State of Oregon Department of Environmental Quality

Attachment E

Willamette Subbasins amendment to include Willamette mainstem and major tributaries

This document contains copies of the Total Maximum Daily Load and Water Quality Management Plan with changes that have been made to the versions that went out on notice highlighted.

Redline versions of the following documents are attached:

Attachment E.1 – Total Maximum Daily Load

Attachment E.2 – Water Quality Management Plan

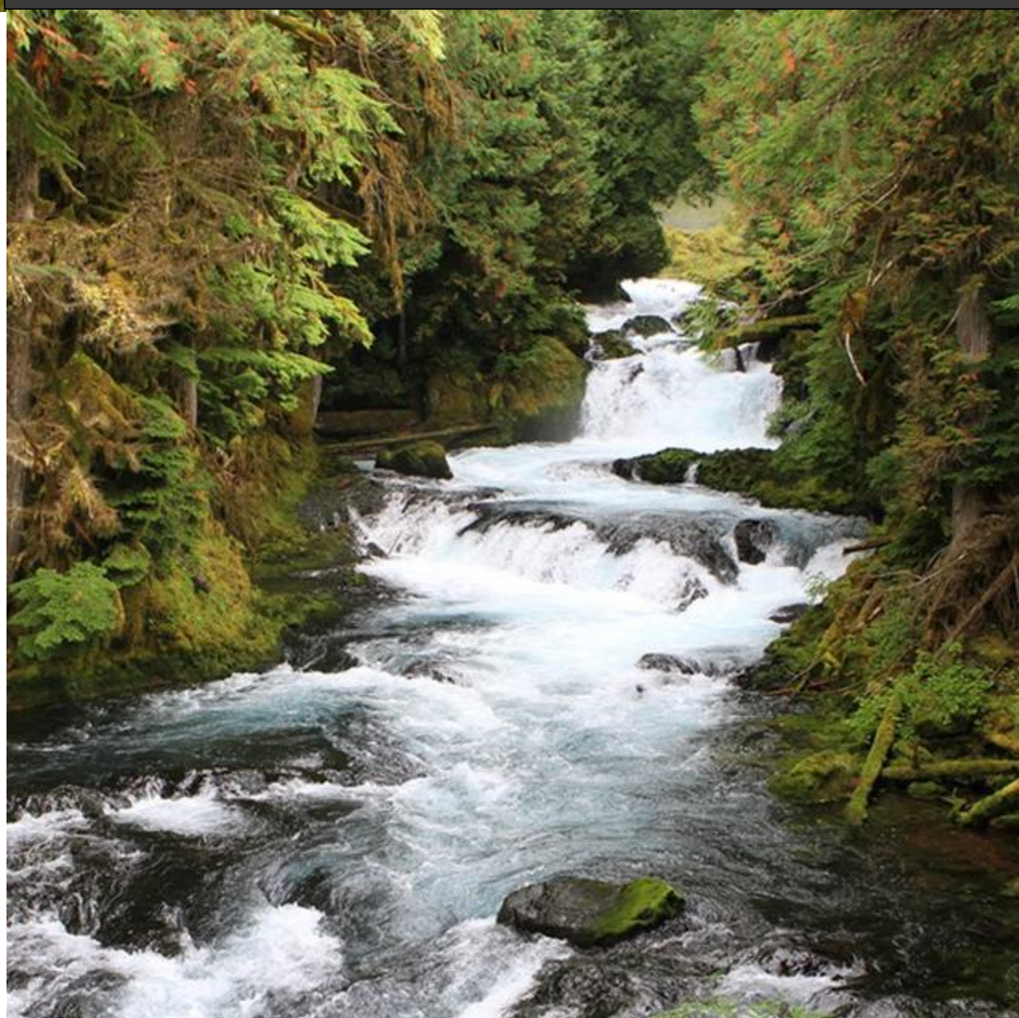
Total Maximum Daily Loads for the Willamette Subbasins

Temperature

~~Amended to include the Willamette River and major tributaries – DRAFT~~

~~August 2024~~

Amended, May 2025



State of Oregon
DEQ Department of Environmental Quality

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DEQ Department of Environmental Quality

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Acronyms

7DADM	7-Day Average Daily Maximum
7Q10	7-Day, 10-Year Low Flow
ADWDF	Average Dry Weather Design Flow
AU	Assessment Unit
CF	Coast Fork
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
DEQ	Oregon Department of Environmental Quality
DMA	Designated Management Agency
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
EWEB	Eugene Water and Electric Board
GNIS	USGS Geographic Names Information System
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
IMD	Internal Management Directive
LA	Load Allocation
LC	Loading Capacity
MF	Middle Fork
MGD	Millions of Gallons per Day
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
OAR	Oregon Administrative Rules
ODC	Oregon Department of Corrections
ODFW	Oregon Department of Fish & Wildlife
ORS	Oregon Revised Statutes
POMI	Point of Maximum Impact
SIC	Standard Industrial Classification
STP	Sewage Treatment Plant
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan

WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

This Total Maximum Daily Load (TMDL) project includes the following Willamette Subbasins: Coast Fork Willamette, McKenzie, Middle Fork Willamette, Upper Willamette, Middle Willamette, Molalla-Pudding, North Santiam, South Santiam, Lower Willamette, and Clackamas Subbasins. This TMDL was adopted by reference in Oregon Administrative Rules OAR 340-42-0090.

OAR 340-42-0040(3) requires the Oregon Department of Environmental Quality (DEQ) or the Oregon Environmental Quality Commission (EQC) to prioritize and schedule TMDLs for completion considering various factors outlined in the rule. Temperature TMDLs for the Willamette Subbasins were identified as a high priority on Oregon's TMDL priority ranking submitted with Oregon's 2022 Integrated Report and due to court order to Oregon and the Environmental Protection Agency (EPA) to establish TMDLs to replace the temperature TMDLs developed as part of the 2006 Willamette Basin TMDL (action ID 30674) and the 2008 Molalla-Pudding Subbasin TMDL and Water Quality Management Plan (WQMP) (action ID 35888) (**Table 1-1**).

1.1 Previous TMDLs

In 2006 and 2008 DEQ issued, and EPA approved, two TMDL actions addressing temperature impairments (**Table 1-1**) within the project area for the Willamette Subbasins temperature TMDLs. Once approved by EPA, the Willamette Subbasins TMDLs for temperature will replace the temperature TMDLs listed in **Table 1-1**. TMDLs for other water quality impaired parameters listed in **Table 1-1** are still effective.

Table 1-1: Summary of previous temperature TMDLs developed for the Willamette Subbasins.

TMDL Action ID	TMDL Name	EPA Approval Date	Water Quality Impairments Addressed
30674	Willamette Basin TMDL	9/29/2006	Ammonia, Bacteria (water contact recreation), DDT 4,4', Dieldrin, Dissolved Oxygen, Mercury, Temperature, Turbidity
35888	Molalla-Pudding Subbasin TMDL and WQMP	12/31/2008	Bacteria (water contact recreation), Chlordane, DDD 4,4', DDE 4,4', DDT 4,4', Dieldrin, Iron, Nitrates, Temperature

1.2 TMDL administrative process and public participation

Following completion of DEQ's drafting process, including engagement of a rule advisory committee on the fiscal impact statement and aspects of the rule, this revised temperature TMDL for the Willamette Subbasins was adopted by EQC, by reference, into rule section OAR 340-042-0090. Any subsequently amended or renumbered rules cited in this document are intended to apply.

DEQ convened a rule advisory committee to provide input on drafts of the TMDL, WQMP, Technical Support Document (TSD) (DEQ, 2023a and 2023b), fiscal and economic impacts, and Environmental Justice and Racial Equity. The committee met on February 23, 2023, and April 6, 2023. The agency held two informational webinars about this TMDL. A public comment period was held from January 10 through March 15, 2024. DEQ held a public hearing on February 16, 2024. DEQ considered all input received during these public participation opportunities and used input to guide the analyses and preparation of documents. DEQ developed a response to comments that is available online. EQC adopted the Willamette Subbasins TMDL and WQMP rule on August 6, 2024. EPA approved the TMDL on September 12, 2024.

~~EQC adopted revisions to the Willamette Subbasins TMDL and WQMP rule on [DATE TBA].~~ The TMDL and WQMP were revised to add temperature TMDLs for 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, Dorena Dam, and Cottage Grove Dam. The name of this project area is the Willamette River mainstem and major tributaries. DEQ convened a rule advisory committee for these TMDL additions. The rule advisory committee provided input on drafts of the updated TMDL, WQMP, Technical Support Document, fiscal and economic impacts, and Environmental Justice and Racial Equity. The committee met on March 14, 2024, May 16, 2024, and July 30, 2024. A public comment period was held from ~~[DATE1 TBA]~~August 9, 2024 through ~~[DATE2 TBA].~~October 14, 2024. DEQ extended the public comment period for 21 days at the request of the public. DEQ held a public hearing on ~~[DATE TBA].~~September 17, 2024. DEQ considered all input received during these public participation opportunities and used input to guide the analyses and preparation of documents. DEQ developed a response to comments that is available online. EQC adopted the amended Willamette Subbasins TMDL and WQMP rule on May 8, 2025.

2 TMDL name and location

Per OAR 340-042-0040(4)(a), this element describes the geographic area for which the TMDL was developed.

The Willamette Subbasins comprise ten 8-digit hydrologic unit code (HUC) subbasins, including 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), the 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) (**Table 2-1**).

Temperature TMDLs for the Willamette Subbasins address all Category 5 listed assessment units (AUs) impaired for temperature on Oregon's 2022 Section 303(d) list (**Table 2-2** through **Table 2-11**) and, as applicable, any AUs identified as temperature impaired in the future. ~~Likewise, this TMDL includes a protection plan for all other assessment categories, including AUs identified as a potential concern, attaining, or unassessed~~In total, the TMDL applies to 958 unique AUs, of which 258 are impaired for temperature. Some of these assessment units have

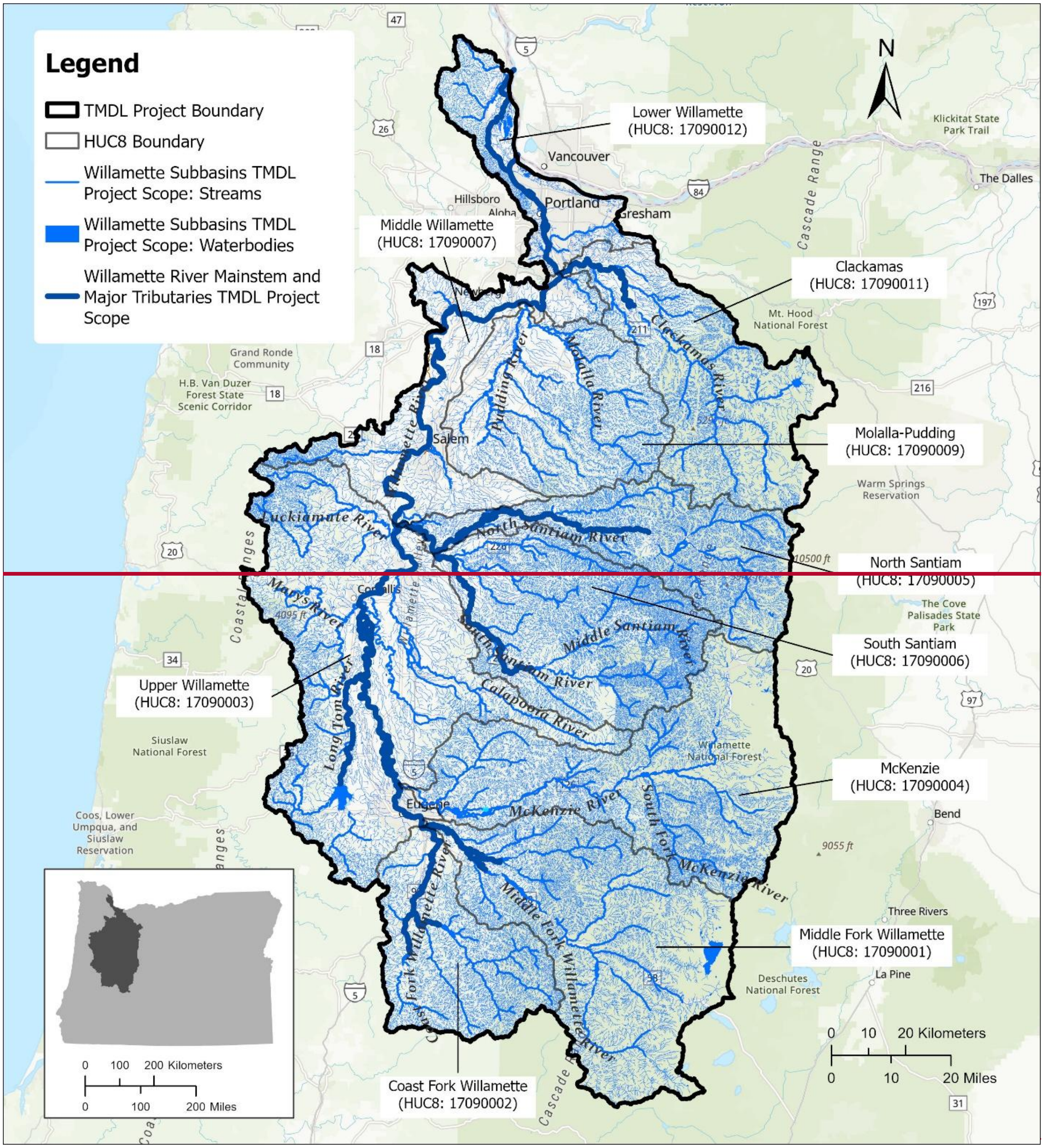
both year-round and spawning use designations impaired. If both use designations are impaired, it is counted as two Category 5 303(d) listings. Therefore, the TMDL addresses a total of 329 Category 5 temperature listings identified on the 2022 Integrated Report.
The loading capacity, allocations, surrogate measures, and implementation framework apply to all waters in the Willamette Subbasins determined to be waters of the state as defined under Oregon Revised Statutes ORS 468B.005(10), including all perennial and intermittent streams that have surface flow or residual pools during the TMDL allocation period.

The TMDL implementation framework is presented in the Willamette Subbasins TMDL WQMP and includes implementation activities and timeframes to improve water quality, as well as measures of success. These and other protection plan elements are further explained in Section 12.

The map in **Figure 2-1** provides an overview of where the temperature TMDLs are applicable. Appendix D of the Willamette Subbasin TSD provides a list of all AUs addressed by the TMDL.

Table 2-1: HUC8 codes and names in the Willamette Subbasins.

HUC8	Subbasin Name
17090001	Middle Fork Willamette
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


Legend
TMDL Project Boundary
HUC8 Boundary
Willamette Subbasins TMDL Project Scope: Streams
Willamette Subbasins TMDL Project Scope: Waterbodies
Willamette River Mainstem and Major Tributaries TMDL Project Scope
Lower Willamette (HUC8: 17090012)
Middle Willamette (HUC8: 17090007)
Clackamas (HUC8: 17090011)
Molalla-Pudding (HUC8: 17090009)
North Santiam (HUC8: 17090005)
South Santiam (HUC8: 17090006)
Upper Willamette (HUC8: 17090003)
McKenzie (HUC8: 17090004)
Middle Fork Willamette (HUC8: 17090001)
Coast Fork Willamette (HUC8: 17090002)
Vancouver
Portland
Hillsboro
Gresham
Salem
Corvallis
Eugene
The Dalles
Bend
La Pine
Three Rivers
0 10 20 Kilometers
0 10 20 Miles
0 100 200 Kilometers
0 100 200 Miles
N

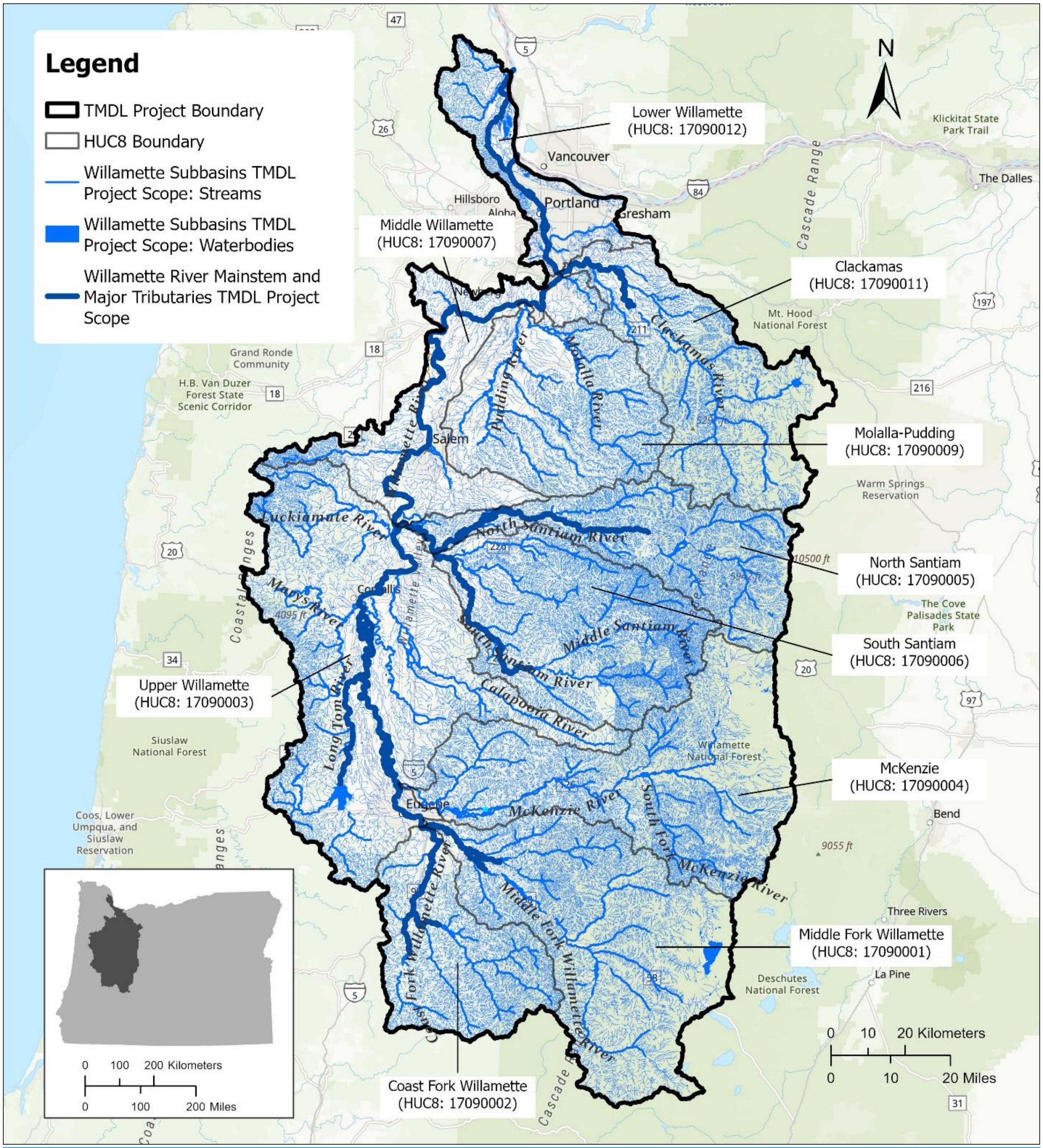


Figure 2-1: Willamette Subbasins temperature TMDLs project area overview.

