing Of Portland – Fabrication Division	NPDES-IW-B16	9269	OR0031828	Osburn Creek	1.6
Brownsville STP	NPDES-DOM-Db	11770	OR0020079	Calapooia River	31.6
Coburg Wastewater Treatment Plant	NPDES-DOM-Da	115851	OR0044628	Muddy Creek	50.7
Coffin Butte Landfill	NPDES-IW-B15	104176	OR0043630	Roadside ditch to Soap Creek tributary	4.5
Columbia Helicopters	NPDES-IW-B16	100541	OR0033391	Unnamed Stream (tributary to Pudding River)	2
Creswell STP	NPDES-DOM-Db	20927	OR0027545	Camas Swale Creek	4
Dallas STP	NPDES-DOM-C1a	22546	OR0020737	Rickreall Creek	10.5
Duraflake	NPDES-IW-B20	97047	OR0000426	Murder Creek	0.57
Estacada STP	NPDES-DOM-Da	27866	OR0020575	Clackamas River	23.3
EWEB Carmen-Smith Trail Bridge Powerhouse and Carmen Powerhouse:	NPDES-IW-B16	28393	OR0000680	McKenzie River	76, 77
Falls City STP	NPDES-DOM-Da	28830	OR0032701	Little Luckiamute River	12
Foster Farms	NPDES-IW-B04	97246	OR0026450	Camas Swale Creek	3.3
Fujimi Corporation – SW Commerce Circle	NPDES-IW-B15	107178	OR0040339	Coffee Lake Creek	1.8
Georgia-Pacific Chemicals LLC	NPDES-IW-B16	32864	OR0002101	Amazon Creek	2.7
Gervais STP	NPDES-DOM-Db	33060	OR0027391	Pudding River	28.2
GP Millersburg Resin Plant	NPDES-IW-B16	32650	OR0032107	Murder Creek	0.6
Halsey STP	NPDES-DOM-Db	36320	OR0022390	Muddy Creek	23
Hubbard STP	NPDES-DOM-Da	40494	OR0020591	Mill Creek	5.3
Hull-Oakes Lumber Co.	NPDES-IW-B19	107228	OR0038032	Oliver Creek	4.8
International Paper –	NPDES-IW-B01	96244	OR0000515	McKenze River (Outfall 001 – 002)	

Springfield Paper Mill				Storm Ditch – Near 42nd St. (Outfall 003)	
J.H. Baxter & Co., Inc.	NPDES-IW-B21	6553	OR0021911	Amazon Diversion Canal	1.5
JLR, LLC	NPDES-IW-B05	32536	OR0001015	Pudding River	27
Junction City STP	NPDES-DOM-Db	44509	OR0026565	Flat Creek	9.2
Kingsford Manufacturing Company – Springfield Plant	NPDES-IW-B20	46000	OR0031330	Patterson Slough	3.7
Knoll Terrace MHC	NPDES-DOM-Db	46990	OR0026956	Mountain View Creek	0.4
Lakewood Utilities, Ltd	NPDES-DOM-Da	96110	OR0027570	Mill Creek (Molalla-Pudding Subbasin)	3.9
Lane Community College	NPDES-DOM-Db	48854	OR0026875	Russel Creek	0.7
Lowell STP	NPDES-DOM-Da	51447	OR0020044	Dexter Reservoir	20 feet upstream of the Dexter dam penstock
Mcfarland Cascade Pole & Lumber Co	NPDES-IW-B21	54370	OR0031003	Storm Ditch to Amazon Creek	1.8
Molalla STP	NPDES-DOM-Db	57613	OR0022381	Molalla River	8.2
Mt. Angel STP	NPDES-DOM-Da	58707	OR0028762	Pudding River	37.5
Murphy Veneer, Foster Division	NPDES-IW-B20	97070	OR0021741	Wiley Creek	0.9
Norpac Foods – Brooks Plant No. 5	NPDES-IW-B04	84791	OR0021261	Fitzpatrick Creek	1
Norpac Foods-Plant #1, Stayton	NPDES-IW-B04	84820	OR0001228	Salem Ditch (flows to Mill Creek)	18.5
Oakridge STP	NPDES-DOM-Da	62886	OR0022314	Middle Fork Willamette River	39.8
ODC – Oregon State Penitentiary	NPDES-IW-B15	109727	OR0043770	Mill Creek (Middle Willamette Subbasin)	2.5
ODFW – Leaburg Hatchery	NPDES-IW-B17	64490	OR0027642	McKenzie River	33.7
ODFW – Marion Forks Hatchery	NPDES-IW-B17	64495	OR0027847	Horn Creek	72.1
ODFW – McKenzie River Hatchery	NPDES-IW-B17	64500	OR0029769	McKenzie River	31.5
Philomath WWTP	NPDES-DOM-Db	103468	OR0032441	Marys River	10.2
Portland International Airport	NPDES-IW-B15	107220	OR0040291	Columbia Slough	2.7
RSG Forest Products – Liberal	NPDES-IW-B19	72596	OR0021300	Unnamed ditch to Molalla River	9.8
Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Tickle Creek	3.1
Scio STP	NPDES-DOM-Db	79633	OR0029301	Thomas Creek	7.2
Seneca Sawmill Company	NPDES-IW-B19	80207	OR0022985	Ditch to A-1 Amazon Channel	7.0
SFPP, L.P.	NPDES-IW-B15	103159	OR0044661	Amazon Creek	7.9

Sherman Bros. Trucking	NPDES-DOM-Db	36646	OR0021954	Little Muddy Creek	8
Silverton STP	NPDES-DOM-C1a	81395	OR0020656	Silver Creek	2.4
Sunstone Circuits	NPDES-IW-B15	26788	OR0031127	Milk Creek	5.3298
Tangent STP	NPDES-DOM-Db	87425	OR0031917	Calapooia River	10.8
Timberlake STP	NPDES-DOM-Da	90948	OR0023167	Clackamas River	51.1
USFW – Eagle Creek National Fish Hatchery	NPDES-IW-B17	91035	OR0000710	Eagle Creek	12.3
Veneta STP	NPDES-DOM-Db	92762	OR0020532	Long Tom River	34.9
WES (Boring STP)	NPDES-DOM-Db	16592	OR0031399	North Fork Deep Creek	3
Westfir STP	NPDES-DOM-Da	94805	OR0028282	Nork Fork Middle Fork Willamette River	1
Willamette Leadership Academy	NPDES-DOM-Db	34040	OR0027235	Wild Hog Creek	2
Woodburn WWTP	NPDES-DOM-C1a	98815	OR0020001	Pudding River	21.4

Table 7-2: Individual NPDES Municipal Separate Storm Sewer System (MS4) permittees in the Willamette Subbasins.

Permittee	Permit type	DEQ WQ File Number	EPA Number
City of Eugene	NPDES-DOM-MS4-1	107989	ORS107989
City of Fairview	NPDES-DOM-MS4-1	108013	ORS108013
City of Gresham			
City Of Portland	NPDES-DOM-MS4-1	108015	ORS108015
Port of Portland			
City of Gladstone	NPDES-DOM-MS4-1	108016	ORS108016
City of Happy Valley			
City of Johnson City			
City of Lake Oswego			
City of Milwaukie			
City of Oregon City			
City of Rivergrove			
City of West Linn			
City of Wilsonville			
Clackamas County			
Oak Lodge Water Services			
WES (Clackamas Co. Service District #1)			
City of Salem	NPDES-DOM-MS4-1	108919	ORS108919
ODOT	NPDES-DOM-MS4-1	110870	ORS110870
Multnomah County	NPDES-DOM-MS4-1	120542	ORS120542

7.1.2 General NPDES permitted point sources

There are multiple categories of general NPDES permit types with registrants in the Willamette Subbasins including:

- 100-J Industrial Wastewater: NPDES cooling water
- 200-J Industrial Wastewater: NPDES filter backwash
- 300-J Industrial Wastewater: NPDES fish hatcheries
- 400-J Industrial Wastewater: NPDES log ponds
- 1200-A Stormwater: NPDES sand & gravel mining
- 1200-C Stormwater: NPDES construction more than 1 acre disturbed ground
- 1200-Z Stormwater: NPDES specific SIC codes
- 1500-A Industrial Wastewater: NPDES petroleum hydrocarbon cleanup
- 1700-A Industrial Wastewater: NPDES wash water
- MS4 – Phase II – Stormwater: NPDES Municipal Separate Storm Sewer System

DEQ determined the following general permit categories have potential to discharge thermal loads that contribute to exceedances of the applicable temperature criteria:

- 100-J when river flow is < 44 cfs, or any flow range for hydropower facilities
- 200-J
- 300-J

There are twelve registrants of the 100-J, ten registrants of the 200-J, and two registrants of the 300-J general permits (Table 7-3) found to be potential significant sources of thermal load with a temperature impact. Other registrants to the industrial wastewater general permits were found to have a de minimis temperature increase based on the permit requirements, available dilution, or frequency and magnitude of discharge based on review of available discharge data.

Table 7-3: General NPDES permit registrants that contribute thermal loads to Willamette Subbasins streams at a frequency or magnitude that contributes to exceedances of the temperature standard.

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name	River mile
Americold Logistics, LLC	100-J	87663	ORG253544	Claggett Creek	4.9
EWEB Leaburg	100-J	28391	ORG253525	Stream without a name	34
EWEB Walterville	100-J	28395	ORG253526	Stream without a name	21
First Premier Properties - Spinnaker II Office Building	100-J	110603	ORG253511	Stone Quarry Lake	0.8
Forrest Paint Co.	100-J	100684	ORG253508	Amazon Creek	17.0
Holiday Plaza	100-J	108298	ORG253504	Stone Quarry Lake	0.2
Malarkey Roofing	100-J	52638	ORG250024	Columbia Slough	5.9
Miller Paint Company	100-J	103774	ORG250040	Columbia Slough	Unknown
Owens-Brockway Glass Container Plant	100-J	65610	ORG250029	Johnson Lake	0
PCC Structurals, Inc.	100-J	71920	ORG250015	Mount Scott Creek	2.3
Sundance Lumber Company, Inc.	100-J	107401	ORG253618	Stream without a name	14.0
Ventura Foods, LLC	100-J	103832	ORG250005	Columbia Slough	Unknown
Albany Water Treatment Plant	200-J	66584	ORG383501	Calapooia River	0.1

Corvallis Rock Creek Water Treatment Plant	200-J	20160	ORG383513	Marys River	13.5
Dallas Water Treatment Plant	200-J	22550	ORG383529	Rickreall Creek	17.0
Deer Creek Estates Water Association	200-J	23650	ORG383526	Mill Creek	7.1
EWEB – Hayden Bridge Filter Plant	200-J	28385	ORG383503	McKenzie River	8
International Paper	200-J	108921	ORG383548	McKenzie River	11.4
Molalla Municipal Water Treatment Plant	200-J	109846	ORG380014	Molalla River	21.6
Philomath Water Treatment Plant	200-J	100048	ORG383536	Marys River	12.2
Row River Valley Water District	200-J	100075	ORG383534	Layng Creek	1.4
Silverton Water Treatment Plant	200-J	81398	ORG383527	Silver Creek	3.9
ODFW - Roaring River Hatchery	300-J	64525	ORG133506	Roaring River	1.1
ODFW - Willamette Fish Hatchery	300-J	64585	ORG133507	Salmon Creek	0.4

DEQ completed a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon and found there is not sufficient evidence to demonstrate that stormwater discharges authorized under the current municipal (MS4s) permits or the construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits contribute to exceedances of the temperature standard. The substantive findings are summarized below.

A review of studies in the mid-west and east coast of the United States provides evidence that, under certain conditions, runoff from impervious pavement or runoff that is retained in uncovered open ponds can produce short duration warm discharges (Herb et. al. 2008, Jones and Hunt 2009, UNH Stormwater Center 2011, Winston et. al. 2011, Hester and Bauman 2013). Increases in runoff temperature are highly dependent on many factors including air temperature, dewpoint, pavement type, percent impervious and the amount of impervious surface blocked from solar radiation (Nelson and Palmer 2007, Herb et. al. 2008, Thompson et. al. 2008, Winston et. al. 2011, Jones et. al. 2012, Sabouri et. al. 2013, and Zeiger and Hubbert 2015). These warm runoff discharges can create "surges" that produce increases in stream temperature typically for short durations (Hester and Bauman 2013, Wardynski et. al. 2014, Zeiger and Hubbert 2015). However, studies that evaluated stormwater discharges over weekly averaging periods did not indicate exceedances above biologically based critical thresholds (Wardynski et. al. 2014, WDOE 2011a and 2011b).

DEQ evaluated temperature, rainfall, cloud cover, and stream temperature data for warm seasons in three years in the adjacent Miles Creeks area of the Middle Columbia-Hood Subbasin (DEQ 2008b). In this evaluation, DEQ found no consistent patterns between runoff events in urban areas and stream temperature. In Oregon, cooling trends during warm season rain events are much more clearly related to stream temperature than is precipitation. The limited analysis of local stream temperature in response to precipitation suggests no consistent thermal effects, and any increase in temperature would be small and short term relative to the 7-day average criteria.

7.2 Nonpoint and background sources

OAR 340-41-0002 (42) defines nonpoint sources as "diffuse or unconfined sources of pollution where wastes can either enter, or be conveyed by the movement of water, into waters of the state." Generally, nonpoint thermal sources in the Willamette Subbasins include activities associated with agriculture, forestry, dam and reservoir management, and development. Example sources and/or activities that contribute nonpoint thermal loads that increase stream temperature include:

- Human-caused increases in solar radiation loading to streams from stream-side vegetation disturbance or removal;
- Channel modification and widening;
- Dam and reservoir operation;
- Activities that modify flow rate or volume; and,
- Background sources, including natural sources and anthropogenic sources of warming through climate change and other factors.

Anthropogenically influenced thermal loads are targeted for reduction to attain the applicable temperature water quality criteria. The following actions are needed to attain the TMDL allocations:

- Restoration of stream-side vegetation to reduce thermal loading from exposure to solar radiation,
- Management and operation of dams and reservoirs to minimize temperature warming, and,
- Maintenance of minimum instream flows.

7.2.1 Background sources

By definition (OAR 340-042-0030(1)), 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. Stream temperature warming from climate change is a background source as the majority of the climate change causing pollutants emanate from outside of Oregon.

The background thermal loading a stream receives is influenced by a number of landscape and meteorological characteristics, such as: substrate and channel morphology conditions; streambank and channel elevations; near-stream vegetation; groundwater; hyporheic flow; tributary inflows; precipitation; cloudiness; air temperature; relative humidity and others. Many of these factors, however, are influenced by anthropogenic impacts. As such, it was not possible to develop a model in which all human influences were controlled or accounted for. As a best estimate, background thermal sources were quantified for the modeled rivers with delineable anthropogenic influences (i.e., dams and reservoirs, vegetation alterations, point source discharges) accounted for, thus isolating the remaining background sources.

In some of the rivers modeled, thermal loading from background sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant source of thermal loading. Reductions from background sources will be required to attain the applicable temperature criteria. The contribution from background sources for each model stream is summarized in model river sections below.

DEQ completed a literature review to assess climate change-driven stream temperature impacts. Based on that review (Appendix G), stream temperature impacts from climate change can range from +0.05°C to +0.27°C per decade on unregulated streams and -0.48°C to +0.52°C per decade on regulated streams. Stream temperature trends in regulated systems are more variable, as upstream flow and temperature management can confound natural long-term warming trends in the data (Isaak et al., 2012).

7.2.2 Dams and reservoirs

Reservoirs attenuate flood flows and hold spring runoff. Stored water is released when reservoir capacity is met or to augment stream flows during the dry months of summer and early fall. As currently constructed and operated, the release of water from many reservoirs modifies natural temperature patterns downstream during late summer and early fall, but also during spring and early summer. The temperature seasonal shifts occur because stored water in reservoirs stratifies, and the reservoirs were typically constructed with regulating outlets near the bottom of each structure.

Seasonal pattern shifts are of concern because water temperature triggers aquatic life activities such as spawning, length of time needed for incubation, and fry emergence. The food supplies (macroinvertebrates) that salmonids rely on are also affected by seasonal temperature shifts. In late summer and early autumn, the reservoirs are drawn down to provide flood storage capacity for the coming winter precipitation. During this time, thermal stratification in the reservoirs breaks down but reservoir water temperatures remain warmer than inflowing upstream tributary temperatures. This is also the season when fall spawning fish have moved into reaches below the reservoirs to wait for spawning. Salmon and trout will hold in the coldest water they can find to wait for stream temperatures to cool enough to trigger their spawning migration.

Alternately, colder winter waters are released during spring and early summer when inflowing upstream tributary temperatures are warmer than stored reservoir waters. This is the season when fall-spawned fry should be emerging, but the colder water shifts the timing of their emergence. Spring spawning is also delayed until winter water temperatures warm up enough to trigger spawning. Late spring spawning can indicate that fry emergence occurs when summer water temperatures are too warm for emerging fry.

USGS evaluated the thermal effects of 14 dams in the Willamette River Basin and found that dams have a substantial and measurable effect on downstream streamflow and water temperature (Rounds, 2010). The temperature effects of each dam are specific to the characteristics and operation of each structure. In general, the larger, taller dams typically release water from a mid-depth or deeper outlet in the upstream impoundment, which tends to be colder in mid-summer than it would be without the dam. In September or October, a large amount of water is released from many of these dams to make room for flood storage, which can bring warmer surface waters down to the elevation of the outlet, thus releasing the warmest water of the year during a time period when the river without the dam would be cooler because of shorter days and colder air temperatures. USGS concluded that the thermal effects of the dams are greatest at the dam sites, where the 7DADM temperatures are as much as 6 to 10 °C cooler or warmer compared to what would occur without the dams. Downstream, the effects decrease, but are still in the 0.5 to 1.0 °C range near the mouth of the Willamette River (Rounds, 2010).

In the Lower Willamette Subbasin, multiple studies have examined the thermal impacts of in-channel ponds on water temperature and found that human built in-channel ponds showed trends on raising downstream temperature (Holzer, 2020; Fairbairn, 2022). For example, Holzer (2020) demonstrated that most in-channel ponds increased the amount of time that a stream segment exceeded the temperature standard by several weeks. Fairbairn (2022) found that human constructed ponds in the Johnson Creek (n=14), Columbia Slough (n=1) and Sandy River (n=2) Watersheds increased median 7-Day Average Daily Maximum stream temperatures by -1.0 to 6 degrees Celsius. Nine of the seventeen human constructed in channel ponds raised the median 7 Day Average Daily Maximum stream temperature by greater than 1 degree Celsius.

7.2.3 Johnson Creek

Thermal pollutant sources identified for Johnson Creek in the Lower Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Johnson Creek with waters exceeding the temperature criteria, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Johnson Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 26%, corresponding to daily maximum water temperature increases of 8.27 deg-C at the point of maximum impact at model kilometer 18.9, and 3.76 deg-C at the mouth.
- Warming from tributary waters that exceeded water quality criteria was associated with daily maximum water temperature increases of 1.52 deg-C at the point of maximum impact at model kilometer 2, and 1.40 deg-C at the mouth.
- Reducing USGS estimated mean August stream flow for Johnson Creek by 4% resulted in a daily maximum water temperature increase equal to the portion of the HUA allocated to water withdrawals (0.05 deg-C) at the flow reference site at model kilometer 1.2. The greatest daily maximum temperature change between these two scenarios was 0.16 deg-C at model kilometer 25.5.
- Reducing USGS estimated mean August stream flow for Johnson Creek by 20% (the consumptive use rate above which OWRD assumes water quality impacts) resulted in daily maximum water temperature increases of 0.90 deg-C at the point of maximum impact at model kilometer 25.5, and 0.29 deg-C at the flow reference site at model kilometer 1.2.
- Background sources were associated with a water temperature standard exceedance of 1.83 deg-C above the applicable numeric criteria at model kilometer 11.7. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 1.83 deg-C.

7.2.4 Molalla River

Thermal pollutant sources identified for the Molalla River include lack of sufficient shade-producing streamside vegetation, channel modification, consumptive use water withdrawals, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Molalla River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 14%, corresponding to 7DADM water temperature increases of 2.42 deg-C at the point of maximum impact at model kilometer 70.06, and 0.52 deg-C at the mouth.
- Surface water withdrawals were associated with 7DADM water temperature increases of 1.50 deg-C at the point of maximum impact at model kilometer 19.86, and 1.07 deg-C at the mouth.
- Channel modifications, such as decreases in channel width, were associated with 7DADM water temperature increases of 1.09 deg-C at the point of maximum impact at model kilometer 36.36, and 0.31 deg-C at the mouth.

- Wasteload Allocations for the Molalla STP have the potential to cool the river up to 0.3 deg-C at their point of discharge at model kilometer 34.08. This is due to the relatively high ambient temperatures of the Molalla River. All model scenarios indicate that Molalla River water temperatures are expected to exceed water temperature standards along most of the modeled reach.
- Background sources were associated with a water temperature standard exceedance of 9.16 deg-C above the applicable numeric criteria at model kilometer 35.76. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 9.16 deg-C.

7.2.5 Pudding River

Thermal pollutant sources identified for the Pudding River include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Pudding River with waters exceeding the temperature criteria, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Pudding River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 11%, corresponding to 7DADM water temperature increases of 3.97 deg-C at the point of maximum impact at model kilometer 82.1, and 1.95 deg-C at the mouth.
- Wasteload allocations for Woodburn WWTP and JLR have the potential to increase 7DADM water temperature by 0.03 deg-C at the point of maximum impact at model kilometer 24.8, but are not expected to have an impact at the mouth.
- Surface water withdrawals were associated with 7DADM water temperature increases of 4.01 deg-C at the point of maximum impact at model kilometer 82.9, and 1.68 deg-C at the mouth.
- Reducing surface water withdrawals to 25% of normal consumptive use was associated with 7DADM water temperature increases of 0.61 deg-C at the point of maximum impact at model kilometer 82, and 0.3 deg-C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Reducing surface water withdrawals to 50% of normal consumptive use was associated with 7DADM water temperature increases of 1.37 deg-C at the point of maximum impact at model kilometer 82, and 0.69 deg-C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Reducing surface water withdrawals to 75% of normal consumptive use was associated with 7DADM water temperature increases of 2.51 deg-C at the point of maximum impact at model kilometer 82.4, and 1.15 deg-C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Warming from tributary waters that exceeded water quality criteria was associated with 7DADM water temperature increases of 8.65 deg-C at the point of maximum impact at model kilometer 84.6, and 1.19 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 3.86 deg-C above the applicable numeric criteria at model kilometer 11.4. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 3.86 deg-C.

7.2.6 Litte North Santiam River

Thermal pollutant sources identified for the Little North River include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Little North Santiam River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9%, corresponding to daily maximum water temperature increases of 1.72 deg-C at the point of maximum impact at model kilometer 13.7, and 0.65 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.89 deg-C above the applicable numeric criteria at model kilometer 1.0. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.89 deg-C.

7.2.7 Thomas Creek

Thermal pollutant sources identified for Thomas Creek in the South Santiam Subbasin include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Thomas Creek with waters exceeding the temperature criteria, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Thomas Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of less than 1%, corresponding to daily maximum water temperature increases of 1.14 deg-C at the point of maximum impact at model kilometer 32.3. This indicates that current vegetation is nearly at site potential conditions.
- Surface water withdrawals were associated with daily maximum water temperature increase of 1.83 deg-C at the point of maximum impact at model kilometer 4.8, and 0.10 deg-C at the mouth.
- Warming from tributary waters that exceeded water quality criteria was associated with daily maximum water temperature increases of 1.08 deg-C at the point of maximum impact at model kilometer 30.2, and 0.60 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.91 deg-C above the applicable numeric criteria at model kilometer 30.6. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.91 deg-C.

7.2.8 Crabtree Creek

Thermal pollutant sources identified for Crabtree Creek in the South Santiam Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along Crabtree Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13%, corresponding to daily maximum water temperature increases of 3.78 deg-C at the point of maximum impact at model kilometer 5.2, and 1.93 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.39 deg-C above the applicable numeric criteria at model kilometer 35.1. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.39 deg-C.

7.2.9 Luckiamute River

Thermal pollutant sources identified for the Luckiamute River in the Upper Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Luckiamute River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9%, corresponding to daily maximum water temperature increases of 3.56 deg-C at the point of maximum impact at model kilometer 42.8, and 0.34 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.18 deg-C above the applicable numeric criteria at model kilometer 2.1. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.18 deg-C.

7.2.10 Mohawk River

Thermal pollutant sources identified for the Mohawk River in the McKenzie Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Mohawk River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13%, corresponding to daily maximum water temperature increases of 2.87 deg-C at the point of maximum impact at model kilometer 29.6, and 0.32 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.53 deg-C above the applicable numeric criteria at model kilometer 5.7. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.53 deg-C.

7.2.11 Upper McKenzie River

Thermal pollutant sources identified for the Upper McKenzie River include lack of sufficient shade-producing streamside vegetation, point sources, and background sources in the Lower McKenzie. See Technical Support Document Appendix A for details. Briefly, along the Upper McKenzie River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 20%, corresponding to daily maximum water temperature increases of 0.43 deg-C at the point of maximum impact at model kilometer 10.0, and 0.36 deg-C at the mouth.
- Wasteload Allocations for EWEB's Trail Bridge Powerhouse facility has the potential to warm the river 0.02 deg-C at the point of discharge. The impact dissipates moving downstream.
- Background sources were not associated with a water temperature standard exceedance in the Upper McKenzie River.

7.2.12 Coyote Creek

Thermal pollutant sources identified for Coyote Creek in the Upper Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Coyote Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 23%, corresponding to daily maximum water temperature increases of 7.87 deg-C at the point of maximum impact at model kilometer 35, and 2.61 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.18 deg-C above the applicable numeric criteria at model kilometer 1.7. This means

that to attain the temperature criteria, background sources need to have a temperature reduction of 7.18 deg-C.

7.2.13 Mosby Creek

Thermal pollutant sources identified for Mosby Creek in the Coast Fork Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See Technical Support Document Appendix A for details. Briefly, along the Mosby Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 4%, corresponding to daily maximum water temperature increases of 3.05 deg-C at the point of maximum impact at model kilometer 28.1, and 1.50 deg-C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.81 deg-C above the applicable numeric criteria at model kilometer 9.8. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.81 deg-C.