Table 2-2 through **Table 2-11** present stream AUs 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. AUs listed in Category 5 (i.e., 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 2-2: Middle Fork Willamette Subbasin (17090001) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000106_02_103722	Christy Creek	Spawning
OR_SR_1709000109_02_103735	Fall Creek	Year Round
OR_SR_1709000109_02_103735	Fall 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	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Spawning
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

AU ID	AU Name	Use Period
OR_SR_1709000105_02_104579	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Year Round
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_1709000107_02_104583	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_104583	Middle Fork Willamette River	Spawning
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Year Round
OR_SR_1709000110_02_104584	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 2-3: Coast Fork Willamette Subbasin (17090002) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000202_02_103771	Brice Creek	Year Round
OR_SR_1709000203_02_104585	Coast Fork Willamette River	Year Round
OR_SR_1709000203_02_104586	Coast Fork Willamette River	Year Round
OR_SR_1709000204_02_103787	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_103779	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 2-4: Upper Willamette Subbasin (17090003) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000303_02_103815	Calapooia River	Year Round

AU ID	AU Name	Use Period
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
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Spawning
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_1709000301_02_103791	Long Tom 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
OR_SR_1709000306_05_103854	Willamette River	Year Round
OR_SR_1709000306_05_103854	Willamette River	Spawning

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

AU ID	AU 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

AU ID	AU Name	Use Period
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
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 2-6: North Santiam Subbasin (17090005) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU 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

AU ID	AU Name	Use Period
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	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Spawning
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_1709000504_02_103906	North Santiam River	Spawning
OR_SR_1709000506_02_103930	North Santiam River	Year Round
OR_SR_1709000506_02_103930	North Santiam River	Spawning
OR_SR_1709000506_02_103927	Santiam River	Year Round
OR_SR_1709000506_02_103927	Santiam River	Spawning
OR_SR_1709000506_02_103929	Stout Creek	Year Round

Table 2-7: South Santiam Subbasin (17090006) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU 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
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

AU ID	AU Name	Use Period
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_1709000608_02_103925	South Santiam River	Year Round
OR_SR_1709000608_02_103925	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 2-8: Middle Willamette Subbasin (17090007) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU 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	Year Round
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Spawning
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
OR_SR_1709000701_05_104005	Willamette River	Year Round
OR_SR_1709000701_05_104005	Willamette River	Spawning
OR_SR_1709000703_04_104013	Willamette River	Year Round
OR_SR_1709000703_04_104013	Willamette River	Spawning
OR_SR_1709000703_88_104015	Willamette River	Year Round
OR_SR_1709000704_88_104020	Willamette River	Year Round
OR_LK_1709000703_02_100792	Willamette Slough	Year Round

Table 2-9: Molalla-Pudding Subbasin (17090009) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000901_02_104062	Abiqua Creek	Year Round

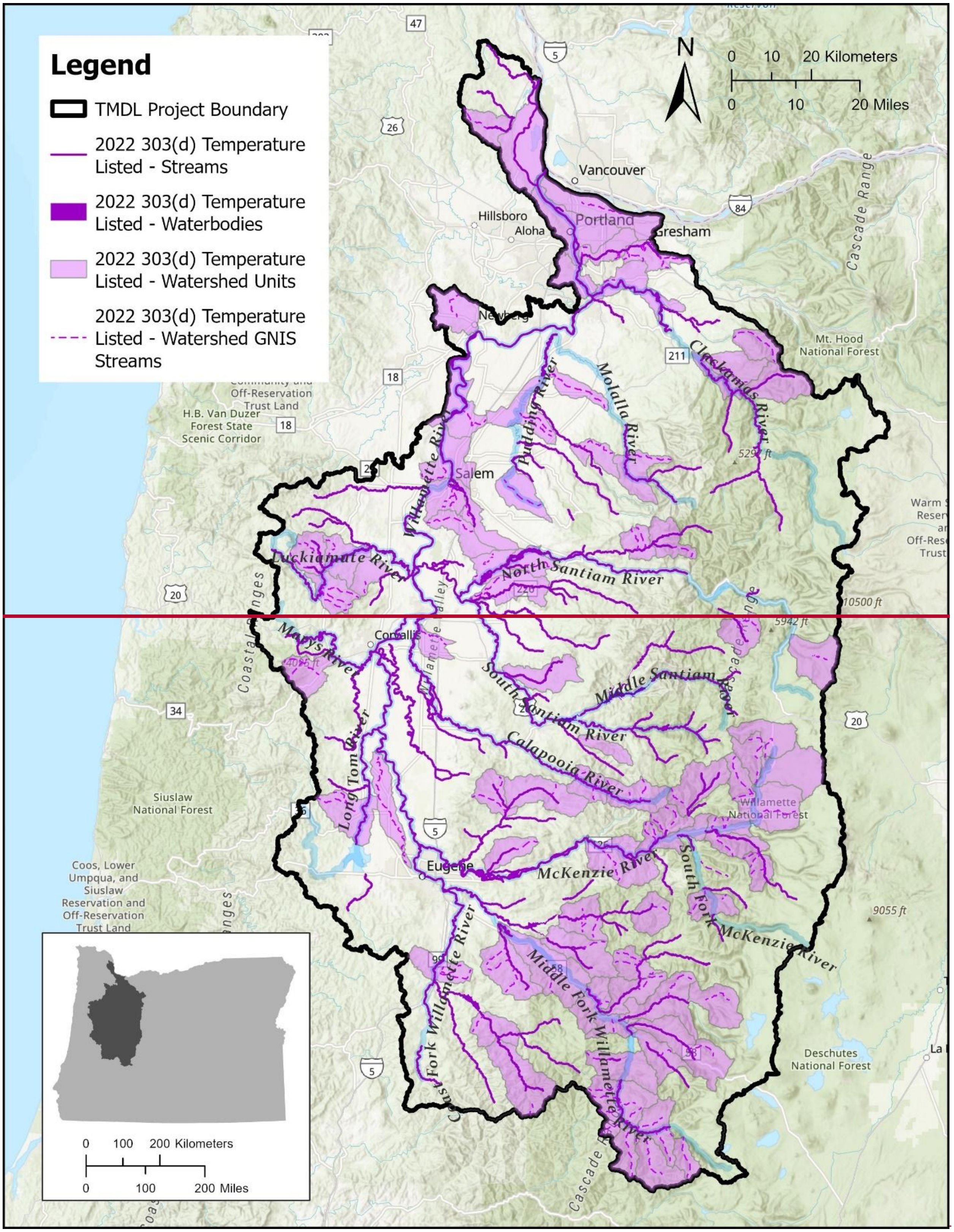
AU ID	AU Name	Use Period
OR_SR_1709000902_02_104070	Butte Creek	Year Round
OR_SR_1709000902_02_104072	Butte Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Spawning
OR_WS_170900090303_02_104470	HUC12 Name: Bear Creek	Year Round
OR_WS_170900090204_02_104467	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 2-10: Clackamas Subbasin (17090011) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU 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_1709001106_02_104597	Clackamas River	Year Round
OR_SR_1709001106_02_104597	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 2-11: Lower Willamette Subbasin (17090012) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Year Round
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	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Spawning
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Spawning
OR_WS_170900120301_02_104557	HUC12 Name: South Scappoose Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Year Round
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Spawning
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_88_104184	Multnomah Channel	Year Round
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
OR_SR_1709001201_88_104019	Willamette River	Year Round
OR_SR_1709001202_88_104175	Willamette River	Year Round


Legend
TMDL Project Boundary
2022 303(d) Temperature Listed - Streams
2022 303(d) Temperature Listed - Waterbodies
2022 303(d) Temperature Listed - Watershed Units
2022 303(d) Temperature Listed - Watershed GNIS Streams
N
0 10 20 Kilometers
0 10 20 Miles
Vancouver
Portland
Gresham
Hillsboro
Aloha
Salem
Corvallis
Eugene
Mt. Hood National Forest
Willamette National Forest
Deschutes National Forest
Siuslaw National Forest
Clackamas River
Molalla River
Pudding River
Willamette River
Luckiamute River
North Santiam River
Marys River
South Santiam River
Middle Santiam River
Calapooia River
Long Tom River
McKenzie River
South Fork McKenzie River
Middle Fork Willamette River
Coast Fork Willamette River
Cascade Range
Coast Ranges
0 100 200 Kilometers
0 100 200 Miles

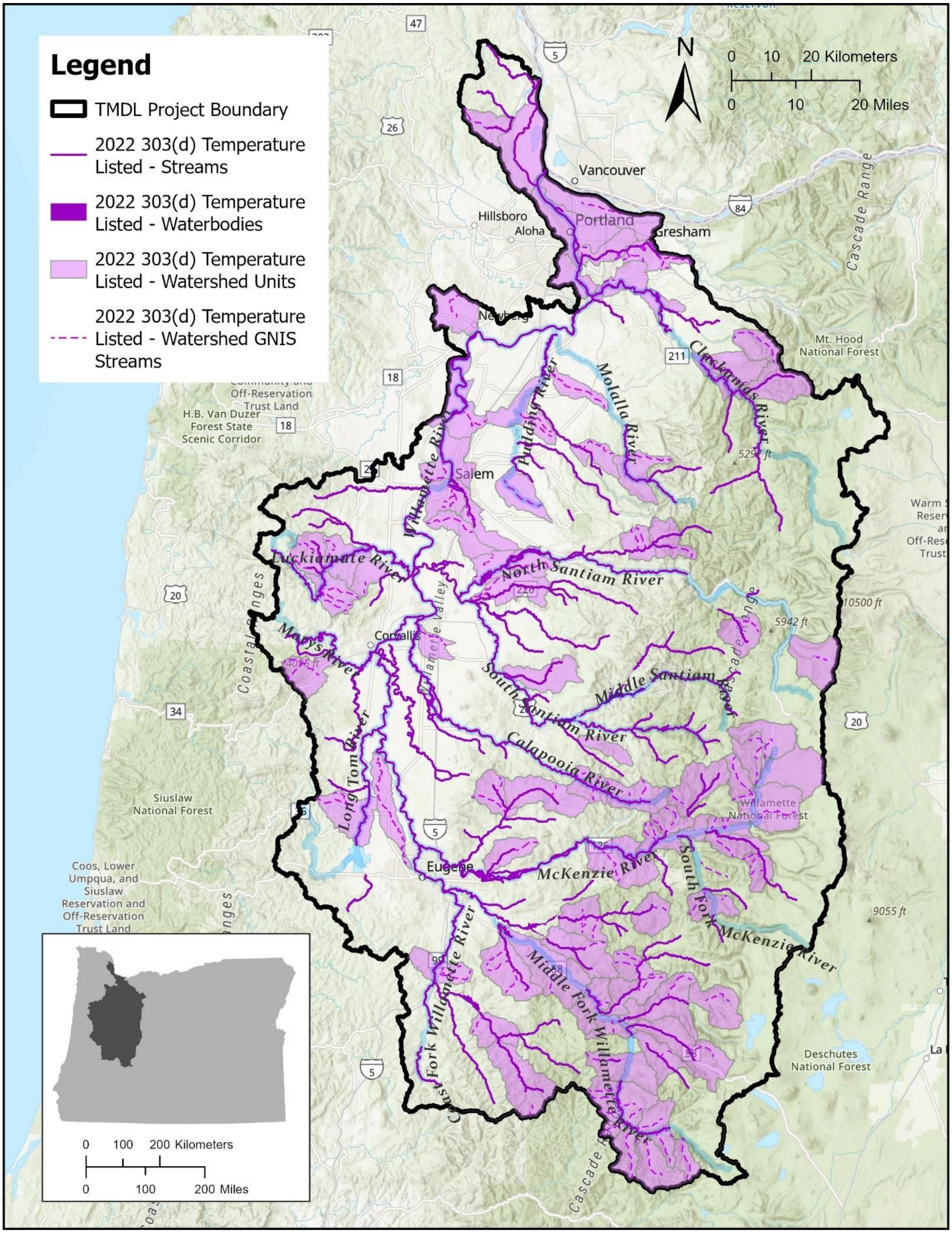


Figure 2-2: Willamette Subbasins Category 5 temperature impairments on the 2022 Integrated Report.

3 Pollutant identification

As stated in OAR 340-042-0040(4)(b), this element identifies the pollutants causing impairment of water quality that are addressed by these TMDLs. The associated water quality standards and beneficial uses are identified in Section 4.

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.

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 excessive 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 Water quality standards and beneficial uses

As stated in OAR 340-042-0040(4)(c), this element identifies the beneficial uses in the basin, specifying the most sensitive beneficial use, and the relevant water quality standards established in OAR 340-041-0202 through 340-041-0975.

Table 4-1 and **Table 4-2** specify the designated beneficial uses in the Willamette Subbasins surface water and the applicable numeric and narrative water quality standards and antidegradation rule and policy addressed by these TMDLs, as well as indicate the most sensitive beneficial uses related to each standard. These TMDLs are designed such that meeting water quality standards for the most sensitive beneficial uses will be protective of all other uses for that parameter. Oregon's water quality standards for temperature are designed to protect fish and aquatic life uses. Fish and aquatic life use is the most temperature sensitive beneficial use.

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

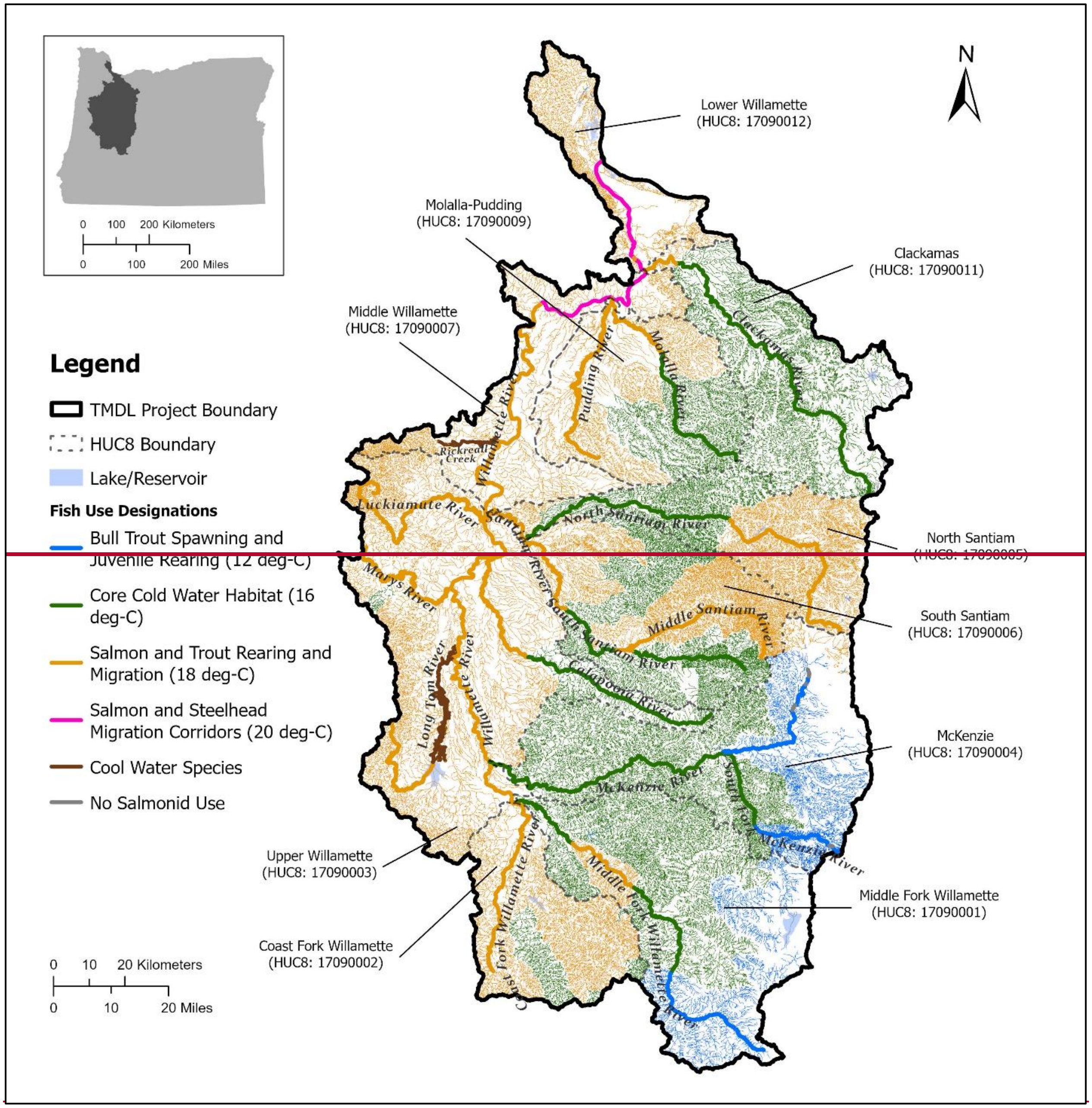
Beneficial Uses	All waterbodies
Public Domestic Water Supply	X
Private Domestic Water Supply	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Fish and Aquatic Life	X

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

Table 4-2: ~~Applicable~~Summary of applicable temperature water quality standards~~ and most sensitive beneficial uses~~.

Rule Citation	Summary of applicable standards	Waters where standards are applicable
Statewide Narrative Criteria OAR 340-041-0007(1)	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.	All waters of the state
Biologically Based Numeric Criteria OAR 340-041-0028(4) OAR 340-041-0340 Figures 340A and 340B	(a) The 7-day average maximum temperature of a stream identified as having salmon and steelhead spawning use may not exceed 13.0˚C (55˚F) at the times indicated on maps and tables (b) The 7-day average maximum temperature of a stream identified as having core cold water habitat use may not exceed 16.0˚C (60.8˚F) (c) The 7-day average maximum temperature of a stream identified as having salmon and trout rearing and migration use may not exceed 18.0˚C (64.4˚F) (d) The 7-day average maximum temperature of a stream identified as having a migration corridor use may not exceed 20.0˚C (68.0˚F) and cold water refugia that are sufficiently distributed. (f) The 7-day average maximum temperature may of a stream identified as having bull trout spawning and juvenile rearing use not exceed 12.0°C (53.6 ˚F). From August 15 through May 15 there may be no more than a 0.3°C (0.5°F) increase between the water temperature immediately upstream of Carmen reservoir on the Upper McKenzie River and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0°C (48°F) or greater, and no more than a 1.0°C (1.8°F) increase when the seven-day-average stream temperature is less than 9°C.	See OAR Figures 340A and 340B (**Figure 4-1** and **Figure 4-2** in this document)
Natural Lakes OAR 340-041-0028(6)	Natural lakes may not be warmed by more than 0.3°C (0.5°F) above the natural condition unless a greater	Natural ~~Lakes~~lakes or natural lakes that

Rule Citation	Summary of applicable standards	Waters where standards are applicable
	increase would not reasonably be expected to adversely affect fish or other aquatic life.	have been modified
Cool Water Species OAR 340-041-0028(9)	No increase in temperature is allowed that would reasonably be expected to impair cool water species. See Section 4.1 for interpretation of this narrative standard to temperature targets.	Cool WaterLong Tom River and Rickreall Creek. See OAR Figures 340A and 340B (**Figure 4-1** and **Figure 4-2** in this document)
Protecting Cold Water OAR 340-041-0028(11)	(a) Not(a) Except as described in subsection (c) of this rule, waters of the State that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based criteria in section (4) of this rule, may not be warmed by more than 0.3˚C (0.5˚F) above the colder water ambient temperature, by all sources taken together at the point of maximum impact.	Cold water
Minimum Duties OAR 340-041-0028(12)	(a) Minimum Duties. There is no duty for anthropogenic sources to reduce heating of the waters of the State below their natural condition. Similarly, each anthropogenic point and nonpoint source is responsible only for controlling the thermal effects of its own discharge or activity in accordance with its overall heat contribution. In no case may a source cause more warming than that allowed by the human use allowance.	All waters of the state
Human Use Allowance OAR 340-041-0028(12)(b)	(Bb) Human Use Allowance. Insignificant additions of heat are authorized in waters that exceed the applicable temperature criteria. (B) Following a temperature TMDL or other cumulative effects analysis, wasteload and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3˚C (0.5˚F) above the applicable criteria after complete mixing in the waterbody, and at the point of maximum impact.	All waters of the state
Antidegradation OAR 340-041-0004 and 40 CFR 131.12(a)(2)	(3)(c) Insignificant temperature increases authorized under OAR 340-041-0028(11) and (12) are not considered a reduction in water quality.	
	(5)(a) Riparian Restoration Activities Exemption: When DEQ determines that activities to restore geomorphology or riparian vegetation have a net ecological benefit, antidegradation review is not needed.	



Lower Willamette
(HUC8: 17090012)
Molalla-Pudding
(HUC8: 17090009)
Clackamas
(HUC8: 17090011)
Middle Willamette
(HUC8: 17090007)
North Santiam
(HUC8: 17090005)
South Santiam
(HUC8: 17090006)
McKenzie
(HUC8: 17090004)
Upper Willamette
(HUC8: 17090003)
Middle Fork Willamette
(HUC8: 17090001)
Coast Fork Willamette
(HUC8: 17090002)
N
0 100 200 Kilometers
0 100 200 Miles
Legend
TMDL Project Boundary
HUC8 Boundary
Lake/Reservoir
Fish Use Designations
Bull Trout Spawning and Juvenile Rearing (12 deg-C)
Core Cold Water Habitat (16 deg-C)
Salmon and Trout Rearing and Migration (18 deg-C)
Salmon and Steelhead Migration Corridors (20 deg-C)
Cool Water Species
No Salmonid Use
0 10 20 Kilometers
0 10 20 Miles
Pudding River
Molalla River
Clackamas River
Willamette River
Rickreall Creek
Luckiamute River
Santiam River
North Santiam River
Marys River
South Santiam River
Middle Santiam River
Calapooia River
Long Tom River
McKenzie River
South Fork McKenzie River
Middle Fork Willamette River
Coast Fork Willamette River