7.2.14 Southern Willamette shade

Thermal pollutant sources identified for the Southern Willamette analysis include lack of sufficient shade-producing vegetation. See Technical Support Document Appendix A for details. Briefly, within the Southern Willamette model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 28 percentage points over the entire model assessment area (approximately 21,410 stream kilometers).
- The Oregon Department of Forestry (ODF), Oregon Department of Agriculture (ODA), U.S. Forest Service (USFS), and U.S. Bureau of Land Management (BLM) were the designated management agencies responsible for the largest number of assessed stream nodes totaling about 88% of the assessed stream network (18,986 kilometers out of 21,410 total assessed kilometers).
- Of the four DMAs with the largest percentage of stream miles, Oregon Department of Agriculture had the largest mean shade gap of 53 percentage points over the 4,823 stream kilometers of agricultural lands assessed.
- Private non-federal forestlands regulated by the Oregon Department of Forestry have the largest number of assessed stream nodes (8603 kilometers) with a mean shade gap of 26 percentage points.
- While individual cities typically have fewer assessed stream kilometers relative to other DMAs, streams within the city limits of 32 cities were assessed. 16 of the cities had mean shade gaps greater than 50 percentage points.
- The Muddy Creek-Willamette River Watershed (1709000306) had the largest number of assessed stream nodes (827 kilometers out of 1398 total assessed kilometers) with effective shade gaps exceeding 50 percentage points.

7.2.15 Lower Willamette shade

Thermal pollutant sources identified for the Lower Willamette analysis include lack of sufficient shade-producing vegetation. See Technical Support Document Appendix A and B for details. Briefly, within the Lower Willamette model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13 percentage points over the entire model assessment area (approximately 201 stream kilometers).
- The assessed streams in the Johnson Creek-Willamette River watershed (1709001201) had the largest mean shade gap of 14 percentage points over the 109 stream kilometers assessed.
- The streams on the westside of the Willamette River draining the Tualatin Mountains in the Multnomah Channel Watershed (1709001203) had the lowest mean shade gap of 3 percentage points over the 5 stream kilometers assessed.
- The City of Portland had the largest number of stream kilometers (5.6 km) with mean effective shade gaps exceeding 50 percentage points, followed by Clackamas County and ODA.

8 Loading capacity and excess loads

As described in the TMDL report, the pollutant load that a waterbody can receive and still meet water quality standards is called the loading capacity (LC). For temperature, a thermal loading capacity is assigned to all assessment units in the Willamette Subbasins. Loading capacity is calculated using Equation 8-1.

$$LC = (T_C + \text{HUA}) \cdot Q_R \cdot C_F$$ **Equation 8-1**

where,

$LC =$ Loading Capacity (kcal/day).

$T_C =$ The applicable river temperature criterion (°C).

$\text{HUA} =$ The 0.3°C human use allowance allocated to point sources, nonpoint sources, margin of safety, or reserve capacity.

$Q_R =$ The daily mean river flow rate (cfs).

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$\left(\frac{1\,m}{3.2808\,ft}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1℃} = 2{,}446{,}665$$

Table 8-1 presents the loading capacity for select temperature impaired category 5 assessment units modeled for the TMDL analysis at the critical 7Q10 low flow. It is intended that Equation 8-1 be used to calculate the loading capacity for any assessment unit or stream location in the Willamette Subbasins not identified in Table 8-1 or when river flows are greater than 7Q10. In cases when there are two year-round applicable temperature criteria that apply to the same assessment unit, the more stringent criteria shall be used for the loading capacity.

Table 8-1: Thermal loading capacity (LC) for modeled assessment units by applicable fish use period at 7Q10 flow.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion + HUA (°C)	Spawning Criterion + HUA (°C)	7Q10 LC Year Round (kilocalories/day)	7Q10 LC Spawning (kilocalories/day)
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.3	NA	264.17E+6	NA

Crabtree Creek OR_SR_1709000606_02_103978	25.4	16.3	13.3	1,012.97E+6	826.53E+6
Johnson Creek OR_SR_1709001201_02_104170	11.1	18.3	13.3	497.34E+6	361.45E+6
Little North Santiam River OR_SR_1709000505_02_104564	19.5	16.3	13.3	776.38E+6	633.49E+6
Luckiamute River OR_SR_1709000305_02_103829	15.9	18.3	13.3	711.37E+6	517.01E+6
McKenzie River OR_SR_1709000407_02_103884	975.1	16.3	13.3	38,887.61E+6	31,730.38E+6
Mohawk River OR_SR_1709000406_02_103871	15.7	16.3	13.3	624.22E+6	509.33E+6
Molalla River OR_SR_1709000904_02_104086	38.1	16.3	13.3	1,519.45E+6	1,239.8E+6
Mosby Creek OR_SR_1709000201_02_103752	10.7	16.3	13.3	426.72E+6	348.18E+6
Pudding River OR_SR_1709000905_02_104088	10.4	18.3	NA	467.03E+6	NA
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.3	NA	307.22E+6	NA

The excess load is the difference between the actual pollutant load in a waterbody and the loading capacity of that waterbody. In accordance with OAR 340-042-0040(4)(e), Oregon TMDLs must include the excess load to the extent existing data allow.

Because flow monitoring data were not available at most temperature monitoring locations, it was not possible to calculate the excess thermal load. Instead, the excess temperature and percent load reduction were calculated for each assessment unit where temperature data were available. The extensive monitoring across the Willamette subbasin represents a wide range of waterbodies; however not all streams in the Willamette subbasins have monitoring data. Equation 8-2 can be used to determine excess temperature and percent reduction for additional streams if data becomes available in the future. Temperature data collected in Willamette Subbasins between 1/1/2012 and 12/31/2022 were downloaded from DEQ's AWQMS database. Following data review and filtering for acceptable data quality there were 452 temperature monitoring stations available where excess temperature could be calculated. The maximum excess temperature and corresponding percent reduction were summarized in Table 8-2 for each assessment unit and each temperature criteria applicable on that assessment unit.

The excess temperature is the maximum difference between the monitored 7DADM river temperature and the applicable numeric criterion including the human use allowance. The percent load reduction (Equation 8-2) represents the maximum portion of the actual thermal loading that must be reduced to attain the TMDL loading capacity.

The percent load reduction is mathematically equal to the percent temperature reduction calculated from the monitoring data. This is because the river flow rate used to calculate a thermal load is the same number in the numerator and denominator and is cancelled out when calculating the percent reduction. The percent load reductions shown in Table 8-2 were calculated from temperatures in degrees Celsius.

$$\mathrm{PR} = \frac{(T_R - T_C - \mathrm{HUA})}{T_R} \cdot 100$$

Equation 8-2

where,

$\mathrm{PR} =$ Percent load reduction (%). If PR < 0, PR = 0

$T_R =$ The maximum 7DADM ambient river temperature (°C).

$T_C =$ The applicable river temperature criterion (°C).

$\mathrm{HUA} =$ The 0.3°C human use allowance allocated to point sources, nonpoint sources, margin of safety, or reserve capacity.

Table 8-2: Excess temperature and percent load reduction for assessment units with available temperature data in the Willamette Subbasins.

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Alex Creek	OR_SR_1709000202_02_103762	16.7	18.3	0.0	0.0
Big Creek	OR_SR_1709001104_02_104153	13.7	16.3	0.0	0.0
Blowout Creek	OR_SR_1709000503_02_103907	21.0	18.3	2.7	12.9
Boulder Creek	OR_SR_1709000502_02_103902	19.3	18.3	1.0	5.3
Breitenbush River	OR_SR_1709000501_02_103892	17.5	18.3	0.0	0.0
Brice Creek	OR_SR_1709000202_02_103771	23.1	18.3	4.8	20.6
Calapooia River	OR_SR_1709000303_02_103815	16.0	16.3	0.0	0.0
Camp Creek	OR_SR_1709000407_02_103889	19.3	13.3	6.0	31.1
Camp Creek	OR_SR_1709000407_02_103889	22.4	16.3	6.1	27.2
Canyon Creek	OR_SR_1709000602_02_103949	20.7	16.3	4.4	21.4
Cedar Creek	OR_SR_1709000407_02_103891	20.9	13.3	7.6	36.4
Cedar Creek	OR_SR_1709000407_02_103891	24.3	16.3	8.0	32.9
Christy Creek	OR_SR_1709000106_02_103722	15.5	16.3	0.0	0.0
Clackamas River	OR_SR_1709000704_02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709000704_02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709000704_02_104597	24.5	18.3	6.2	25.3
Clackamas River	OR_SR_1709001104_02_104154	16.6	13.3	3.3	19.8
Clackamas River	OR_SR_1709001104_02_104154	18.5	16.3	2.2	11.9
Clackamas River	OR_SR_1709001104_02_104155	16.2	13.3	2.9	17.9
Clackamas River	OR_SR_1709001104_02_104155	19.5	16.3	3.2	16.5
Collawash River	OR_SR_1709001101_02_104142	17.4	13.3	4.1	23.5
Collawash River	OR_SR_1709001101_02_104142	19.8	16.3	3.5	17.8
Collawash River	OR_SR_1709001101_02_104144	16.3	13.3	3.0	18.6
Collawash River	OR_SR_1709001101_02_104144	20.5	16.3	4.2	20.4
Fall Creek	OR_SR_1709000109_02_103737	21.6	13.3	8.3	38.3
Fall Creek	OR_SR_1709000109_02_103737	24.5	16.3	8.2	33.3
Fall Creek	OR_SR_1709000109_02_103743	18.6	13.3	5.3	28.5
Fall Creek	OR_SR_1709000109_02_103743	22.4	16.3	6.1	27.3
Fish Creek	OR_SR_1709001104_02_104161	19.1	13.3	5.8	30.4

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Fish Creek	OR_SR_1709001104_02_104161	21.2	16.3	4.9	23.0
French Pete Creek	OR_SR_1709000403_02_103862	15.7	16.3	0.0	0.0
Grass Creek	OR_SR_1709000202_02_103780	15.6	16.3	0.0	0.0
Hamilton Creek	OR_SR_1709000608_02_103996	27.3	16.3	11.0	40.3
Hehe Creek	OR_SR_1709000109_02_103734	21.0	16.3	4.7	22.5
Hills Creek	OR_SR_1709000102_02_103715	16.5	13.3	3.2	19.4
Hills Creek	OR_SR_1709000102_02_103715	18.7	16.3	2.4	12.8
Horse Creek	OR_SR_1709000401_02_103856	13.8	12.3	1.5	10.9
HUC12 Name: Andy Creek-Fall Creek	OR_WS_170900010904_02_104219	18.3	16.3	2.0	10.7
HUC12 Name: Balch Creek-Willamette River	OR_WS_170900120202_02_104555	21.8	18.3	3.5	15.9
HUC12 Name: Boulder Creek-McKenzie River	OR_WS_170900040206_02_104310	14.4	12.3	2.1	14.8
HUC12 Name: Buck Creek-Middle Fork Willamette River	OR_WS_170900010502_02_104200	18.9	12.3	6.6	34.9
HUC12 Name: Canyon Creek	OR_WS_170900090601_02_104482	8.2	18.3	0.0	0.0
HUC12 Name: Columbia Slough (Lower)	OR_WS_170900120201_02_104554.1	26.8	18.3	8.5	31.8
HUC12 Name: Columbia Slough (Upper)	OR_WS_170900120201_02_104554.2	29.5	18.3	11.2	38.0
HUC12 Name: Cougar Creek-South Fork McKenzie River	OR_WS_170900040308_02_104321	15.0	16.3	0.0	0.0
HUC12 Name: Cougar Reservoir-South Fork McKenzie	OR_WS_170900040307_02_104320	14.6	16.3	0.0	0.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	19.6	13.3	6.3	32.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	24.8	18.3	6.5	26.2
HUC12 Name: Dartmouth Creek-North Fork Middle For*	OR_WS_170900010608_02_104210	16.5	16.3	0.2	1.2
HUC12 Name: Deer Creek	OR_WS_170900040205_02_104309	20.0	12.3	7.7	38.4
HUC12 Name: Echo Creek-	OR_WS_170900010106_02_104190	15.6	12.3	3.3	21.1

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Middle Fork Willamette River					
HUC12 Name: Eighth Creek-North Fork Middle Fork Willamette	OR_WS_170900010607_02_104209	16.2	16.3	0.0	0.0
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	15.3	13.3	2.0	12.9
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	17.9	16.3	1.6	8.8
HUC12 Name: Elk Creek-South Fork McKenzie River	OR_WS_170900040301_02_104314	8.4	12.3	0.0	0.0
HUC12 Name: Fish Creek	OR_WS_170900110403_02_104536	16.0	16.3	0.0	0.0
HUC12 Name: Flat Creek	OR_WS_170900030603_02_104290	25.7	18.3	7.4	28.8
HUC12 Name: Glenn Creek-Willamette River	OR_WS_170900070303_02_104415	27.2	18.3	8.9	32.7
HUC12 Name: Gray Creek-Middle Fork Willamette Riv*	OR_WS_170900010505_02_104202	17.7	13.3	4.4	24.9
HUC12 Name: Gray Creek-Middle Fork Willamette Riv*	OR_WS_170900010505_02_104202	18.1	16.3	1.8	9.9
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	25.0	16.3	8.7	34.8
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	19.1	18.3	0.8	4.1
HUC12 Name: Hackleman Creek-McKenzie River	OR_WS_170900040202_02_104306	12.3			
HUC12 Name: Helion Creek-Clackamas River	OR_WS_170900110406_02_104539	16.5	16.3	0.2	1.2
HUC12 Name: Hill Creek-Coast Fork Willamette River	OR_WS_170900020401_02_104238	25.9	18.3	7.6	29.3
HUC12 Name: Kink Creek-McKenzie River	OR_WS_170900040204_02_104308	12.7	12.3	0.4	3.1
HUC12 Name: Last Creek-Pinhead Creek	OR_WS_170900110204_02_104526	10.4	16.3	0.0	0.0
HUC12 Name: Layng Creek	OR_WS_170900020201_02_104227	17.6	18.3	0.0	0.0
HUC12 Name: Lowe Creek-Clackamas River	OR_WS_170900110203_02_104525	15.6	16.3	0.0	0.0

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	19.9	13.3	6.6	33.1
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	23.1	18.3	4.8	20.8
HUC12 Name: Lower Mill Creek	OR_WS_170900070204_02_104412	25.9	18.3	7.6	29.3
HUC12 Name: Lower Quartzville Creek	OR_WS_170900060305_02_104379	23.7	18.3	5.4	22.8
HUC12 Name: Maxfield Creek-Luckiamute River	OR_WS_170900030503_02_104277	21.1	18.3	2.8	13.3
HUC12 Name: McKinney Creek	OR_WS_170900070203_02_104411	26.9	18.3	8.6	32.0
HUC12 Name: Middle Little Luckiamute River	OR_WS_170900030507_02_104281	17.5	18.3	0.0	0.0
HUC12 Name: Minto Creek-North Santiam River	OR_WS_170900050205_02_104347	11.4	18.3	0.0	0.0
HUC12 Name: Morgan Creek-North Santiam River	OR_WS_170900050604_02_104362	23.0	16.3	6.7	29.1
HUC12 Name: Multnomah Channel	OR_WS_170900120305_02_104561	18.5	18.3	0.2	1.2
HUC12 Name: North Fork Clackamas River	OR_WS_170900110405_02_104538	17.0	16.3	0.7	4.2
HUC12 Name: North Fork Eagle Creek	OR_WS_170900110502_02_104541	12.8	16.3	0.0	0.0
HUC12 Name: Oswego Creek-Willamette River	OR_WS_170900120104_02_104553	14.1	13.3	0.8	5.7
HUC12 Name: Oswego Creek-Willamette River	OR_WS_170900120104_02_104553	20.7	18.3	2.4	11.7
HUC12 Name: Owl Creek	OR_WS_170900060205_02_104371	15.5	16.3	0.0	0.0
HUC12 Name: Paddys Valley-Middle Fork Willamette *	OR_WS_170900010101_02_104185	10.0	12.3	0.0	0.0
HUC12 Name: Pedee Creek-Luckiamute River	OR_WS_170900030504_02_104278	19.5	18.3	1.2	6.3
HUC12 Name: Pot Creek-Clackamas River	OR_WS_170900110205_02_104527	10.1	16.3	0.0	0.0
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	11.7	13.3	0.0	0.0

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	16.3	16.3	0.0	0.2
HUC12 Name: Roaring River	OR_WS_170900110402_02_104535	24.0	16.3	7.7	32.1
HUC12 Name: Sauers Creek-North Santiam River	OR_WS_170900050208_02_104350	15.8	18.3	0.0	0.0
HUC12 Name: Sharps Creek	OR_WS_170900020203_02_104229	16.3	16.3	0.0	0.0
HUC12 Name: Smith River	OR_WS_170900040203_02_104307	23.4	12.3	11.1	47.4
HUC12 Name: Smith River	OR_WS_170900040203_02_104307	18.7			
HUC12 Name: South Fork Clackamas River	OR_WS_170900110404_02_104537	12.8	16.3	0.0	0.0
HUC12 Name: Staley Creek	OR_WS_170900010105_02_104189	16.4	12.3	4.1	25.0
HUC12 Name: Straight Creek-North Santiam River	OR_WS_170900050202_02_104344	14.2	18.3	0.0	0.0
HUC12 Name: Tumblebug Creek	OR_WS_170900010102_02_104186	15.4	12.3	3.1	20.2
HUC12 Name: Upper Canyon Creek	OR_WS_170900060204_02_104370	17.6	16.3	1.3	7.6
HUC12 Name: Upper Clear Creek	OR_WS_170900110601_02_104543	13.1	16.3	0.0	0.0
HUC12 Name: Upper Eagle Creek	OR_WS_170900110501_02_104540	17.7	16.3	1.4	8.0
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	19.4	13.3	6.1	31.4
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	29.3	18.3	11.0	37.5
HUC12 Name: Whitewater Creek	OR_WS_170900050206_02_104348	14.1	18.3	0.0	0.0
HUC12 Name: Winberry Creek	OR_WS_170900010905_02_104220	19.5	16.3	3.2	16.4
Johnson Creek	OR_SR_1709001201_02_104170	21.3	13.3	8.0	37.6
Johnson Creek	OR_SR_1709001201_02_104170	28.9	18.3	10.6	36.6
Junetta Creek	OR_SR_1709000202_02_103763	16.6	18.3	0.0	0.0
Layng Creek	OR_SR_1709000202_02_103765	24.3	18.3	6.0	24.8
Layng Creek	OR_SR_1709000202_02_103770	16.6	18.3	0.0	0.0
Little Fall Creek	OR_SR_1709000108_02_103730	16.1	13.3	2.8	17.2
Little Fall Creek	OR_SR_1709000108_02_103730	18.1	16.3	1.8	10.1

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Little North Santiam River	OR_SR_1709000505_02_104564	23.0	13.3	9.7	42.2
Little North Santiam River	OR_SR_1709000505_02_104564	28.1	16.3	11.8	42.0
Lookout Creek	OR_SR_1709000404_02_104571	20.9	16.3	4.6	22.0
Lower Blue River	OR_SR_1709000404_02_104569	21.8	13.3	8.5	39
Lower Blue River	OR_SR_1709000404_02_104569	21.6	16.3	5.3	24.5
Marion Creek	OR_SR_1709000502_02_103897	17.4	18.3	0.0	0.0
Martin Creek	OR_SR_1709000202_02_103756	19.9	18.3	1.6	8.0
McDowell Creek	OR_SR_1709000608_02_103994	21.7	18.3	3.4	15.6
McKenzie River	OR_SR_1709000407_02_103884	19.5	13.3	6.2	31.8
McKenzie River	OR_SR_1709000407_02_103884	21.2	16.3	4.9	23.1
McKenzie River	OR_SR_1709000402_02_104587	8.4	12.3	0.0	0.0
McKenzie River	OR_SR_1709000402_02_104588	11.8	12.3	0.0	0.0
Middle Fork Willamette River	OR_SR_1709000101_02_103713	13.4	12.3	1.1	8.1
Middle Fork Willamette River	OR_SR_1709000105_02_104579	21.0	12.3	8.7	41.4
Middle Fork Willamette River	OR_SR_1709000107_02_103725	17.8	13.3	4.5	25.3
Middle Fork Willamette River	OR_SR_1709000107_02_103725	19.2	16.3	2.9	15.1
Middle Santiam River	OR_SR_1709000601_02_103936	19.7	18.3	1.4	7.3
Middle Santiam River	OR_SR_1709000603_02_103965	24.0	18.3	5.7	23.8
Middle Santiam River	OR_SR_1709000604_02_103969	16.0	13.3	2.7	16.9
Middle Santiam River	OR_SR_1709000604_02_103969	14.4	18.3	0.0	0.0
Mill Creek	OR_SR_1709000702_02_104007	18.6	13.3	5.3	28.6
Mill Creek	OR_SR_1709000702_02_104007	25.3	18.3	7.0	27.8
Moose Creek	OR_SR_1709000602_02_103954	19.3	16.3	3.0	15.4
Nohorn Creek	OR_SR_1709001101_02_104145	17.1	16.3	0.8	4.7
North Fork Clackamas River	OR_SR_1709001104_02_104152	19.2	16.3	2.9	15.1
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	20.7	13.3	7.4	35.7
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	22.9	16.3	6.6	28.8
North Fork Pedee Creek	OR_SR_1709000305_02_103828	20.2	18.3	1.9	9.5
North Santiam River	OR_SR_1709000502_02_103899	17.9	18.3	0.0	0.0
North Santiam River	OR_SR_1709000503_02_103906	16.7	13.3	3.4	20.4

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
North Santiam River	OR_SR_1709000503_02_103906	16.7	16.3	0.4	2.4
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104149	12.2	16.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	12.6	13.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	13.8	16.3	0.0	0.0
Owl Creek	OR_SR_1709000602_02_103941	19.2	16.3	2.9	15.2
Portland Creek	OR_SR_1709000109_02_103741	22.5	16.3	6.2	27.4
Pringle Creek	OR_SR_1709000703_02_104012	25.1	18.3	6.8	27.1
Pyramid Creek	OR_SR_1709000601_02_103935	20.3	18.3	2.0	9.8
Quartz Creek	OR_SR_1709000405_02_103867	12.1	13.3	0.0	0.0
Quartz Creek	OR_SR_1709000405_02_103867	16.3	16.3	0.0	0.2
Quartzville Creek	OR_SR_1709000603_02_103957	19.3	18.3	1.0	5.2
Quartzville Creek	OR_SR_1709000603_02_103960	22.0	18.3	3.7	16.7
Rebel Creek	OR_SR_1709000403_02_103861	13.3	16.3	0.0	0.0
Ritner Creek	OR_SR_1709000305_02_103833	21.8	18.3	3.5	16.0
Roaring River	OR_SR_1709000403_02_103864	7.2	12.3	0.0	0.0
Roaring River	OR_SR_1709001104_02_104160	14.2	13.3	0.9	6.3
Roaring River	OR_SR_1709001104_02_104160	15.4	16.3	0.0	0.0
Row River	OR_SR_1709000202_02_103761	25.1	18.3	6.8	27.1
Row River	OR_SR_1709000202_02_103766	25.1	18.3	6.8	27.1
Salmon Creek	OR_SR_1709000104_02_103719	13.5	12.3	1.2	9.1
Salmon Creek	OR_SR_1709000104_02_103719	18.4	13.3	5.1	27.6
Salmon Creek	OR_SR_1709000104_02_103719	19.3	16.3	3.0	15.7
Salt Creek	OR_SR_1709000103_02_103716	16.1	13.3	2.8	17.1
Salt Creek	OR_SR_1709000103_02_103716	17.9	16.3	1.6	8.7
Separation Creek	OR_SR_1709000401_02_103857	10.0	12.3	0.0	0.0
Sharps Creek	OR_SR_1709000202_02_103755	24.0	18.3	5.7	23.8
Sharps Creek	OR_SR_1709000202_02_103775	19.2	18.3	0.9	4.6
Sheep Creek	OR_SR_1709000602_02_103953	20.9	16.3	4.6	21.9
Shelton Ditch	OR_SR_1709000703_02_104008	18.5	13.3	5.2	28.2
Shelton Ditch	OR_SR_1709000703_02_104008	23.8	18.3	5.5	23.1
Soda Fork	OR_SR_1709000602_02_103947	16.1	16.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104590	16.2	13.3	2.9	17.9

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
South Fork McKenzie River	OR_SR_1709000403_02_104590	17.8	16.3	1.5	8.4
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0.0	0.0
South Santiam River	OR_SR_1709000506_02_103925	15.0	13.3	1.7	11.3
South Santiam River	OR_SR_1709000506_02_103925	14.1	16.3	0.0	0.0
South Santiam River	OR_SR_1709000602_02_103950	18.1	13.3	4.8	26.4
South Santiam River	OR_SR_1709000602_02_103950	21.4	16.3	5.1	23.7
South Santiam River	OR_SR_1709000604_02_103968	21.8	13.3	8.5	39.0
South Santiam River	OR_SR_1709000604_02_103968	24.4	16.3	8.1	33.2
Teal Creek	OR_SR_1709000305_02_103824	20.3	18.3	2.0	9.9
Trout Creek	OR_SR_1709000602_02_103942	17.2	16.3	0.9	5.5
Trout Creek	OR_SR_1709001104_02_104157	16.3	16.3	0.0	0.0
Upper Blue River	OR_SR_1709000404_02_104574	20.6	16.3	4.3	20.9
Whitewater Creek	OR_SR_1709000502_02_103898	12.4	18.3	0.0	0.0
Winberry Creek	OR_SR_1709000109_02_103747	20.2	13.3	6.9	34.2
Winberry Creek	OR_SR_1709000109_02_103747	22.5	16.3	6.2	27.6

9 Allocation approach

Figure 9-1 provides three separate conceptual representations of the total load to a temperature-impaired water. The left (completely orange) block shows the total load, with the bisecting lines representing the load that would meet the biologically-based numeric criteria plus the human use allowance (the temperature standard). The middle block represents the portions of the total load contributed by the different source categories (point, nonpoint, and background). The right block illustrates how the loading capacity element of the TMDL defines the various allocations.

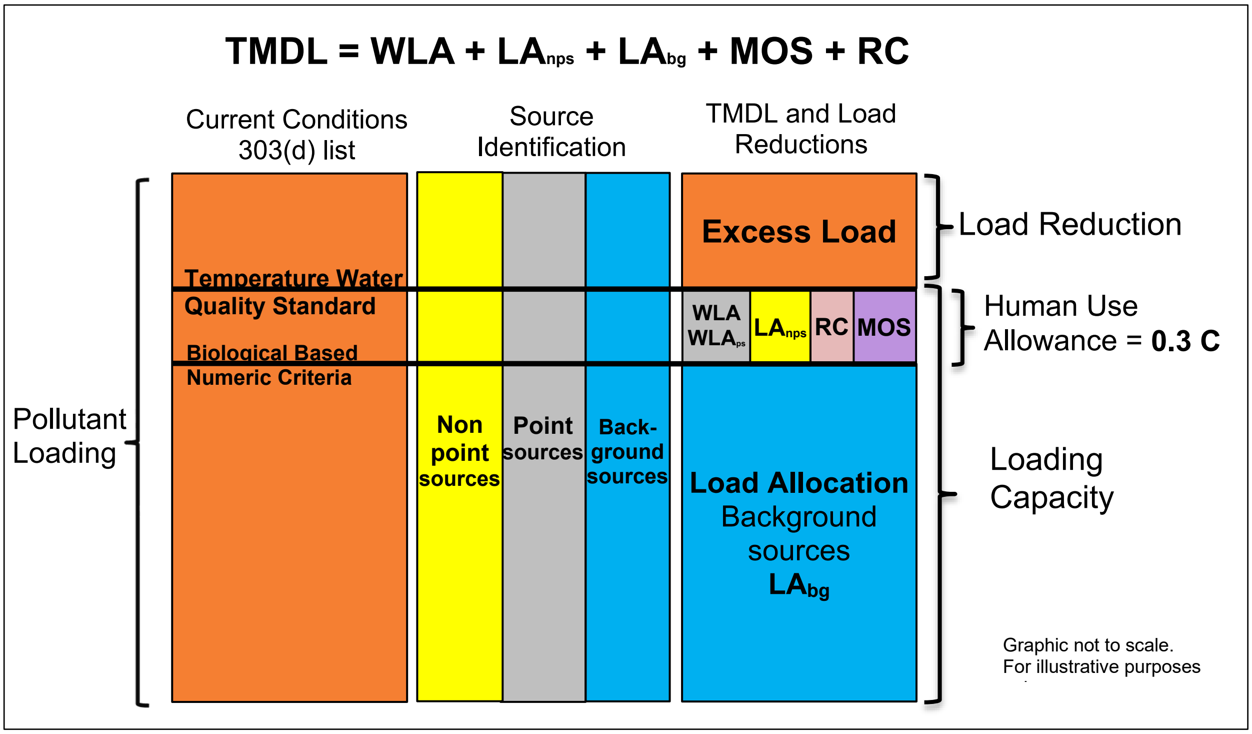


Figure 9-1: Conceptual representation and breakdown of total pollutant loading to a temperature-impaired waterbody.

Wasteload allocations (shown as WLA) are the portion of the TMDL loading capacity allocated to point sources and load allocations (shown as LAnps and LAbg) are the portion attributed to nonpoint sources, including background sources. OAR 340-042-0040(6) identifies the factors that DEQ or EQC may consider when distributing wasteload and load allocations.

The factors include:

a) Contributions from sources;
b) Costs of implementing measures;
c) Ease of implementation;
d) Timelines for attainment of water quality standards;
e) Environmental impacts of allocations;
f) Unintended consequences;
g) Reasonable assurances of implementation.
h) Any other relevant factor.

Oregon's temperature standard provides a framework for how the loading capacity is distributed between human sources of warming and background sources. The human use allowance at OAR 340-041-0028(12)(b)(B) identifies the portion of the loading capacity reserved for human uses. The rule requires that wasteload and load allocations restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.30°C (0.5°F) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact (POMI). DEQ allocated a thermal load equivalent to a 0.30°C increase to human sources and the remainder of the loading capacity to background sources.

When distributing the thermal loads associated with a 0.30°C increase, DEQ considered the magnitude of the thermal load contributed from known sources, ease of implementing the allocations, the environmental impact of those contributions including where the impact occurs, and how the source contribution impacts cumulative warming.

9.1 Point source wasteload allocations (WLAs)

DEQ's approach to point source allocations was to assign an equal portion of the human use allowance (0.075 degrees Celsius) at the point of discharge with some exceptions described below. A human use allowance of 0.075 degrees Celsius was selected because many of the current NPDES permit limits are based on this amount of allowed warming and is consistent with the allocation approach in DEQ's 2006 Willamette Basin temperature TMDL.

The following describes other factors DEQ considered when assigning the point of discharge human use allowance to point sources:

- If a point source is not authorized to discharge in the current NPDES permit (maximum effluent flow = 0), a human use allowance of 0.00 degrees Celsius was assigned during the no discharge period. A human use allocation of zero means there may be no warming above the applicable temperature criteria.
- When analysis completed for the TMDL indicated current thermal loads are less than 0.075 degrees Celsius, the allocation was reduced to be consistent with the current thermal load.
- The allocation was increased above 0.075 when analysis indicated that 0.075 would result in immediate noncompliance. DEQ only increased the allocation if there was sufficient loading capacity available. An assessment of current thermal loading was not possible for all point sources due to project time constraints or lack of data. DEQ prioritized source assessment on model streams or where it was known or suspected a 0.075 allocation would result in immediate noncompliance.
- On modeled streams, a characterization of point source discharge and cumulative effects analysis was completed. The results of the characterization and modeling informed the portion of the human use allowance assigned.

Cumulative warming effects were considered for assignment of the human use allowance to all NPDES point sources. On the McKenzie River, Pudding River, and Molalla River, the model results informed the total portion assigned. On unmodeled streams where a cumulative effects modeling analysis was not completed, the total portion of the human use allowance allocated to the point source sector represents the sum of the individual human use allowance allocations. For example, a stream with two NPDES discharges that each have 0.075 degrees Celsius assigned at the point of discharge would have a point source sector allocation of 0.15°C cumulatively at the point of maximum impact. This was done to ensure there would be no exceedance to the allocated portion of the human use allowance. The approach is protective based on model results from other streams that show the temperature impacts dissipating moving downstream from the outfall.

Table 9-1 summarizes the allocated portion of the human use allowance for each point source, the rationale, and the source of effluent discharge used in the waste load allocation equation. The time periods when the wasteload allocations apply are consistent with the critical periods discussed in Section 5.

Table 9-1: Rationale for human use allowance allocation and source of effluent discharge used for calculation of the Wasteload allocation in Table 9-2.

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
Albany Water Treatment Plant 66584 : ORG383501	0.075	0.77	Assumed 0.5 MGD (0.77 cfs)	
Alpine Community 100101 : OR0032387	0.00	0.03	Effluent flow is ADWDF from permit (0.02 MGD).	Based on no discharge requirement in NPDES permit.
Americold Logistics, LLLC 87663 : ORG253544	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Arclin 16037 : OR0021857	0.075	1.55	Effluent flow is based on maximum allowed in permit (1.00 MGD)	
Arclin 81714 : OR0000892	0.075	0.93	Effluent discharge recorded on Permit Evaluation and Fact Sheet dated 7/21/2009.	
ATI Albany Operations 64300 : OR0001716	0.075	0.46	Effluent flow from Permit Evaluation and Fact Sheet, dated 11/30/2005	
Aumsville STP 4475 : OR0022721	0.00	0.52	Effluent flow is ADWDF from permit (0.335 MGD).	Based on no discharge requirement in NPDES permit.
Aurora STP 110020 : OR0043991	0.00	0.1	Effluent flow is ADWDF from permit (0.087 MGD).	Based on no discharge requirement in NPDES permit.
Bakelite Chemicals LLC 32650 : OR0032107	0.00	0.0		Based on no discharge requirement in NPDES permit.
Bakelite Chemicals LLC 32864 : OR0002101	0.075	0.0	No effluent discharge reported on May 2019 and 2020 DMR for Outfall 001	
	0.00	0.0	No Discharge	Based on no discharge requirement in NPDES permit.
Blount Oregon Cutting Systems Division 63545 : OR0032298	0.075	0.19	Effluent discharge from Permit Evaluation Report, prepared 8/19/2010. Maximum flow from August 2009-July 2010.	
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.075	0.46	Effluent flow from Permit Evaluation Report prepared 6/18/2012. Average combined discharge flow for 2012.	
Brownsville STP 11770 : OR0020079	0.00	0.0		Based on no discharge requirement in NPDES permit.

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
City of Silverton Drinking WTP 81398 : ORG383527	0.20	0.095	Using design effluent flow reported in 2008 TMDL	Assessment of loading and allocation in 2008 TMDL
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.075	0.68	Effluent flow is ADWDF from permit (0.44 MGD).	
Coffin Butte Landfill 104176 : OR0043630	0.075	0.0	Based on review of DMRs showing no discharge	
Columbia Helicopters 100541 : OR0033391	0.075	0.01	Effluent flow from peak design flow listed in Permit Evaluation Report received 2/6/2007 (expired 3/19/2019)	
Corvallis Rock Creek WTP 20160 : ORG383513	0.075	0.77	Assumed 0.5 MGD (0.77 cfs)	
Creswell STP 20927 : OR0027545	0.075	0.31	Effluent flow is ADWDF from permit (0.20 MGD).	
	0.00	0.31	Effluent flow is ADWDF from permit (0.20 MGD).	Based on no discharge requirement in NPDES permit.
Dallas STP 22546 : OR0020737	0.075	3.09	Effluent flow is ADWDF from permit (2.0 MGD).	
Dallas WTP 22550 : ORG383529	0.075	0.77	Assumed 0.5 MGD (0.77 cfs)	
Duraflake 97047 : OR0000426	0.075	0.55	Using 95th percentile effluent flow from permit which is 0.248604 MGD for outfall 002 and 0.108250 MGD for outfall 003. (combined 0.356854 MGD)	
Estacada STP 27866 : OR0020575	0.075	0.84	Effluent discharge is recorded on the Permit Evaluation Form from May 1 to October 2009.	
EWEB Carmen-Smith Carmen Powerhouse (Outfalls 001A and 001B) 28393 : OR0000680	0.075	2.68	Effluent flow based on current permit requirement limiting outfall 001 flow to maximum of 1.73 MGD.	
EWEB Carmen-Smith Trail Bridge Powerhouse (Outfalls 002A and 002B) 28393 : OR0000680	0.030	0.93	Effluent flow based on current permit requirement limiting outfall 002a flow to average of 0.6 MGD.	Assessment of loading
Falls City STP 28830 : OR0032701	0.00	0.0		Based on no discharge requirement in NPDES permit.
First Premier Properties 110603 : ORG253511	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
Forrest Paint Co. 100684 : ORG253508	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Foster Farms 97246 : OR0026450	0.00	0.0		Based on no discharge requirement in NPDES permit.
Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.075	0.2	Effluent discharge recorded on Permit Evaluation and Fact Sheet. Finalized 9/4/2012.	
Gervais STP 33060 : OR0027391	0.00	0.34	Effluent flow is ADWDF from permit (0.22 MGD).	Based on no discharge requirement in NPDES permit.
Halsey STP 36320 : OR0022390	0.00	0.30	Effluent flow is ADWDF from permit (0.197 MGD).	Based on no discharge requirement in NPDES permit.
Herbert Malarkey Roofing Company 52638 : ORG250024	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Holiday Retirement Corp 108298 : ORG253504	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Hubbard STP 40494 : OR0020591	0.20	0.35	Effluent flow is maximum monthly dry weather design flow (0.223 MGD) from 2022 NPDES permit fact sheet. Effluent temperature is maximum daily effluent temperature reported in 2018 – 2020.	Assessment of loading and allocation in 2008 TMDL
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	0.08	Outfall 001 (Log Pond) no discharge July 1 - Oct 31. Outfall 002 max flow of 0.05 MGD. Using 0.05 MGD as effluent flow.	
International Paper - Springfield (Outfall 001 + Outfall 002) 96244 : OR0000515	0.12	28.8	Effluent flow is the 7-day average flow from DMRs that results in the maximum temperature change using the 7-day average effluent temperature and 7Q10 river flow	Assessment of loading
	0.20	28.8		
	0.18	28.8		
International Paper - Springfield (Outfall 003) 96244 : OR0000515	0.075	3.09	Effluent is the maximum discharge (2.0 MGD) at Outfall 003 reported on DMRs May-Oct 2013-2017.	
J.H. Baxter & Co 6553 : OR0021911	0.075	0.12	Effluent flow from average listed in Permit Evaluation from 9/13/2010	

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
JLR 32536 : OR0001015	0.01	0.5	Effluent discharge from April-October of 2018-2020 NetDMR data	Assessment of loading and allocation in 2008 TMDL
Junction City STP 44509 : OR0026565	0.00	0.0		Based on no discharge requirement in NPDES permit.
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330	0.075	0.08	Using maximum effluent flow (133300 gallons/day) reported on April 2020 DMR.	
	0.00	0	No discharge	Based on no discharge requirement in NPDES permit.
Knoll Terrace Mhc 46990 : OR0026956	0.00	0.09	Effluent flow is ADWDF from permit (0.06 MGD)	Based on no discharge requirement in NPDES permit.
Lakewood Utilities, Ltd 96110 : OR0027570	0.00	0.0		Based on no discharge requirement in NPDES permit.
Lane Community College 48854 : OR0026875	0.00	0.22	Effluent flow is ADWDF from permit (0.142 MGD).	Based on no discharge requirement in NPDES permit.
Lowell STP 51447 : OR0020044	0.03	3.03	Effluent discharge characterized from 2015-2019 DMRs. Max discharge of 1.96 MGD reported on September 2017 DMR. Max temperature of 23.2 reported on Aug 2016 DMR.	Assessment of loading
Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.00	0.0		NPDES permit limits effluent temperatures to a maximum of 17.8 C (May 1 - Oct 31), thus there are no increases above the temperature criterion.
Miller Paint Co Inc 103774 : ORG250040	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Molalla Municipal Drinking WTP 109846 : ORG380014	0.02	0.08	Using effluent flow reported in 2008 TMDL	Assessment of loading and allocation in 2008 TMDL
Molalla STP 57613 : OR0022381	0.10	3.46	Effluent discharge is max effluent flow recorded from March-October in NetDMR data. 2.234 MGD recorded on 4/24/2020.	Assessment of loading and immediate noncompliance
Mt. Angel STP 58707 : OR0028762	0.00	0.87	Effluent flow is ADWDF from permit (0.56 MGD).	Based on no discharge requirement in NPDES permit.

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
Murphy Veneer, Foster Division 97070 : OR0021741	0.075	1.11	Effluent flow reported in Permit Evaluation Report from July 1, 2010. 7 day average flow occuring between June 1st-15th during past 3 years (2007-2010?)	
Norpac Foods- Plant #1, Stayton 84820 : OR0001228	0.075	6.19	Effluent flow is the peak processing flow reported in the permit evaluation report.	
Oakridge STP 62886 : OR0022314	0.075	0.73	Effluent flow is ADWDF from permit (0.47 MGD).	
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	2.48	Used maximum flow of 1.6 MGD (2.48 cfs) authorized by NPDES permit.	
ODFW - Marion Forks Hatchery 64495 : OR0027847	0.075	18.6	Effluent flow is maximum from data submitted by ODFW	
ODFW - Roaring River Hatchery 64525 : ORG133506	0.01	14.2	Effluent flow is maximum from data submitted by ODFW	Based on assessment of loading completed by ODFW
ODFW - Willamette Fish Hatchery 64585 : ORG133507	0.075	79.0	Effluent flow is the maximum of the combined discharge from outfalls 001 and 002 as summarized from data submitted by ODFW.	
ODFW Leaburg Hatchery 64490 : OR0027642	0.14	67.9		Assessment of loading
	0.02	39.0		
	0.04	88.3		
ODFW McKenzie River Hatchery 64500 : OR0029769	0.12	53.8		Assessment of loading
	0.05	11.8		
	0.070	12.3		
Owens-Brockway Glass Container Inc. 65610 : ORG250029	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
PCC Structurals, Inc. 71920 : ORG250015	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Philomath WTP 100048 : ORG383536	0.075	0.77	Assumed 0.5 MGD (0.77 cfs)	
Philomath WWTP 103468 : OR0032441	0.00	0.0		Based on no discharge

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
				requirement in NPDES permit.
PNW Veg Co DBA Norpac Foods No. 5 84791 : OR0021261	0.00	0.0		Based on no discharge requirement in NPDES permit.
Portland International Airport 107220 : OR0040291	0.00	0.0		Based on no discharge requirement in NPDES permit for outfall CS-001. Other outfalls are stormwater or stormwater mixed with deicing and there is no heat expected.
Row River Valley Water District 100075 : ORG383534	0.075	0.77	Assumed 0.5 MGD (0.77 cfs)	
RSG Forest Products - Liberal 72596 : OR0021300	0.16	1.24	Effluent flow is maximum reported on DMRs May - Oct 2018 - 2021. 0.8 MGD in September 2020.	Assessment of loading and allocation in 2008 TMDL
Sandy WWTP 78615 : OR0026573	0.00	0.00		Based on no discharge requirement in NPDES permit.
Scio STP 79633 : OR0029301	0.00	0.14	Effluent flow is ADWDF from permit (0.09 MGD).	Based on no discharge requirement in NPDES permit.
Seneca Sawmill Company 80207 : OR0022985	0.00	1.19	Effluent flow from Permit Evaluation and Fact Sheet, dated 6/15/2006	NPDES permit limits effluent temperatures to a maximum of 18.0 C, thus there are no increases above the temperature criterion.
SFPP 103159 : OR0044661	0.075	0.02	Effluent flow reported in Permit Evaluation Report received 8/19/09	
Sherman Bros. Trucking 36646 : OR0021954	0.00	0.02	Effluent flow is ADWDF from permit (.014 MGD).	Based on no discharge requirement in NPDES permit.
Silverton STP 81395 : OR0020656	0.20	3.87	Effluent flow is ADWDF from permit (2.5 MGD).	Assessment of loading and allocation in 2008 TMDL
Sundance Lumber Company, Inc. 107401 : ORG253618	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
Sunstone Circuits 26788 : OR0031127	0.04	0.065	Using design effluent flow reported in 2008 TMDL	Assessment of loading and allocation in 2008 TMDL

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Effluent discharge (cfs)	Effluent discharge data source	HUA Allocation Rationale
Tangent STP 87425 : OR0031917	0.00	0.17	Effluent flow is ADWDF from permit (0.11 MGD).	Based on no discharge requirement in NPDES permit.
Timberlake STP 90948 : OR0023167	0.00	0.22	Effluent flow is ADWDF from permit (0.144 MGD).	Based on no discharge requirement in NPDES permit.
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20	52.6	Effluent flow from 2006 TMDL.	Assessment of loading and allocation in 2008 TMDL
Veneta STP 92762 : OR0020532	0.075	0.81	Effluent flow is average design wet weather flow from permit (0.524 MGD).	
	0.00	0.00	No Discharge	Based on no discharge requirement in NPDES permit.
	0.075	0.81	Effluent flow is average design wet weather flow from permit (0.524 MGD).	
Ventura Foods, LLLC 103832 : ORG250005	0.075	0.77	Set at maximum allowed by permit (0.5 MGD)	
WES - Boring STP 16592 : OR0031399	0.075	0.03	Using effluent flow from 2006 TMDL as reported in the WES temperature management plan. Permit says ADWDF is 0.02 MGD.	
Westfir STP 94805 : OR0028282	0.075	0.05	Effluent flow is ADWDF from permit (0.030 MGD).	
Willamette Leadership Academy 34040 : OR0027235	0.00	0.01	Effluent flow is ADWDF from permit (0.007 MGD).	Based on no discharge requirement in NPDES permit.
Woodburn WWTP 98815 : OR0020001	0.20	7.79	Effluent flow is ADWDF from permit (5.037 MGD).	Assessment of loading and allocation in 2008 TMDL

9.1.1 Wasteload allocations

Wasteload allocations for NPDES permitted point sources listed in Table 9-2 were calculated using **Equation 9-1**.

Wasteload allocations may be implemented in NPDES permits in any of the following ways: 1) incorporating the 7Q10 wasteload allocation in Table 9-2 as a static numeric limit. Permit writers may recalculate the static limit using different values for 7Q10 (Q_R), and effluent flow (Q_E), if better estimates are available. 2) incorporating **Equation 9-1** directly into the permit with effluent flow (Q_E), river flow (Q_R), and the wasteload allocation (WLA) being dynamic and calculated on a daily basis. The allocated portion of the human use allowance (ΔT) is based on the value in Table 9-2.

Table 9-2: Thermal wasteload allocations (WLA) for point sources.

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Albany Water Treatment Plant 66584 : ORG383501	0.075	5/1	10/31	24	0.77	4.546E+6
Alpine Community 100101 : OR0032387	0.00	5/1	10/31	0.4	0.03	0
Americold Logistics, LLLC 87663 : ORG253544	0.075	5/1	10/31	0	0.77	0.142E+6
Arclin 16037 : OR0021857	0.075	5/1	10/31	0	1.55	0.284E+6
Arclin 81714 : OR0000892	0.075	4/1	10/31	0	0.93	0.17E+6
ATI Albany Operations 64300 : OR0001716	0.075	5/1	10/31	1.4	0.46	0.342E+6
Aumsville STP 4475 : OR0022721	0.00	5/1	10/31	0.7	0.52	0
Aurora STP 110020 : OR0043991	0.00	5/1	10/31	10.1	0.1	0
Bakelite Chemicals LLC 32650 : OR0032107	0.00	5/1	10/31	0	0.0	0
Bakelite Chemicals LLC 32864 : OR0002101	0.075	5/1	5/31	0	0.0	0
	0.00	6/1	10/31	0	0.0	0
Blount Oregon Cutting Systems Division 63545 : OR0032298	0.075	2/15	11/15	0	0.19	0.034E+6
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.075	4/1	10/31	0	0.46	0.085E+6

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Brownsville STP 11770 : OR0020079	0.00	5/1	10/31	14.4	0.0	0
City of Silverton Drinking WTP 81398 : ORG383527	0.20	5/1	10/31	5	0.095	2.493E+6
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.075	5/1	10/31	0	0.68	0.125E+6
Coffin Butte Landfill 104176 : OR0043630	0.075	5/1	10/31	0	0.0	0
Columbia Helicopters 100541 : OR0033391	0.075	5/1	10/31	0	0.01	0.002E+6
Corvallis Rock Creek WTP 20160 : ORG383513	0.075	5/1	10/31	0	0.77	0.142E+6
Creswell STP 20927 : OR0027545	0.075	5/1	5/31	0	0.31	0.057E+6
	0.00	6/1	10/31	0	0.31	0
Dallas STP 22546 : OR0020737	0.075	5/1	10/31	4.2	3.09	1.339E+6
Dallas WTP 22550 : ORG383529	0.075	5/1	10/31	3.3	0.77	0.748E+6
Duraflake 97047 : OR0000426	0.075	5/1	10/31	0	0.55	0.101E+6
Estacada STP 27866 : OR0020575	0.075	5/1	10/31	317	0.84	58.323E+6
EWEB Carmen-Smith Carmen Powerhouse (Outfalls 001A and 001B) 28393 : OR0000680	0.075	5/1	10/31	146	2.68	27.282E+6
EWEB Carmen-Smith Trail Bridge Powerhouse (Outfalls 002A and 002B) 28393 : OR0000680	0.030	5/1	10/31	497.5	0.93	36.585E+6
Falls City STP 28830 : OR0032701	0.00	5/1	10/31	5.34	0.0	0
First Premier Properties 110603 : ORG253511	0.075	5/1	10/31	0	0.77	0.142E+6
Forrest Paint Co. 100684 : ORG253508	0.075	5/1	10/31	0	0.77	0.142E+6
Foster Farms 97246 : OR0026450	0.00	5/1	10/31	0	0.0	0

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.075	5/1	10/31	0	0.2	0.035E+6
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	7.3	0.34	0
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Herbert Malarkey Roofing Company 52638 : ORG250024	0.075	4/1	10/31	0	0.77	0.142E+6
Holiday Retirement Corp 108298 : ORG253504	0.075	5/1	10/31	0	0.77	0.142E+6
Hubbard STP 40494 : OR0020591	0.20	5/1	10/31	2.39	0.35	1.338E+6
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	5/1	10/31	0	0.08	0.014E+6
International Paper - Springfield (Outfall 001 + Outfall 002) 96244 : OR0000515	0.12	5/1	6/15	2,459	28.8	730.418E+6
	0.20	6/15	9/1	1,538	28.8	766.687E+6
	0.18	9/1	10/31	1,630	28.8	730.535E+6
International Paper - Springfield (Outfall 003) 96244 : OR0000515	0.075	5/1	10/31	0	3.09	0.568E+6
J.H. Baxter & Co 6553 : OR0021911	0.075	5/1	10/31	0.6	0.12	0.132E+6
JLR 32536 : OR0001015	0.01	5/1	10/31	6.7	0.5	0.176E+6
Junction City STP 44509 : OR0026565	0.00	5/1	10/31	0	0.0	0
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330	0.075	5/1	5/31	0	0.08	0.015E+6
	0.00	6/1	10/31	0	0	0
Knoll Terrace Mhc 46990 : OR0026956	0.00	5/1	10/31	0	0.09	0
Lakewood Utilities, Ltd 96110 : OR0027570	0.00	5/1	10/31	0	0.0	0
Lane Community College 48854 : OR0026875	0.00	5/1	10/31	0	0.22	0

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Lowell STP 51447 : OR0020044	0.03	5/1	11/15	998.4	3.03	73.505E+6
Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.00	5/1	10/31	0	0.0	0
Miller Paint Co Inc 103774 : ORG250040	0.075	4/1	10/31	0	0.77	0.142E+6
Molalla Municipal Drinking WTP 109846 : ORG380014	0.02	5/1	10/31	55.5	0.08	2.72E+6
Molalla STP 57613 : OR0022381	0.10	5/1	10/31	55.8	3.46	14.498E+6
Mt. Angel STP 58707 : OR0028762	0.00	5/1	10/31	7.3	0.87	0
Murphy Veneer, Foster Division 97070 : OR0021741	0.075	5/1	11/30	4.2	1.11	0.974E+6
Norpac Foods- Plant #1, Stayton 84820 : OR0001228	0.075	5/1	10/31	0	6.19	1.136E+6
Oakridge STP 62886 : OR0022314	0.075	5/1	10/31	449.8	0.73	82.672E+6
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	5/1	10/31	6.53	2.48	1.653E+6
ODFW - Marion Forks Hatchery 64495 : OR0027847	0.075	5/1	10/31	6.3	18.6	4.562E+6
ODFW - Roaring River Hatchery 64525 : ORG133506	0.10	5/1	11/30	0.5	14.2	3.597E+6
ODFW - Willamette Fish Hatchery 64585 : ORG133507	0.075	5/1	10/31	110	79.0	34.681E+6
ODFW Leaburg Hatchery 64490 : OR0027642	0.14	5/1	6/15	994.5	67.9	363.907E+6
	0.02	6/15	9/1	923.3	39.0	47.089E+6
	0.04	9/1	10/31	965.2	88.3	103.102E+6
ODFW McKenzie River Hatchery 64500 : OR0029769	0.12	5/1	6/15	994.5	53.8	307.781E+6
	0.05	6/15	9/1	923.3	11.8	114.394E+6
	0.070	9/1	10/31	965.2	12.3	167.413E+6

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Owens-Brockway Glass Container Inc. 65610 : ORG250029	0.075	4/1	10/31	0	0.77	0.142E+6
PCC Structurals, Inc. 71920 : ORG250015	0.075	2/15	11/15	0	0.77	0.142E+6
Philomath WTP 100048 : ORG383536	0.075	5/1	10/31	6.55	0.77	1.344E+6
Philomath WWTP 103468 : OR0032441	0.00	5/1	10/31	6.6	0.0	0
PNW Veg Co DBA Norpac Foods No. 5 84791 : OR0021261	0.00	5/1	10/31	0	0.0	0
Portland International Airport 107220 : OR0040291	0.00	4/1	10/31	0	0.0	0
Row River Valley Water District 100075 : ORG383534	0.075	5/1	10/31	11.5	0.77	2.252E+6
RSG Forest Products - Liberal 72596 : OR0021300	0.16	5/1	10/31	0	1.24	0.485E+6
Sandy WWTP 78615 : OR0026573	0.00	5/1	10/31	0	0.00	0
Scio STP 79633 : OR0029301	0.00	5/1	11/30	6.9	0.14	0
Seneca Sawmill Company 80207 : OR0022985	0.00	5/1	10/31	0	1.19	0
SFPP 103159 : OR0044661	0.075	5/1	10/31	0	0.02	0.004E+6
Sherman Bros. Trucking 36646 : OR0021954	0.00	5/1	10/31	0.2	0.02	0
Silverton STP 81395 : OR0020656	0.20	5/1	10/31	14	3.87	8.743E+6
Sundance Lumber Company, Inc. 107401 : ORG253618	0.075	5/1	10/31	0	0.77	0.142E+6
Sunstone Circuits 26788 : OR0031127	0.04	5/1	10/31	10.5	0.065	1.034E+6
Tangent STP 87425 : OR0031917	0.00	5/1	10/31	20.3	0.17	0
Timberlake STP 90948 : OR0023167	0.00	5/1	10/31	254	0.22	0
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20	5/1	10/31	21.3	52.6	36.162E+6

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcals/day)
Veneta STP 92762 : OR0020532	0.075	5/1	5/31	6.3	0.81	1.305E+6
	0.00	6/1	9/30	6.3	0.00	0
	0.075	10/1	10/31	6.3	0.81	1.305E+6
Ventura Foods, LLLC 103832 : ORG250005	0.075	4/1	10/31	0	0.77	0.142E+6
WES - Boring STP 16592 : OR0031399	0.075	5/1	10/31	0.65	0.03	0.125E+6
Westfir STP 94805 : OR0028282	0.075	5/1	10/31	174	0.05	31.937E+6
Willamette Leadership Academy 34040 : OR0027235	0.00	5/1	10/31	0	0.01	0
Woodburn WWTP 98815 : OR0020001	0.20	5/1	10/31	6.7	7.79	7.092E+6

9.1.2 Wasteload allocation equation

Equation 9-1 was used to calculate the thermal wasteload allocations in Table 9-2.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F$$ **Equation 9-11**

where,

$WLA =$ Wasteload allocation (kilocalories/day).