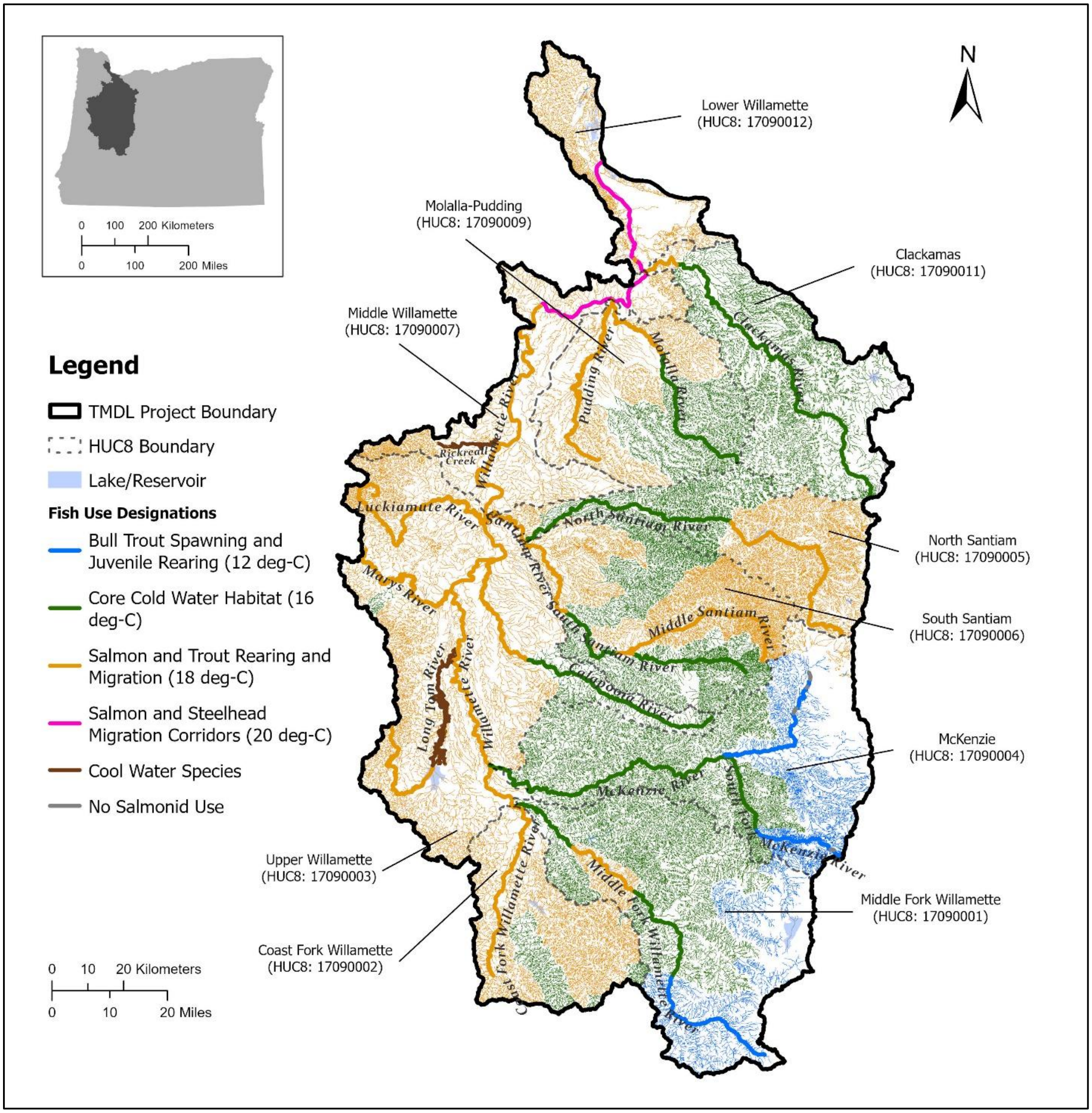
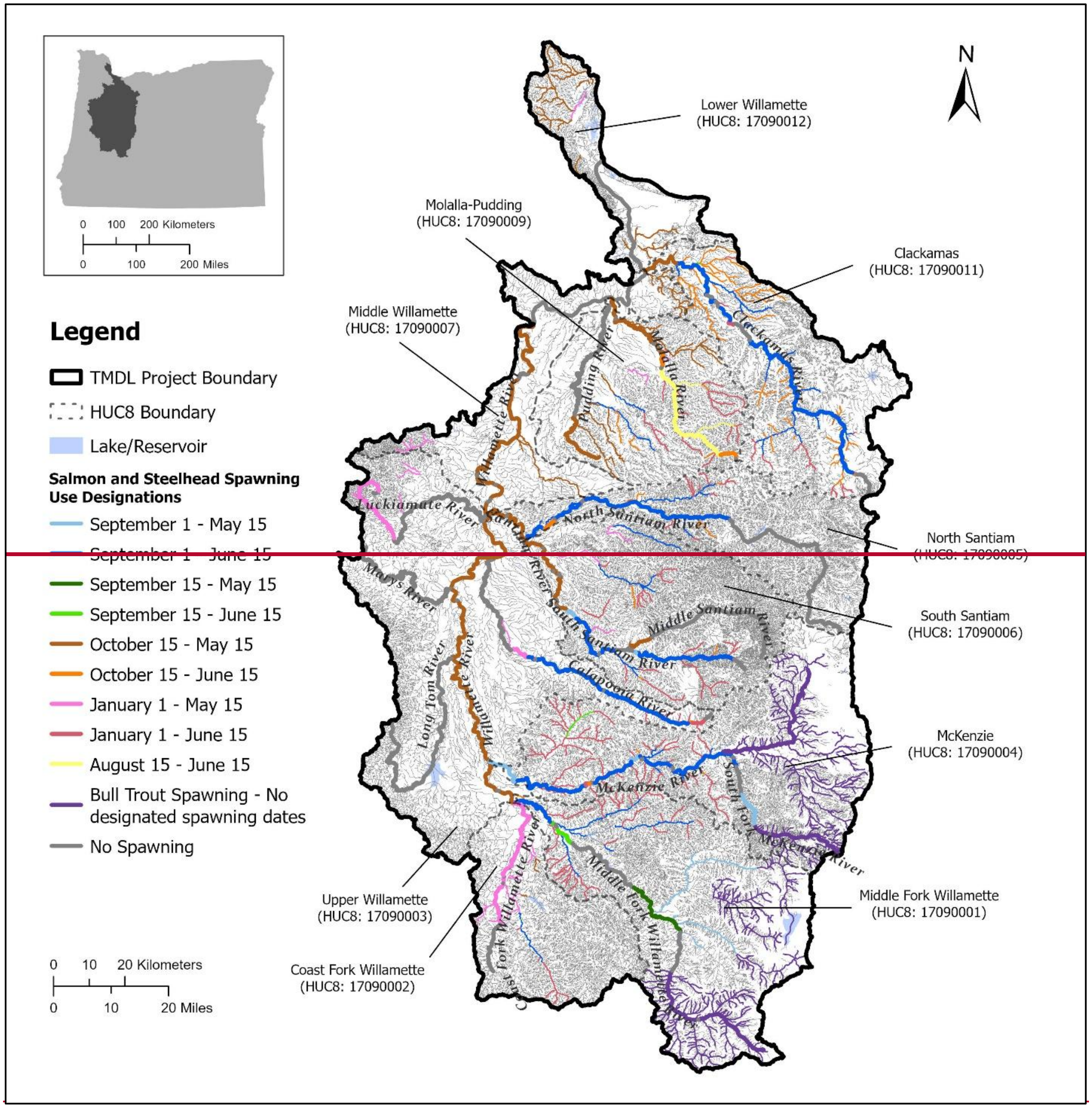


Figure 4-1: Fish use designations in the Willamette Subbasins TMDL project area.



Lower Willamette
(HUC8: 17090012)
Molalla-Pudding
(HUC8: 17090009)
Clackamas
(HUC8: 17090011)
Middle Willamette
(HUC8: 17090007)
North Santiam
(HUC8: 17090005)
South Santiam
(HUC8: 17090006)
McKenzie
(HUC8: 17090004)
Middle Fork Willamette
(HUC8: 17090001)
Upper Willamette
(HUC8: 17090003)
Coast Fork Willamette
(HUC8: 17090002)
0 100 200 Kilometers
0 100 200 Miles
Legend
TMDL Project Boundary
HUC8 Boundary
Lake/Reservoir
Salmon and Steelhead Spawning Use Designations
September 1 - May 15
September 1 - June 15
September 15 - May 15
September 15 - June 15
October 15 - May 15
October 15 - June 15
January 1 - May 15
January 1 - June 15
August 15 - June 15
Bull Trout Spawning - No designated spawning dates
No Spawning
0 10 20 Kilometers
0 10 20 Miles
N

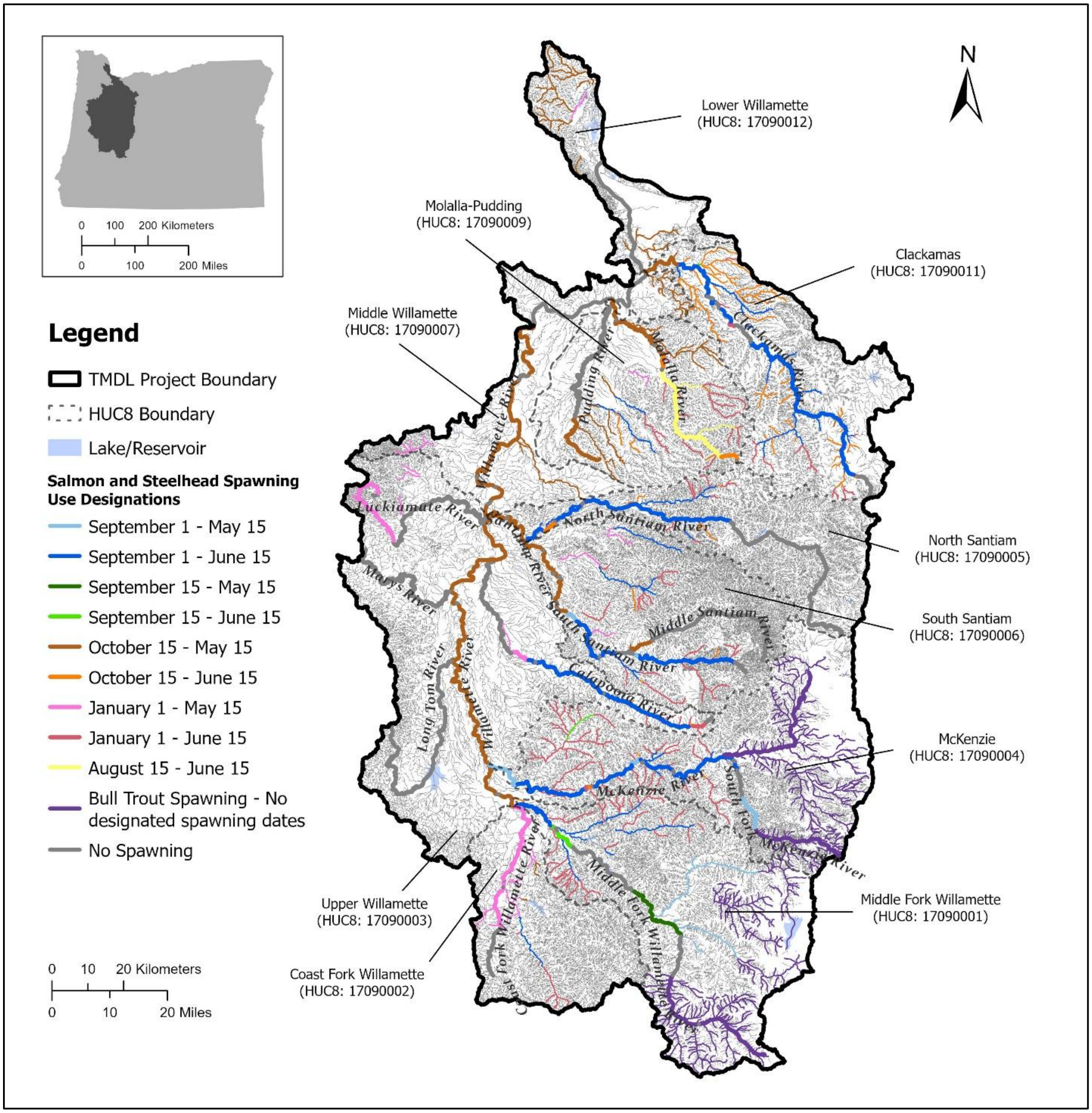


Figure 4-2: Salmon and steelhead spawning use designations in the Willamette Subbasins TMDL project area.

~~4.1 Human use allowance~~

~~Oregon water quality standards also have provisions for human use (OAR 340-041-0028(12)(b)). The human use allowance (HUA) is an insignificant addition of heat (0.3°C) authorized in waters that exceed the applicable temperature criteria. The applicable temperature criteria are defined in OAR 340-041-0002(4) to mean "the biologically based temperature criteria in OAR 340-041-0028(4), or the superseding cold water protection criteria in 340-041-0028(11)". Following a temperature TMDL, or other cumulative effects analysis, wasteload and load allocations will restrict all National Pollutant Discharge Elimination System (NPDES) point sources and nonpoint sources to a cumulative increase of no greater than 0.3°C (0.5°F) above~~

~~the applicable biological criterion after complete mixing in the waterbody, and at the point of maximum impact (POMI). The rationale behind selection of 0.3°C for the HUA and how DEQ implements this portion of the standard can be found in the Staff Report to the EQC (DEQ, 2003) and DEQ's Internal Management Directive (IMD) for temperature water quality standard implementation (DEQ, 2008).~~

~~4.2 Cool Water Species~~

4.1 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." The Long Tom River (Upper Willamette Subbasin) and Rickreall Creek (Middle Willamette Subbasin) are the only waterbodies designated for cool water species use in the Willamette Subbasins.

~~4.2.1~~4.1.1 Long Tom River

The cool water species designation on the Long Tom River applies from the mouth at the confluence with the Willamette River (river mile 0) to Fern Ridge Dam (approximate river mile 24.1). In consultation with ODFW, DEQ determined what cool water species are present in the Long Tom River and translated the narrative criterion into a target temperature based on the thermal tolerance information available for those species. Redside shiner (*Richardsonius balteatus*) are the most temperature sensitive cool water species in the Long Tom River with studies showing an upper lethal temperature threshold between 22.8°C and 27.7°C (Black, 1953). DEQ also determined that Chinook Salmon (Oncorhynchus tshawytscha) are present from approximately November 1 to June 14. Spawning of Chiselmouth, Northern Pikeminnow, Peamouth, and Mountain Sucker could occur in the lower reach between April and July. These species initiate spawning when water temperatures exceed 12°C to18°C. DEQ will rely upon the 18.0°C target temperature established for protection of 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)).

Based on these findings, the temperature targets (**Table 4-3**) for the Long Tom River are:

1) ~~1)~~ 24.0°C + the 0~~°C + 0.3°C~~.3°C human use allowance (HUA) from June 15 through October 31 (based on thermal tolerance for Redside Shiner~~.~~);
2) ~~2)~~ 18.~~0°C + 0.3°C human use allowance (~~0°C + HUA~~)~~ from November 1 to June 14 ~~based~~(Based on Spring Chinook rearing and juvenile migration~~ and~~; spawning preferences for Mountain Sucker, Peamouth, and Chiselmouth~~.~~).

Table 4-3: Summary of temperature targets implementing the cool water species narrative in lower Long Tom River.

Time period	7DADM Temperature Target (°C)	Most Temperature Sensitive Species
June 15 – October 31	24.0 + 0.3 HUA	Redside shiner (*Richardsonius balteatus*)
November 1 – June 14	18.0 + 0.3 HUA	Chinook Salmon (*Oncorhynchus tshawytscha*)

If 7DADM temperatures trend to always being cooler than temperature targets presented in Table 4 3, the protecting cold water criterion at OAR 340-041-0028 (11) shall be applied with the

0.3°C human use allowance (HUA) based on an increase above the cooler ambient temperature.

Analysis and rationale for the numeric temperature targets are further described in the TMDL Technical Support Document, Section 4.8.

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 impacts. This TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

~~4.2.2~~4.1.2 Rickreall Creek

The cool water species designation on Rickreall Creek 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. In consultation with the Oregon Department of Fish & Wildlife (ODFW), DEQ determined what cool water species are present in Rickreall Creek and translated the narrative criterion into a target temperature based on the thermal tolerance information available for those species. Prickly sculpin are the most temperature sensitive cool water species in lower Rickreall Creek with studies showing complete survival after 24 hours at 22.8°C (Black, 1953). DEQ also determined that adult winter steelhead (*Oncorhynchus mykiss*), Coho salmon, and Chinook salmon may be migrating through the lower reach of Rickreall Creek, and juvenile winter steelhead or Coastal Cutthroat trout (*Oncorhynchus clarkii*) may be rearing in lower Rickreall Creek. Based on ODFW's timing tables, steelhead may migrate through lower Rickreall Creek from February 15 through May 31. In addition, there may be resident trout present in this segment, particularly at the upper end, from October through spring. DEQ will rely upon the 18.0°C target temperature established for protection of salmon and trout rearing and migration uses suggested by EPA's guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)).

Based on these findings, from June 1 to September 30, where the cool water species criterion applies in Rickreall Creek, warming from anthropogenic sources shall be limited to a cumulative increase of no greater than 0.3°C above 22.8°C after complete mixing in the waterbody, and at the POMI. During the remainder of the year (October 1 – May 31), the numeric target protecting cool water fish and migrating or rearing cold water fish is an instream 7-day average daily maximum (7DADM) temperature target of 18.0°C plus an insignificant addition of heat for human use equal to 0.3°C after complete mixing in the waterbody, and at the POMI. A summary of the temperature targets are presented in **Table 4-4**.

The provisions of the protecting cold water criterion at OAR 340-41-0028(11) are also incorporated into the temperature target. If ambient 7DADM temperatures trend to always being cooler than both temperature targets presented in **Table 4-4** and all exceptions outlined in OAR 340-41-0028(11)(c) are not applicable, the protecting cold water shall be applied with the 0.3°C HUA based on an increase above the cooler ambient temperature.

Analysis and rationale for the numeric temperature targets are further described in the TMDL Technical Support Document Section 4.8.

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 impacts. This TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

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

Time period	7DADM Temperature Target (°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*)

4.2 Natural lakes narrative

The narrative natural lakes criterion at OAR 340-041-0028(6) states that natural lakes may not be warmed by more than 0.3°C (0.5°F) 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.

The HUA assigned to anthropogenic sources in this TMDL do not exceed 0.3°C. Therefore, any increase above the natural condition temperatures shall be implemented so the target temperature plus 0.3°C HUA is protective of fish or other aquatic life.

For the purpose of applying the natural lakes criterion, ambient temperatures has the same meaning as defined in OAR 340-041-0002(2) where ambient means the temperature measured at a specific time and place. The selected location for measuring ambient temperature must be representative of the lake in the vicinity of the point being measured. The sampling approach and number of monitoring locations may vary depending on the lake size, temperature variability, and stratification regime. Monitoring and interpretation approaches are further discussed in TSD Section 4.7. Consistent with other temperature criteria, the 7DADM temperatures will be used for characterizing ambient or natural condition temperatures.

4.3 Numeric water quality targets

TMDLs must contain numeric water quality targets. The targets represent the instream endpoint that ensures all applicable temperature water quality standards are attained and beneficial uses are protected. Temperature targets summarized in Table 4-5 are similar to the water quality standards summarized in Table 4-2 but include application of water quality standard implementation provisions, relevant narrative provisions, and the antidegradation policy.

Table 4-5: Summary of applicable numeric temperature targets in the Willamette Subbasins.

Applicable Criteria	Fish and Aquatic Life Use Protected	7DADM Temperature Target (°C)	Notes
Biologically based numeric criteria apply OAR 340-041-0028(4) or Protecting cold water criterion OAR 340-041-0028(11)	**Waters that exceed the biologically based numeric criteria**		
	Salmon and steelhead spawning	13.0 + 0.3 HUA	Seasonally applies
	Bull trout spawning and juvenile rearing	12.0 + 0.3 HUA	
	Core cold water habitat	16.0 + 0.3 HUA	
	Salmon and trout rearing and migration	18.0 + 0.3 HUA	
	Salmon and steelhead migration corridor	20.0 + 0.3 HUA	
	Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criterion does not apply		
	Salmon and steelhead spawning	13.0	Seasonally applies
	Core cold water habitat	16.0	
	Salmon and trout rearing and migration	18.0	
	Salmon and steelhead migration corridor	20.0	
	Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criterion applies		
	Fish and aquatic life	Ambient temperature + 0.3 HUA	
Bull trout spawning narrative OAR 340-041-0028(4){f)	Bull trout spawning and juvenile rearing use McKenzie River	Ambient temperature + 0.3 HUA when the ambient is ≥ 9.0	August 15 - May 15
		Ambient temperature + 1.0 HUA when the ambient < 9.0	
Coldwater refugia narrative OAR 340-041-0028(4)(d)	Salmon and steelhead migration corridor cold water refuges	2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed water body	Cold water refugia must be sufficiently distributed. See cold water refugia narrative interpretation study (DEQ, 2020).
Cool Water Species OAR 340-041-0028(9)	Cool water species Long Tom River	24.0 + 0.3 HUA	June 15 – October 31
		18.0 + 0.3 HUA	November 1 – June 14
	Cool water species Rickreall Creek	22.8 + 0.3 HUA	June 1 – September 30
		18.0 + 0.3 HUA	October 1 – May 31
Natural lakes narrative OAR 340-041-0028(6)	Fish and aquatic life Natural Lakes	Natural thermal condition + 0.3 HUA as a 7DADM	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

5 Seasonal variation and critical period for temperature

Per OAR 340-042-0040(4)(j) and 40 Code of Federal Regulation 130.7(c)(1), TMDLs must also identify any seasonal variation and the critical condition or period of each pollutant, if applicable.

Maximum 7DADM stream temperatures typically occur in July or August. July and August are months when stream flows typically are low, solar radiation fluxes are high, and ambient air temperature conditions are warmest. Maximum 7DADM temperatures downstream of some large dam and reservoir operations are shifted from July and August to September, October, and November.

The critical period is based on the frequency and period when 7DADM stream temperatures exceed the applicable temperature criteria. 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 and frequency 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~~ when the downstream waterbodies were not modeled; or if the model shows thermal loads to upstream waterbodies contribute to temperature criteria exceedances in downstream waterbodies. For example, the period of exceedance for the lower McKenzie River based on temperature data from the lower McKenzie River is May 1 to October 31 (TSD Section 5). However, the period of exceedance for the Willamette River downstream from the confluence of the McKenzie River is April 1 to November 15. Since lower McKenzie River point sources, including IP Springfield, contribute to temperature criteria exceedances in the Willamette River, the McKenzie River critical period for which WLAs apply is set to April 1 to November 15. This ensures warming of upstream waters does not contribute to downstream exceedances.

The critical periods for waterbodies in the Willamette Subbasins are presented in **Table 5-1**. Allocations presented in the TMDL apply during these periods. Section 5 of the TSD summarizes the critical period approach and presents plots of 7DADM temperature data used to determine seasonal variation and the critical periods.

Table 5-1: Designated critical periods for ~~waterbodies~~waters in the Willamette Subbasins.