$\Delta T =$ The allocated portion of the human use allowance and the maximum temperature increase (°C) above the applicable temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0. **Equation 9-6** was used to determine if the minimum duties provision applies.

$Q_E =$ The daily mean effluent flow (cfs).
When effluent flow is in million gallons per day (MGD) convert to cfs:

$$\frac{1{,}000{,}000\ gallons}{1\ day} \cdot \frac{0.13368 ft^3}{1\ \text{gallon}} \cdot \frac{1\ day}{86{,}400\ sec} = 1.5472\ ft^3/sec$$

$Q_R =$ The daily mean river flow rate, upstream (cfs).
When flow is <= 7Q10, Q_R = 7Q10. When flow is > 7Q10, Q_R equals the daily mean river flow, upstream.

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,899

$$\left(\frac{1\ m}{3.2808\ ft}\right)^3 \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1°\text{C}} = 2{,}446{,}899$$

9.1.3 WLA attainment equation

When evaluating current discharge, DEQ used **Equation 9-2** to calculate the excess thermal loading (ETL). The ETL was compared against the wasteload allocation (WLA) to assess attainment.

$$ETL = (T_E - T_C) \cdot Q_E \cdot C_F$$ **Equation 9-22**

where,

$ETL =$ The daily excess thermal load (kilocalories/day).

$T_{C,i} =$ The point of discharge applicable river temperature criterion (°C) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i). **Equation 9-6** was used to determine if the minimum duties provision applies.

$T_E =$ The daily maximum effluent temperature (°C)

$Q_E =$ The daily mean effluent flow (cfs or MGD)

$C_F =$ Conversion factor for flow in cubic feet per second (cfs): 2,446,665

$$\left(\frac{1\ \text{m}}{3.2808\ \text{ft}}\right)^3 \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1\text{°C}} = 2{,}446{,}665$$

Conversion factor for flow in millions of gallons per day (MGD): 3,785,411

$$\frac{1\ m^3}{264.17\ gal} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{1000000\ gal}{1\ million\ gal} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1\text{°C}} = 3{,}785{,}441$$

9.1.4 Calculating current change in temperature

Equation 9-3 was used to assess the change in temperature based on point source effluent discharge, river flow, and the applicable temperature criteria.

$$\Delta T_{Current} = \left(\frac{Q_E}{Q_E + Q_R}\right) \cdot (T_E - T_C)$$ **Equation 9-33**

where,

$\Delta T_{Current} =$ The current river temperature increase (°C) above the applicable river temperature criterion using 100% of river flow.

$Q_E =$ The daily mean effluent flow (cfs).
When effluent flow is in million gallons per day (MGD) convert to cfs:

$$\frac{1\ \text{million}\ gallons}{1\ day} \cdot \frac{1.5472\ ft^3}{1\ \text{million gallons}} = 1.5472$$

$Q_R =$ The daily mean river flow rate, upstream (cfs).
When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow, upstream.

$T_E =$ The daily maximum effluent temperature (°C)

$T_C =$ The point of discharge applicable river temperature criterion (°C). When the minimum duties provision at OAR 340-041-0028(12)(a) applies T_C = the 7DADM measured at the facility intake.

9.1.5 Calculating acceptable effluent temperatures

Equation 9-4 was used to calculate the daily maximum effluent temperatures (°C) acceptable under the allocated portion of the human use allowance (ΔT) and the wasteload allocation (WLA).

$$T_{E\_WLA} = \frac{(Q_E + Q_R) \cdot (T_C + \Delta T) - (Q_R \cdot T_C)}{Q_E}$$ **Equation 9-4a** (using ∆T)

$$T_{E\_WLA} = \frac{(WLA)}{Q_E \cdot C_F} + T_C$$ **Equation 9-4b** (using WLA)

where,

$T_{E\_WLA} =$ Daily maximum effluent temperature (°C) allowed under the wasteload allocation. When T_{E_WLA} is > 32 deg-C, T_{E_WLA} = 32 deg-C as required by the thermal plume limitations in OAR 340-041-0053(2)(d)(B).

$WLA =$ Wasteload allocation (kilocalories/day) from **Equation 9-1**.

$\Delta T =$ The allocated portion of the human use allowance and the maximum temperature increase (°C) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

$Q_E =$ The daily mean effluent flow (cfs). When effluent flow is in million gallons per day (MGD) convert to cfs:

$$\frac{1 \text{ million } gallons}{1\ day} \cdot \frac{1.5472\ ft^3}{1 \text{ million gallons}} = 1.5472$$

$Q_R =$ The daily mean river flow rate, upstream (cfs). When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow, upstream.

$T_{C,i} =$ The point of discharge applicable river temperature criterion (°C) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i).

$C_F =$ Conversion factor for flow in cubic feet per second (cfs): 2,446,665

$$\left(\frac{1\ m}{3.2808\ ft}\right)^3 \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1°\text{C}} = 2{,}446{,}665$$

9.1.6 Calculating acceptable effluent flows

Equation 9-5 was used to calculate the daily mean effluent flow (cfs) acceptable under the allocated portion of the human use allowance (∆T) and the wasteload allocation (WLA).

$$Q_{E\_WLA} = \frac{(Q_R \cdot T_C) - ((T_C + \Delta T) * Q_R)}{T_C + \Delta T - T_E}$$ **Equation 9-5a** (using ∆T)

$$Q_{E\_WLA} = \frac{(WLA)}{(T_E - T_C) * C_F}$$ **Equation 9-5b** (using WLA)

where,

$Q_{E\_WLA} =$ Daily mean effluent flow (cfs) allowed under the wasteload allocation.

$WLA =$ Wasteload allocation (kilocalories/day) from **Equation 9-1**.

$\Delta T =$ The allocated portion of the human use allowance and the maximum temperature increase (°C) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

$T_E =$ The daily maximum effluent temperature (°C).

$Q_R =$ The daily mean river flow rate, upstream (cfs). When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow, upstream.

$T_{C,i} =$ The point of discharge applicable river temperature criterion (°C) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i).

$C_F =$ Conversion factor for flow in cubic feet per second (cfs): 2,446,665

$$\left(\frac{1\,m}{3.2808\,ft}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\,\cdot 1°\mathrm{C}} = 2{,}446{,}665$$

9.1.7 Determination of when minimum duties provision applies

The minimum duties provision at OAR 340-041-0028(12)(a) states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with its overall heat contribution.

For point sources, DEQ is implementing the minimum duties provision if a facility operation meets acceptable operation and design requirements in regard to flow pass through. Generally, the facility must be operated as a "flow through" facility where intake water moves through the facility and is not processed. The water must also be returned to the same stream where the intake is located. Under these circumstances, the facility cannot add any additional thermal loading to the intake temperatures if the intake temperatures are warmer than discharge temperatures allowed by the wasteload allocation. The purpose is to ensure the facility controls for thermal effects resulting from passing the water through and not from upstream sources.

The minimum duties provision is not used for a facility that processes intake water as part of their industrial or wastewater treatment operations. This may include mixing the intake water with other wastewater or as method to cool equipment.

In the Willamette Subbasins, DEQ determined that ODFW's Marion Forks Fish Hatchery, Roaring River Fish Hatchery, and Willamette Fish Hatchery, and USFW's Eagle Creek National Fish Hatchery, operate as a flow through facility. When assessing the wasteload allocation for attainment, DEQ used the approach described in **Equation 9-6** to implement the minimum duties provision.

The minimum duties provision applies on days when $T_{E\_WLA} < T_i$.

When the minimum duties provision at OAR 340-041-0028(12)(a) applies, $\Delta T = 0.0$. **Equation 9-66**

where,

$T_{E\_WLA} =$ Daily maximum effluent temperature (°C) allowed under the wasteload allocation as calculated using **Equation 9-4**.

$T_i =$ The daily maximum influent temperature (°C) measured at the facility intake.

9.2 Nonpoint source load allocations (LAs)

As summarized in Section 7.2 lack of streamside vegetation is one of the largest sources of stream warming contributing multiple degrees of warming to the model stream. The load allocations provided to entities that manage or have authority over streamside vegetation management activities require those activities not cause a temperature increase (no warming). DEQ considered the difficulty in addressing this requirement where there is existing infrastructure (roads, railroads, buildings, and utility corridors) and provided a separate load allocation to these land use types to allow some warming and minimize the costs of trying to eliminate their warming impact. The no warming requirement for other land management activities is implemented through an effective shade target. Effective shade can be easily measured in the field and is simpler to monitor relative to a thermal load. Based on an extensive literature review, DEQ determined that a vegetation buffer width based on a slope distance of 120 feet would be sufficient in most cases to have no warming and attain the shade targets (TSD Appendix I).

DEQ assigned a load allocation and human use allowance of up to 0.05 degrees Celsius for temperature impacts associated with consumptive water use (water management and water withdrawals).

Load allocations are assigned to background sources and anthropogenic nonpoint sources on all waters in the Willamette Subbasins. Load allocations for background sources are calculated using **Equation 9-7**.

$$LA_{BG} = (T_C) \cdot (Q_R) \cdot C_F \qquad \textbf{Equation 9-7}$$

where,

$LA_{BG} =$ Load allocation to background sources (kilocalories/day).

$T_C =$ The applicable temperature criteria, not including the human use allowance. When there are two year-round applicable temperature criteria that apply to the same assessment unit, the more stringent criteria shall be used.

$Q_R =$ The daily average river flow rate (cfs).

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$\left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1\,m^3}{35.31\,ft^3} \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1^{\circ}\text{C}} = 2{,}446{,}665$$

Table presents the load allocation assigned to background sources for temperature impaired category 5 assessment units that were modeled for the TMDL analysis. The load allocation presented is based on the critical 7Q10 low flow. Equation 9-7 shall be used to calculate the load allocation to background sources for any assessment unit or stream location in the Willamette Subbasins not identified in Table 10-1 or when river flows are greater than 7Q10.

Equation 9-7 may also be used to calculate the load allocations for background nonpoint sources if in the future the applicable temperature criteria are updated and approved by EPA.

Load allocations assigned to anthropogenic nonpoint sources on any assessment unit or stream location in the Willamette Subbasins are calculated using Equation 9-8. The portions of the human use allowance (ΔT) assigned to nonpoint sources or source categories are presented in Section 9.1.1 Human Use Allowance allocations of the Willamette Subbasins TMDL.

$$LA_{NPS} = (\Delta T) \cdot (Q_R) \cdot C_F \qquad \textbf{Equation 9-8}$$

where,

$LA_{NPS} =$ Load allocation to anthropogenic nonpoint sources (kilocalories/day).

$\Delta T =$ The portion of the human use allowance assigned to each nonpoint source or source category representing the maximum cumulative temperature increase

(°C) from the nonpoint source or source category. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ∆T = 0.0.

$Q_R =$ The daily average river flow rate (cfs).

Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$C_F = \left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1\,m^3}{35.31\,ft^3} \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\,\cdot 1°\text{C}} = 2{,}446{,}665$$

Table 9-3: Thermal load allocations (LA) for background sources.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion (°C)	Spawning Criterion (°C)	LA period start	LA period end	7Q10 LA Non-Spawning (kcal/day)	7Q10 LA Spawning (kcal/day)
Coyote Creek OR_SR_1709000301_02_103796	5.9	18	NA	5/1	10/31	259.84E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25.4	16	13	5/1	10/31	994.32E+6	807.89E+6
Johnson Creek OR_SR_1709001201_02_104170	11.1	18	13	2/15	11/15	489.18E+6	353.3E+6
Little North Santiam River OR_SR_1709000505_02_104564	19.5	16	13	5/1	10/31	762.09E+6	619.2E+6
Luckiamute River OR_SR_1709000305_02_103829	15.9	18	13	5/1	10/31	699.71E+6	505.35E+6
McKenzie River OR_SR_1709000407_02_103884	975.1	16	13	5/1	10/31	38,171.89E+6	31,014.66E+6
Mohawk River OR_SR_1709000406_02_103871	15.7	16	13	3/15	11/15	612.73E+6	497.84E+6
Molalla River OR_SR_1709000904_02_104086	38.1	16	13	5/1	10/31	1,491.49E+6	1,211.83E+6
Mosby Creek OR_SR_1709000201_02_103752	10.7	16	13	5/1	10/31	418.87E+6	340.33E+6
Pudding River OR_SR_1709000905_02_104088	10.4	18	NA	5/1	10/31	459.37E+6	NA
Thomas Creek OR_SR_1709000607_02_103988	6.9	18	NA	5/1	10/31	302.18E+6	NA

9.3 Surrogate measures

EPA regulations (40 CFR 130.2(i)) and OAR 340-042-0040(O)(5)(b) allow for TMDLs to utilize other appropriate measures (or surrogate measures). This section presents surrogate measures that implement the load allocations.

9.3.1 Dam and reservoir operations

Dam and reservoir operations have been allocated 0.00 °C of the human use allowance and the equivalent load allocation as calculated using Equation 9-8. Monitoring stream temperature, rather than a thermal load, is easier and a more meaningful approach for reservoir management. Temperature is mathematically related to excess thermal loading and directly linked to the temperature water quality standard. For these reasons, DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations. The minimum duties provision in rule at OAR 340-042-0028(12)(a) states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with its overall heat contribution. For dam and reservoir operations, the minimum duties provision is implemented when 7DADM temperatures upstream of the reservoirs exceed the applicable temperature criteria, the dam and reservoir operations must not contribute any additional warming above and beyond those upstream temperatures entering the reservoir. DEQ has developed the following surrogate measure temperature approach to implement the load allocation. The surrogate measure compliance point is located just downstream of the dam or just downstream of where impounded water is returned to the free-flowing stream. The surrogate measure is:

a) The 7DADM temperatures immediately upstream of the reservoirs. If multiple streams flow into the reservoir, 7DADM temperatures upstream of the reservoirs may be calculated as a flow weighted mean of temperatures from each inflowing tributary. With DEQ approval, the estimated free flowing (no dam) temperatures may also be calculated using a model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations and applied as the temperature surrogate measure.

b) On days the surrogate measure calculated or measured under item a) is cooler than the most restrictive applicable temperature criteria anywhere in the assessment unit immediately downstream of the dam, the surrogate 7DADM temperature may be the no warmer than the applicable criteria when all of the following are true:

    i. The protecting cold water criterion at OAR 340-041-0028(11) does not apply;
    ii. DEQ approves a cumulative effects analysis demonstrating release temperatures warmer than the cooler ambient temperatures will not increase downstream 7DADM temperatures more than the portion of the HUA allocated to the dam and reservoir above the applicable criteria. Currently, dam and reservoir operations receive zero HUA; however, in the future if warranted, a specific operation may receive a portion of the HUA currently allotted to reserve capacity.

For implementation of the low flow conditions provision at OAR 340-041-0028(12)(d), the 7Q10 shall be calculated at a gage upstream of the reservoir or at nearby monitoring gage that isn’t influenced by the dam’s operations.

9.3.1.1 Protecting cold water criterion and dams in the Willamette Subbasins

There are approximately 202 instream large dams located within the Willamette Subbasins temperature TMDL project area. The list of dams was obtained from the USACE National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department, dam safety program. For each of these dams, we were interested in determining whether the Protective Cold Water (PCW) criterion applied to immediate downstream and upstream reaches. As many reservoirs have multiple inflowing streams, the stream contributing the most flow was evaluated to see whether the PCW applied.

Several sources were examined for this analysis. An ArcGIS online map of the Oregon 2022 Integrated Report was first used to determine whether each dam was located along a temperature-impaired waterway, as a Category 5 temperature impairment (either year-round or spawning) precludes qualification for the PCW criterion. As such, if downstream and/or upstream reaches were listed as impaired for temperature, it was noted that the PCW did not apply. However, if the waterbody was listed as attaining for temperature, it was reported that the PCW did apply.

The NorWeST SSN stream temperature models developed by Isaak et al 2017, were also used to determine if the PCW was applicable. These models use covariates derived from NHD and other sources to make temperature predictions to all river and stream reaches in various subregions in the Pacific Northwest. DEQ used the model outputs for the Oregon Coast processing unit. The specific model outputs used were from the MWMT S2_02_11 composite scenario which is the prediction of the 10 year average (2002-2011) August Maximum Weekly Maximum (MWMT) stream temperature. The MWMT is similar to the 7DADM.

The NorWeST model outputs consists of observed (point) temperature data as well as modeled (line) stream temperatures. Where available, NorWeST temperatures upstream and downstream of each reservoir were compared to the year round (non-spawning) 7DADM temperature criterion for that particular reach. If the MWMT S2_02_11 scenario temperatures exceeded the applicable temperature criterion immediately upstream or downstream of the dam and reservoir, it was reported that the PCW did not apply. Conversely, if the MWMT S2_02_11 temperature was less than the criterion both up and downstream, it was noted that the PCW did apply. In the rare instance of a discrepancy between the Integrated Report and the NorWeST data, priority for PCW determination was given to the Integrated Report. One major limitation in the Norwest data is that the model does not make predictions during the fall when the spawning criterion apply.

The applicability of the PCW criterion was not always immediately apparent. In multiple instances, while the NHD stream network showed an upstream reach flowing into a reservoir, no upstream NorWeST data existed. In these cases, it was noted that the applicability of the PCW criterion was unclear. For other dams, there existed a short downstream NHD line with no corresponding NorWeST data until the stream flowed into a connecting stream. In these cases, it was noted that the applicability of the PCW was unclear. For off-channel lagoons associated with treatment systems, N/A was reported. For reservoirs with no inflowing streams such as offstream irrigation ponds, N/A was selected for upstream and Integrated Report/NorWeST data were evaluated for the downstream reach. When it was unclear whether the reservoir connected to a downstream flowline, it was noted that the applicability of the PCW was unclear.

Based on these methods, DEQ determined that the PCW criterion likely applies at four dams in the Willamette Subbasins (Table 9-4).

Table 9-4: Dams where the protecting colder water criterion likely applies.

Dam name	NID ID	Dam owner	Latitude	Longitude	Stream	Notes
Carmen Diversion	OR00539	EWEB	44.3384	-122.0057	McKenzie River	Based on NorWest model S2_02_11 showing MWMT temperatures < 12 deg C
Harriet Lake	OR00546	PGE	45.0746	-121.9697	Oak Grove River	Based on attaining status on DEQ 2022 IR (OR_SR_1709001103_02_104150)
Timothy Lake	OR00545	PGE	45.1136	-121.8067	Oak Grove River	Based on attaining status downstream of Oak Grove Fork Clackamas River on DEQ 2022 IR (OR_SR_1709001103_02_104150)
Trail Bridge	OR00540	EWEB	44.2734	-122.0507	McKenzie River	Based on attaining status on DEQ 2022 IR (OR_SR_1709000402_02_104588; OR_SR_1709000402_02_104587)
Trail Bridge Saddle Dike	OR00540	EWEB	44.2733	-122.0470	McKenzie River	Same location as Trail Bridge

9.3.2 Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in Table 9-5 through Table 9-9 represent a surrogate for the amount of solar loading that will attain the human use allowance and load allocations for nonpoint sources managing streamside vegetation. The surrogate measure is the arithmetic mean of the effective shade values at all model nodes assigned to each designated management agency (Equation 9-9). Equation 9-9 may be used to recalculate the mean effective shade targets if designated management agency boundaries change or the designated management agency boundary needs to be corrected. Equation 9-9 may also be used to recalculate the mean effective shade targets based on an updated shade gap assessments following the process and methods outlined in the Water Quality Management Plan.

Changes in the target effective shade from the values presented in Table 9-5 through Table 9-9 may result in redistribution of the sector or source responsible for excess load reduction. If the shade target increases, the equivalent portion of the excess load is reassigned from background sources to nonpoint sources. If the shade target decreases, the portion of the excess load is reassigned from nonpoint sources to background sources. The exact portion reassigned can only be determined in locations where temperature models have been developed. In locations without temperature models, the reassignment remains unquantified. Changes to the target effective shade do not impact the loading capacity, human use allowance, or the load allocations. They remain the same as presented in this TMDL.