Subbasin	Watershed or Waterbody Name	Critical Period
Middle Fork Willamette Subbasin 17090001	All waters, except those noted	May 1 – October 31
	Middle Fork Willamette River from Hills Creek Dam to North Fork Middle Fork Willamette River OR_SR_1709000105_02_104580 OR_SR_1709000105_02_103720	May 1 – November 30
	Middle Fork Willamette River from North Fork Middle Fork Willamette River to Dexter Reservoir OR_SR_1709000107_02_103725	May 1 – November 15
	Middle Fork Willamette River downstream from Dexter Reservoir OR_SR_1709000107_02_104583 OR_SR_1709000110_02_103750 OR_SR_1709000110_02_104584	April 1 – November 15
	Fall Creek downstream from Fall Creek Dam OR_SR_1709000109_02_103735	April 1 – November 15
	Lookout Point Lake OR_LK_1709000107_02_100700 Dexter Reservoir OR_LK_1709000107_02_100699	May 1 – November 15
Coast Fork Willamette Subbasin 17090002	All waters, except those noted	May 1 – October 31
	Coast Fork Willamette River downstream from Cottage Grove Dam OR_SR_1709000203_02_104585 OR_SR_1709000204_02_103787	April 1 – November 15
	Row River downstream from Dorena Dam. OR_SR_1709000202_02_103779	April 1 – November 15
Upper Willamette Subbasin 17090003	All waters, except those noted	May 1 – October 31
	Long Tom River downstream of Fern Ridge Reservoir OR_SR_1709000301_02_10379	April 1 – November 15
	Willamette River OR_SR_1709000306_05_103854 Willamette River side channels and sloughs AUs listed in TSD Appendix D	April 1 – November 15
McKenzie River Subbasin 17090004	All waters, except those noted	May 1 – October 31
	McKenzie River Watershed (1709000407)	April 1 – November 15
	Lower Blue River from Blue River Dam to McKenzie River AU: OR_SR_1709000404_02_104569	May 1 – November 15
	All waters, except those noted	May 1 – October 31

Subbasin	Watershed or Waterbody Name	Critical Period
North Santiam Subbasin 17090005	North Santiam River downstream from Detroit Dam OR_SR_1709000504_02_103906 OR_SR_1709000506_02_103930	April 1 – November 15
South Santiam Subbasin 17090006	All waters, except those noted	May 1 – October 31
	Middle Santiam River from Green Peter Dam to Foster Lake: OR_SR_1709000604_02_103969	May 1 – November 30
	South Santiam River downstream from Foster Dam OR_SR_1709000608_02_103925	April 1 – November 15
	Santiam River OR_SR_1709000506_02_10392	April 1 – November 15
Middle Willamette Subbasin 17090007	All waters, except those noted	May 1 – October 31
	Willamette River upstream of ~~the Yamhill~~Chehalem Creek OR_SR_1709000701_05_104005 OR_SR_1709000703_05_104014 Willamette Slough, Lambert Slough, Mission Lake and other Willamette River side channel and sloughs AUs listed TSD Appendix D	April 1 – November 15
	Willamette River downstream of ~~the Yamhill River~~Chehalem Creek OR_SR_1709000703_88_104015 OR_SR_1709000704_88_104020 OR_SR_1709000703_04_104013	June 1 – September 30
Molalla-Pudding Subbasin 17090009	All waters	May 1 – October 31
Clackamas Subbasin 17090011	All waters, except those noted	May 1 – October 31
	Clackamas River downstream of River Mill Dam OR_SR_1709001106_02_104597 OR_LK_1709001106_02_100852 Clackamas Cove OR_LK_1709001106_02_100259	April ~~1 – November~~ 15 – October 31
Lower Willamette Subbasin 17090012	All waters, except those noted	April 1 – October 31
	Johnson Creek Watershed (1709001201)	February 15 – November 15
	Willamette River OR_SR_1709001201_88_104019 OR_SR_1709001202_88_104175~~downstream of the Yamhill River~~	June 1 – September 30
	Multnomah Channel OR_SR_1709001203_88_10418	~~June 1 – September 30~~May 15 – October 15

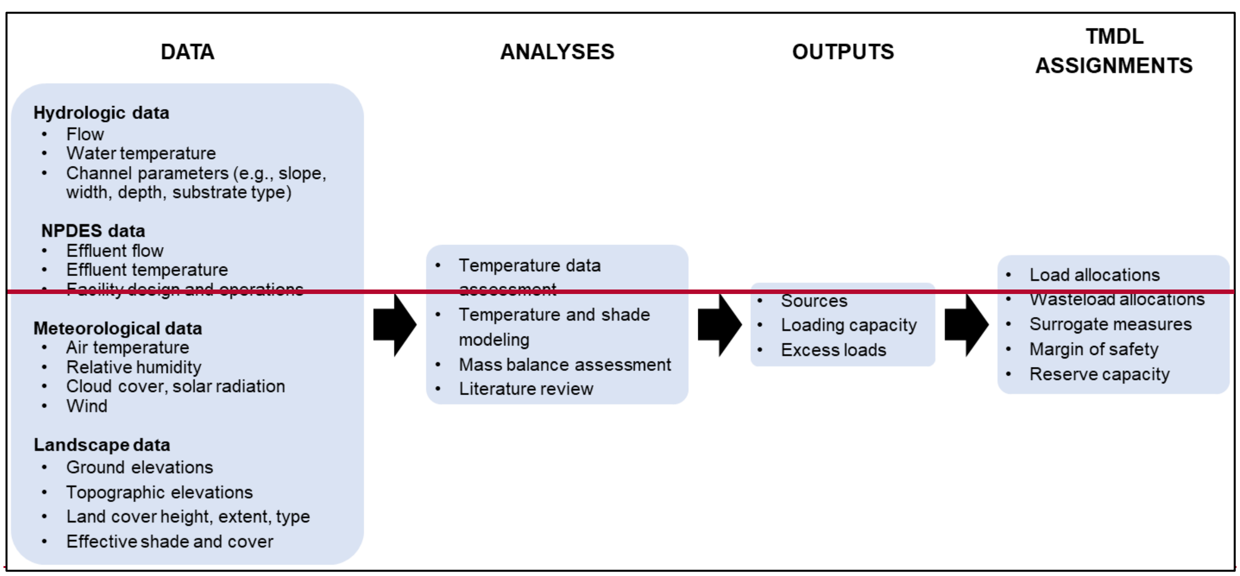
6 Temperature water quality data evaluation overview

A critical TMDL element is water quality data evaluation and analysis to the extent that existing data allow. To understand the water quality impairment, quantify the loading capacity, identify pollutant sources, and assess various management scenarios that achieve the TMDL and applicable water quality standards, the analysis requires a predictive component. Certain models provide a means to evaluate potential stream warming sources and, to the extent existing data allow, their current and potential pollutant loads. Heat Source and CE-QUAL-W2 temperature models were used in this effort and are described in the TSD model appendices.

The modeling framework needs for this project included the abilities to predict or evaluate the following on an hourly basis:

1. Stream temperatures spanning months at ≤500 m longitudinal resolution.
2. Solar radiation fluxes and ~~daily~~ effective shade at ≤100 m longitudinal resolution.
3. Stream temperature responses due to changes in:
    a. Streamside vegetation,
    b. Water withdrawals and upstream tributaries' stream flow,
    c. Channel morphology in the upstream catchment, and
    d. Effluent temperature and flow discharge from NPDES permitted facilities.

Figure 6-1 provides an overview of the analyses completed for this TMDL.



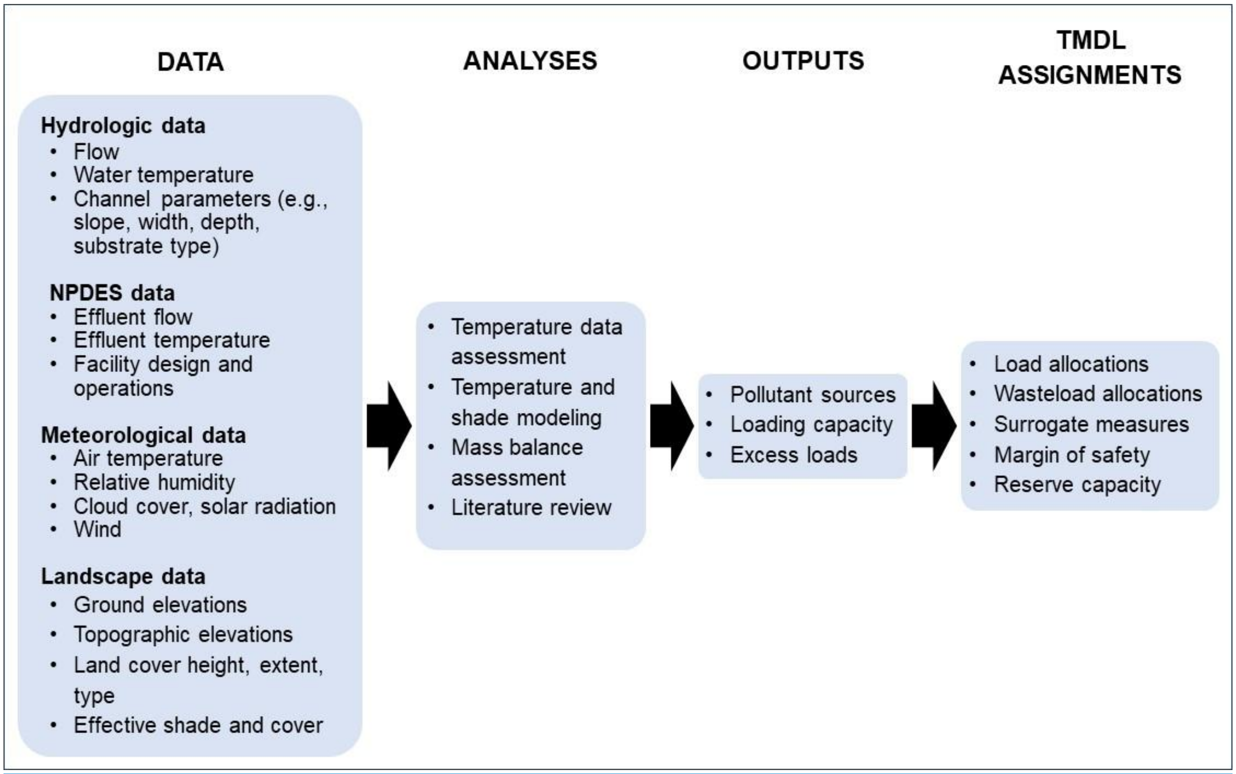


Figure 6-1: Willamette Subbasins temperature analysis overview.

7 Pollutant sources or source categories

As noted in OAR 340-042-0040(4)(f) and OAR 340-042-0030(12), a source is any process, practice, activity or resulting condition that causes or may cause pollution or the introduction of pollutants to a waterbody. This section identifies the various pollutant sources and estimates, to the extent existing data allow, the significance of pollutant loading from existing sources.

Both point and nonpoint sources are sources of thermal pollution to surface waters in the Willamette Subbasins. Within the nonpoint source category, both background and anthropogenic nonpoint sources contribute thermal pollution. Each source's thermal loading varies in frequency and magnitude based on the flow rate and temperature of discharge, prevalence of the activities, size of the land area on which the activities occur, locations of activities in relation to surface water, and transport mechanisms.

7.1 Thermal point sources

OAR 340-045-0010(17) defines a point source as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged."

Individual and some general NPDES permittees were identified as sources of thermal loading to waters in the Willamette Subbasins and assigned thermal waste load allocations. While individual and some general NPDES permittees identified in this TMDL discharge or have potential to discharge thermal loads that increase stream temperature, the loading from the majority of the individual facilities evaluated do not result in temperature increases that exceed the 0.30°C human use allowance.

7.1.1 Individual NPDES permitted point sources

There are ~~121~~113 domestic or industrial facilities with an individual NPDES ~~permitted point source discharges~~permit within the Willamette Subbasins. In addition, there are 8 facilities that have submitted individual NPDES permit applications for discharge to waters in the Willamette Subbasins. 112 of the permitted facilities and all 8 of the facilities with pending permits were identified as potential sources of thermal load (**Table 7-1**). There also are ~~21~~7 individual Municipal Separate Storm Sewer System (MS4 Phase I and Phase II) NPDES permits covering 21 permittees~~.~~ (**Table 7-3**).

~~Portland International Airport is an individual NPDES permitted point source that only discharges stormwater during the TMDL allocation period. For this reason, Portland International Airport is included in **Table 7-2** as a facility where stormwater requirements apply.~~ The point sources covered by individual NPDES permits identified in **Table 7-2** discharge stormwater only or have a stormwater only outfall. DEQ determined that these stormwater discharges and those covered under the MS4 stormwater permits (**Table 7-3**) do not have potential to discharge thermal loads that contribute to exceedances of applicable temperature criteria. Therefore, no additional TMDL requirements are needed for the stormwater sources to control temperature, other than those included in the current individual NPDES permits. More specific thermal wasteload allocations can be considered if subsequent data and evaluation demonstrates a need and if reserve capacity is available. Note that numeric thermal WLAs have been provided to Arkema and Jasper Wood Products for non-stormwater discharges that may contribute to exceedances of applicable temperature criteria, including process water, boiler condensate, and non-contact cooling water.

Table 7-1: Individual NPDES permitted point source discharges that have the potential to 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 (AU ID)	River mile
Adair Village STP	NPDES-DOM-Da	500	OR0023396	Willamette River (OR_SR_1709000306_05_103854)	122
Albany Millersburg WRF	NPDES-DOM-Ba	1098	OR0028801	Willamette River (OR_SR_1709000306_05_103854)	118
Alpine Community	NPDES-DOM-Db	100101	OR0032387	Muddy Creek (OR_SR_1709000302_02_103808)	25.6
Arclin	NPDES-IW-B10	81714	OR0000892	Columbia Slough (OR_WS_170900120201_02_104554.1)	6

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Arclin	NPDES-IW-B16	16037	OR0021857	Patterson Slough (OR_WS_170900030601_02_104287)	1.8
Arkema, Inc. outfall 004 in permit # 103075	NPDES-IW-B14	68471	OR0044695	Willamette River (OR_SR_1709001202_88_104175)	7.2
Ash Grove Cement - Rivergate Lime Plant	NPDES-IW-B16	3690	OR0001601	Willamette River (OR_SR_1709001202_88_104175)	3.3
ATI Albany Operations	NPDES-IW-B08	64300	OR0001716	Oak Creek (OR_WS_170900030402_02_104273)	1.6
ATI Millersburg	NPDES-IW-B07	87645	OR0001112	Willamette River (OR_SR_1709000306_05_103854)	~~2~~118
Aumsville STP	NPDES-DOM-Db	4475	OR0022721	Beaver Creek (OR_WS_170900070202_02_104410)	2.5
Aurora STP	NPDES-DOM-Db	110020	OR0043991	Pudding River (OR_SR_1709000905_02_104088)	8.8
Bakelite Chemicals LLC	NPDES-IW-B16	32864	OR0002101	Amazon Creek (OR_WS_170900030108_02_104250)	2.7
Bakelite Chemicals LLC	NPDES-IW-B16	32650	OR0032107	Murder Creek (OR_WS_170900030610_02_104298)	0.6
Blount Oregon Cutting Systems Division	NPDES-IW-B16	63545	OR0032298	Minthorne Creek (OR_WS_170900120102_02_104551)	0.9
Boeing Of Portland – Fabrication Division	NPDES-IW-B16	9269	OR0031828	Osburn Creek (OR_WS_170900120201_02_104554.2)	1.6
Brooks STP	NPDES-DOM-Db	100077	OR0033049	Willamette River (OR_SR_1709000703_04_104013)	71.7
Brownsville STP	NPDES-DOM-Db	11770	OR0020079	Calapooia River (OR_SR_1709000303_02_103816)	31.6
Canby Regency Mobile Home Park	NPDES-DOM-Da	97612	OR0026280	Willamette River (OR_SR_1709000704_88_104020)	31.6
Canby STP	NPDES-DOM-C1a	13691	OR0020214	Willamette River (OR_SR_1709000704_88_104020)	33

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Cascade Pacific Pulp, LLC	NPDES-IW-B01	36335	OR0001074	Willamette River (OR_SR_1709000306_05_103854)	147.7
Century Meadows Sanitary System (CMSS)	NPDES-DOM-Da	96010	OR0028037	Willamette River (OR_SR_1709000704_88_104020)	42.8
Coburg Wastewater Treatment Plant	NPDES-DOM-Da	115851	OR0044628	Muddy Creek (OR_WS_170900030606_02_104294)	50.7
Coffin Butte Landfill	NPDES-IW-B15	104176	OR0043630	Roadside ditch to Soap Creek tributary (OR_WS_170900030511_02_104285)	4.5
Columbia Helicopters	NPDES-IW-B16	100541	OR0033391	Unnamed Stream (tributary to Pudding River) (OR_WS_170900090502_02_104481)	2
Corvallis STP	NPDES-DOM-Ba	20151	OR0026361	Willamette River (OR_SR_1709000306_05_103854)	130.8
Cottage Grove STP	NPDES-DOM-C2a	20306	OR0020559	Coast Fork Willamette River (OR_SR_1709000203_02_104585)	20.6
Covanta Marion, Inc	NPDES-IW-B16	89638	OR0031305	Willamette River (OR_SR_1709000703_04_104013)	72
Creswell STP	NPDES-DOM-Db	20927	OR0027545	Unnamed stream (tributary to Camas Swale Creek) (OR_WS_170900020403_02_104240)	4
Dallas STP	NPDES-DOM-C1a	22546	OR0020737	Rickreall Creek (OR_SR_1709000701_02_104591)	9.3
Dundee STP	NPDES-DOM-Db	25567	OR0023388	Willamette River (OR_SR_1709000703_04_104013)	51.7
Duraflake	NPDES-IW-B20	97047	OR0000426	Murder Creek (OR_WS_170900030610_02_104298)	0.57
Estacada STP	NPDES-DOM-Da	27866	OR0020575	Clackamas River (OR_LK_1709001106_02_100850)	23.3
Eugene Public Library	NPDES-IW-B16	112467	OR0044725	Willamette River (OR_SR_1709000306_05_103854)	179.5
Evraz Oregon Steel	NPDES-IW-B08	64905	OR0000451	Willamette River (OR_SR_1709001202_88_104175)	2.4

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
EWEB Carmen-Smith Trail Bridge Powerhouse	NPDES-IW-B16	28393	OR0000680	McKenzie River (OR_SR_1709000402_02_104588)	76
EWEB Carmen-Smith Carmen Powerhouse	NPDES-IW-B16	28393	OR0000680	Trail Bridge Reservoir/McKenzie River (OR_LK_1709000402_02_100742)	77
Falls City STP	NPDES-DOM-Da	28830	OR0032701	Little Luckiamute River (OR_SR_1709000305_02_103822)	12
Forest Park Mobile Village	NPDES-DOM-Da	30554	OR0031267	Willamette River (OR_SR_1709000704_88_104020)	28.2
Foster Farms	NPDES-IW-B04	97246	OR0026450	Camas Swale Creek (OR_SR_1709000204_02_103786)	3.3
Frank Lumber Co. Inc.	NPDES-IW-B19	30904	OR0000124	North Santiam River (OR_SR_1709000504_02_103906)	32.5
Fujimi Corporation – SW Commerce Circle	NPDES-IW-B15	107178	OR0040339	Coffee Lake Creek (OR_WS_170900070402_02_104419)	1.8
Gervais STP	NPDES-DOM-Db	33060	OR0027391	Pudding River (OR_SR_1709000902_02_104073)	28.2
GP Halsey Mill	NPDES-IW-B01	105814	OR0033405	Willamette River (OR_SR_1709000306_05_103854)	147.7
Halsey STP	NPDES-DOM-Db	36320	OR0022390	Muddy Creek (OR_SR_1709000306_02_103838)	23
Harrisburg Lagoon Treatment Plant	NPDES-DOM-Db	105415	OR0033260	Willamette River (OR_SR_1709000306_05_103854)	158.4
Hollingsworth & Vose Fiber Co - Corvallis	NPDES-IW-B15	28476	OR0000299	Willamette River (OR_SR_1709000306_05_103854)	132.5
Hubbard STP	NPDES-DOM-Da	40494	OR0020591	Mill Creek (OR_WS_170900090502_02_104481)	5.3
Hull-Oakes Lumber Co.	NPDES-IW-B19	107228	OR0038032	Oliver Creek (OR_SR_1709000302_02_103807)	4.8
Independence STP	NPDES-DOM-Db	41513	OR0020443	Willamette River (OR_SR_1709000701_05_104005)	95.5

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
International Paper – Springfield Paper Mill (Outfall ~~1~~001 + Outfall ~~2~~002)	NPDES-IW-B01	96244	OR0000515	McKenzie River (OR_SR_1709000407_02_103884)	~~8~~14.7 (001) 15.5 (002)
International Paper – Springfield Paper Mill (Outfall ~~3~~003)	NPDES-IW-B01	96244	OR0000515	Storm Ditch to Q Street Canal (OR_WS_170900030601_02_104287)	0
J.H. Baxter & Co., Inc.	NPDES-IW-B21	6553	OR0021911	Amazon Diversion Canal (OR_WS_170900030108_02_104250)	1.5
Jasper Wood Products, LLC	NPDES-IW-B21	100097	OR0042994	Middle Fork Willamette River (OR_SR_1709000110_02_104584)	9
Jefferson STP	NPDES-DOM-Da	43129	OR0020451	Santiam River (OR_SR_1709000506_02_103927)	9.2
JLR, LLC	NPDES-IW-B05	32536	OR0001015	Pudding River (OR_SR_1709000902_02_104073)	27
Junction City STP	NPDES-DOM-Db	44509	OR0026565	Flat Creek (OR_WS_170900030603_02_104290)	9.2
Kingsford Manufacturing Company – Springfield Plant	NPDES-IW-B20	46000	OR0031330	Patterson Slough (OR_WS_170900030601_02_104287)	3.7
Knoll Terrace MHC	NPDES-DOM-Db	46990	OR0026956	Mountain View Creek (OR_WS_170900030609_02_104297)	0.4
Lakewood Utilities, Ltd	NPDES-DOM-Da	96110	OR0027570	Mill Creek (Molalla-Pudding Subbasin) (OR_WS_170900090502_02_104481_	3.9
Lane Community College	NPDES-DOM-Db	48854	OR0026875	Russel Creek (OR_WS_170900020405_02_104242)	0.7
Lebanon WWTP	NPDES-DOM-C1a	49764	OR0020818	South Santiam River (OR_SR_1709000608_02_103925)	17.4
Lowell STP	NPDES-DOM-Da	51447	OR0020044	Dexter Reservoir 20 ft upstream of the Dexter dam penstock (OR_LK_1709000107_02_100699)	~~0~~15.8

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Mcfarland Cascade Pole & Lumber Co	NPDES-IW-B21	54370	OR0031003	Storm Ditch to Amazon Creek (OR_WS_170900030108_02_104250)	1.8
Molalla STP	NPDES-DOM-Db	57613	OR0022381	Molalla River (OR_SR_1709000906_02_104093)	8.2
Monmouth STP	NPDES-DOM-Db	57871	OR0020613	Willamette River (OR_SR_1709000701_05_104005)	95.5
Monroe STP	NPDES-DOM-Db	57951	OR0029203	Long Tom River (OR_SR_1709000301_02_103791)	6.9
Mt. Angel STP	NPDES-DOM-Da	58707	OR0028762	Pudding River (OR_SR_1709000901_02_104064)	37.5
Murphy Veneer, Foster Division	NPDES-IW-B20	97070	OR0021741	Wiley Creek (OR_SR_1709000605_02_103971)	0.9
MWMC - Eugene/Springfield STP	NPDES-DOM-A2	55999	OR0031224	Willamette River (OR_SR_1709000306_05_103854)	178
Newberg - Wynooski Road STP	NPDES-DOM-C1a	102894	OR0032352	Willamette River (OR_SR_1709000703_88_104015)	49.7
Newberg OR, LLC	NPDES-IW-B01	72615	OR0000558	Willamette River (OR_SR_1709000703_88_104015)	49.7
Norpac Foods – Brooks Plant No. 5	NPDES-IW-B04	84791	OR0021261	Fitzpatrick Creek (OR_WS_170900090109_02_104462)	1
Norpac Foods- Plant #1, Stayton	NPDES-IW-B04	84820	OR0001228	Salem Ditch (flows to Mill Creek) (OR_WS_170900070201_02_104409)	3.7
NW Natural Gas Site Remediation	NPDES-IW-B14	120589	OR0044687	Willamette River (OR_SR_1709001202_88_104175)	6.4
Oak Lodge Water Services Water Reclamation Facility	NPDES-DOM-C1a	62795	OR0026140	Willamette River (OR_SR_1709001201_88_104019)	20.1
Oakridge STP	NPDES-DOM-Da	62886	OR0022314	Middle Fork Willamette River (OR_SR_1709000105_02_103720)	39.8
ODC – Oregon State Penitentiary	NPDES-IW-B15	109727	OR0043770	Mill Creek (Middle Willamette Subbasin) (OR_SR_1709000703_02_104007)	2.5

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
ODFW - Clackamas River Hatchery	NPDES-IW-B17	64442	OR0034266	Clackamas River (OR_SR_1709001106_02_104597)	22.6
~~ODFW - Dexter Ponds~~	~~GEN 300-J~~	~~64450~~	~~ORG133514~~	~~North Santiam River (OR_SR_1709000504_02_103906)~~	~~41.1~~
ODFW – Leaburg Hatchery	NPDES-IW-B17	64490	OR0027642	McKenzie River (OR_SR_1709000407_02_103884)	33.7
ODFW – Marion Forks Hatchery	NPDES-IW-B17	64495	OR0027847	Horn Creek (OR_WS_170900050203_02_104345)	0.1
ODFW – McKenzie River Hatchery	NPDES-IW-B17	64500	OR0029769	McKenzie River (OR_SR_1709000407_02_103884)	31.5
ODFW - Minto Fish Facility	NPDES-IW-B17	64495	OR0027847	~~Middle Fork Willamette~~North Santiam River (OR_SR_~~1709000107~~1709000504_02_~~104583~~103906)	41.1
~~ODFW - South Santiam Hatchery~~	~~GEN 300-J~~	~~64560~~	~~ORG133511~~	~~South Santiam River (OR_SR_1709000608_02_103925)~~	~~37.8~~
OHSU Center For Health and Healing	NPDES-IW-B16	113611	OR0034371	Willamette River (OR_SR_1709001202_88_104175)	14.5
OSU John L. Fryer Aquatic Animal Health Lab	NPDES-IW-B15	103919	OR0032573	Willamette River (OR_SR_1709000306_05_103854)	130.6
Philomath WWTP	NPDES-DOM-Db	103468	OR0032441	Marys River (OR_SR_1709000302_02_103813)	10.2
RSG Forest Products – Liberal	NPDES-IW-B19	72596	OR0021300	Unnamed ditch to Molalla River (OR_WS_170900090607_02_104488)	9.8
Salem Willow Lake STP	NPDES-DOM-A2	78140	OR0026409	Willamette River (OR_SR_1709000703_04_104013)	78.4
Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Tickle Creek (OR_WS_170900110604_02_104546)	3.1
Scappoose STP	NPDES-DOM-Da	78980	OR0022420	Multnomah Channel (OR_SR_1709001203_88_104184)	10.6
Scio STP	NPDES-DOM-Db	79633	OR0029301	Thomas Creek (OR_SR_1709000607_02_103988)	7.2
Seneca Sawmill Company	NPDES-IW-B19	80207	OR0022985	Ditch to A-1 Amazon Channel (OR_WS_170900030108_02_104250)	7.0

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
SFPP, L.P.	NPDES-IW-B15	103159	OR0044661	Unnamed tributary to Flat Creek (OR_WS_170900030603_02_104290)	7.9
Sherman Bros. Trucking	NPDES-DOM-Db	36646	OR0021954	Little Muddy Creek (OR_SR_1709000306_02_103838)	8
Siltronic Corporation	NPDES-IW-B14	93450	OR0030589	Willamette River (OR_SR_1709001202_88_104175)	6.6
Silverton STP	NPDES-DOM-C1a	81395	OR0020656	Silver Creek (OR_SR_1709000901_02_104595)	2.4
SLLI	NPDES-IW-B15	74995	OR0001741	Willamette River (OR_SR_1709001202_88_104175)	7
Stayton STP	NPDES-DOM-C2a	84781	OR0020427	North Santiam River (OR_SR_1709000506_02_103930)	14.9
Sunstone Circuits	NPDES-IW-B15	26788	OR0031127	Milk Creek (OR_SR_1709000906_02_104091)	5.3
Sweet Home STP	NPDES-DOM-C2a	86840	OR0020346	South Santiam River (OR_SR_1709000608_02_103925)	31.5
Tangent STP	NPDES-DOM-Db	87425	OR0031917	Calapooia River (OR_SR_1709000304_02_103821)	10.8
Timberlake STP	NPDES-DOM-Da	90948	OR0023167	Clackamas River (OR_SR_1709001104_02_104155)	51.1
Tryon Creek WWTP	NPDES-DOM-Ba	70735	OR0026891	Willamette River (OR_SR_1709001201_88_104019)	20.3
U.S. Army Corp of Engineers Big Cliff Project	NPDES-~~DOM-Da~~IW-B15	126715	Not Assigned	North Santiam River (OR_SR_1709000504_02_103906)	~~45.2~~ 46.6
U.S. Army Corp of Engineers Cougar Project	NPDES-~~DOM-Da~~IW-B15a	126712	Not Assigned	South Fork McKenzie River (OR_SR_1709000403_02_104590)	4.5
U.S. Army Corp of Engineers Detroit Project	NPDES-~~DOM-Da~~IW-B15	126716	Not Assigned	Big Cliff Reservoir (OR_LK_1709000503_02_100770)	0
U.S. Army Corp of Engineers Dexter Project	NPDES-~~DOM-Da~~IW-B15	126714	Not Assigned	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	~~15.7~~ 16.5

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
U.S. Army Corp of Engineers Foster Project	NPDES-~~DOM-Da~~IW-B15	126713	Not Assigned	South Santiam River (OR_SR_1709000608_02_103925)	~~35.7~~ 37.8
U.S. Army Corp of Engineers Green Peter Project	NPDES-~~DOM-Da~~IW-B15	126717	Not Assigned	Middle Santiam River (OR_SR_1709000604_02_103969)	5.3
U.S. Army Corp of Engineers Hills Creek Project	NPDES-~~DOM-Da~~IW-B15	126699	Not Assigned	Middle Fork Willamette River (OR_SR_1709000105_02_104580)	44.3
U.S. Army Corp of Engineers Lookout Point Project	NPDES-~~DOM-Da~~IW-B15	126700	Not Assigned	Dexter Reservoir (OR_LK_1709000107_02_100699)	0
Univar USA Inc	NPDES-IW-B15	100517	OR0034606	Willamette River (OR_SR_1709001202_88_104175)	9
USFW – Eagle Creek National Fish Hatchery	NPDES-IW-B17	91035	OR0000710	Eagle Creek (OR_SR_1709001105_02_104162)	12.3
Veneta STP	NPDES-DOM-Db	92762	OR0020532	Long Tom River (OR_SR_1709000301_02_103789)	34.9
Vigor Industrial	NPDES-IW-B15	70596	OR0022942	Willamette River (OR_SR_1709001202_88_104175)	8.2
WES - Boring STP	NPDES-DOM-Db	16592	OR0031399	North Fork Deep Creek (OR_WS_170900110605_02_104547)	3
WES - Blue Heron ~~Discharge~~	NPDES-IW-B01	72634	OR0000566	Willamette River (OR_SR_1709000704_88_104020)	27.8
WES - Kellogg Creek WWTP	NPDES-DOM-A3	16590	OR0026221	Willamette River (OR_SR_1709001201_88_104019)	18.5
WES - Tri-City WPCP	NPDES-DOM-A3	89700	OR0031259	Willamette River (OR_SR_1709000704_88_104020)	25.5
Westfir STP	NPDES-DOM-Da	94805	OR0028282	Nork Fork Middle Fork Willamette River (OR_SR_1709000106_02_103721)	1
Willamette Falls Paper Company	NPDES-IW-B01	21489	OR0000787	Willamette River (OR_SR_1709000704_88_104020)	27.5

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Willamette Leadership Academy	NPDES-DOM-Db	34040	OR0027235	Wild Hog Creek (OR_WS_170900020405_02_104242)	2
Wilsonville STP	NPDES-DOM-C1a	97952	OR0022764	Willamette River (OR_SR_1709000704_88_104020)	38.5
Woodburn WWTP	NPDES-DOM-C1a	98815	OR0020001	Pudding River (OR_SR_1709000902_02_104073)	21.4

Table 7-2: Individual NPDES permitted point sources that discharge stormwater and do not have potential to contribute to exceedances of the applicable temperature criteria.

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Arkema, Inc. outfalls 001-004, in permit 100752	NPDES-IW-B14	68471	OR0044695	Willamette River (OR_SR_1709001202_88_104175)	7.3-7.4
Jasper Wood Products, LLC outfall 002	NPDES-IW-B21	100097	OR0042994	Middle Fork Willamette River (OR_SR_1709000110_02_104584)	9
Portland International Airport	NPDES-IW-B15	107220	OR0040291	Columbia Slough (OR_WS_170900120201_02_104554.2)	Multiple

Table 7-3: 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
~~Portland International Airport~~	~~NPDES-IW-B15~~	~~107220~~	~~OR0040291~~

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 (GEN01)
- 200-J Industrial Wastewater: NPDES filter backwash (GEN02)
- 300-J Industrial Wastewater: NPDES fish hatcheries (GEN03)
- 400-J Industrial Wastewater: NPDES log ponds (GEN04)
- 500-J Industrial Wastewater: NPDES boiler blowdown (GEN05)
- 700-PM Industrial Wastewater: NPDES suction dredges (GEN07PM)
- 1200-A Stormwater: NPDES sand & gravel mining (GEN12A)
- 1200-C and 1200-CA - Stormwater: NPDES construction more than 1 acre disturbed ground (GEN12C and GEN12CA)
- 1200-Z Stormwater: NPDES specific SIC codes (GEN12Z)
- 1500-A Industrial Wastewater: NPDES petroleum hydrocarbon cleanup (GEN15Z)
- 1700-A Industrial Wastewater: NPDES wash water (GEN17A)
- 2000-J and 2300-A Pesticide application (GEN20 and GEN23)
- CAFO Confined Animal Feeding Operations
- MS4 – Phase II – Stormwater: NPDES Municipal Separate Storm Sewer System (GEN40)

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

- ~~100-J~~
- ~~200-J~~
- ~~300-J~~

- 100-J Industrial Wastewater: NPDES cooling water
- 200-J Industrial Wastewater: NPDES filter backwash
- 300-J Industrial Wastewater: NPDES fish hatcheries

There are ~~twelve~~twenty registrants of the 100-J, ~~ten~~eleven registrants of the 200-J, and four registrants of the 300-J general permits (~~Table 7-3~~**Table 7-4**) found to be potential significant sources of thermal load with a temperature impact. Wasteload allocations for these registrants are provided in Section 9.1. Not all registrants to the 200-J were found to be a significant source. DEQ's analysis is documented in TSD Section 7.1.2.2.

DEQ has received multiple 200-J general permit applications from facilities seeking coverage under that permit. Action on these applications are awaiting 200-J permit renewal. Should it be determined by DEQ that discharges from these facilities have reasonable potential to increase temperatures above the applicable criteria, reserve capacity may be assigned as appropriate.

Other registrants to the industrial wastewater, stormwater, and other general permits ~~were found to have a de minimis~~will not contribute to exceedances of applicable temperature ~~increase~~criteria and impact beneficial uses based on the permit requirements, available dilution, or frequency and magnitude of discharge~~.~~

DEQ completed a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon (see TSD Section 7.1.2) and concluded that stormwater discharges authorized under the current municipal (MS4), construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits are unlikely to contribute to exceedances of the temperature standard.). Therefore, no additional TMDL requirements are needed for stormwater sources to control temperature, other than those included in the current permit.NPDES permits. More specific wasteload allocations can be considered if subsequent data and evaluation demonstrates a need and if reserve capacity is available.

Table 7-4: General NPDES permit registrants that have the potential to contribute thermal loads to Willamette Subbasins streams at a frequency and magnitude to cause exceedances to the temperature standard.

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Americold Logistics, LLC	100-J	87663	ORG253544	Claggett Creek (OR_WS_170900070303_02_104415)	4.9
EWEB Leaburg	100-J	28391	ORG253525	Leaburg Canal (OR_SR_1709000407_02_103884)	34
EWEB Walterville	100-J	28395	ORG253526	Walterville Canal (OR_SR_1709000407_02_103884)	21
First Premier Properties - Spinnaker II Office Building	100-J	110603	ORG253511	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.8
Forrest Paint Co.	100-J	100684	ORG253508	Amazon Creek (OR_WS_170900030106_02_104248)	17.0
Holiday Plaza	100-J	108298	ORG253504	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.2
Malarkey Roofing	100-J	52638	ORG250024	Columbia Slough (OR_WS_170900120201_02_104554.1)	5.9
Miller Paint Company	100-J	103774	ORG250040	Columbia Slough OR_WS_170900120201_02_104554.2)	Un-known
Owens-Brockway Glass Container Plant	100-J	65610	ORG250029	Johnson Lake (OR_WS_170900120201_02_104554.2)	0
PCC Structurals, Inc.	100-J	71920	ORG250015	Mount Scott Creek (OR_WS_170900120102_02_104551)	2.3
Sundance Lumber Company, Inc.	100-J	107401	ORG253618	Ditch to Q Street Canal (OR_WS_170900030601_02_104287	14.0
Ventura Foods, LLC	100-J	103832	ORG250005	Unnamed tributary to Columbia Slough (OR_WS_170900120201_02_104554.2)	Un-known

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Hexion Inc.	100-J	10125	ORG253527	Willamette River (OR_SR_1709000306_05_103854)	184.9
Solenis LLC	100-J	38192	ORG250030	Willamette River (OR_SR_1709001202_88_104175)	12
Hewlett-Packard - Corvallis	100-J	38385	ORG253533	Willamette River (OR_SR_1709000306_05_103854)	131
Northwest Natural Gas Company (LNG Plant)	100-J	62231	ORG250033	Willamette River (OR_SR_1709001202_88_104175)	6.4
Linnton Asphalt Facility	100-J	65589	ORG250004	Willamette River OR_SR_1709001202_88_104175)	4
Isovolta Inc.	100-J	82095	ORG253619	Willamette River (OR_SR_1709000306_05_103854)	161.1
Pacific Cast Technologies, Inc.	100-J	102789	ORG253513	Willamette River (OR_SR_1709000306_05_103854)	119
Albers Mill Building Partnership (ABN)	100-J	104545	ORG250014	Willamette River (OR_SR_1709001202_88_104175)	12
Franklin International, Inc.	100-J	106458	ORG250008	Willamette River (OR_SR_1709001202_88_104175)	5
Albany Water Treatment Plant	200-J	66584	ORG383501	Calapooia River (OR_SR_1709000304_02_103821)	0.1
City of Silverton Drinking WTP	200-J	81398	ORG383527	Unnamed tributary to Abiqua Creek (OR_WS_170900090107_02_104460	Un-known
Corvallis Rock Creek Water Treatment Plant	200-J	20160	ORG383513	Rock Creek (OR_WS_170900030204_02_104256)	13.5
Dallas Water Treatment Plant	200-J	22550	ORG383529	Rickreall Creek (OR_SR_1709000701_02_104591)	17.0
Deer Creek Estates Water Association	200-J	23650	ORG383526	Mill Creek OR_WS_170900090502_02_104481)	7.1
EWEB – Hayden Bridge Filter Plant	200-J	28385	ORG383503	McKenzie River (OR_SR_1709000407_02_103884)	11
International Paper – Springfield	200-J	108921	ORG383548	Irving Slough (OR_WS_170900030601_02_104287)	Un-known

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Molalla Municipal Water Treatment Plant	200-J	109846	ORG380014	Ditch to Molalla River (OR_WS_170900090607_02_104488)	Un-known
North Clackamas County Water Commission	200-J	110117	ORG380011	Clackamas River (OR_SR_1709001106_02_104597)	2.75
Philomath Water Treatment Plant	200-J	100048	ORG383536	Marys River (OR_SR_1709000302_02_103813)	12.2
Row River Valley Water District	200-J	100075	ORG383534	Layng Creek (OR_SR_1709000202_02_103765)	1.4
ODFW - Dexter Ponds	300-J	64450	ORG133514	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	15.7
ODFW - Roaring River Hatchery	300-J	64525	ORG133506	Roaring River (OR_SR_1709000606_02_103974)	1.1
ODFW - South Santiam Hatchery	300-J	64560	ORG133511	South Santiam River (OR_SR_1709000608_02_103925)	37.8
ODFW - Willamette Fish Hatchery	300-J	64585	ORG133507	Salmon Creek (OR_SR_1709000104_02_103719)	0.4

7.2 Thermal nonpoint sources

OAR 340-041-0002(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.” Nonpoint sources of heat in the Willamette Subbasins streams include activities associated with agriculture, forestry, dam and reservoir management, and development.

Nonpoint sources or activities that contribute thermal load and may increase stream temperature include:

- Human caused increases in solar radiation loading to the stream network from the disturbance or removal of near-stream vegetation;
- 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 temperature water quality criteria. The following actions are needed to attain the TMDL allocations:

- Restoration of streamside vegetation to reduce thermal loading from exposure to solar radiation;

- Restoration of complex channel morphology and hyporheic or groundwater connection;
- Management and operation of dams and reservoirs to minimize temperature warming; and
- Maintenance of minimum instream flows.

In many of the modeled streams, thermal loading from nonpoint sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant sources of thermal loading. The maximum daily maximum or 7DADM water temperature increase from nonpoint sources ranged from 0.43°C in the Upper McKenzie River to 8.65°C in the Pudding River. See the TSD for details. Reductions from nonpoint sources will be required to attain the applicable temperature criteria.

7.3 Thermal 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 the authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state.

The amount of 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 related to the surrogate measures. 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, channel modification) accounted for, thus isolating the remaining background sources.

In many of the modeled streams, thermal loading from background sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant source of thermal loading. The maximum daily maximum or 7DADM temperature standard exceedances of background sources ranged from 1.~~83°C in Johnson Creek to 9.16~~81°C in the ~~Molalla~~South Fork McKenzie River~~.~~ to 9.32°C in the South Santiam River. Background sources from ~~seven~~all but one of the ~~nine~~24 modeled streams exceeded the applicable temperature criteria. 15 of the 24 modeled streams exceeded the applicable temperature criteria by more than 7°C. See the TSD for detailed descriptions of analysis and results. Reductions from background sources will be required to attain the applicable temperature criteria.

8 Loading capacity and excess loads

Summarizing OAR 340-042-0040(4)(d) and 40 CFR 130.2(f), loading capacity is the amount of a pollutant or pollutants that a waterbody can receive and still meet water quality standards.

For temperature, thermal loading capacity is calculated on AUs using **Equation 8-1**.

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

where,

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

$T_C =$ The applicable river temperature criterion (ºC).

$\text{HUA} =$ 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 in cubic feet per second (cfs). For a lake, a dilution factor of 1 may be used for Q_R unless determined using another method.

$C_F =$ Conversion factor using flow in cfs: 2,446,665

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

Equation 8-1 shall be used to calculate the thermal loading capacity for any surface water location in the Willamette Subbasins. **Table 8-1** presents the loading capacity for select temperature impaired Category 5 AUs modeled for the TMDL analysis at the critical 7Q10 low flow. **Equation 8-1** may be used to calculate the loading capacity when river flows are greater than 7Q10. **Equation 8-1** may also be used to calculate the loading capacity if in the future the applicable temperature criteria are updated and approved by EPA.

Table 8-1: Thermal loading capacity (LC) for select AUs 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 (kcal/day)	7Q10 LC Spawning (kcal/day)
Clackamas River OR_SR_1709001106_02_104597	671	16.3	13.3	26,759.91E+6	21,834.77E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18.3	13.3	1,701.41E+6	1,236.54E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18.3	13.3	5,910.16E+6	4,295.37E+6
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.3	NA	264.17E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25	16.3	13.3	997.02E+6	813.52E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18.3	13.3	492.51E+6	357.95E+6

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion + HUA (°C)	Spawning Criterion + HUA (°C)	7Q10 LC Year Round (kcal/day)	7Q10 LC Spawning (kcal/day)
Little North Santiam River OR_SR_1709000505_02_104564	21	16.3	13.3	837.49E+6	683.35E+6
Long Tom River OR_SR_1709000301_02_103791	22	24.3	18.3	1,307.99E+6	985.03E+6
Luckiamute River OR_SR_1709000305_02_103829	16	18.3	13.3	716.38E+6	520.65E+6
McKenzie River OR_SR_1709000407_02_103884	1537	16.3	13.3	61,296.54E+6	50,014.97E+6
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16.3	13.3	39,960.4E+6	32,605.73E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16.3	13.3	50,967.46E+6	41,586.94E+6
Mohawk River OR_SR_1709000406_02_103871	16	16.3	13.3	638.09E+6	520.65E+6
Molalla River OR_SR_1709000904_02_104086	38	16.3	13.3	1,515.46E+6	1,236.54E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16.3	13.3	438.69E+6	357.95E+6
North Santiam River OR_SR_1709000504_02_103906	859	16.3	13.3	34,257.47E+6	27,952.41E+6
North Santiam River OR_SR_1709000506_02_103930	914	16.3	13.3	36,450.9E+6	29,742.15E+6
Pudding River OR_SR_1709000905_02_104088	10	18.3	NA	447.74E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18.3	13.3	51,221.42E+6	37,226.5E+6
South Santiam River OR_SR_1709000608_02_103925	615	16.3	13.3	24,526.59E+6	20,012.5E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.3	NA	308.94E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18.3	13.3	173,588.68E+6	126,160.08E+6
Willamette River OR_SR_1709000701_05_104005	5684	18.3	13.3	254,495.24E+6	184,961.02E+6
Willamette River OR_SR_1709000703_88_104015	5734	20.3	NA	284,792.3E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20.3	NA	297,407.79E+6	NA
Willamette River OR_SR_1709001201_88_104019	6740	20.3	NA	334,757.6E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20.3	NA	334,757.6E+6	NA

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

Because flow monitoring data were not available at most temperature monitoring locations, it was not possible to calculate the excess load. Instead, the excess temperatures and percent load reduction were calculated for each AU where temperature data were available (**Table 8-2**). 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 from the TSD can be used to determine excess temperature and percent reduction for additional streams if data becomes available in the future.

$$PR = \frac{(T_R - T_C - HUA)}{T_R} \cdot 100$$ Equation 8-2

where,

$PR =$ Percent load reduction (%). If PR < 0, PR = 0

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

$T_C =$ The applicable river temperature criterion (ºC).