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i}$$ **Equation 9-99**

Where,

$\overline{ES} =$	The mean effective shade for designated management agency *i.*
$\sum ES_{n_i} =$	The sum of effective shade from all model nodes or measurement points assigned to designated management agency *i.*
$n_i =$	Total number of model nodes or measurement points assigned to designated management agency *i.*

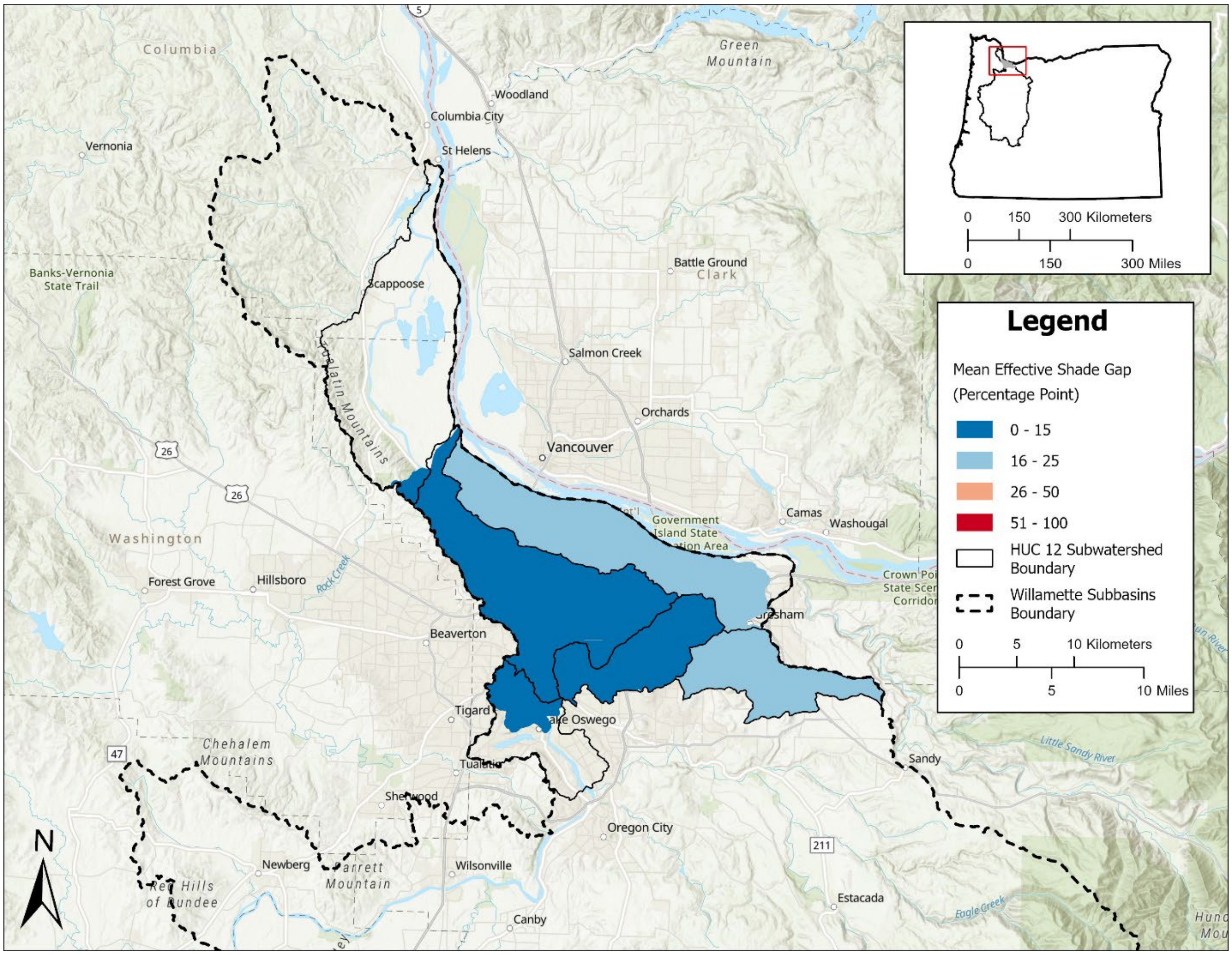


Figure 9-2: Lower Willamette Subbasin model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-5: Effective shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the Lower Willamette Subbasin model area.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
BNSF	0.1	35	42	7
City of Fairview	0.1	21	54	33
City of Gresham	16	63	81	18
City of Happy Valley	0.8	79	90	11
City of Lake Oswego	5.8	83	90	7
City of Milwaukie	2.9	62	80	18
City of Portland	127.4	61	73	12
Clackamas County	13.3	66	86	20
Multnomah County	9.7	75	90	15
Oregon Department of Agriculture	13.5	65	85	20
Oregon Department of Forestry - Private	6.6	89	92	3
Oregon Parks and Recreation Department	0.1	91	91	0
Port of Portland	2.1	29	45	16
Portland & Western Railroad	<0.1	82	89	7
Roads	3.1	54	77	23
Union Pacific Railroad	0.1	34	62	28

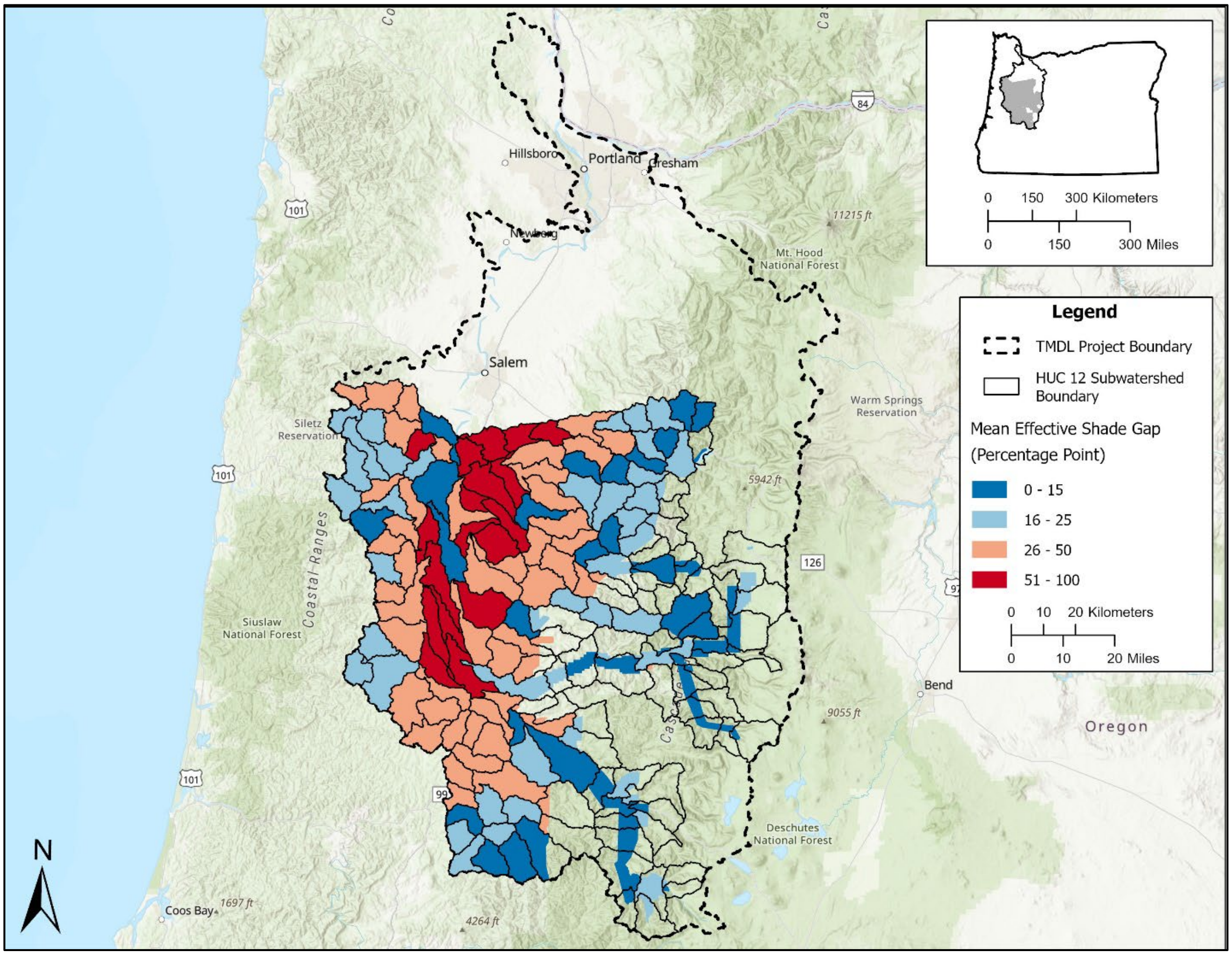


Figure 9-3: Southern Willamette model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-6: Effective shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the Southern Willamette model area.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Albany & Eastern Railroad	0.1	95	97	2
Benton County	119.3	57	89	32
Bonneville Power Administration	2.3	34	94	60
Central Oregon & Pacific Railroad	0.2	8	86	78
City of Adair Village	2	27	93	66
City of Albany	47.7	35	76	41
City of Brownsville	4	28	67	39
City of Coburg	2.8	22	91	69
City of Corvallis	63.8	59	86	27
City of Cottage Grove	6.2	38	85	47
City of Creswell	4.6	18	91	73
City of Eugene	139.4	27	81	54
City of Falls City	9	56	96	40
City of Gates	4.7	36	85	49
City of Halsey	1.6	8	87	79
City of Harrisburg	0.8	3	88	85
City of Jefferson	3.2	22	82	60
City of Junction City	11.6	9	85	76
City of Lebanon	16.2	37	85	48
City of Lowell	2.7	33	90	57
City of Lyons	2.3	32	88	56
City of Mill City	2.9	18	76	58
City of Millersburg	17.2	26	78	52
City of Monmouth	0.5	82	89	7
City of Monroe	1.2	26	75	49
City of Oakridge	9.2	28	75	47
City of Philomath	7.6	37	88	51
City of Salem	0.8	24	45	21
City of Scio	1.7	51	59	8
City of Springfield	45.9	30	83	53
City of Stayton	3.9	41	86	45
City of Sweet Home	26.2	33	87	54
City of Tangent	10.9	48	82	34
City of Veneta	8.7	50	95	45
City of Waterloo	0.4	48	94	46
City of Westfir	3.1	29	80	51
Lane County	773.3	49	84	35
Lincoln County	0.2	9	96	87
Linn County	180.7	42	88	46
Marion County	49	42	78	36
Oregon Department of Agriculture	4823	32	85	53
Oregon Department of Aviation	0.2	1	92	91
Oregon Department of Fish and Wildlife	13.8	37	73	36
Oregon Department of Forestry - Private	8603.4	70	96	26
Oregon Department of Forestry - Public	526.6	85	97	12
Oregon Department of Geology and Mineral Industries	5	40	93	53
Oregon Department of State Lands	3.7	37	56	19
Oregon Department of Transportation	54.9	35	78	43
Oregon Military Department	0.2	0	86	86
Oregon Parks and Recreation Department	28.2	48	72	24
Polk County	64.9	50	93	43

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Port of Coos Bay	1.9	56	93	37
Portland & Western Railroad	1.9	46	74	28
State of Oregon	2.5	63	68	5
U.S. Army Corps of Engineers	73.6	59	81	22
U.S. Bureau of Land Management	2574.4	89	97	8
U.S. Department of Agriculture	1.2	30	46	16
U.S. Department of Defense	1.5	47	85	38
U.S. Fish and Wildlife Service	39.7	47	77	30
U.S. Forest Service	2985.3	84	95	11
U.S. Government	10.3	59	82	23
Union Pacific Railroad	5.4	65	90	25

Table 9-7: Effective shade surrogate measure targets to meet nonpoint source load allocations for specific model extents.

Model Stream	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Pudding River	85.55	44	52	8
Molalla River	75.36	27	41	14

Table 9-8: Effective shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the Pudding River model extent.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
City of Aurora	0.2	28	33	5
Clackamas County	0.5	33	49	16
Marion County	0.2	43	63	20
Oregon Department of Agriculture	96.1	47	57	10
Oregon Department of Transportation	0.2	74	77	3
Oregon Parks and Recreation Department	1.6	36	42	6
State of Oregon	0.1	66	64	-2

Table 9-9: Effective shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the Molalla River model extent.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
City of Canby	3.1	26	42	16
City of Molalla	0.1	5	29	24
Clackamas County	2.9	19	33	14
Oregon Department of Agriculture	26.8	13	27	14
Oregon Department of Forestry - Private	13.8	40	51	11
Oregon Department of Transportation	0.1	16	51	35
Oregon Parks and Recreation Department	2.1	13	23	10
State of Oregon	0.7	16	24	8
U.S. Bureau of Land Management	24.4	51	65	14
U.S. Government	0.1	49	44	-5
Union Pacific Railroad	0.3	24	47	23

9.3.3 Effective shade curve surrogate measure

Effective shade curves are applicable to any stream that does not have site specific shade targets (9.3.3). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented within the effective shade curves (Figure 9-6 to Figure 9-27) represent the mean effective shade target for different mapping units, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer widths used for each mapping unit vegetation type is summarized in Table 9-10. See the Technical Support Document Appendix A and C for additional details on the model approach for shade curves and the methodologies used to determine the mapping units and vegetation characteristics. Section 14 of the TMDL provides tables of the plotted shade curve values. A map of all mapping units in the Willamette Basin can be found in Appendix H of the Technical Support Document.

Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other factors may prevent effective shade from reaching the target effective shade. No enforcement action will be taken by DEQ for reductions in effective shade caused by natural disturbances.

Table 9-10: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets for each mapping unit.

Mapping Unit	Height (m)	Height (ft)	Density (%)	Overhang (m)	Buffer Width (m)
Qff1	40.7	134	70	4.9	36.8
Qfc	37.7	124	64	4.5	36.8
Qalc	26.9	88	71	3.2	36.8
Qg1	21.6	71	64	2.6	36.8
Qau	22.6	74	69	2.7	36.8
Qalf	17.5	57	68	2.1	36.8
Qff2	21.5	71	66	2.6	36.8
Qbf	22.0	72	68	2.6	36.8
Tvc	27.8	91	65	3.3	36.8
Qtg	40.5	133	72	4.9	36.8
Tvw	35.1	115	65	4.2	36.8
Tcr	36.9	121	68	4.4	36.8
Tm	29.7	97	68	3.6	36.8
QTt	25.2	83	66	3.0	36.8
QTb	35.2	115	64	4.2	36.8
Qls	44.0	144	65	5.3	36.8
OW	1.9	6	74	0.2	36.8
Upland Forest	40.9	134	75	4.9	36.8
1d/1f - Coast Range - Volcanics and Willapa Hills	36.0	118.1	75	3.9	36.8
3a -Willamette Valley - Portland/Vancouver Basin	26.0	85.3	75	1.9	36.8
3c -Willamette Valley - Prairie Terraces	33.2	108.9	75	1.9	36.8
3d - Willamette Valley – Valley Foothills	31.0	101.7	75	1.9	36.8

How to use a shade curve:

1. Determine the applicable mapping unit for the stream location you are applying a shade curve to.

   Example: Your site of interest is in the Rickreall Creak watershed, in the City of Independence, along the west bank of a tributary to the Willamette River. By using the appropriate map, (Figure 9-4: Mapping units in the Rickreall Creek Watershed.Figure 9-4), you identify the mapping unit at your site to be Qalc (Quaternary alluvium floodplain deposits).

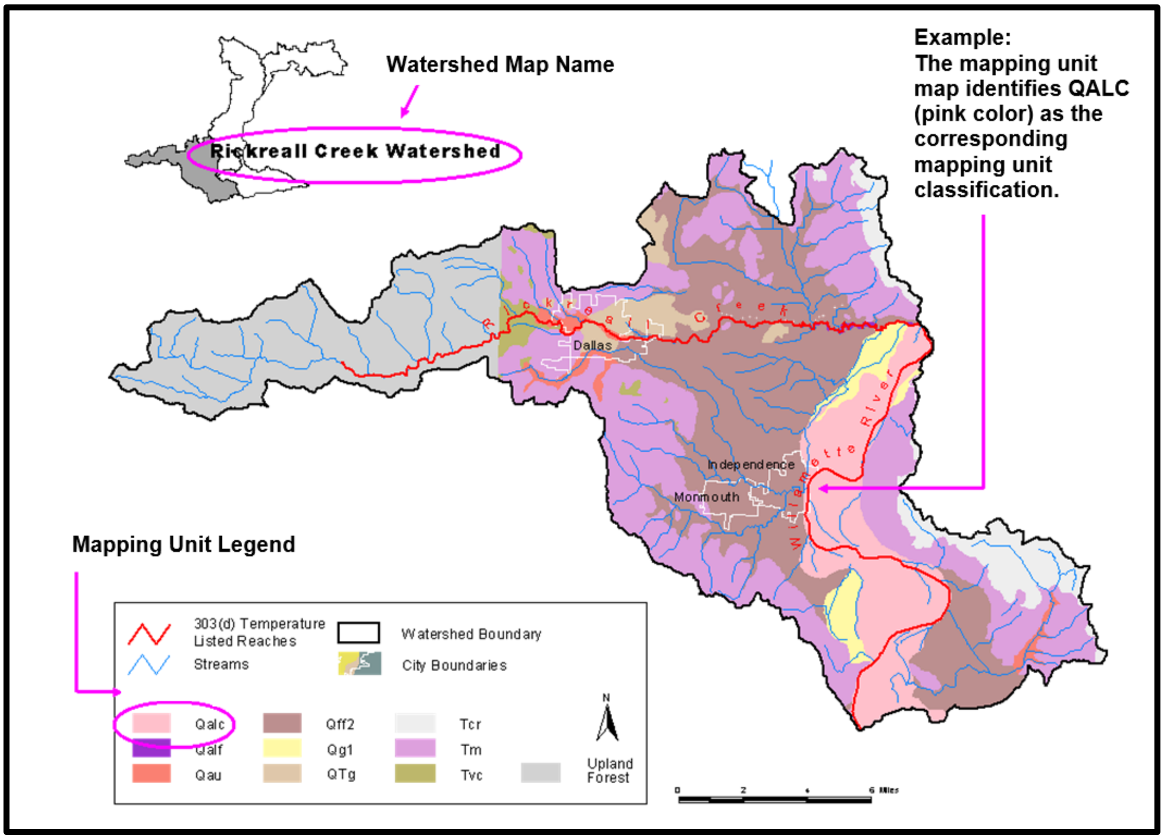


Figure 9-4: Mapping units in the Rickreall Creek Watershed.

2. Determine the stream aspect from north.

   Example: Standing in-stream mid-channel, facing north determine the river's aspect as 0º or 180º from north (this means the river reach runs south to north).

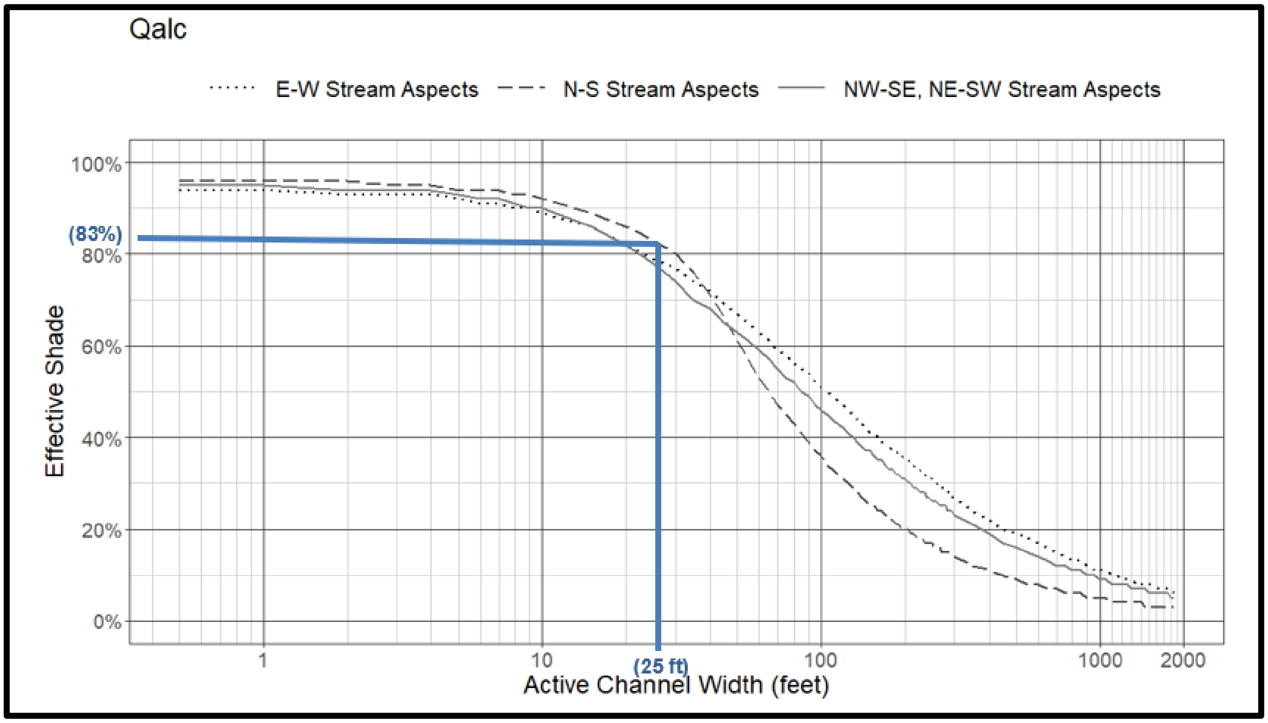
3. Determine the active channel width of the stream reach.

   Example: At your location you measure the active channel width using a tape measure or laser range finder and determine that it is 25 feet.

4. Use the appropriate mapping unit shade curve, stream aspect line and active channel width (x-axis), to determine the percent effective shade of your site (y-axis). This is the non-point source load allocation of the stream reach at system potential vegetation. *Example*: You have determined that the appropriate shade curve mapping unit for your site is Qalc (Figure 9-5). Since you are located on a tributary with a North- South stream

aspect and an active channel width of 25 feet, you use the dashed line to determine the effective shade. By reading the y- axes, you determine that the effective shade to be ~83% when system potential vegetation is applied to the left and right bank of the stream reach. System potential vegetation defines the average riparian vegetation height as 88.2 feet (26.9 meters), and the stand density (canopy density) as 71%.

Figure 9-5: Example illustrating use of the shade curve for the Qalc mapping unit based on a north to south aspect and an active channel width of 25 feet.



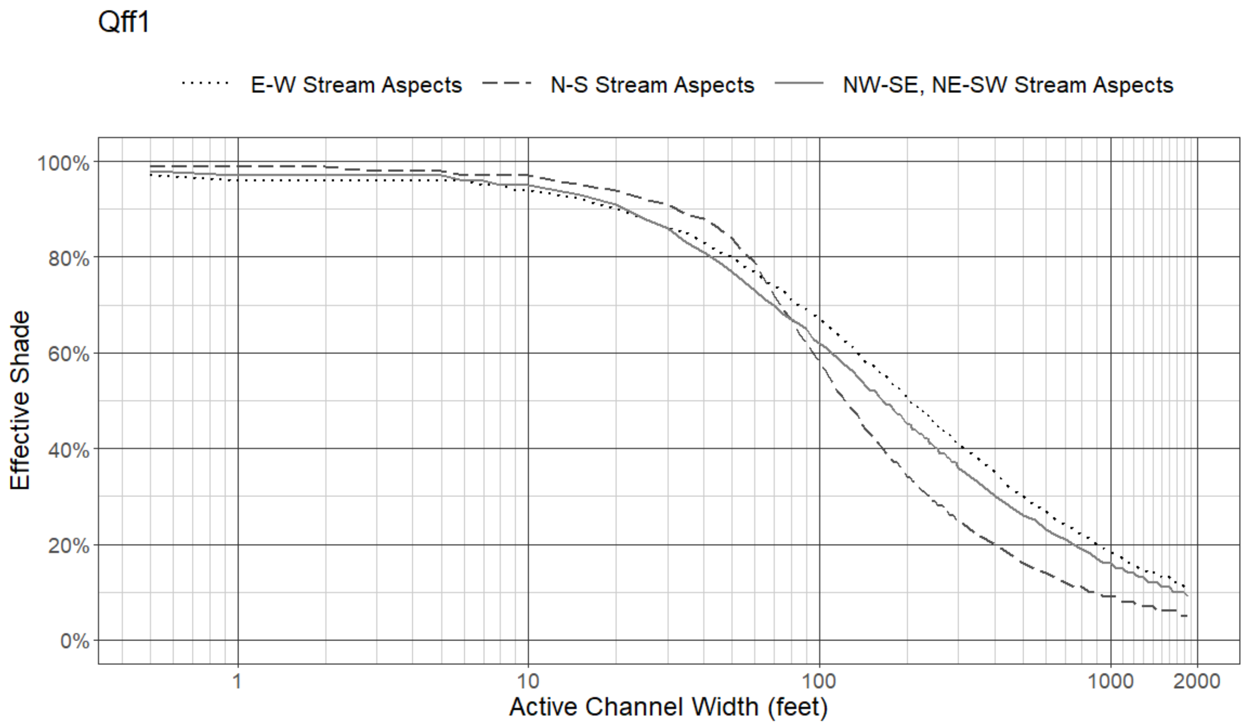


Figure 9-6: Effective shade targets for stream sites in the Qff1 mapping unit.

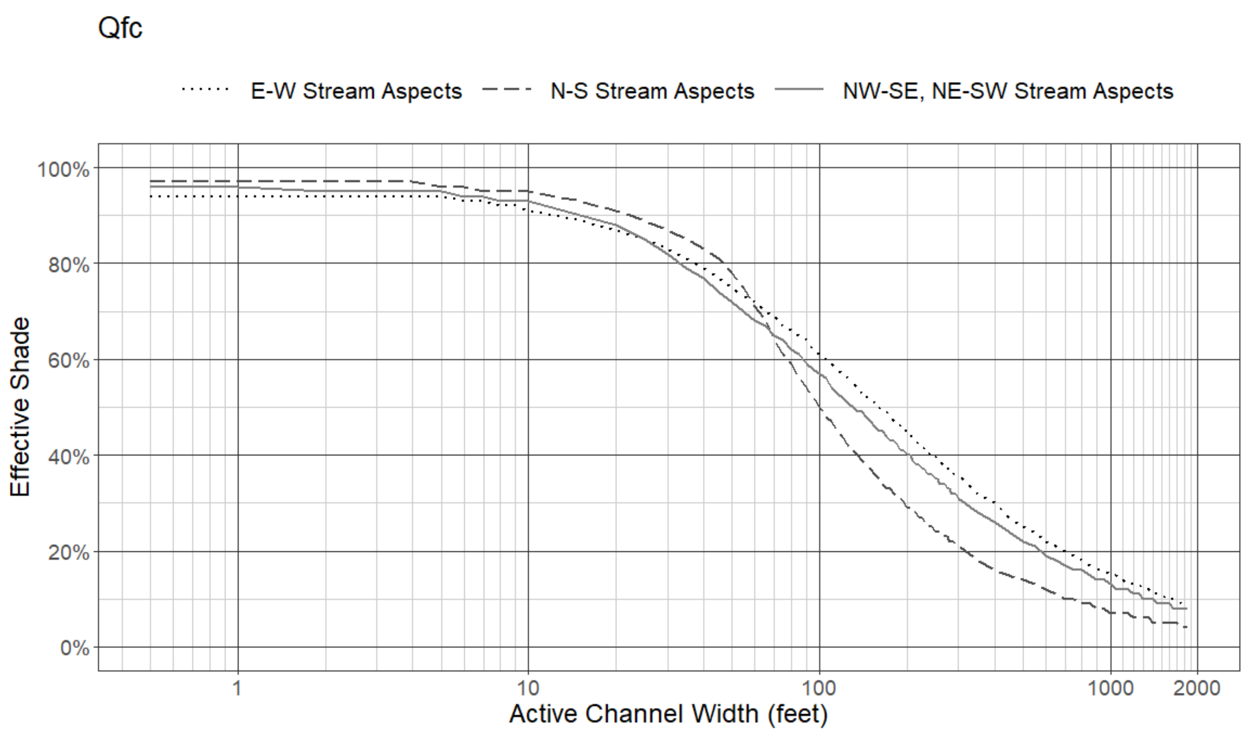


Figure 9-7: Effective shade targets for stream sites in the Qfc mapping unit.