$HUA =$ The 0.3°C human use allowance assigned to point sources, nonpoint sources, margin of safety, or reserve capacity.

The excess temperatures are the maximum difference between the monitored 7DADM river temperatures and applicable numeric criteria plus the HUA. The percent load reduction represents the portion of the actual thermal loading that must be reduced to attain the TMDL loading capacity. The percent load reduction can be calculated from the excess temperature.

Table 8-2: Excess temperature and percent load reduction for ~~various~~ AUs with available temperature data in the Middle Fork Willamette ~~Subbasins.~~Subbasin (17090001).

AU Name	AU 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~~

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~Clackamas River~~Fall Creek	OR_SR_~~1709001104~~1709000109_02_~~104154~~103735	~~16.6~~21.9	13.3	~~3.3~~8.6	~~19.8~~39.3
~~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~~
~~Clackamas River~~	~~OR_SR_1709001106_02_104597~~	~~17.7~~	~~13.3~~	~~4.4~~	~~24.9~~
~~Clackamas River~~Fall Creek	OR_SR_~~1709001106~~1709000109_02_~~104597~~103735	20.~~5~~8	16.3	4.~~2~~5	~~20.5~~21.6
~~Clackamas River~~	~~OR_SR_1709001106_02_104597~~	~~24.5~~	~~18.3~~	~~6.2~~	~~25.3~~
~~Coast Fork Willamette River~~	~~OR_SR_1709000203_02_104585~~	~~12.5~~	~~13.3~~	~~0~~	~~0.0~~
~~Coast Fork Willamette River~~	~~OR_SR_1709000203_02_104585~~	~~24.2~~	~~18.3~~	~~5.9~~	~~24.4~~
~~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
~~Fall Creek~~	~~OR_SR_1709000109_02_103735~~	~~21.9~~	~~13.3~~	~~8.6~~	~~39.3~~
~~Fall Creek~~	~~OR_SR_1709000109_02_103735~~	~~20.8~~	~~16.3~~	~~4.5~~	~~21.6~~
~~Fish Creek~~	~~OR_SR_1709001104_02_104161~~	~~19.1~~	~~13.3~~	~~5.8~~	~~30.4~~
~~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

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
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 Riv*	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-Middle Fork Willamette Riv*	OR_WS_170900010106_02_104190	15.6	12.3	3.3	21.1

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Eighth Creek-North Fork Middle Fork W*	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: 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~~
~~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~~

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~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~~
~~HUC12 Name: Quartz Creek~~	~~OR_WS_170900040501_02_104325~~	~~16.3~~	~~16.3~~	~~0.0~~	~~0.2~~

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~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

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Little Fall Creek	OR_SR_1709000108_02_103730	18.1	16.3	1.8	10.1
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
Long Tom River	OR_SR_1709000301_02_103791	24.7	24.3	0.4	1.6
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_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
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
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_1709000105_02_104580	17.7	13.3	4.4	24.9
Middle Fork Willamette River	OR_SR_1709000105_02_104580	18.1	16.3	1.8	9.9
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 Fork Willamette River	OR_SR_1709000107_02_104583	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000107_02_104583	21.3	16.3	5	23.5
Middle Fork Willamette River	OR_SR_1709000110_02_104584	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000110_02_104584	22.3	16.3	6	26.9
Middle Santiam River	OR_SR_1709000601_02_103936	19.7	18.3	1.4	7.3

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~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~~
~~North Santiam River~~	~~OR_SR_1709000503_02_103906~~	~~16.7~~	~~16.3~~	~~0.4~~	~~2.4~~
~~North Santiam River~~	~~OR_SR_1709000504_02_103906~~	~~16.7~~	~~13.3~~	~~3.4~~	~~20.4~~
~~North Santiam River~~	~~OR_SR_1709000504_02_103906~~	~~16.7~~	~~16.3~~	~~0.4~~	~~2.4~~
~~North Santiam River~~	~~OR_SR_1709000506_02_103930~~	~~19.2~~	~~13.3~~	~~5.9~~	~~30.7~~
~~North Santiam River~~	~~OR_SR_1709000506_02_103930~~	~~21.1~~	~~16.3~~	~~4.8~~	~~22.7~~
~~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~~

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~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~~
~~Row River~~	~~OR_SR_1709000202_02_103779~~	~~13.6~~	~~13.3~~	~~0.3~~	~~2.2~~
~~Row River~~	~~OR_SR_1709000202_02_103779~~	~~23~~	~~18.3~~	~~4.7~~	~~20.4~~
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
~~Santiam River~~Winberry Creek	OR_SR_~~1709000506~~1709000109_02_~~103927~~103747	~~16.3~~20.2	13.3	~~3~~6.9	~~18.4~~34.2
~~Santiam River~~	~~OR_SR_1709000506_02_103927~~	~~23.4~~	~~18.3~~	~~5.1~~	~~21.8~~
~~Separation~~Winberry Creek	OR_SR_~~1709000401~~1709000109_02_~~103857~~103747	~~10.0~~22.5	~~12~~16.3	~~0.0~~6.2	~~0.0~~27.6

Table 8-3: Excess temperature and percent load reduction for AUs with available temperature data in the Coast Fork Willamette Subbasin (17090002).

AU Name	AU 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
Brice Creek	OR_SR_1709000202_02_103771	23.1	18.3	4.8	20.6
Coast Fork Willamette River	OR_SR_1709000203_02_104585	12.5	13.3	0	0.0
Coast Fork Willamette River	OR_SR_1709000203_02_104585	24.2	18.3	5.9	24.4
Grass Creek	OR_SR_1709000202_02_103780	15.6	16.3	0.0	0.0
HUC12 Name: Hill Creek-Coast Fork Willamette River	OR_WS_170900020401_02_104238	25.9	18.3	7.6	29.3
HUC12 Name: Layng Creek	OR_WS_170900020201_02_104227	17.6	18.3	0.0	0.0
HUC12 Name: Sharps Creek	OR_WS_170900020203_02_104229	16.3	16.3	0.0	0.0
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
Martin Creek	OR_SR_1709000202_02_103756	19.9	18.3	1.6	8.0
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
Row River	OR_SR_1709000202_02_103779	13.6	13.3	0.3	2.2
Row River	OR_SR_1709000202_02_103779	23	18.3	4.7	20.4
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

Table 8-4: Excess temperature and percent load reduction for AUs with available temperature data in the Upper Willamette Subbasin (17090003).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Calapooia River	OR_SR_1709000303_02_103815	16.0	16.3	0.0	0.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Flat Creek	OR_WS_170900030603_02_104290	25.7	18.3	7.4	28.8
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
~~Sheep~~HUC12 Name: Maxfield Creek-Luckiamute River	OR_~~SR_1709000602~~WS_170900030503_02_~~103953~~104277	~~20.9~~21.1	~~16~~18.3	~~4.6~~2.8	~~21.9~~13.3
HUC12 Name: Middle Little Luckiamute River	OR_WS_170900030507_02_104281	17.5	18.3	0.0	0.0
HUC12 Name: Pedee Creek-Luckiamute River~~Shelton Ditch~~	OR_~~SR_1709000703~~WS_170900030504_02_~~104008~~104278	~~18~~19.5	~~13~~18.3	~~5~~1.2	~~28.2~~6.3
Long Tom River	OR_SR_1709000301_02_103791	24.7	24.3	0.4	1.6
~~Shelton Ditch~~North Fork Pedee Creek	OR_SR_~~1709000703~~1709000305_02_~~104008~~103828	~~23.8~~20.2	18.3	~~5.5~~1.9	~~23.1~~9.5
~~Soda Fork~~Ritner Creek	OR_SR_~~1709000602~~1709000305_02_~~103947~~103833	~~16.1~~21.8	~~16~~18.3	~~0.0~~3.5	~~0~~16.0
Teal Creek	OR_SR_1709000305_02_103824	20.3	18.3	2.0	9.9
Willamette River	OR_SR_1709000306_05_103854	17.5	13.3	4.2	24.0
Willamette River	OR_SR_1709000306_05_103854	23.8	18.3	5.5	23.1

Table 8-5: Excess temperature and percent load reduction for AUs with available temperature data in the McKenzie Subbasin (17090004).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
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
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
French Pete Creek	OR_SR_1709000403_02_103862	15.7	16.3	0.0	0.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Horse Creek	OR_SR_1709000401_02_103856	13.8	12.3	1.5	10.9
HUC12 Name: Boulder Creek-McKenzie River	OR_WS_170900040206_02_104310	14.4	12.3	2.1	14.8
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: Deer Creek	OR_WS_170900040205_02_104309	20.0	12.3	7.7	38.4
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: Hackleman Creek-McKenzie River	OR_WS_170900040202_02_104306	12.3	12.3	0.0	0.0
HUC12 Name: Kink Creek-McKenzie River	OR_WS_170900040204_02_104308	12.7	12.3	0.4	3.1
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	11.7	13.3	0.0	0.0
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	16.3	16.3	0.0	0.2
HUC12 Name: Smith River	OR_WS_170900040203_02_104307	23.4	12.3	11.1	47.4
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
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
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

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
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
Rebel Creek	OR_SR_1709000403_02_103861	13.3	16.3	0.0	0.0
Roaring River	OR_SR_1709000403_02_103864	7.2	12.3	0.0	0.0
Separation Creek	OR_SR_1709000401_02_103857	10.0	12.3	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_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 Fork McKenzie River	OR_SR_1709000403_02_104590	16.2	13.3	2.9	17.9
South Fork McKenzie River	OR_SR_1709000403_02_104590	17.8	16.3	1.5	8.4
Upper Blue River	OR_SR_1709000404_02_104574	20.6	16.3	4.3	20.9

Table 8-6: Excess temperature and percent load reduction for AUs with available temperature data in the North Santiam Subbasin (17090005).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
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
HUC12 Name: Minto Creek-North Santiam River	OR_WS_170900050205_02_104347	11.4	18.3	0.0	0.0
HUC12 Name: Morgan Creek-	OR_WS_170900050604_02_104362	23.0	16.3	6.7	29.1

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
North Santiam River					
HUC12 Name: Sauers Creek-North Santiam River	OR_WS_170900050208_02_104350	15.8	18.3	0.0	0.0
HUC12 Name: Straight Creek-North Santiam River	OR_WS_170900050202_02_104344	14.2	18.3	0.0	0.0
HUC12 Name: Whitewater Creek	OR_WS_170900050206_02_104348	14.1	18.3	0.0	0.0
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
Marion Creek	OR_SR_1709000502_02_103897	17.4	18.3	0.0	0.0
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
North Santiam River	OR_SR_1709000503_02_103906	16.7	16.3	0.4	2.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	13.3	3.4	20.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	16.3	0.4	2.4
North Santiam River	OR_SR_1709000506_02_103930	19.2	13.3	5.9	30.7
North Santiam River	OR_SR_1709000506_02_103930	21.1	16.3	4.8	22.7
Santiam River	OR_SR_1709000506_02_103927	16.3	13.3	3	18.4
Santiam River	OR_SR_1709000506_02_103927	23.4	18.3	5.1	21.8
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
Whitewater Creek	OR_SR_1709000502_02_103898	12.4	18.3	0.0	0.0

Table 8-7: Excess temperature and percent load reduction for AUs with available temperature data in the South Santiam Subbasin (17090006).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Canyon Creek	OR_SR_1709000602_02_103949	20.7	16.3	4.4	21.4
Hamilton Creek	OR_SR_1709000608_02_103996	27.3	16.3	11.0	40.3
HUC12 Name: Lower Quartzville Creek	OR_WS_170900060305_02_104379	23.7	18.3	5.4	22.8
HUC12 Name: Owl Creek	OR_WS_170900060205_02_104371	15.5	16.3	0.0	0.0
HUC12 Name: Upper Canyon Creek	OR_WS_170900060204_02_104370	17.6	16.3	1.3	7.6
McDowell Creek	OR_SR_1709000608_02_103994	21.7	18.3	3.4	15.6
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
Moose Creek	OR_SR_1709000602_02_103954	19.3	16.3	3.0	15.4
Owl Creek	OR_SR_1709000602_02_103941	19.2	16.3	2.9	15.2
Pyramid Creek	OR_SR_1709000601_02_103935	20.3	18.3	2.0	9.8
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
Sheep Creek	OR_SR_1709000602_02_103953	20.9	16.3	4.6	21.9
Soda Fork	OR_SR_1709000602_02_103947	16.1	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
South Santiam River	OR_SR_1709000608_02_103925	15	13.3	1.7	11.3

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
South Santiam River	OR_SR_1709000608_02_103925	14.1	16.3	0	0.0
~~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

Table 8-8: Excess temperature and percent load reduction for AUs with available temperature data in the Middle Willamette Subbasin (17090007).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
~~Trout~~HUC12 Name: Croisan Creek-Willamette River	OR_~~SR_1709001104~~WS_170900070301_02_~~104157~~104413	~~16.3~~19.6	~~16~~13.3	~~0.0~~6.3	~~0~~32.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	24.8	18.3	6.5	26.2
HUC12 Name: Glenn Creek-Willamette River	OR_WS_170900070303_02_104415	27.2	18.3	8.9	32.7
HUC12 Name: Lower Mill Creek	OR_WS_170900070204_02_104412	25.9	18.3	7.6	29.3
HUC12 Name: McKinney Creek	OR_WS_170900070203_02_104411	26.9	18.3	8.6	32.0
~~Upper Blue River~~Mill Creek	OR_SR_~~1709000404~~1709000702_02_~~104574~~104007	~~20~~18.6	~~16~~13.3	~~4~~5.3	~~20.9~~28.6
~~Whitewater~~Mill Creek	OR_SR_~~1709000502~~1709000702_02_~~103898~~104007	~~12.4~~25.3	18.3	~~0~~7.0	~~0.0~~27.8
Pringle Creek	OR_SR_1709000703_02_104012	25.1	18.3	6.8	27.1
Shelton Ditch~~Willamette River~~	OR_SR_~~1709000306_05_103854~~1709000703_02_104008	~~17~~18.5	13.3	~~4~~5.2	~~24.0~~28.2
~~Willamette River~~Shelton Ditch	OR_SR_~~1709000306_05_103854~~1709000703_02_104008	23.8	18.3	5.5	23.1
Willamette River	OR_SR_1709000703_04_104013	17.6	13.3	4.3	24.4
Willamette River	OR_SR_1709000703_04_104013	25.7	18.3	7.4	28.8
Willamette River	OR_SR_1709000703_88_104015	26.1	20.3	5.8	22.2

Table 8-9: Excess temperature and percent load reduction for AUs with available temperature data in the Molalla-Pudding Subbasin (17090009).

~~Willamette River~~AU Name	AU ID~~OR_SR_1709001202_88_104175~~	~~26.6~~Maximum 7DADM River Temperature (°C)	~~20.3~~Applicable Criterion + HUA (°C)	~~6.3~~Excess Temperature (°C)	~~23.7~~Percent Load Reduction
~~Winberry~~HUC12 Name: Canyon Creek	OR_~~SR_1709000109~~WS_170900090601_02_~~103747~~104482	~~20~~8.2	~~13~~18.3	~~6.9~~0.0	~~34.2~~0.0
~~Winberry Creek~~	~~OR_SR_1709000109_02_103747~~	~~22.5~~	~~16.3~~	~~6.2~~	~~27.6~~

Table 8-10: Excess temperature and percent load reduction for AUs with available temperature data in the Clackamas Subbasin (17090011).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Big Creek	OR_SR_1709001104_02_104153	13.7	16.3	0.0	0.0
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
Clackamas River	OR_SR_1709001106_02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709001106_02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709001106_02_104597	24.5	18.3	6.2	25.3
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
Fish Creek	OR_SR_1709001104_02_104161	19.1	13.3	5.8	30.4
Fish Creek	OR_SR_1709001104_02_104161	21.2	16.3	4.9	23.0
HUC12 Name: Fish Creek	OR_WS_170900110403_02_104536	16.0	16.3	0.0	0.0
HUC12 Name: Helion Creek-Clackamas River	OR_WS_170900110406_02_104539	16.5	16.3	0.2	1.2

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Last Creek-Pinhead Creek	OR_WS_170900110204_02_104526	10.4	16.3	0.0	0.0
HUC12 Name: Lowe Creek-Clackamas River	OR_WS_170900110203_02_104525	15.6	16.3	0.0	0.0
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: Pot Creek-Clackamas River	OR_WS_170900110205_02_104527	10.1	16.3	0.0	0.0
HUC12 Name: Roaring River	OR_WS_170900110402_02_104535	24.0	16.3	7.7	32.1
HUC12 Name: South Fork Clackamas River	OR_WS_170900110404_02_104537	12.8	16.3	0.0	0.0
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
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
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
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
Trout Creek	OR_SR_1709001104_02_104157	16.3	16.3	0.0	0.0

Table 8-11: Excess temperature and percent load reduction for AUs with available temperature data in the Lower Willamette Subbasin (17090012).

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Balch Creek-Willamette River	OR_WS_170900120202_02_104555	21.8	18.3	3.5	15.9
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: 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: Multnomah Channel	OR_WS_170900120305_02_104561	18.5	18.3	0.2	1.2
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: 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
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
Willamette River	OR_SR_1709001202_88_104175	26.6	20.3	6.3	23.7

9 Allocations, reserve capacity, and margin of safety

OAR 340-042-0040(4)(g),(h),(i) and (k) [and 40 CFR 130.2(h) and (g) and 130.7(c)(2)] respectively define the required TMDL elements of apportionment of the allowable pollutant load: point source wasteload allocations; nonpoint source load allocations (including background); margin of safety; and reserve capacity. Collectively, these elements add up to the maximum load of a pollutant that still allows a waterbody to meet water quality standards. OAR 304-042-0040(5) and (6) describe the potential factors of consideration for determining and distributing these allocations of the allowable pollutant loading capacities. Water quality data analysis must be conducted to determine allocations, potentially including statistical analysis and mathematical modeling. Factors to consider in allocation distribution may include: source contributions; costs of implementing management measures; ease of implementation; timelines for attaining water quality standards; environmental impacts of allocations; unintended consequences; reasonable assurance of implementation; and any other relevant factor.

9.1 Thermal allocations

9.1.1 Human use allowance assignments

The HUA at OAR 340-041-0028(12)(b)(B) identifies the allowed temperature increase 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 0.3°C (0.5°F) above the applicable criteria after complete mixing in the waterbody, and at the POMI.

Table 9-1 through **Table 9-11** present the portions of the HUA assigned to anthropogenic source categories across different AUs and stream extents in the Willamette Subbasins. Temperature impacts associated with climate change sources are assigned a zero HUA. See TSD Section 9 for approach to HUA assignments.

The dam and reservoir operations source category accounts for nonpoint source temperature impacts associated with the dam impoundment and release of the impounded water back into the natural channel. Dam and reservoir discharges associated with an NPDES permit are included in the NPDES assigned HUA.

The water management activities and water withdrawals source category accounts for nonpoint source temperature impacts associated with the withdrawal of water that is intended for consumptive uses (such as irrigation) and the warming that might occur as that water moves through a canal or ditch before being returned to the natural river.

The assigned HUA for NPDES point sources is the maximum ~~for~~cumulative warming allowed anywhere in the AU from all NPDES ~~induvial~~individual permittees and registrants to general NPDES permits. The HUA assigned to any single NPDES point source is summarized in **Table 9-12**. Similarly, the assigned portion of the HUA for nonpoint sources represents the maximum cumulative warming allowed anywhere in the AU and stream extents at the POMI from all ~~point and~~ nonpoint source activities within each source category. Therefore, DEQ expects the amount of warming for each unique point or nonpoint source activity to be less than the values shown in **Table 9-1** through **Table 9-11**. DEQ will implement the TMDL in a manner consistent with the HUA rule by requiring all nonpoint sources to implement management strategies and reduce their warming impact such that the assigned HUA is attained. Point sources will be required to implement their wasteload allocations through their NPDES permits such that the assigned HUA is attained.

The HUA assignments in **Table 9-1** through **Table 9-11** for nonpoint source categories are achieved through the implementation of the load allocations described in Section 9.1.4 and the surrogate measures described in Section 9.1.5. Designated Management Agencies (DMAs) are responsible for implementing management activities that achieve the surrogate measure targets appropriate to their source category and location. A DMA has achieved their load allocation when surrogate measure targets are met. When all DMAs within a nonpoint source category have met their surrogate measure targets and achieved their load allocations, the HUA assigned to that nonpoint source category is achieved.

This TMDL HUA assignments and associated allocations implement EPA's Columbia and Lower Snake Rivers temperature TMDL (EPA, 2021) allocation to anthropogenic sources in Columbia River tributaries, including the Willamette River. See TSD Appendix M for additional details.

Table 9-1: HUA assignments for source or source categories on assessment units in the Middle Fork Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Dexter Reservoir	OR_LK_1709000107_02_100699	0.073	0.00	0.05	0.02	0.00	0.157	0.30
Fall Creek	OR_SR_1709000109_02_103735	0.~~02~~01	0.00	0.~~04~~02	0.~~05~~03	0.00	0.~~19~~24	0.30
Middle Fork Willamette River	OR_SR_1709000105_02_104580	0.06	0.00	0.05	0.02	0.00	0.17	0.30
Middle Fork Willamette River	OR_SR_1709000107_02_104583, OR_SR_1709000110_02_103750, OR_SR_1709000110_02_104584	0.04	0.00	0.~~04~~02	0.~~04~~03	0.00	0.~~18~~21	0.30
Unnamed Lake Units	OR_LK_1709000110_02_100703, OR_LK_1709000110_02_100704	0.04	0.00	0.~~04~~02	0.~~04~~03	0.00	0.~~18~~21	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-2: HUA assignments for source or source categories on assessment units in the Coast Fork Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Camas Swale Creek	OR_SR_1709000204_02_103786	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Coast Fork Willamette River	OR_SR_1709000203_02_104585	0.21	0.00	0.02	0.~~05~~03	0.00	0.~~02~~04	0.30
Coast Fork Willamette River	OR_SR_1709000204_02_103787	0.~~08~~07	0.00	0.~~04~~02	0.~~04~~03	0.00	0.~~14~~18	0.30
Lower Camas Swale Creek	OR_WS_170900020403_02_104240	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Row ~~River~~River[a]	OR_SR_1709000202_02_103779	0.~~02~~01	0.00	0.~~04~~02	0.~~05~~03	0.00	0.~~19~~20	0.~~30~~26[a]
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

a. 0.04 of HUA is attributed to a portion of warming in the Row River from tributary sources. See TSD Appendix M for details.

Table 9-3: HUA assignments for source or source categories on assessment units in the Upper Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Amazon Creek	OR_WS_170900030106_02_104248, OR_WS_170900030108_02_104250, OR_WS_170900030109_02_104251	0.15	0.00	0.05	0.02	0.00	0.08	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Calapooia River	OR_SR_1709000303_02_103816, OR_SR_1709000304_02_103821	0.21	0.00	0.05	0.02	0.00	0.02	0.30
Colorado Lake	OR_LK_1709000306_02_100720	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Fern Ridge Lake	OR_LK_1709000301_02_100708	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Greasy Creek	OR_SR_1709000302_02_103810	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Greasy Creek and Rock Creek tributaries	OR_WS_170900030204_02_104256	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Long Tom River	OR_SR_1709000301_02_103791	0.~~07~~06	0.00	0.~~04~~02	0.~~05~~03	0.00	0.~~14~~19	0.30
Long Tom River and tributaries in 170900030107	OR_SR_1709000301_02_103789 OR_WS_170900030107_02_104249	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Mary's River	OR_SR_1709000302_02_103813	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Muddy Creek	OR_SR_1709000306_02_103838	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Muddy Creek tributaries	OR_WS_170900030606_02_104294	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Murder Creek and other streams	OR_WS_170900030610_02_104298	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Oak Creek	OR_WS_170900030402_02_104273	0.21	0.00	0.05	0.02	0.00	0.02	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Spring Creek – Willamette River	OR_WS_170900030601_02_104287	0.30[a] 0.225[b]	0.00	0.05	0.02	0.00	0.00[a] 0.075[b]	0.30
All other AUs*	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

a. May 1 – May 31
b. June 1 – Oct 31
* For Willamette River or Willamette River side channels, see Table 9-11.

Table 9-4: HUA assignments for source or source categories on assessment units in the McKenzie Subbasin.

AU Name	AU ID	NPDES point sources	Dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
McKenzie River from Trail Bridge Dam to Leaburg Diversion	OR_SR_1709000402_02_104588, OR_SR_1709000402_02_103858, OR_SR_1709000405_02_103868, OR_SR_1709000405_02_103869, OR_SR_1709000405_02_103866, OR_SR_1709000407_02_103884 from Ennis Creek to Leaburg Diversion (McKenzie River Miles 35.7 – 48.2)	0.03	0.00	0.03	0.02	0.00	0.22	0.30
McKenzie River from Leaburg Diversion to International Paper Springfield outfall	OR_SR_1709000407_02_103884 from McKenzie River Mile 12.4 – 35.7	0.08	0.00[a] 0.16[b] 0.00[c]	0.03	0.02	0.00	0.02	0.30

AU Name	AU ID	NPDES point sources	Dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
McKenzie River from International Paper Springfield's outfall to the mouth	OR_SR_1709000407_02_103884 from McKenzie River Mile 0 – 12.4	0.20[d] 0.22[e] 0.23[f]	0.00[a] 0.02[b] 0.00[c]	0.02	0.02	0.00	0.04[d] 0.02[e] 0.01[f]	0.30
South Fork McKenzie	OR_SR_1709000403_02_104590	0.01	0.00	0.05	0.02	0.00	0.22	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

a: NPS dam and reservoir operations
b: EWEB Walterville NPS and NPDES increases
c: EWEB Leaburg project NPS increases
d: Spring spawning period
e: Summer non spawning period
f: Fall spawning period

Table 9-5: HUA assignments for source or source categories on assessment units in the North Santiam Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Big Cliff Reservoir	OR_LK_1709000503_02_100770	0.10	0.00	0.05	0.02	0.00	0.13	0.30
North Santiam River	OR_SR_1709000504_02_103906, OR_SR_1709000506_02_103930	0.~~07~~08	0.00	0.~~04~~02	0.~~05~~03	0.00	0.~~14~~17	0.30
Santiam River	OR_SR_1709000506_02_103927	0.04	0.00	0.~~04~~02	0.~~04~~03	0.00	0.~~18~~21	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-6: HUA assignments for source or source categories on assessment units in the South Santiam Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Crabtree Creek	OR_SR_1709000606_02_103978	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Foster Lake	OR_LK_1709000604_02_100772	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Middle Santiam River	OR_SR_1709000604_02_103969	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Roaring River	OR_SR_1709000606_02_103974	0.10	0.00	0.05	0.02	0.00	0.13	0.30
South Santiam River	OR_SR_1709000608_02_103925	0.13	0.00	0.~~04~~02	0.~~05~~03	0.00	0.~~08~~12	0.30
Wiley Creek	OR_SR_1709000605_02_103971	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-7: HUA assignments for source or source categories on assessment units in the Middle Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Coffee Lake Creek-Willamette River	OR_WS_170900070402_02_104419	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Rickreall Creek	OR_SR_1709000701_02_104591	0.22	0.00	0.05	0.02	0.00	0.01	0.30
Stone Quarry Lake	OR_LK_1709000703_02_100809	0.15	0.00	0.05	0.02	0.00	0.08	0.30
Upper Mill Creek	OR_WS_170900070201_02_104409	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs*	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30
* For Willamette River or Willamette River side channels, see Table 9-11.								

Table 9-8: HUA assignments for source or source categories on assessment units in the Molalla-Pudding Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Abiqua Creek	OR_SR_1709000901_02_104062	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Lower Abiqua Creek	OR_WS_170900090107_02_104460	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Mill Creek	OR_WS_170900090502_02_104481	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Molalla River	OR_SR_1709000906_02_104093, OR_SR_1709000906_02_104094, OR_LK_1709000906_02_100834, OR_WS_170900090607_02_104488	0.20	0.00	0.05	0.02	0.00	0.03	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Pudding River	OR_SR_1709000902_02_104073, OR_SR_1709000905_02_104088, OR_SR_1709000901_02_104064	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Silver Creek	OR_SR_1709000901_02_104595	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-9: HUA assignments for source or source categories on assessment units in the Clackamas Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Clackamas Cove	OR_LK_1709001106_02_100259	0.~~04~~08	0.~~00~~15 [a]	0.~~05~~02	0.~~05~~03	0.00	0.~~16~~02	0.30
Clackamas River	OR_SR_1709001106_02_104597	0.~~04~~08	0.~~00~~15 [a]	0.~~05~~02	0.~~05~~03	0.00	0.~~16~~02	0.30
Deep Creek	OR_SR_1709001106_02_104166	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Eagle Creek	OR_SR_1709001105_02_104162, OR_SR_1709001105_02_104163	0.20	0.00	0.05	0.02	0.00	0.03	0.30
North Fork Deep Creek	OR_WS_170900110605_02_104547	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Unnamed Lake Unit	OR_LK_1709001106_02_100852	0.~~04~~08	0.~~00~~15 [a]	0.~~05~~02	0.~~05~~03	0.00	0.~~16~~02	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30
a: PGE River Mill Dam								

Table 9-10: HUA assignments for source or source categories on assessment units in the Lower Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Columbia Slough	OR_WS_170900120201_02_104554.1, OR_WS_170900120201_02_104554.2	0.225	0.00	0.05	0.02	0.00	0.005	0.30
Mount Scott Creek	OR_SR_1709001201_02_104171, OR_WS_170900120102_02_104551	0.15	0.00	0.05	0.02	0.00	0.08	0.30
Multnomah Channel	OR_SR_1709001203_88_104184	0.09	0.~~00~~05	0.~~05~~02	0.~~05~~02	0.00	0.~~11~~12	0.30
All other AUs*	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30
* For Willamette River or Willamette River side channels, see Table 9-11.								

Table 9-11: HUA assignments for source or source categories on the Willamette River or Willamette River side channel assessment units.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Willamette River RM 187-107.5 Confluence of MF Willamette River and CF Willamette River to Santiam River	OR_SR_1709000306_05_103854	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Willamette River RM 107.5 – 84.5 ~~Luckiamute~~Santiam River to Willamette Slough	OR_SR_1709000701_05_104005, OR_SR_1709000703_05_104014	0.~~16~~17	0.00	0.~~03~~02	0.03	0.00	0.08	0.30
Willamette River RM 84.5 - 51 Willamette Slough to Chehalem Creek	OR_SR_1709000703_04_104013	0.~~20~~23	0.00	0.~~03~~02	0.03	0.00	0.~~04~~02	0.30
Willamette River RM 51 – 45 Chehalem Creek to Champoeg Creek	OR_SR_1709000703_88_104015	0.13	0.00	0.02	0.02	0.00	0.13	0.30
Willamette ~~River~~River[b] RM 45 - 0 Champoeg Creek to Confluence with Columbia River	OR_SR_1709000704_88_104020, OR_SR_1709001201_88_104019, OR_SR_1709001202_88_104175	0.12	0.~~10~~11[a]	0.02	0.02	0.00	0.~~04~~02	0.~~30~~29[b]
Albany Channel	OR_SR_1709000306_02_103849	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Booneville Channel	OR_SR_1709000306_02_103842	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Curtis Slough	OR_SR_1709000306_02_103848	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Long Tom River (Norwood Island side channel)	OR_SR_1709000306_02_103844	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Marshall Slough	OR_SR_1709000306_02_103850	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Mill Race	OR_SR_1709000306_02_103846	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Spring Creek	OR_SR_1709000306_02_103851	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
Lambert Slough	OR_LK_1709000703_02_100794	0.~~20~~23	0.00	0.~~03~~02	0.03	0.00	0.~~04~~02	0.30
Mission Lake	OR_LK_1709000703_02_100795	0.~~20~~23	0.00	0.~~03~~02	0.03	0.00	0.~~04~~02	0.30
~~Unnamed side channel~~Willamette Slough	OR_~~SR~~LK_1709000703_02_~~104010~~100792	0.~~20~~23	0.00	0.~~03~~02	0.03	0.00	0.~~04~~02	0.30
~~Willamette~~Third Slough	OR_~~LK_1709000703~~SR_1709000306_02_~~100792~~103845	0.~~20~~23	0.00	0.~~03~~02	0.03	0.00	0.~~04~~02	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
~~Third Slough~~Unnamed side channels	OR_SR_1709000703_02_104010, OR_SR_1709000306_02_~~103845~~103840, OR_SR_1709000306_02_103841, OR_SR_1709000306_02_103843, OR_SR_1709000306_02_103847, OR_SR_1709000306_02_103852, OR_SR_1709000306_02_103853	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30
~~Unnamed side channels~~Willamette River West channel between Dodson Slough and McKenzie River	OR_SR_1709000306_02_~~103840, OR_SR_1709000306_02_103841, OR_SR_1709000306_02_103843, OR_SR_1709000306_02_103847, OR_SR_1709000306_02_103852, OR_SR_1709000306_02_103853~~103839	0.23	0.00	0.~~03~~02	0.03	0.00	0.~~01~~02	0.30

a: PGE Willamette Falls and River ~~West channel between Dodson Slough and McKenzie~~Mill Dam
b: 0.01 of HUA is attributed to a portion of warming in the Willamette River from tributary sources. See TSD Appendix M for details.

9.1.2 Thermal wasteload allocations for point sources

Wasteload allocations are assigned to NPDES permitted point sources listed in **Table 9-12**. Discharges covered by a number of NPDES permits have been determined to be unlikely to contribute to exceedances of temperature criteria. The wasteload allocation for the Phase I individual MS4 stormwater permits~~ and~~, individually permitted stormwater discharges from Portland International Airport (DEQ file number 107220, EPA number OR0040291), Jasper Wood Products, LLC outfall 002 (DEQ file number 10009, EPA number OR0042994) and Arkema, Inc. outfalls 001-004 (DEQ file number 68471, EPA number OR0001597), registrants under the general stormwater permits (MS4 phase II, 1200-A, 1200-C, 1200-CA and 1200-Z), and registrants under ~~the ~~400-J, 1500-A, and 1700-A general permits are set equal to loads permitted by ~~these~~the applicable NPDES ~~permits~~permit. This means that individual permittees and registrants must follow their permit conditions to meet the ~~narrative ~~wasteload allocation. Beyond ~~current~~NPDES permit limits, no additional TMDL requirements are needed for these sources to control temperature. For all general wastewater and stormwater NPDES permits, more precise wasteload allocations may be considered if subsequent data analysis indicates a need and loading capacity is available.

Wasteload allocations were calculated using **Equation 9-1**.

$WLA =$ ~~$(\Delta T) \cdot (Q_E + Q_R)$~~ $\Delta T \cdot (Q_E + Q_R) \cdot C_F$ **Equation 9-1a**

$WLA = \Delta T \cdot Q_E \cdot D_F \cdot C_F$ **Equation 9-1b**

where,

$WLA =$ Wasteload allocation (kilocalories/day), expressed as a rolling seven-day average.

$\Delta T =$ The assigned portion of the HUA from **Table 9-12**. It is 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. See **Table 9-13** for list of NPDES permittees where minimum duties provision may apply.

$Q_E =$ 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.

$D_F =$ Dilution factor. $(Q_E + Q_R)/Q_E$ For lakes, the dilution factor is 1 unless determined using another method.

$C_F =$ Conversion factor using flow in cfs: 2,446,665

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

The effluent discharge used to calculate the wasteload allocations presented in **Table 9-12** are based on the average dry weather facility design, a maximum discharge authorized by an NPDES permit, or an effluent discharge characterized from discharge data. More information on the specific source of the effluent discharge flow and the rationale behind the assigned HUA is described in the TSD Section 9.2, or TSD Appendix M for NPDES permittees discharging to the mainstem Willamette River and major tributaries.

Wasteload allocations may be implemented in NPDES permits in any of the following ways:

(1) Incorporate the 7Q10 wasteload allocation in **Table 9-12** as a static numeric limit. Permit writers may recalculate the static limit using different values for 7Q10 (Q_R) and effluent discharge (Q_E~~),~~) using seasonal values or annual values, as appropriate, if more recent data or better estimates are available~~ (including the use of seasonal values, as appropriate).~~.
(2) Incorporate **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 assigned portion of the HUA (ΔT) is static and based on the value in **Table 9-12**. Permit writers may recalculate the 7Q10 using seasonal or annual values, as appropriate, if more recent data or better estimates are available.

The wasteload allocation period for each facility is consistent with the critical period of the receiving waterbody, which is presented in Section 5: Seasonal variation and critical period for temperature. Wasteload allocations in **Table 9-12** for facilities currently enrolled as a registrant under a general permit may be incorporated into an individual permit, if the facility obtains an individual permit for the same discharge in the future.

Table 9-12: Thermal wasteload allocations (WLA) for point sources.