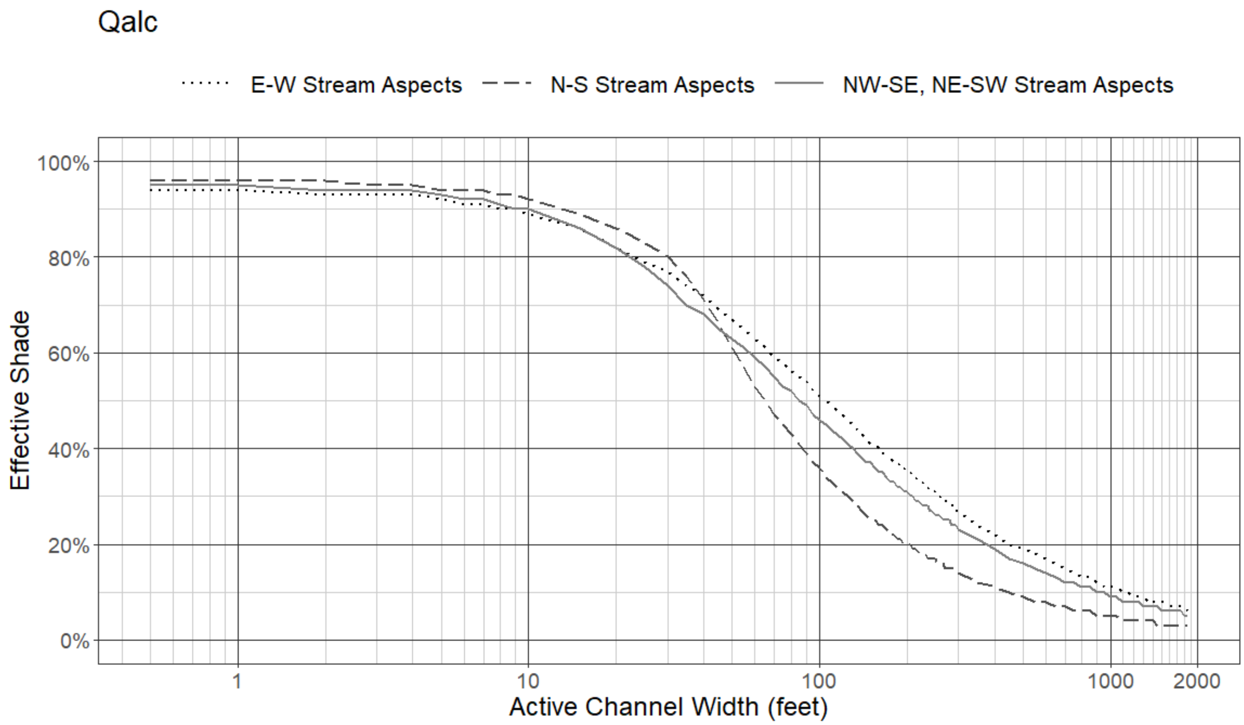


Figure 9-8: Effective shade targets for stream sites in the Qalc mapping unit.

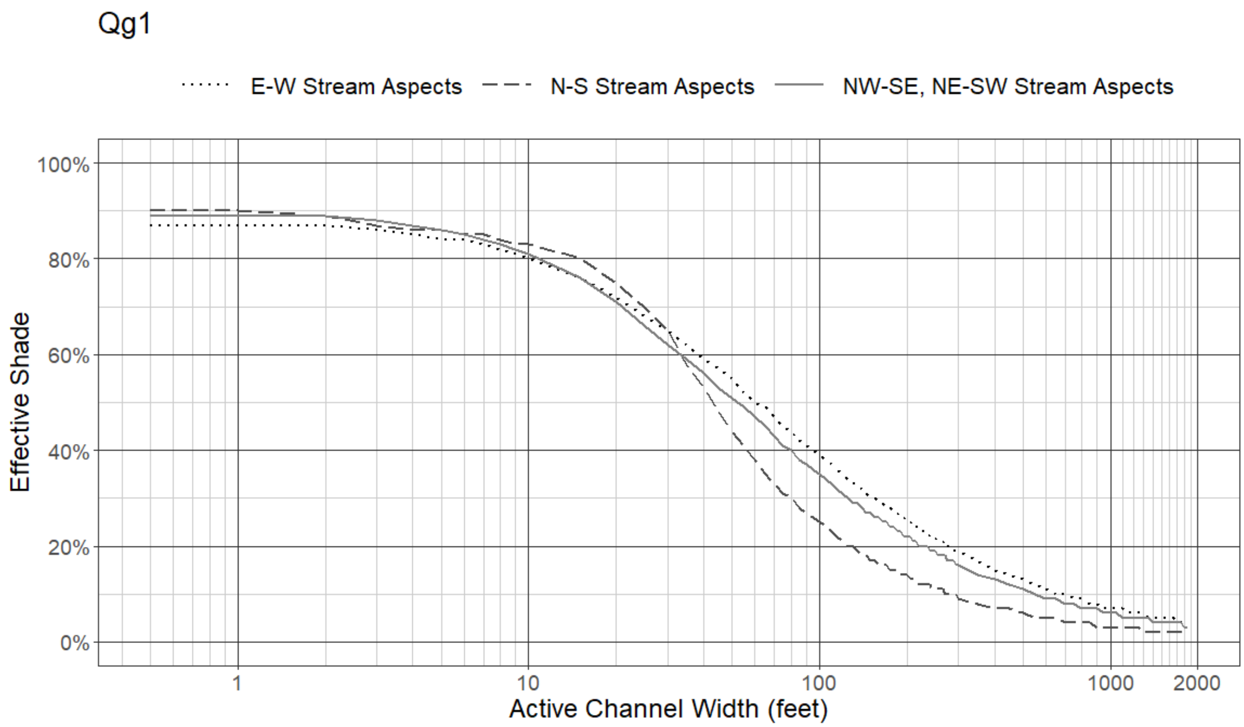


Figure 9-9: Effective shade targets for stream sites in the Qg1 mapping unit.

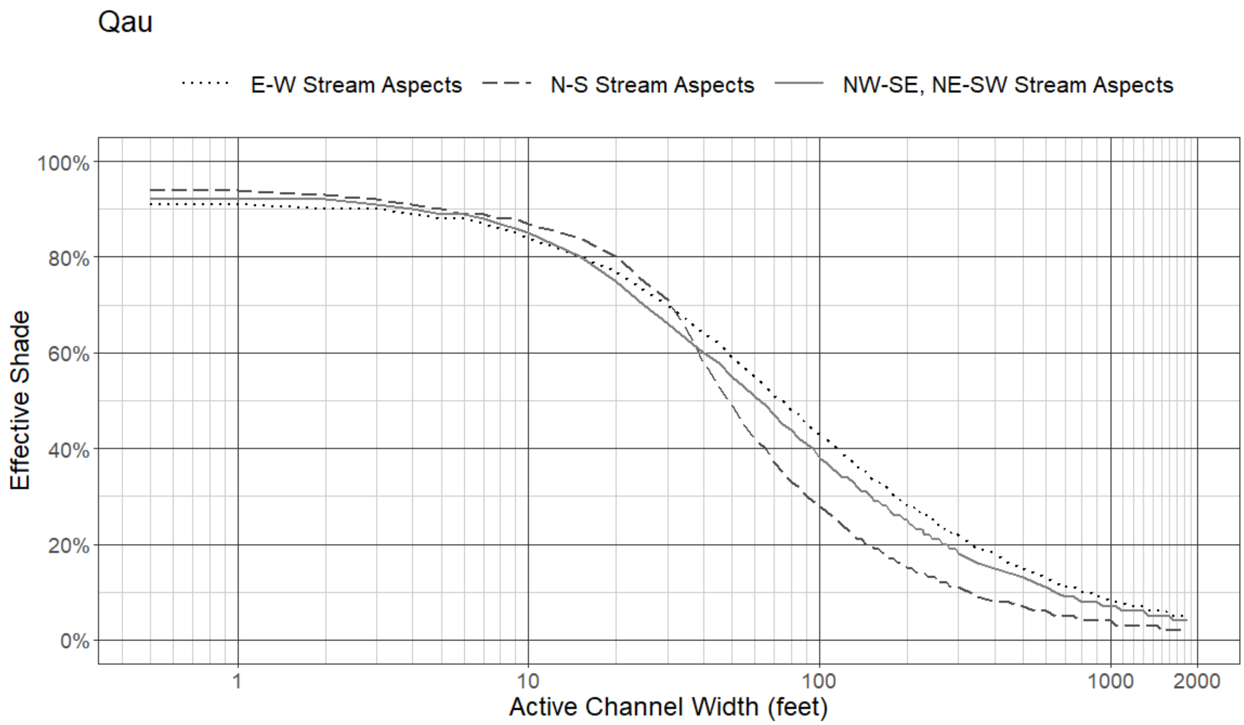


Figure 9-10: Effective shade targets for stream sites in the Qau mapping unit.

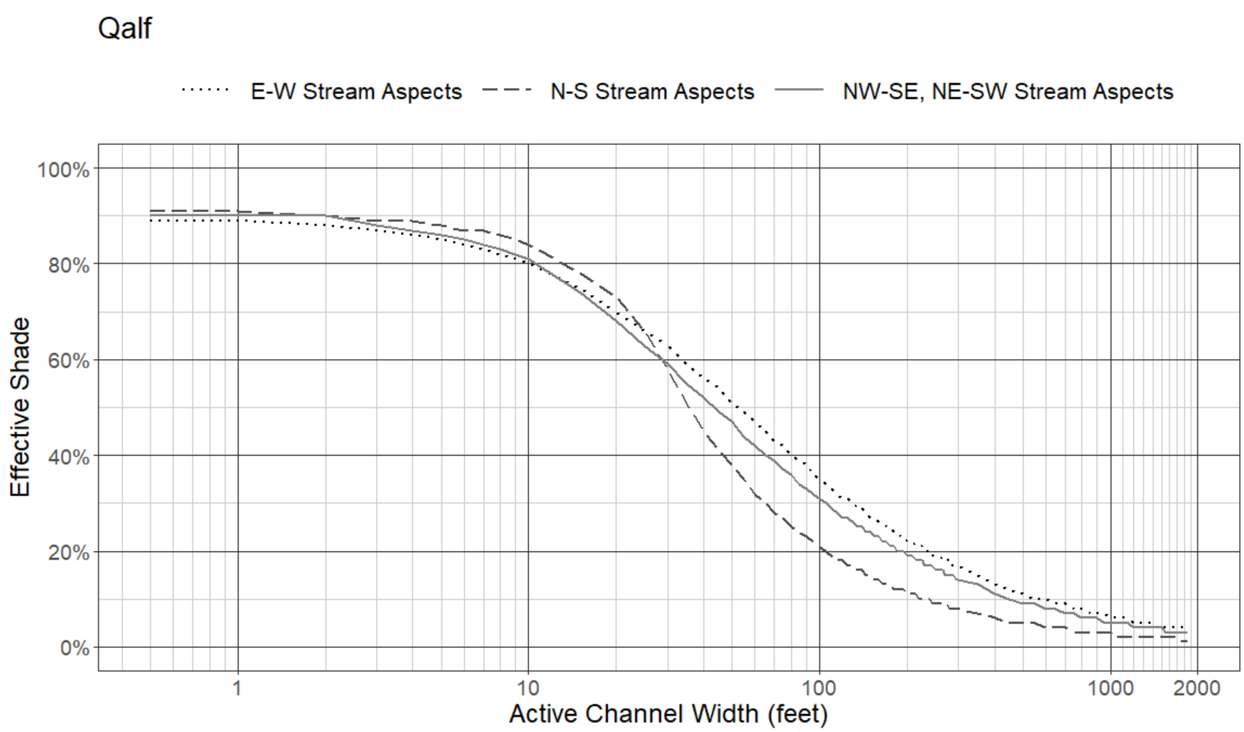


Figure 9-11: Effective shade targets for stream sites in the Qalf mapping unit.

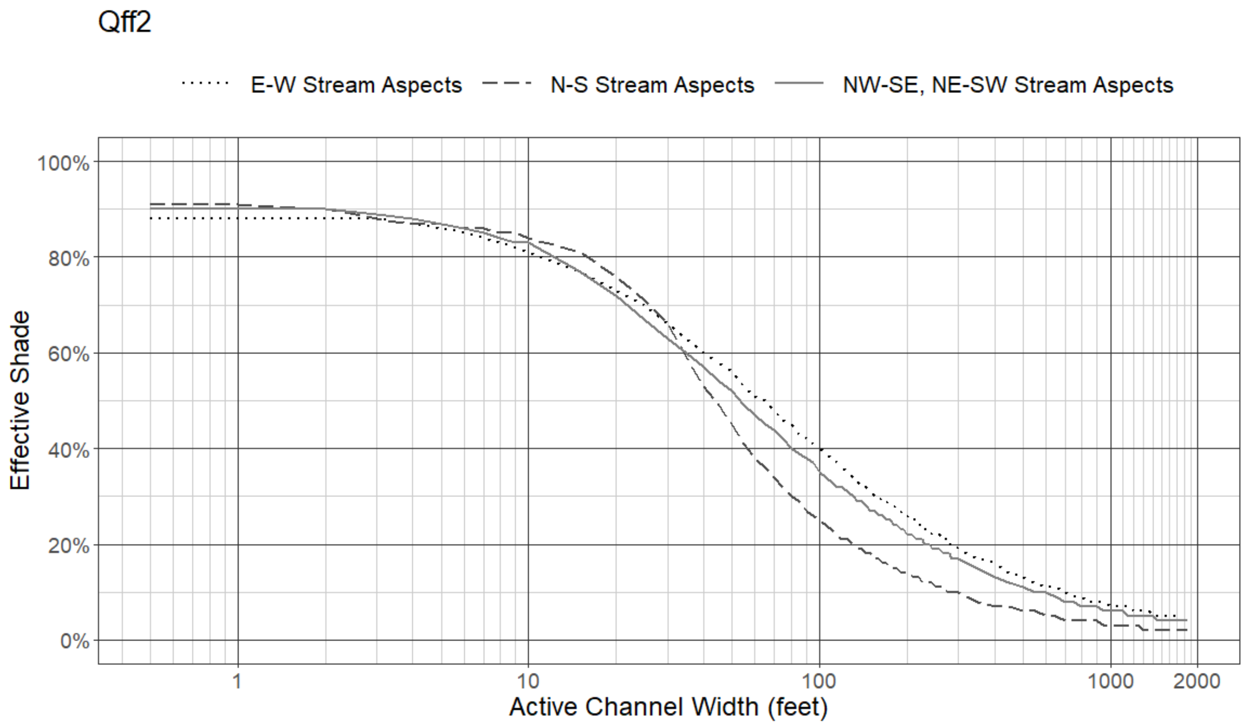


Figure 9-12: Effective shade targets for stream sites in the Qff2 mapping unit.

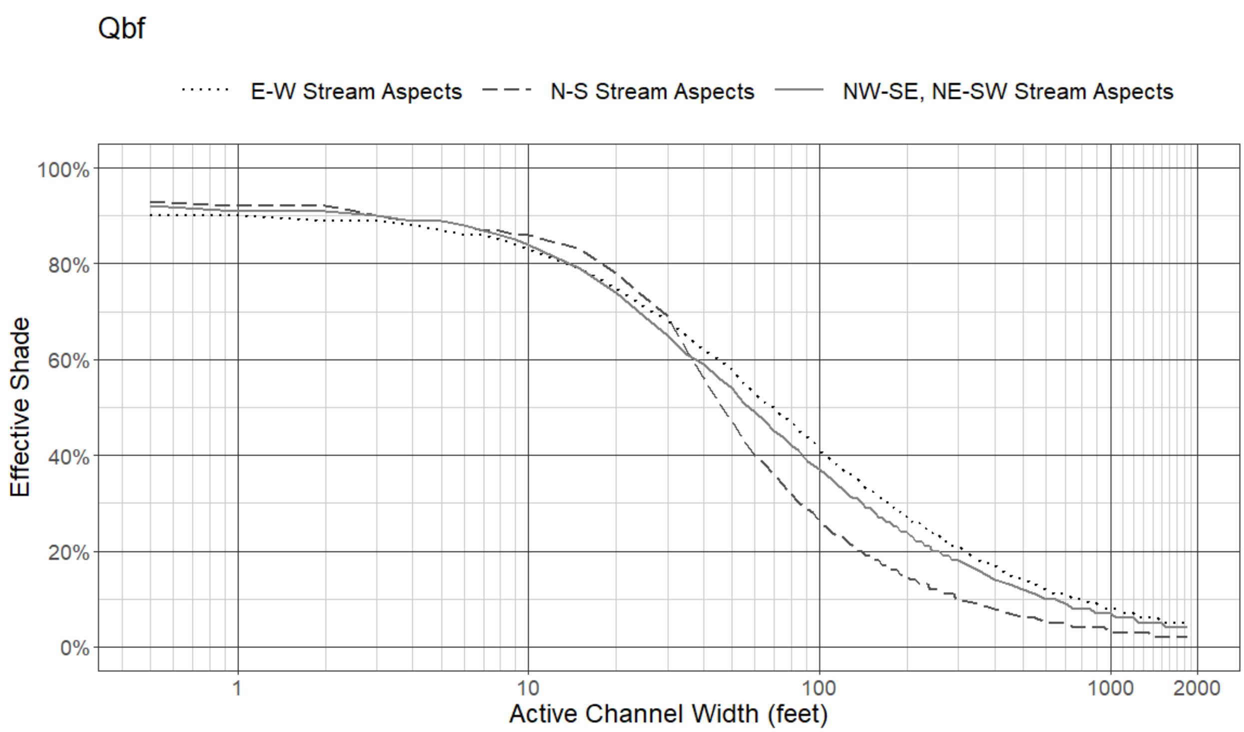


Figure 9-13: Effective shade targets for stream sites in the Qbf mapping unit.

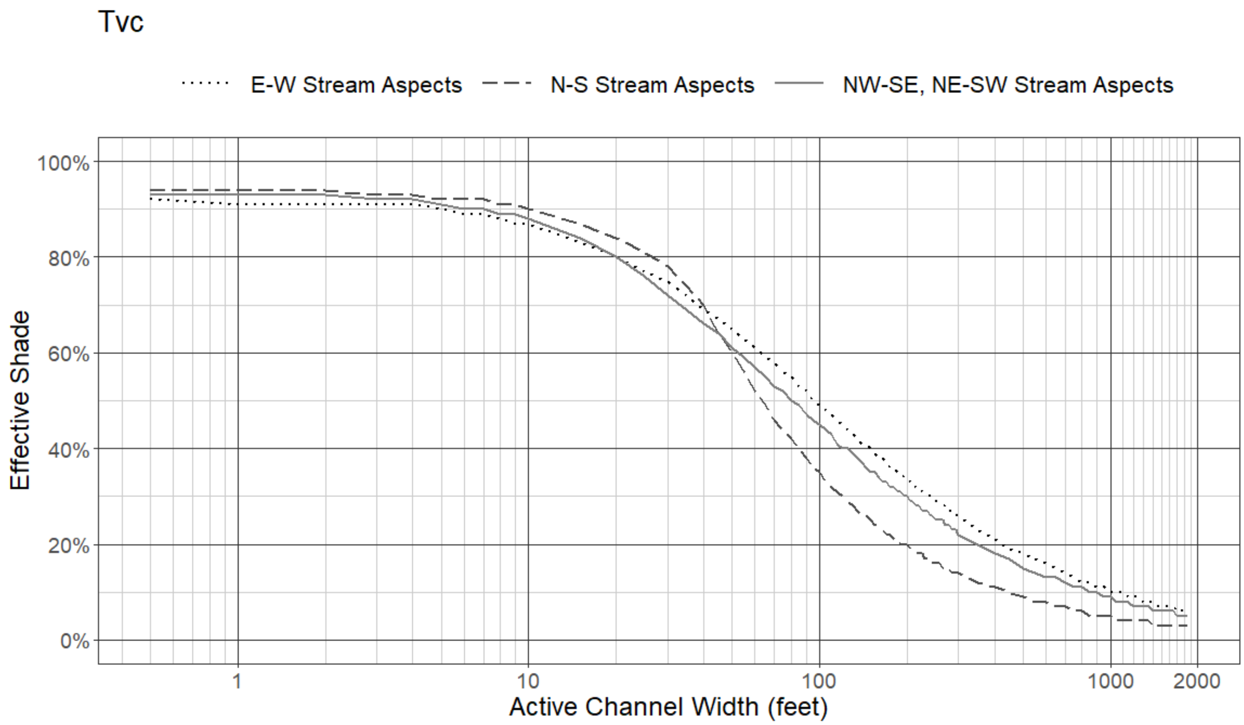


Figure 9-14: Effective shade targets for stream sites in the Tvc mapping unit.

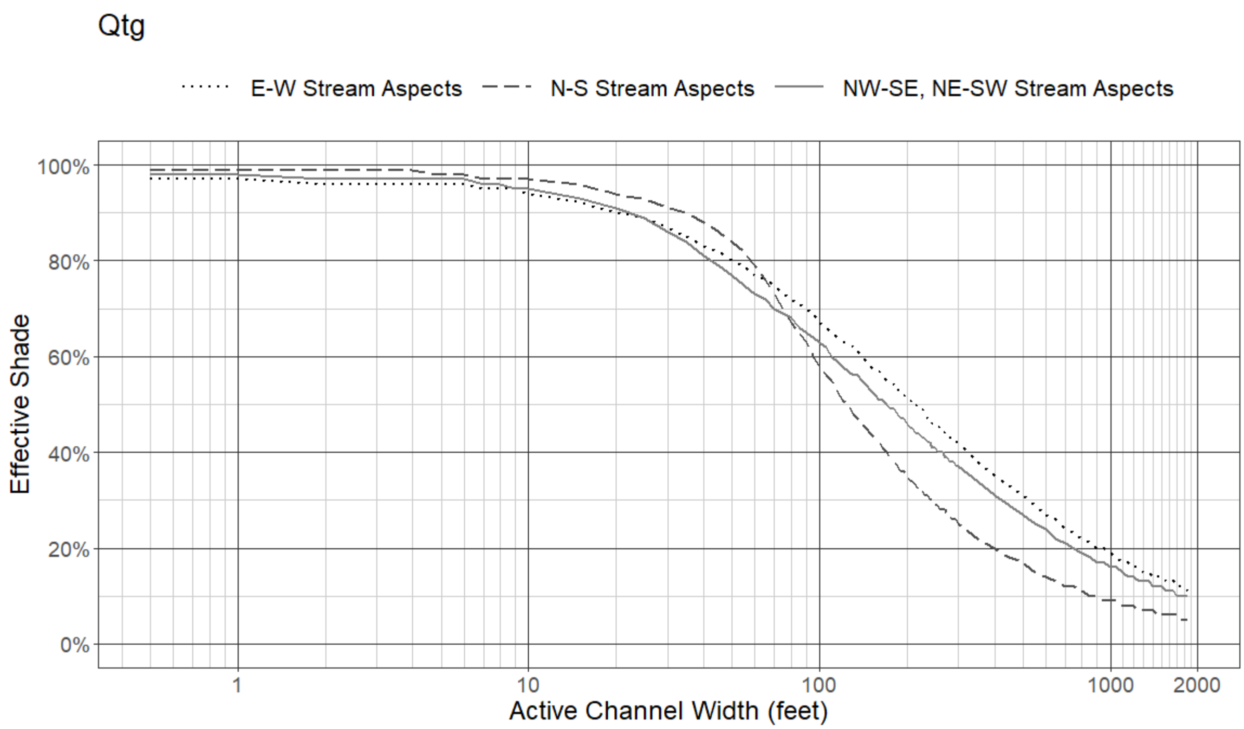


Figure 9-15: Effective shade targets for stream sites in the Qtg mapping unit.

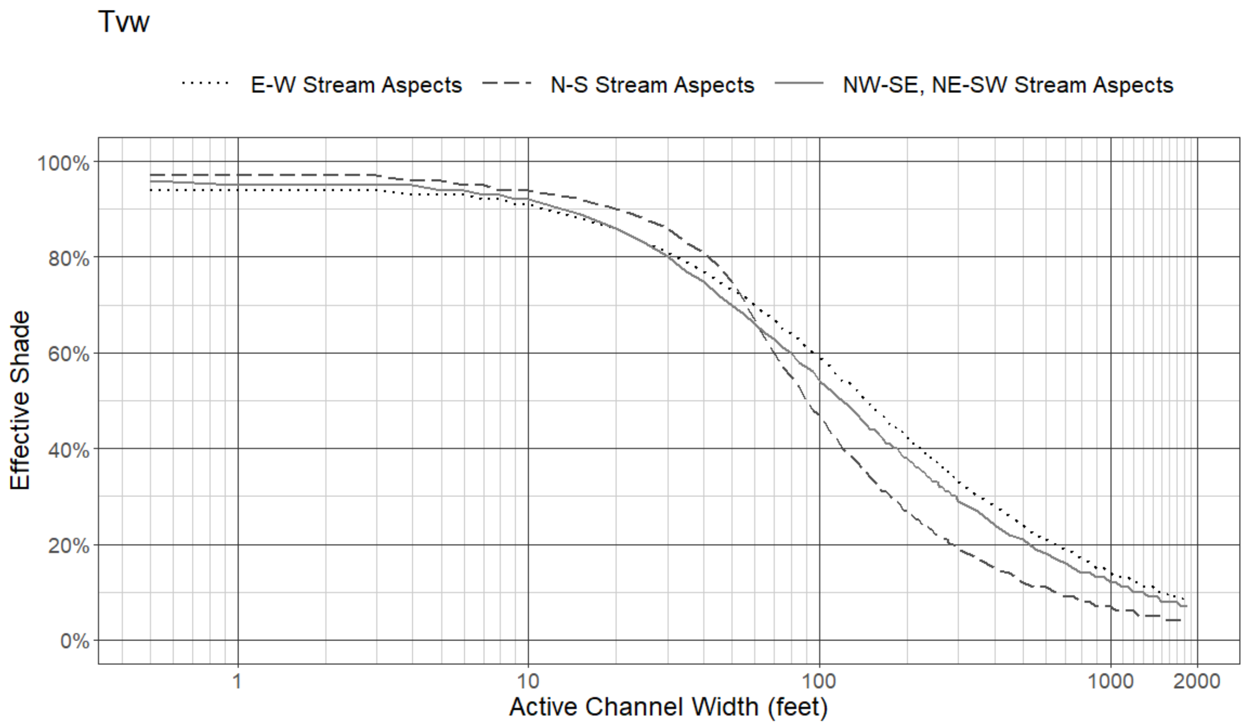


Figure 9-16: Effective shade targets for stream sites in the Tvw mapping unit.

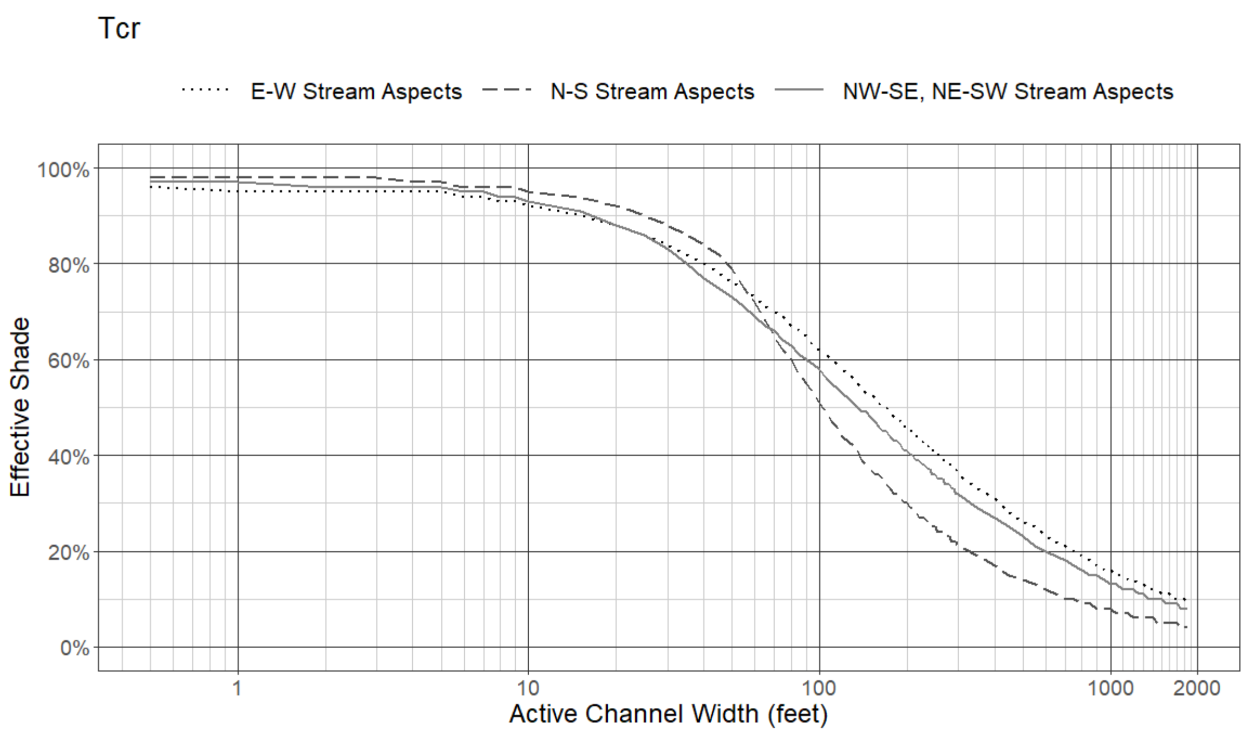


Figure 9-17: Effective shade targets for stream sites in the Tcr mapping unit.

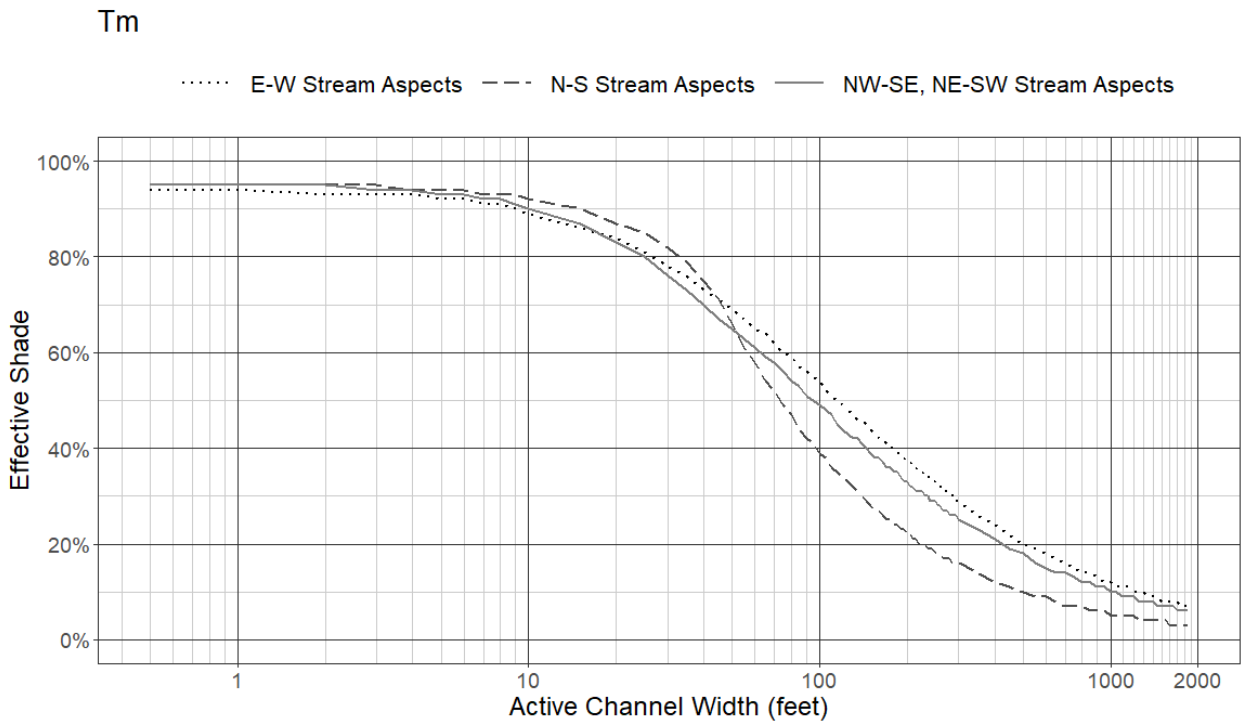


Figure 9-18: Effective shade targets for stream sites in the Tm mapping unit.

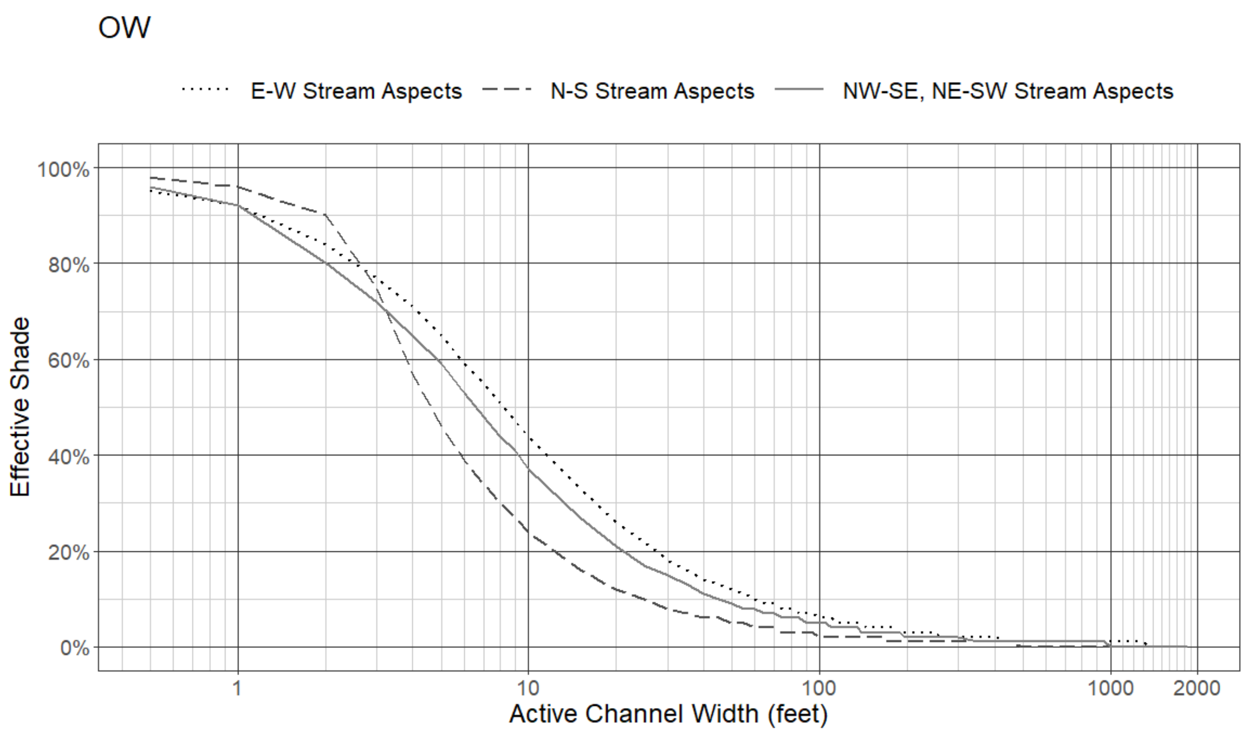


Figure 9-19: Effective shade targets for stream sites in the Open Water (OW) mapping unit.

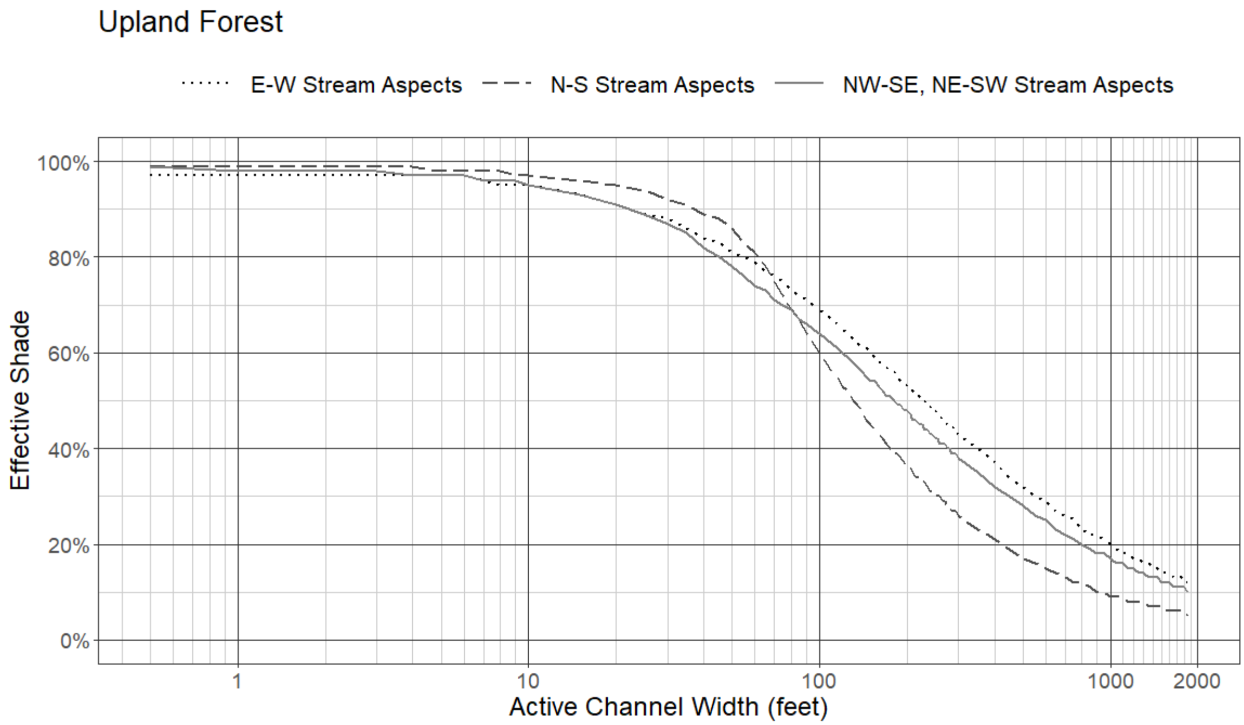


Figure 9-20: Effective shade targets for stream sites in the Upland Forest mapping unit.

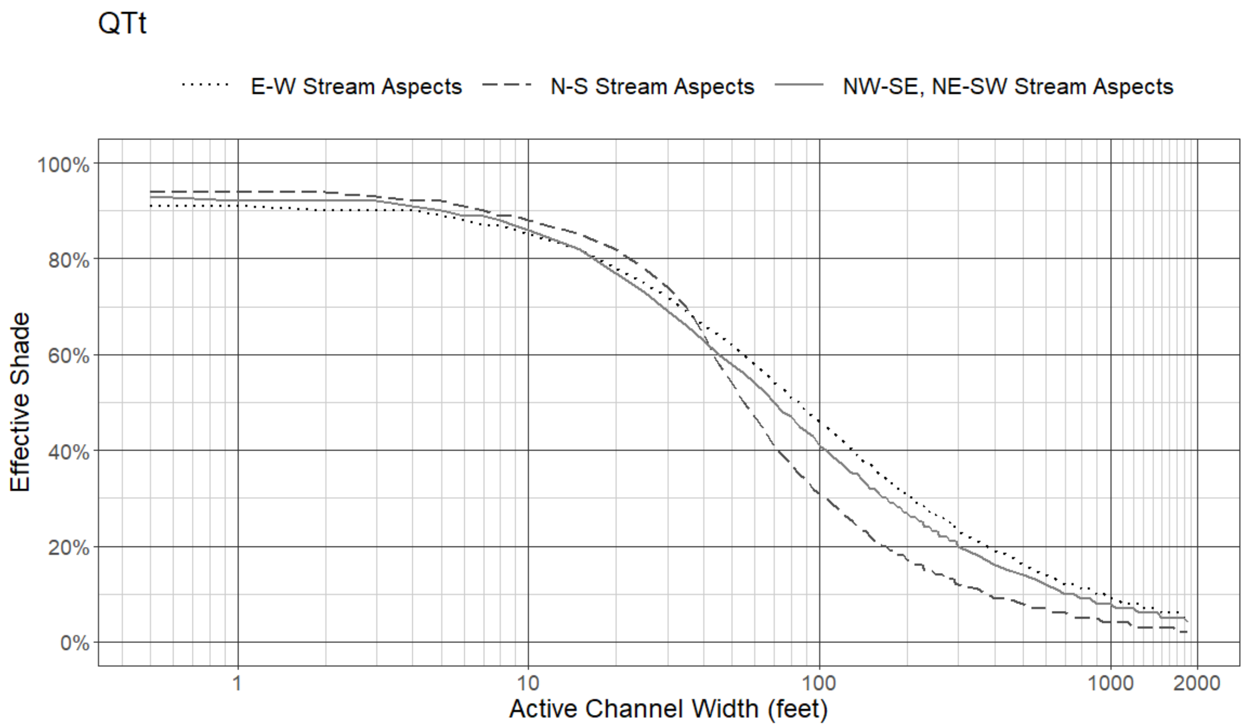


Figure 9-21: Effective shade targets for stream sites in the QTt mapping unit.

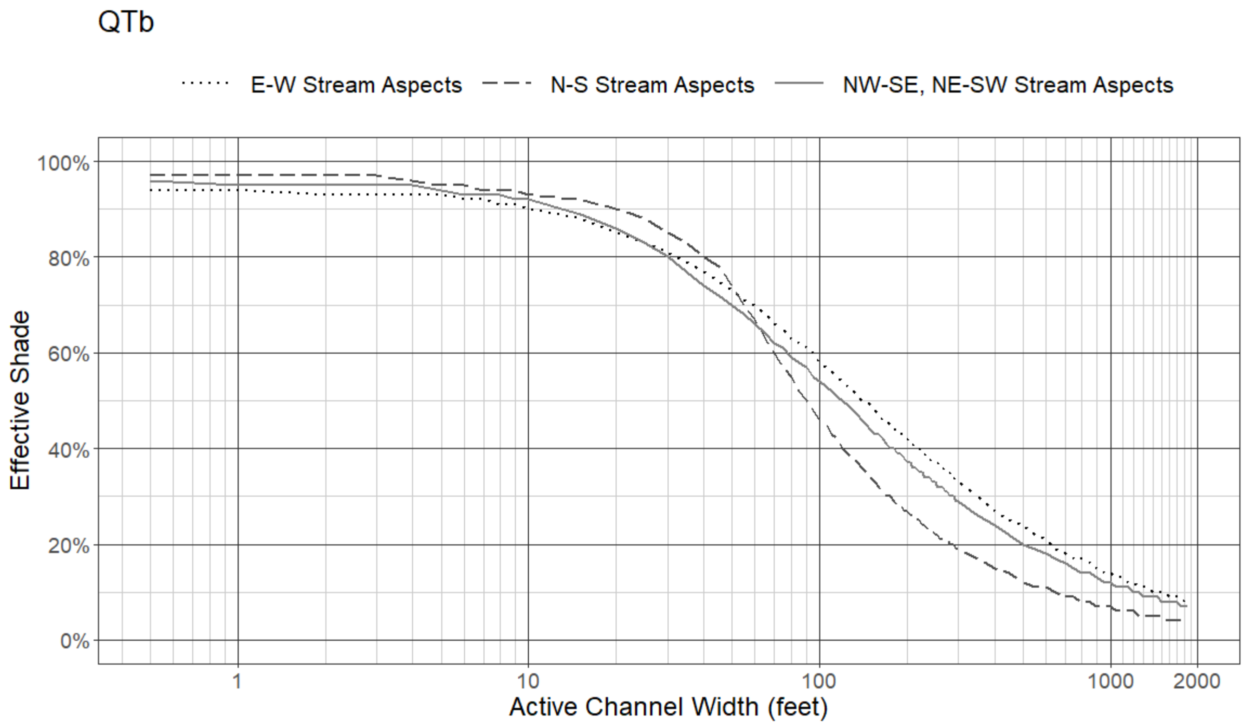


Figure 9-22: Effective shade targets for stream sites in the QTb mapping unit.

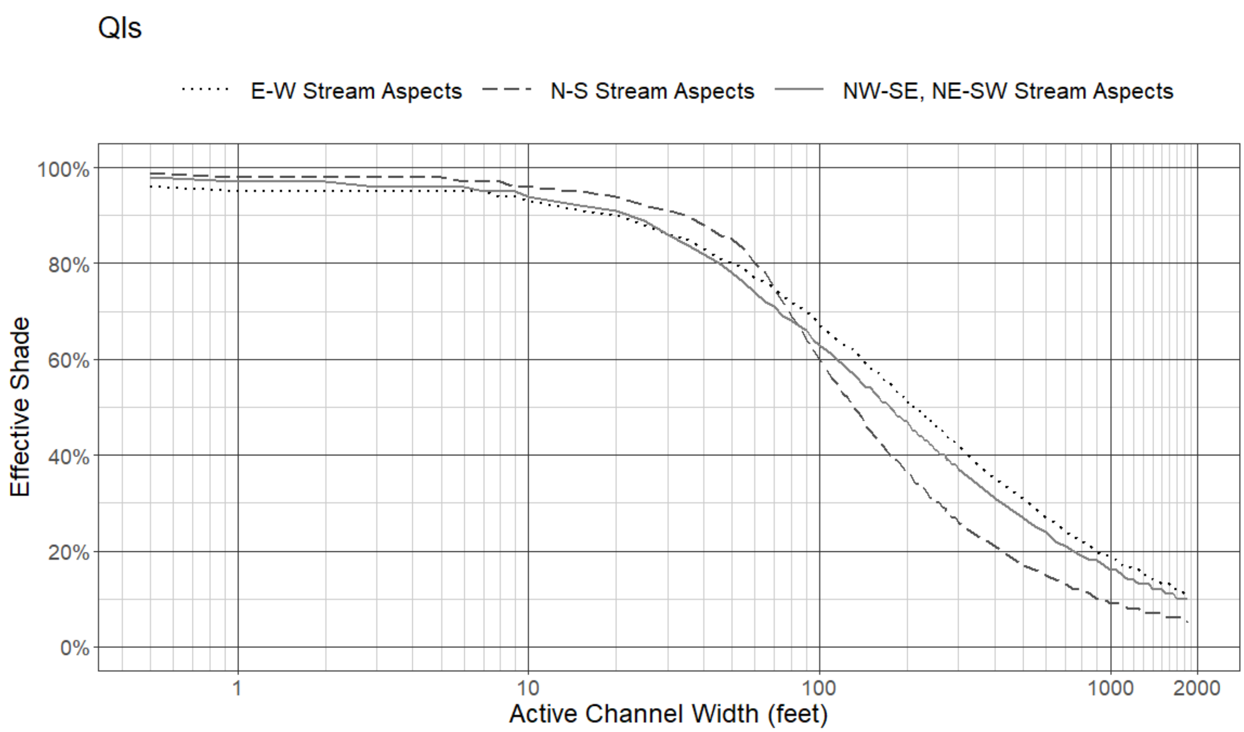


Figure 9-23: Effective shade targets for stream sites in the Qls mapping unit.

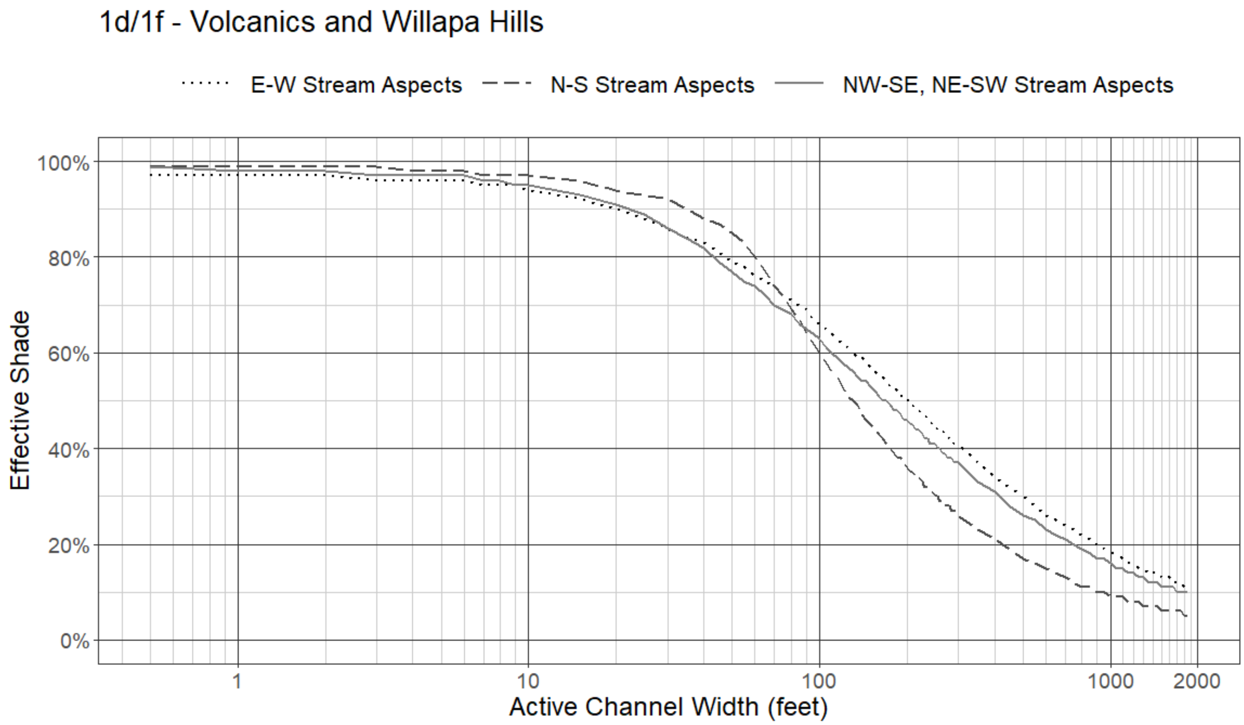


Figure 9-24: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

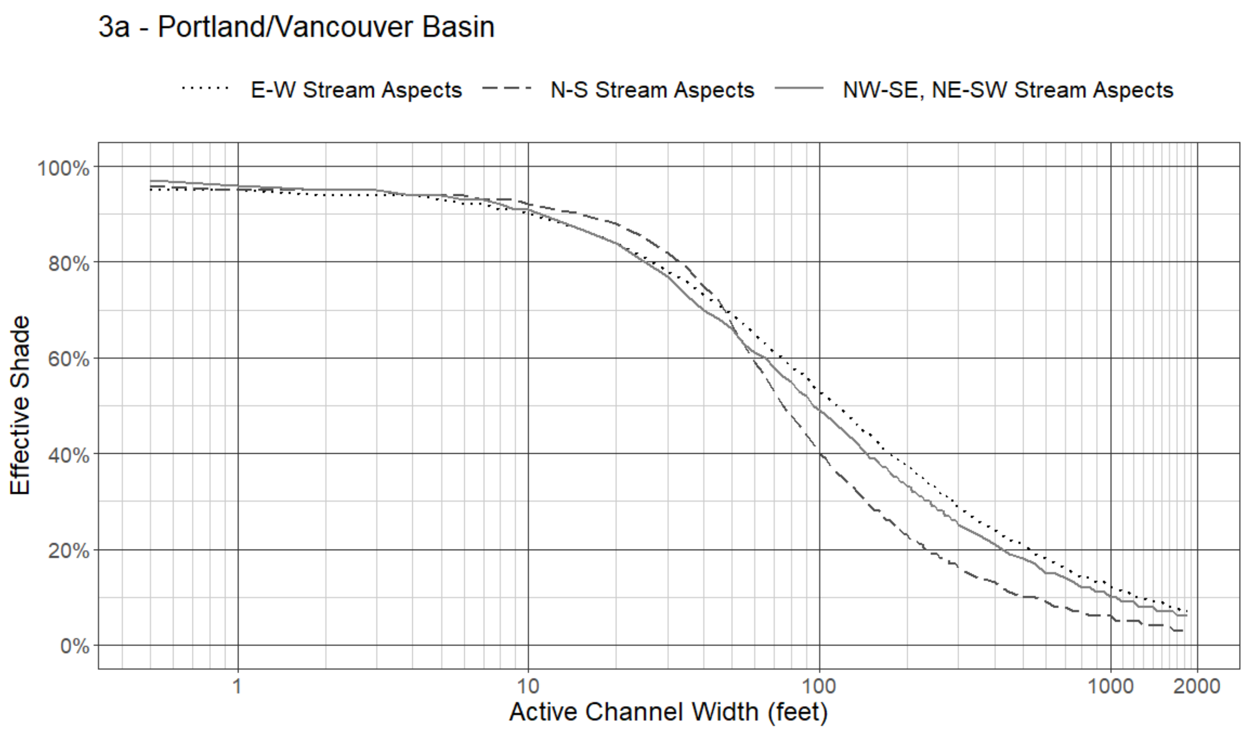


Figure 9-25: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

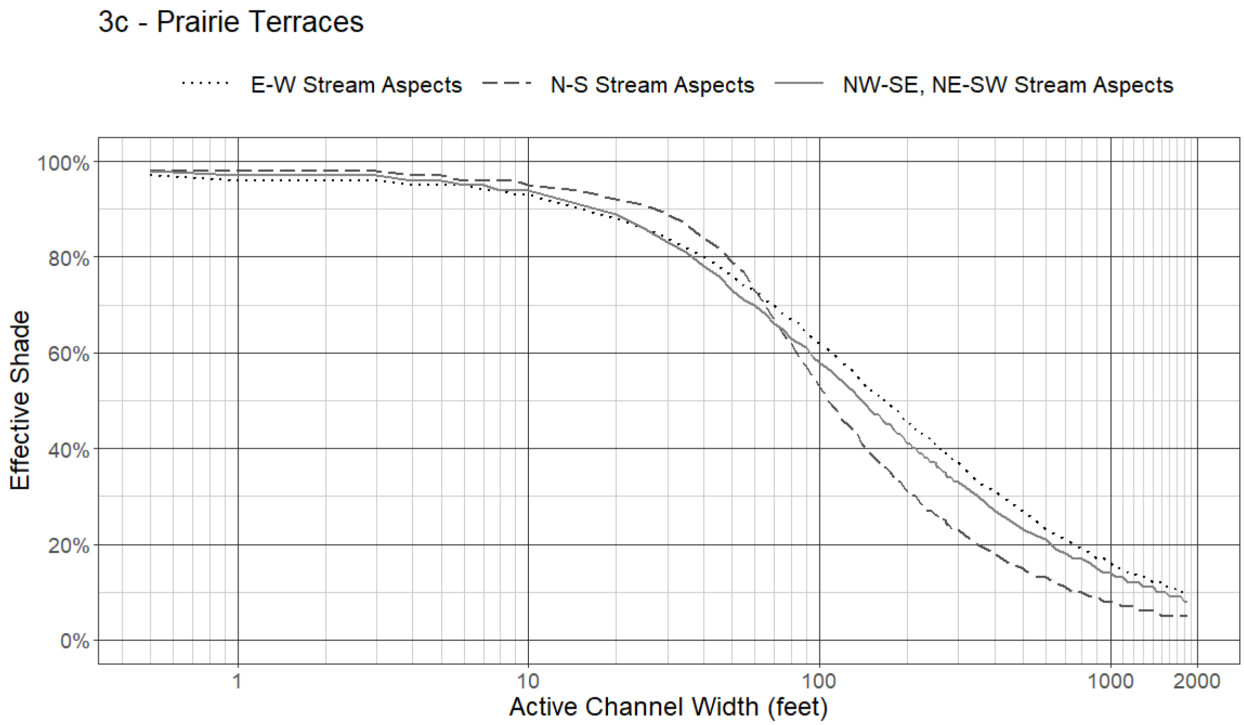


Figure 9-26: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

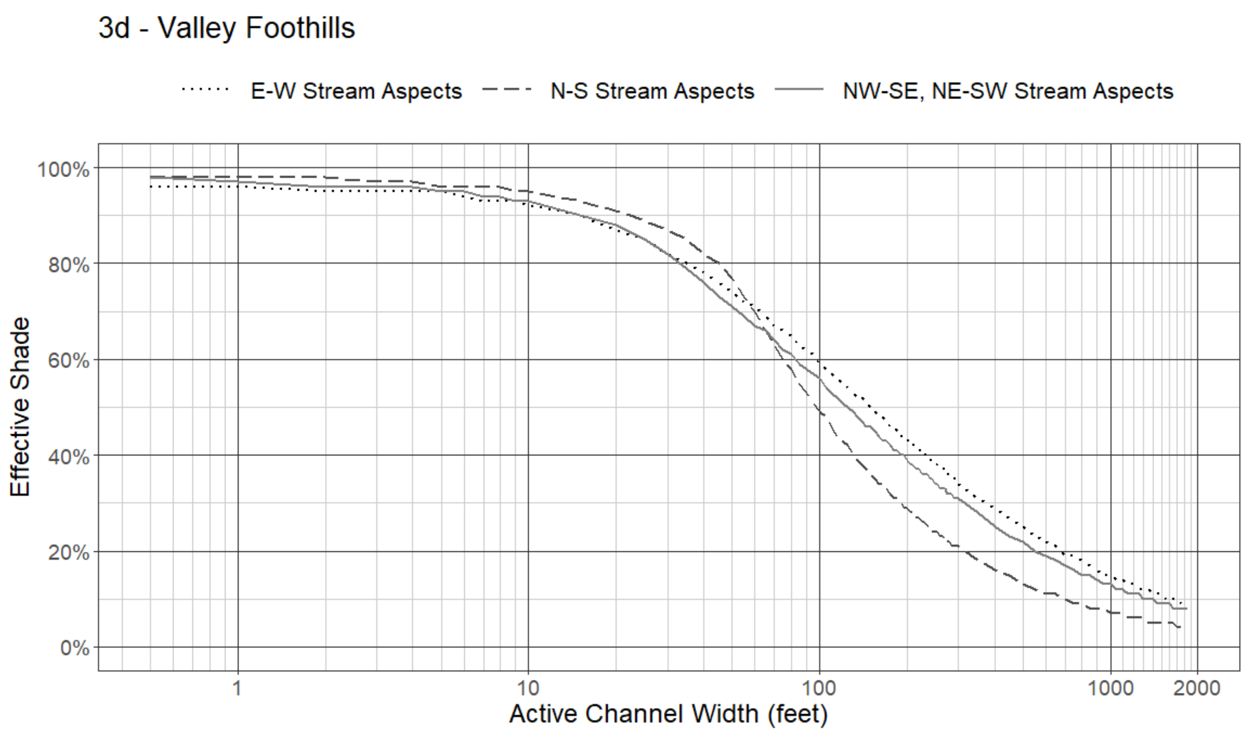


Figure 9-27: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

10 Water quality standards attainment

10.1 Point sources

DEQ's approach to point source allocations was to distribute an equal portion of the human use allowance (0.075 degrees Celsius) with some exceptions described below. A human use allowance of 0.075 degrees Celsius was selected because many of the current NPDES permit limits are based on this amount of allowed warming and it is consistent with allocations provided in DEQ's 2006 Willamette Basin temperature TMDL.

Exceptions were made when the point source was not authorized to discharge in the current NPDES permit (maximum effluent flow = 0). For these point sources, a human use allowance of 0.0 degrees Celsius was allocated during the no discharge period. A human use allocation of zero means there may be no warming above the applicable criteria.

In some cases, analysis indicated current thermal loads are less than 0.075 degrees Celsius and the allocation could be reduced to minimize cumulative effects. In other cases, DEQ increased the allocation above 0.075 when analysis indicated the wasteload allocation would result in immediate noncompliance. Cumulative effects were also considered on streams that had more than one discharge. In this case, it was assumed that warming impacts from individual point sources did not dissipate with distance from the outfall. This is a margin of safety that ensures cumulative warming from all point sources will not exceed the portion of the human use allowance allocated to point sources. See Willamette Subbasins Temperature TMDL Section 9.1 Thermal Allocations for stream specific details.

Cumulative effects were also considered on unmodeled streams that had more than one discharger. On unmodeled streams where a cumulative effects modeling analysis was not completed, the total portion of the human use allowance allocated to the point source sector represents the sum of the individual human use allowance allocations. For example, a stream with two NPDES discharges that each have 0.075 degrees Celsius allocated at the point of discharge would have a point source sector allocation of 0.15°C cumulatively at the point of maximum impact. This was done to ensure there would be no exceedance to the allocated portion of the human use allowance. The approach is protective based on model results from other streams that show the temperature impacts dissipating moving downstream from the outfall.

DEQ modeled water temperature impacts for point sources discharging at their wasteload allocations on the Molalla, Pudding, and McKenzie Rivers. In the Molalla and Pudding Rivers, point sources are allocated 0.2 deg-C of cumulative warming. In both of these rivers wasteload allocations have a cooling effect due to the relatively high water temperatures of the receiving water bodies. The Molalla STP wasteload allocation has the potential to cool the Molalla River about 0.3 deg C at the point of discharge (Figure 10-1). Pudding River point source wasteload allocations have the potential to cool the river less than 0.1 deg-C (Figure 10-2). In the upper McKenzie River the EWEB Trail Bridge Powerhouse wasteload allocation warmed the McKenzie River no more than 0.02 deg-C (Figure 10-3). The model results confirmed that warming did not exceed the portion of the human use allowance allocated to the point sources on their respective waterways.

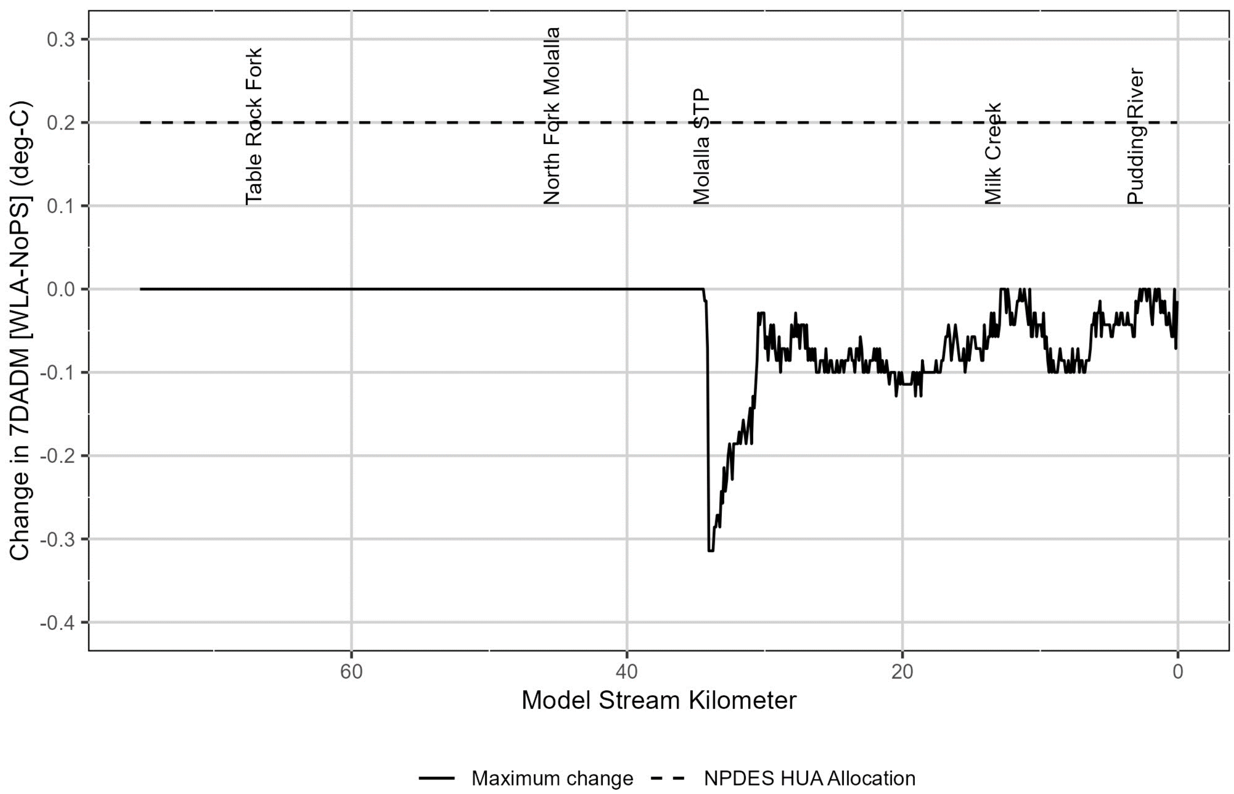


Figure 10-1: Change in maximum 7-Day Average Daily Maximum stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Molalla River over the entire model period.

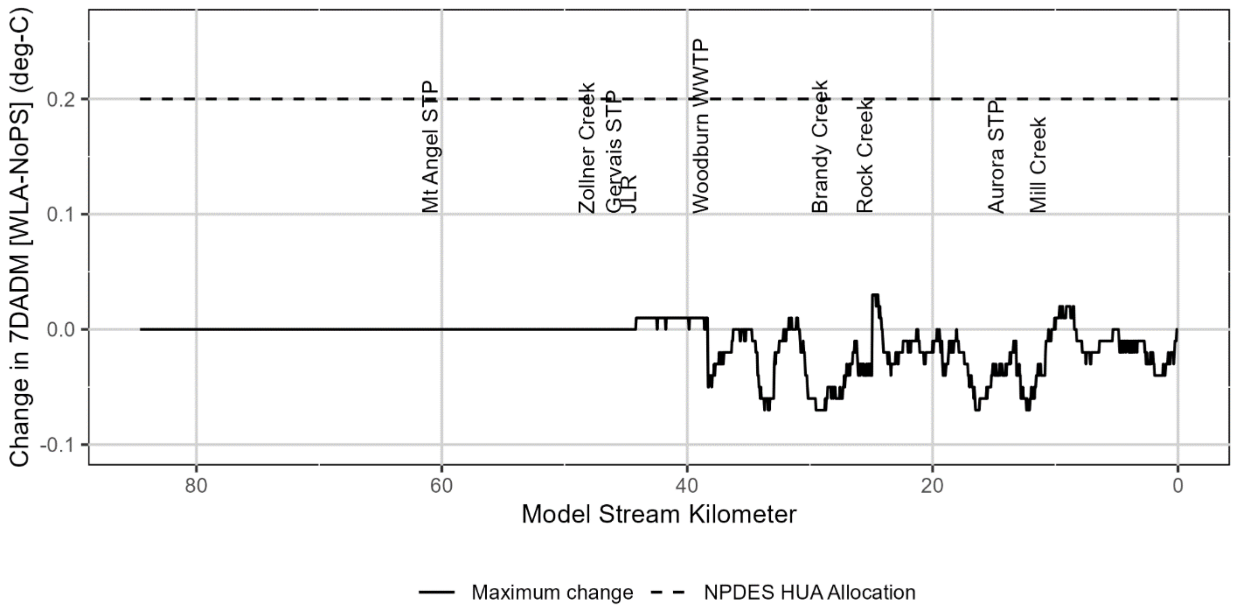


Figure 10-2: Change in maximum 7-Day Average Daily Maximum stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Pudding River over the entire model period.

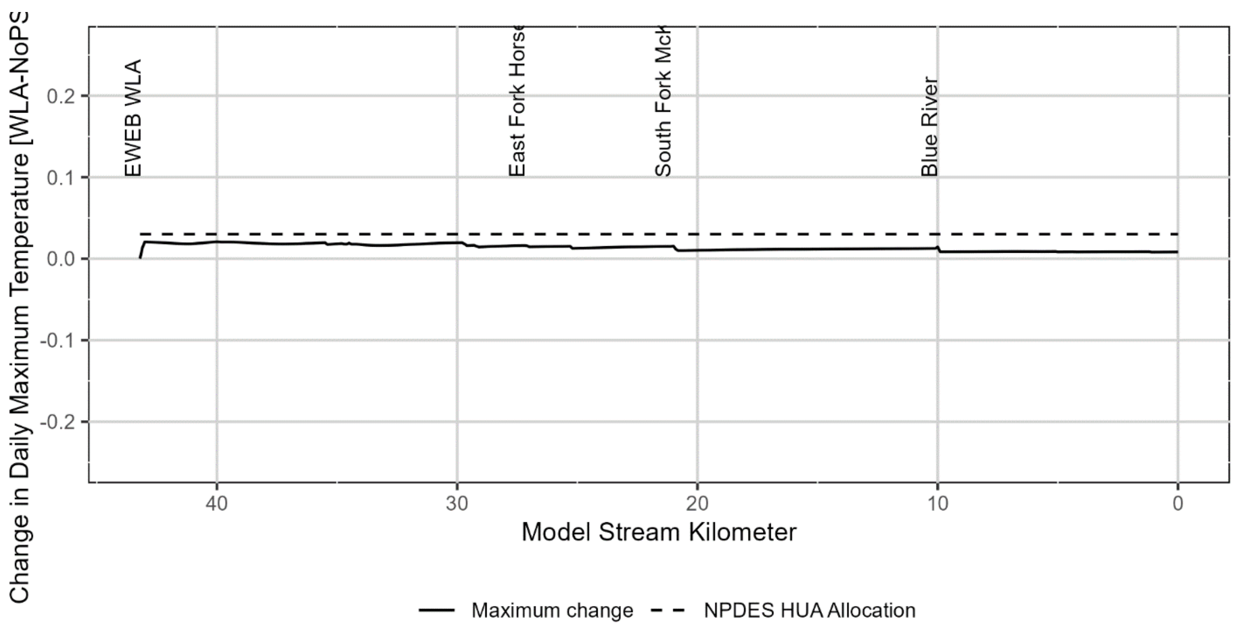


Figure 10-3: Change in daily maximum stream temperature between the Wasteload Allocations and No Point Sources model scenarios for the upper McKenzie River.

10.2 Nonpoint sources

DEQ's approach to nonpoint source allocations was to distribute a portion of the human use allowance to three nonpoint source categories. Water management activities and water withdrawals were allocated 0.05 degrees Celsius, solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure was allocated 0.02 degrees Celsius, and solar loading from all other nonpoint source sectors was allocated zero degrees Celsius of warming.

The portion of the human use allowance allocated to nonpoint source categories was set to ensure no more than 0.3 degrees Celsius of cumulative warming from all nonpoint sources on a given waterbody. The nonpoint source human use allowance allocation will be implemented by assessing the cumulative warming of a waterbody by all nonpoint sources. This is a margin of safety that ensures cumulative warming from all nonpoint sources will not exceed the portion of the human use allowance allocated to nonpoint sources. Designated management agencies responsible for nonpoint source categories are expected to meet their allocations, which were calculated to attain water quality standards.

11 Water quality management plan support

11.1.1 Adequacy of Agricultural Water Quality Management programs in attaining TMDL load allocations and effective shade surrogate measures

The Oregon Legislature passed the Agricultural Water Quality Management Act in 1993, which directed the Oregon Department of Agriculture to adopt rules as necessary and to develop plans to prevent water pollution from agricultural activities (ORS 568.900 to 568.933 and ORS 561.191 and OAR chapter 603, divisions 90 and 95). Subsequently, ODA worked with Local Advisory Committees and Soil and Water Conservation Districts to develop Agricultural Water Quality Area Rules and Area Plans for 38 watershed-based management areas across the state.

The Willamette Subbasins TMDL includes eight management areas: North Coast, Lower Willamette, Clackamas, Middle Willamette, Molalla-Pudding/French Prairie/North Santiam, South Santiam, Southern Willamette, and Upper Willamette/Upper Siuslaw. Each management area has agricultural water quality regulatory requirements, called Area Rules. Each management area also has an Agricultural Water Quality Management Area Plan, which is not regulatory but guides landowners in how to protect water quality from agricultural activities.

Oregon Administrative Rules 603-095 require agricultural activities to allow streamside vegetation to establish and grow to provide shade on perennial and some intermittent streams. Table 7-1 summarizes the streamside management measures required by state law for the seven management areas included in this TMDL. Specific requirements differ depending on the management area; however, most management areas identify vegetation goals based on site capability, which is not clearly defined. However, in OAR 603-095 there are no requirements for streamside vegetation to be established on agricultural lands when streamside vegetation deficiency is not caused by an agricultural activity.

Table 11-1: Summary of Oregon Administrative Rules (OAR 603-095) for streamside management in seven management areas within the Willamette Subbasins Temperature TMDL project area.

Agricultural Water Quality Management Area	Prevention and Control Measures*
North Coast	Allow the natural and managed regeneration and growth of riparian vegetation trees, shrubs, grasses, and sedges along natural waterways to provide shade to moderate water temperatures and bank stability to maintain erosion near background levels. Management activities minimize the degradation of established native vegetation while allowing for the presence of nonnative vegetation. Management activities maintain at least 50% of each year's new growth of woody vegetation -- both trees and shrubs.
Clackamas Subbasin	Allow the establishment, growth, and/or maintenance of native or non-native riparian vegetation appropriate to site capability, sufficient to encourage shade, protect streamside area during high stream flow events expected to occur in a 25-year, 24-hour storm event.
Lower Willamette	Allow the development of riparian vegetation along streams to provide shade for minimizing solar heating of the stream, streambank stability from flows in a 25-year, 24-hour storm event, filtration, settlement, and biological uptake of sediment, organic material, nutrients, and pesticides in surface runoff by intercepting or slowing overland flow, improvement to water storage capacity of the riparian zone, protection of streams from flashy flows by infiltrating runoff and overland flow. Riparian vegetation includes grasses, sedges, shrubs and trees that are consistent with site capability, and site development can be through allowing natural processes or active management. Management within the riparian area is allowed, and sufficient riparian width is site specific, and may vary by soil type, hydrology, climate, geology, man-made limitations, and other factors. Drainage and irrigation ditches are not subject to these prevention control measures.
Molalla-Pudding/French Prairie/North Santiam	Allow natural or managed development of riparian vegetation and riparian function over time along all streams. Riparian width is site specific and may vary, for example by soil type, size of stream, and agricultural use. Natural or managed establishment and maintenance includes riparian vegetation, such as grasses, sedges, shrubs, and trees, appropriate to site capability, that in the normal course of time will provide shade and protect streambank stability from flows at or below those expected in a 25-year, 24-hour storm event.
South Santiam	Allow establishment and maintenance of riparian vegetation consistent with site capability that promotes infiltration of overland flows, moderation of solar heating, and streambank stability. Management within the riparian area is allowed, and minimal breaks in shade vegetation for essential management activities are considered appropriate.
Southern Willamette	Allow establishment and maintenance of vegetation along perennial streams consistent with capability of the site to provide riparian functions necessary to help moderate solar heating and for streambanks to withstand flows in a 25-year, 24-hour storm event.
Upper Willamette/Upper Siuslaw	Allow establishment and development of riparian vegetation along perennial and intermittent streams for

	streambank stability, shading, and proper riparian function, consistent with site capability. Legally constructed drainage and irrigation ditches are exempt.
Yamhill	Allow the establishment, growth, and/or maintenance of riparian vegetation appropriate to the site. Vegetation must provide shade, protect the streamside area to maintains its integrity during high stream flow events in a 25-year, 24-hour storm event. Any agricultural activity that degrades riparian vegetation will be replanted or restored as soon as practical. Indicator of non-compliance is active streambank sloughing or erosion from tillage, grazing, or destruction of vegetation by landowner or occupier.

*Prevention and Control Measures are identified in OAR for each management area for various agricultural activities. The ones summarized in this table are specific to streamside management.

Each management area has an Area Plan, which is not regulatory and does not establish prohibitions on agricultural activities that may impact water quality or require active restoration on agricultural lands. Instead, Area Plans rely on outreach and education, and voluntary landowner actions to implement conservation and management activities that protect water quality. ODA continues to work with LACs, SWCDs, DEQ and other watershed partners to implement, evaluate, and update Area Plans through their Biennial Review process for each of the management areas included in this TMDL.

As part of the biennial review process, DEQ prepares and submits to ODA specific feedback about water quality in the management areas. DEQ's assessments also address land conditions, agricultural activities, and implementation gaps that likely contribute to water quality impairments. DEQ has identified that a high priority for many management areas is to protect and reestablish riparian vegetation. The Area Plans for the eight management areas included in this TMDL have all been reviewed by DEQ within the last three years. Some of these reviews were completed as part of ODA's light biennial review process; during light reviews ODA convenes members of the LAC to report out on restoration and land management accomplishments and water quality status and trends within the management area, but ODA does not change or update plans during a light review. Table 7-2 is a summary of the most recent updates for these Area Plans. Updates to Area Plans typically occur during the full biennial review process.

Table 11-2: Summary of the most recent updates to Area Plans, which occur during ODA's full biennial review process.

Agricultural Water Quality Management Area	Date of most recent Area Plan update
North Coast	2018
Clackamas	2022
Lower Willamette	2020
Middle Willamette	2020
Molalla-Pudding/French Prairie/North Santiam	2018
South Santiam	2019
Southern Willamette	2019
Upper Willamette/Upper Siuslaw	2023

ODA, through coordination with agency and local partners, identifies geographic areas of focus, called Strategic Implementation Areas, for targeted outreach to landowners, land condition assessment and enforcement. The SIA process includes an assessment and compliance evaluation of agricultural lands, outreach to landowners, technical assistance, monitoring of water quality and land conditions, and landowner follow up as needed. ODA identified 12 SIAs in the TMDL project area between 2014 and 2021. While ODA has conducted initial landowner outreach and facilitated local SIA planning meetings for some of these SIAs, as of 2023, ODA has reported limited restoration or enhancement projects as an outcome of the SIA process in this TMDL project area.

There continue to be water quality impairments in all seven of the management areas included in this TMDL. Specifically, water temperatures continue to be identified as impaired on Oregon's Section 303(d) list. In addition, results from the modeling and shade gap analyses DEQ completed for this TMDL indicate that extensive riparian areas are deficient in providing shade along streams. The shade gap results for the Southern Willamette model area and the Lower Willamette model area on land managed for agriculture is 53% and 20%, respectively. However, the shade gaps of specific HUC 12 watersheds within the model area represent a broad range.

ODA assesses riparian vegetation against the Area Rules for streamside management. The Area Rules are regulatory requirements limited to agricultural activities and are not consistent with and do not include specific reference to the TMDL load allocations for temperature and surrogate shade measures. Area Rules do not apply to agricultural land conditions that are not directly impacted by agricultural activities. It is unclear what steps can be taken when landowners are in compliance with Area Rules, yet land conditions contribute to water quality standard exceedances and are unable to meet TMDL load allocations. There has been a lack of implementation of area plans to achieve TMDL allocations and there are no or few assurances that voluntary landowner action will be able to bridge the gap between current and needed riparian condition and function. ODA has also not been able to adequately incorporate or implement water quality priorities as identified in the 2006 TMDL or as part of the Biennial Review process. Therefore, ODA is required to develop a temperature TMDL implementation plan to be submitted to DEQ for review and approval.

12 Acknowledgements

13 References

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Appendix A: Heat Source Model Report

Appendix B: City of Portland Shade Model Report

Appendix C: Potential Near-Stream Land Cover

Appendix D: Assessment Units addressed by Temperature TMDLs for the Willamette Subbasins

Appendix E: Southern Willamette Effective Shade Results

Appendix F: Lower Willamette Effective Shade Results

Appendix G: Climate Change and Stream Temperature in Oregon: A Literature Synthesis

Appendix H: Willamette Shade Curves Map

Appendix I: Stream Buffer Width Literature Review

Appendix J: McKenzie River CE-QUAL-W2 Model Scenario Report

Appendix K: McKenzie River Wasteload Allocation Scenario Model Report