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Adair Village STP 500 : OR0023396	0.001	4/1	5/15	6308	1.3	15.437E+6
	0.001	5/16	10/14	3877	0.2	9.486E+6
	0.002	10/15	11/~~30~~15	4443	1.3	21.747E+6
Albany Millersburg WRF [2] 1098 : OR0028801	0.010	4/1	5/15	6308	14.3	154.686E+6
	0.017	5/16	10/14	3877	13.7	161.827E+6
	0.037	10/15	11/~~30~~15	4443	25.1	404.482E+6
Albany Water Treatment Plant 66584 : ORG383501 (200-J discharge)	0.20	5/1	10/31	24	1.30	12.38E+6
Alpine Community 100101 : OR0032387	0.00	5/1	10/31	0.4	0.03	0
Arclin 16037 : OR0021857	0.075	5/1	10/31	0	1.55	0.284E+6
Arclin 81714 : OR0000892	0.075	4/1	10/31	30	0.93	5.675E+6
Arkema 68471 : OR0044695	0.001	6/1	9/30	6740	0.14	16.491E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Ash Grove Cement - Rivergate Lime Plant 3690 : OR0001601	0.00	6/1	9/30	5934	0	0
ATI Albany Operations 64300 : OR0001716	0.01	5/1	10/31	1.4	3.52	0.12E+6
ATI Millersburg [2] 87645 : OR0001112	0.010	4/1	5/15	6308	5.2	154.463E+6
	0.011	5/16	10/14	3877	5.2	104.483E+6
	0.012	10/15	11/15	4443	5.4	130.605E+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	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
Brooks STP 100077 : OR0033049	0.001	4/1	5/15	11955	1.6	29.254E+6
	0.001	5/16	10/14	5684	0.4	13.908E+6
	0.002	10/15	11/15	7133	1.6	34.912E+6
Brownsville STP 11770 : OR0020079	0.00	5/1	10/31	14	0.0	0
Canby Regency Mobile Home Park 97612 : OR0026280	0.001	6/1	9/30	5790	0.06	14.166E+6
Canby STP 13691 : OR0020214	0.004	6/1	9/30	5790	3.1	56.695E+6
Cascade Pacific Pulp, LLC 36335 : OR0001074	0.024	4/1	5/15	5330	16.5	313.946E+6
	0.049	5/16	10/14	3609	17.3	434.745E+6
	0.037	10/15	11/15	4280	14.5	388.767E+6
Century Meadows Sanitary System (CMSS) 96010 : OR0028037	0.001	6/1	9/30	5734	0.6	14.031E+6
City of Silverton Drinking WTP 81398 : ORG383527 (200-J discharge)	0.20	5/1	10/31	0	0.08	0.038E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.20	5/1	10/31	0	0.68	0.333E+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 (200-J discharge)	0.20	5/1	10/31	0	0.37	0.182E+6
Corvallis STP 20151 : OR0026361	0.~~015~~017	4/1	5/15	5800	~~15.3~~18.9	~~213.421E~~242.027E+6
	0.~~015~~017	5/16	10/14	3683	11.7	~~135.595E~~153.675E+6
	0.~~031~~048	10/15	11/15	4149	~~24.0~~33.3	~~316.508E~~491.169E+6
Cottage Grove STP 20306 : OR0020559	0.154	4/1	5/15	61	2.1	23.775E+6
	0.206	5/16	11/15	38	2.8	20.564E+6
Covanta Marion, Inc 89638 : OR0031305	0.001	4/1	5/15	10688	0.2	26.15E+6
	0.002	5/16	10/14	5684	0.3	27.815E+6
	0.001	10/15	11/15	7133	0.2	17.453E+6
Creswell STP 20927 : OR0027545	0.20	5/1	5/31	0	5.09	2.491E+6
	0.00	6/1	10/31	0	0.31	0
Dallas STP 22546 : OR0020737	0.11	5/1	10/31	4.2	3.09	1.963E+6
Dallas WTP 22550 : ORG383529 (200-J discharge)	0.11	5/1	10/31	3.3	0.17	0.934E+6
Deer Creek Estates Water Association 23650 : ORG383526 (200-J discharge)	0.20	5/1	10/31	0.7	0.004	0.344E+6
Dundee STP 25567 : OR0023388	0.002	6/1	9/30	5734	1.1	28.064E+6
Duraflake 97047 : OR0000426	0.20	5/1	10/31	0	0.55	0.270E+6
Estacada STP 27866 : OR0020575	0.075	5/1	10/31	317	0.84	58.323E+6
Eugene Public Library 112467 - OR0044725	0.001	4/1	5/15	1906	0.04	4.663E+6
	0.001	5/16	10/14	1508	0.04	3.690E+6
	0.001	10/15	11/15	1925	0.04	4.710E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Evraz Oregon Steel 64905 : OR0000451	0.002	6/1	9/30	6740	1.2	32.987E+6
EWEB Carmen Powerhouse (Outfalls 001A and 001B) 28393 : OR0000680	0.075	5/1	10/31	146	2.68	27.282E+6
EWEB Trail Bridge Powerhouse (Outfalls 002A and 002B) 28393 : OR0000680	0.030	5/1	10/31	496	0.93	36.475E+6
EWEB Hayden Bridge Filter Plant 28385 : ORG383503 (200-J discharge)	0.011	4/1	11/15	1538	2.09	41.449E+6
Falls City STP 28830 : OR0032701	0.00	5/1	10/31	5.3	0.0	0
Forest Park Mobile Village 30554 : OR0031267	0.001	6/1	9/30	5988	0.02	14.651E+6
Foster Farms 97246 : OR0026450	0.00	5/1	10/31	0	0.0	0
Frank Lumber Co. Inc. 30904 : OR0000124	0.04	4/1	6/15	987	3	96.888E+6
	0.04	6/16	8/31	859	3	84.361E+6
	0.04	9/1	11/15	957	4.4	94.089E+6
Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.20	5/1	10/31	0	0.2	0.094E+6
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	6.6	0.34	0
GP Halsey Mill 105814 : OR0033405	0.010	4/1	5/15	5330	5.3	130.537E+6
	0.016	5/16	10/14	3609	4.9	141.472E+6
	0.011	10/15	11/15	4280	4.0	115.297E+6
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Harrisburg Lagoon Treatment Plant 105415 : OR0033260	0.002	4/1	4/30	5204	1.9	25.474E+6
	0.004	5/1	10/31	3480	1.6	34.073E+6
	0.003	11/1	11/15	3853	1.9	28.295E+6
Hollingsworth & Vose Fiber Co – Corvallis 28476 : OR0000299	0.001	4/1	5/15	5800	0.1	14.191E+6
	0.001	5/16	10/14	3683	0.2	9.012E+6
	0.001	10/15	11/15	4149	0.1	10.151E+6
Hubbard STP 40494 : OR0020591	0.20	5/1	10/31	0	0.35	0.169E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	5/1	10/31	0	0.08	0.014E+6
Independence STP 41513 : OR0020443	0.005	4/1	5/15	10688	3.9	130.797E+6
	0.005	5/16	10/14	5684	3.8	69.581E+6
	0.003	10/15	11/15	7133	6.2	52.402E+6
International Paper - Springfield 108921 : ORG383548 (200-J discharge)	0.075	5/1	10/31	0	0.01	0.001E+6
International Paper - Springfield (Outfall 001 + Outfall 002) 96244 : OR0000515	0.12	4/1	6/15	2,442	28.9	725.456E+6
	0.20	6/16	8/31	1,537	28.9	766.247E+6
	0.19	9/1	11/15	1,630	28.9	771.167E+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
Jasper Wood Products Outfall 001 100097 : OR0042994	0.~~00~~001	~~6~~4/1	~~9/30~~6/15	~~6691~~1097	0.01	~~0~~2.684E+6
	0.001	6/16	9/14	1089	0.01	2.664E+6
	0.001	9/15	11/15	1589	0.01	3.888E+6
Jefferson STP 43129 : OR0020451	0.002	4/1	5/15	3275	0.6	16.029E+6
	0.006	5/16	10/14	1144	0.8	16.806E+6
	0.003	10/15	11/15	2278	0.6	16.725E+6
JLR 32536 : OR0001015	0.01	5/1	10/31	6.9	0.5	0.181E+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
Lebanon WWTP 49764 : OR0020818	0.03	4/1	5/15	1043	4.1	76.857E+6
	0.05	5/16	10/14	506	4.9	62.50E+6
	0.08	10/15	11/15	726	12.3	144.51E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Lowell STP 51447 : OR0020044	0.013	5/1	11/15	1,002	1.22	31.909E+6
Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.00	5/1	10/31	0	0.0	0
Molalla Municipal Drinking WTP 109846 : ORG380014 (200-J discharge)	0.20	5/1	10/31	0	0.16	0.078E+6
Molalla STP 57613 : OR0022381	0.10	5/1	10/31	56	3.46	14.547E+6
Monmouth STP 57871 : OR0020613	0.004	4/1	5/15	10688	5.8	104.657E+6
	0.005	5/16	10/14	5684	4.3	69.587E+6
	0.003	10/15	11/15	7133	5.8	52.399E+6
Monroe STP 57951 : OR0029203	0.08	4/1	4/30	55	1.2	11.00E+6
	0.03	5/1	10/31	22	0.2	1.629E+6
	0.03	11/1	11/15	55	1.2	4.125E+6
Mt. Angel STP 58707 : OR0028762	0.00	5/1	10/31	6.6	0.87	0
Murphy Veneer, Foster Division 97070 : OR0021741	0.20	5/1	10/31	4.2	1.11	2.598E+6
MWMC - Eugene/Springfield STP 55999 : OR0031224	0.118	4/1	5/15	1906	42.6	562.573E+6
	0.093	5/16	10/14	1508	55.0	355.645E+6
	0.188	10/15	11/15	1925	86.3	925.144E+6
Newberg - Wynooski Road STP 102894 : OR0032352	0.006	6/1	9/30	5734	6.2	84.266E+6
Newberg OR, LLC 72615 : OR0000558	0.00	6/1	9/30	5934	0	0
Norpac Foods- Plant #1, Stayton 84820 : OR0001228	0.20	5/1	10/31	0	6.19	3.028E+6
North Clackamas County Water Commission 110117 : ORG380011 (200-J discharge)	0.03	4/15	10/31	671	2.49	49.434E+6
NW Natural Gas Site Remediation 120589 : OR0044687	0.001	6/1	9/30	6740	0.7	16.492E+6
Oak Lodge Water Services Water Reclamation Facility 62795 : OR0026140	0.003	6/1	9/30	6740	4	49.501E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Oakridge STP 62886 : OR0022314	0.075	5/1	11/30	514	0.73	94.452E+6
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	5/1	10/31	6.5	2.48	1.647E+6
ODFW - Clackamas River Hatchery 64442 : OR0034266	0.072*	4/~~1~~15	6/15	1186	42.1	216.342E+6*
	0.261*	6/16	8/31	627	41.0	426.571E+6*
	0.283*	9/1	~~11/15~~10/31	645	42.0	475.683E+6*
ODFW - Dexter Ponds 64450 : ORG133514 (300-J discharge)	0.036*	4/1	6/15	986	48.0	91.075E+6*
	0.189*	6/16	9/14	1002	48.0	485.541E+6*
	0.255*	9/15	11/15	1301	48.0	841.641E+6*
ODFW - Leaburg Hatchery 64490 : OR0027642	0.074*	4/1	6/15	2,442	92.4	458.861E+6*
	0.012*	6/16	8/31	1,537	39.1	46.274E+6*
	0.026*	9/1	11/15	1,630	78.3	108.671E+6*
ODFW - Marion Forks Hatchery 64495 : OR0027847	0.075*	5/1	10/31	6.3	18.6	4.562E+6*
ODFW - McKenzie River Hatchery 64500 : OR0029769	0.002	4/1	6/15	2442	12.7	12.012E+6
	0.033	6/16	8/31	1537	11.8	125.05E+6
	0.002	9/1	11/15	1,630	1.0	7.981E+6
ODFW - Minto Fish Facility 64495 : OR0027847	0.03*	4/1	6/15	987	30	74.648E+6*
	0.03*	6/16	8/31	859	36	65.693E+6*
	0.03*	9/1	11/15	957	41	73.253E+6*
ODFW - Roaring River Hatchery 64525 : ORG133506 (300-J discharge)	0.10*	5/1	10/31	0.5	14.2	3.597E+6*
ODFW - South Santiam Hatchery 64560 : ORG133511 (300-J discharge)	0.02*	4/1	6/15	841	10.6	41.672E+6*
	0.02*	6/16	8/31	621	25.9	31.655E+6*
	0.02*	9/1	11/15	677	28.5	34.522E+6*
ODFW - Willamette Fish Hatchery 64585 : ORG133507 (300-J discharge)	0.075*	5/1	10/31	110	79.0	34.681E+6*
OHSU Center For Health and Healing 113611 : OR0034371	0.001	6/1	9/30	6740	0.06	16.491E+6
OSU John L. Fryer Aquatic Animal Health Lab	0.001	4/1	5/15	5800	0.9	14.193E+6
	0.001	5/16	10/14	3683	1.2	9.014E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
103919 : OR0032573	0.001	10/15	11/15	4149	0.9	10.153E+6
Philomath WTP 100048 : ORG383536 <u>(200-J discharge)</u>	0.20	5/1	10/31	6.7	0.32	3.435E+6
Philomath WWTP 103468 : OR0032441	0.00	5/1	10/31	6.7	0.0	0
PNW Veg Co DBA Norpac Foods No. 5 84791 : OR0021261	0.00	5/1	10/31	0	0.0	0
Row River Valley Water District 100075 : ORG383534 <u>(200-J discharge)</u>	0.075	5/1	10/31	12	0.04	2.210E+6
RSG Forest Products - Liberal 72596 : OR0021300	0.20	5/1	10/31	0	1.24	0.606E+6
Philomath WTP 100048 : ORG383536	0.20	5/1	10/31	6.7	0.32	3.435E+6
Salem Willow Lake STP 78140 : OR0026409	0.~~024~~<u>026</u>	4/1	5/15	10688	~~52.9~~<u>59.5</u>	~~630.705E~~<u>683.684E</u>+6
	0.~~036~~<u>039</u>	5/16	10/14	5684	~~38.3~~<u>41.1</u>	~~504.02E~~<u>546.289E</u>+6
	0.~~058~~<u>094</u>	10/15	11/15	7133	~~80.2~~<u>112.5</u>	1,~~023.60E~~<u>666.367E</u>+6
Sandy WWTP 78615 : OR0026573	0.00	5/1	10/31	0.2	0.00	0
Scappoose STP 78980 : OR0022420	~~NA~~<u>NA[3]</u>	~~6/1~~<u>5/15</u>	~~9/30~~<u>10/15</u>	~~NA~~<u>NA[3]</u>	0.9	21.00E+6
Scio STP 79633 : OR0029301	0.00	5/1	10/31	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
Siltronic Corporation 93450 : OR0030589	0.007	6/1	9/30	6740	4.2	115.506E+6
Silverton STP 81395 : OR0020656	0.20	5/1	10/31	14	3.87	8.743E+6
SLLI 74995 : OR0001741	0.001	6/1	9/30	6740	0.04	16.491E+6
Stayton STP	0.02	4/1	6/15	1482	1.8	72.607E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
84781 : OR0020427	0.02	6/16	8/31	914	1.9	44.818E+6
	0.02	9/1	11/15	1018	1.8	49.902E+6
Sunstone Circuits 26788 : OR0031127	0.04	5/1	10/31	10.5	0.065	1.034E+6
Sweet Home STP 86840 : OR0020346	0.02	4/1	6/15	841	2.6	41.28E+6
	0.03	6/16	8/31	621	2.1	45.736E+6
	0.04	9/1	11/15	667	3.5	65.62E+6
Tangent STP 87425 : OR0031917	0.00	5/1	10/31	20	0.17	0
Timberlake STP 90948 : OR0023167	0.00	5/1	10/31	254	0.22	0
Tryon Creek WWTP 70735 : OR0026891	0.004	6/1	9/30	6740	12.8	66.087E+6
Univar USA Inc 100517 : OR0034606	0.001	6/1	9/30	6740	0.04	16.491E+6
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20*	5/1	10/31	0	52.6	25.739E+6*
Veneta STP 92762 : OR0020532	0.20	5/1	5/31	6.4	0.98	3.611E+6
	0.00	6/1	9/30	6.4	0.00	0
	0.20	10/1	10/31	6.4	0.98	3.611E+6
U.S Army Corp of Engineers Big Cliff Project 126715 : Not assigned	0.004	4/1	11/15	859	1.1	8.418E+6
U.S. Army Corp of Engineers Cougar Project 126712: Not Assigned	0.01	5/1	10/31	236**	0.21	5.779E+6
U.S. Army Corp of Engineers Detroit Project 126716: Not Assigned	0.10	5/1	10/31	743**	7.94	183.729E+6
U.S Army Corp of Engineers Dexter Project 126714 : Not assigned	0.001	4/1	11/15	1002	0.7	2.453E+6
U.S Army Corp of Engineers Foster Project 126713 : Not assigned	0.003	4/1	11/15	621	1.4	4.568E+6
U.S. Army Corp of Engineers Green Peter Project 126717 : Not Assigned	0.10	5/1	11/30	33**	2.12	8.592E+6

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
U.S. Army Corp of Engineers Hills Creek Project 126699 : Not Assigned	0.06	5/1	11/30	309**	2.85	45.78E+6
U.S. Army Corp of Engineers Lookout Point Project 126700 : Not Assigned	0.06	5/1	11/15	1145**	2.82	168.50E+6
Vigor Industrial 70596 : OR0022942	0.005	6/1	9/30	6740	2.4	82.482E+6
WES - Blue Heron Discharge 72634 : OR0000566	0.00	6/1	9/30	5988	0	0
WES - Boring STP 16592 : OR0031399	0.20	5/1	10/31	0.24	0.06	0.145E+6
WES - Kellogg Creek WWTP 16590 : OR0026221	0.007	6/1	9/30	6740	15.5	115.699E+6
WES - Tri-City WPCP 89700 : OR0031259	0.015	6/1	9/30	5988	18.4	220.435E+6
Westfir STP 94805 : OR0028282	0.075	5/1	10/31	174	0.05	31.937E+6
Willamette Falls Paper Company 21489 : OR0000787	0.007	6/1	9/30	5988	6.5	102.666E+6
Willamette Leadership Academy 34040 : OR0027235	0.00	5/1	10/31	0	0.01	0
Wilsonville STP 97952 : OR0022764	0.005	6/1	9/30	5734	4.2	70.197E+6
Woodburn WWTP 98815 : OR0020001	0.20	5/1	10/31	6.7	7.79	7.092E+6

[1] Listed WLAs were calculated based on the 7Q10 flow.

[2] ATI Millersburg and Albany-Millersburg Water Reclamation Facility discharge to the same outfall, but each holds an individual NPDES permit and is assigned its own thermal ~~wasteload allocation~~WLA. These two WLAs may either be addressed individually with the facilities' permits or may be combined as the sum of the two WLAs and addressed as a single WLA.

[3] 7Q10 not calculated due to lack of flow data and tidal influence. HUA not assigned. Model shows 2015 maximum impacts of all point sources in Multnomah Channel <= 0.09 C. WLA represents a total thermal load calculated as WLA = A_F * Q_E * (T_E - T_C) * C_F, where A_F = 1.3 (adjustment factor), TE = 25.0°C (effluent temperature), T_C = 18 (the applicable temperature criteria), Q_E = 0.9 cfs (average dry weather design flow), and C_F = a conversion factor to produce WLA in kcal/day.

Notes:
WLA = wasteload allocation; kcals/day = kilocalories/day

NPDES Permittee WQ File Number: EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
* When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0 and the WLA = 0 kilocalories/day. ** Listed 7Q10s calculated based on a seasonal period corresponding to WLA period.						

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. The facility must be operated as a “flow through” facility where intake water moves through the facility and is not processed as part of an industrial or wastewater treatment operation. If a facility mixes the intake water with other wastewater or as a method to cool equipment DEQ considers the thermal effects of this operation to be part of the facility’s own activity and the minimum duties provision does not apply. The intake water must also be returned to the same stream where the intake is located. If the water is not returned to the same stream the thermal effects do not originate from the receiving stream and therefore are considered as part of the facilities own discharge.

When the minimum duties provision applies, the facility cannot add any additional thermal loading to the intake temperatures when the intake temperatures are warmer than the maximum effluent 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 specific equations to implement this approach in NPDES permits are included in the TSD Section 9.2.2 through Section 9.2.9. DEQ determined the minimum duties provision is applicable to the facilities listed in **Table 9-13**.

Table 9-13: NPDES permittees where the minimum duties provision may be implemented as part of the TMDL wasteload allocation.

NPDES Permittee	WQ File Number: EPA Number	Intake and Receiving Stream	AU
ODFW - Clackamas River Hatchery	64442: OR0034266	Clackamas River	OR_SR_1709001106_02_104597
ODFW - Dexter Ponds	64450: ORG133514	Middle Fork Willamette River	OR_SR_1709000107_02_104583
ODFW - Leaburg Fish Hatchery	64490: OR0027642	McKenzie River	OR_SR_1709000407_02_103884
ODFW - Marion Forks Fish Hatchery	64495: OR0027847	Horn Creek	OR_WS_170900050203_02_104345
ODFW - Minto Fish Facility	64495: OR0027847	North Santiam River	OR_SR_1709000504_02_103906
ODFW - Roaring River Fish Hatchery	64525: ORG133506	Roaring River	OR_SR_1709000606_02_103974
ODFW - South Santiam Hatchery	64560: ORG133511	South Santiam River	OR_SR_1709000608_02_103925

NPDES Permittee	WQ File Number: EPA Number	Intake and Receiving Stream	AU
ODFW - Willamette Fish Hatchery	64585: ORG133507	Salmon Creek	OR_SR_1709000104_02_103719
USFW - Eagle Creek National Fish Hatchery	91035: OR0000710	Eagle Creek	OR_SR_1709001105_02_104162

9.1.3 Thermal wasteload allocations for 100-J general permit registrants

The TMDL includes narrative wasteload allocationWLA requirements for registrants to the 100-J general permit. The wasteload allocationWLA for current and future registrants to the 100-J general permit is equal to loads permitted by the 100-J general permit and the TMDL requirements identified in **Table 9-14** and **Table 9-15**. See TSD section 9.2.3 for additional information and background.

With some exceptions, 100-J registrants have been assigned a cumulative HUA of 0.075°C (**Table 9-14**). In addition, each AU has a maximum number of registrants that may discharge based on the 7Q10 stream flow at the discharge location. With some exceptions noted in **Table 9-14**, watershed (WS) AUs may only have one registrant due to low flows. The maximum number of registrants ensures the assigned HUA is attained based on DEQ's estimated temperature impacts. Additional registrants above the maximum require reserve capacity. The flow categories in **Table 9-14** are set up so the combined sum of warming from each registrant at the point of discharge does not exceed the maximum warming allowed for that AU. As the river flow increases and provides increased dilution, the maximum number of registrants allowed also increases. On select AUs (Columbia Slough, McKenzie River, and Stone Quarry Lake) the maximum number of registrants and assigned HUA reflect the current number of 100-J registrants. Some AUs do not have sufficient loading capacity for new 100-J registrants. On these AUs the capacity has been assigned to other NPDES permittees. **Table 9-15** identifies the AUs with insufficient loading capacity. On these AUs, the assigned HUA is zero and new 100-J registrants cannot increase stream temperature above the applicable temperature criteria. A maximum number of registrants is not needed on these AUs as there is no temperature increase allowed.

Table 9-14: Assigned HUA and TMDL requirements for 100-J permit registrants in the Willamette Subbasins.

AU 7Q10 stream flow (cfs)ID	AU Name	Assigned HUA (°C)*)	Maximum number of registrants per AU*
All lake (LK) AUs not listed below		0.075	1
OR_LK_1709000107_02_100699	Dexter Reservoir	0.00	0
OR_LK_1709000402_02_100742	Trail Bridge Reservoir	0.00	0
OR_LK_1709000503_02_100770	Big Cliff Reservoir	0.00	0
OR_LK_1709000703_02_100809	Stone Quarry Lake	0.15	2
OR_LK_1709001106_02_100850	Estacada Lake	0.00	0
OR_LK_1709001202_02_100858	Fairview Lake	0.00	0
All stream/river (SR) AUs not listed below		0.075	See Table 9-15
OR_SR_1709000104_02_103719	Salmon Creek	0.00	0
OR_SR_1709000105_02_103720	Middle Fork Willamette River	0.00	0

AU ~~7Q10 stream flow (cfs)~~ID	AU Name	Assigned HUA (°C~~)~~*)	Maximum number of registrants per AU*
OR_SR_1709000105_02_104580	Middle Fork Willamette River	0.00	0
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	0.00	0
OR_SR_1709000107_02_104583	Middle Fork Willamette River	0.02	1
OR_SR_1709000109_02_103735	Fall Creek	0.00	0
OR_SR_1709000110_02_103750	Middle Fork Willamette River	0.02	1
OR_SR_1709000110_02_104584	Middle Fork Willamette River	0.02	1
OR_SR_1709000202_02_103765	Layng Creek	0.00	0
OR_SR_1709000202_02_103779	Row River	0.00	0
OR_SR_1709000203_02_104585	Coast Fork Willamette River	0.00	0
OR_SR_1709000204_02_103787	Coast Fork Willamette River	0.00	0
OR_SR_1709000301_02_103789	Long Tom River	0.00	0
OR_SR_1709000301_02_103791	Long Tom River (Norwood Island side channel)	0.02	0
OR_SR_1709000302_02_103807	Oliver Creek	0.00	0
OR_SR_1709000302_02_103813	Marys River	0.00	0
OR_SR_1709000306_05_103854	Willamette River	0.01	7**
OR_SR_1709000402_02_103858	McKenzie River	0.00	0
OR_SR_1709000402_02_104587	McKenzie River	0.00	0
OR_SR_1709000402_02_104588	McKenzie River	0.00	0
OR_SR_1709000403_02_104590	South Fork McKenzie River	0.00	0
OR_SR_1709000405_02_103866	McKenzie River	0.00	0
OR_SR_1709000405_02_103868	McKenzie River	0.00	0
OR_SR_1709000405_02_103869	McKenzie River	0.00	0
OR_SR_1709000407_02_103884	McKenzie River	0.02	2
OR_SR_1709000504_02_103906	North Santiam River	0.02	1
OR_SR_1709000506_02_103927	Santiam River	0.02	1
OR_SR_1709000506_02_103930	North Santiam River	0.02	1
OR_SR_1709000605_02_103971	Wiley Creek	0.00	0
OR_SR_1709000606_02_103974	Roaring River	0.00	0
OR_SR_1709000608_02_103925	South Santiam River	0.02	1
OR_SR_1709000701_02_104591	Rickreall Creek	0.00	0
OR_SR_1709000701_05_104005	Willamette River	0.01	5
OR_SR_1709000703_02_104007	Mill Creek	0.00	0
OR_SR_1709000703_04_104013	Willamette River	0.01	6
OR_SR_1709000703_05_104014	Willamette River	0.01	5
OR_SR_1709000703_88_104015	Willamette River	0.01	6
OR_SR_1709000704_88_104020	Willamette River	0.01	6
OR_SR_1709000901_02_104595	Silver Creek	0.00	0
OR_SR_1709000902_02_104073	Pudding River	0.00	0
OR_SR_1709001105_02_104162	Eagle Creek	0.00	0
OR_SR_1709001106_02_104597	Clackamas River	0.02	1
OR_SR_1709001201_88_104019	Willamette River	0.01	7
OR_SR_1709001202_88_104175	Willamette River	0.01	7
OR_SR_1709001203_88_104184	Multnomah Channel	0.02	2
All watershed (WS) AUs not listed below		0.075	1
OR_WS_170900020403_02_104240	HUC12 Name: Lower Camas Swale Creek	0.00	0
OR_WS_170900030108_02_104250	HUC12 Name: Amazon Creek	0.00	0

AU ~~7Q10 stream flow (cfs)~~ID	AU Name	Assigned HUA (°C~~)*~~)	Maximum number of registrants per AU*
OR_WS_170900030204_02_104256	HUC12 Name: Greasy Creek	0.00	0
OR_WS_170900030511_02_104285	HUC12 Name: Lower Soap Creek	0.00	0
OR_WS_170900030603_02_104290	HUC12 Name: Flat Creek	0.00	0
OR_WS_170900030606_02_104294	HUC12 Name: Dry Muddy Creek-Muddy Creek	0.00	0
OR_WS_170900030610_02_104298	HUC12 Name: Truax Creek-Willamette River	0.00	0
OR_WS_170900050203_02_104345	HUC12 Name: Marion Creek	0.00	0
OR_WS_170900070201_02_104409	HUC12 Name: Upper Mill Creek	0.00	0
OR_WS_170900070402_02_104419	HUC12 Name: Coffee Lake Creek-Willamette River, Coffee Lake Creek	0.00	0
OR_WS_170900090107_02_104460	HUC12 Name: Lower Abiqua Creek	0.00	0
OR_WS_170900090502_02_104481	HUC12 Name: Mill Creek-Pudding River	0.00	0
OR_WS_170900090607_02_104488	HUC12 Name: Molalla River	0.00	0
OR_WS_170900110605_02_104547	HUC12 Name: North Fork Deep Creek-Deep Creek	0.00	0
OR_WS_170900120201_02_104554.2	Columbia Slough	0.225	3
*Additional 100-J registrants are allowed to discharge above the maximum if they do not increase stream temperature above the applicable temperature criteria or reserve capacity is assigned. **7 industrial 100-J registrants. The maximum number of hydropower 100-J registrants is zero.			

Table 9-15: TMDL requirements for 100-J registrants on stream/river (SR) AUs in the Willamette Subbasins not listed in Table 9-14.

Stream/River AU 7Q10 stream flow (cfs)	Assigned HUA (°C)	Maximum number of registrants per AU*
<= 149	0.075	1
> 149 and <= 297	0.075	2
> 297 and <= 521	0.075	3
> 521 and <= 652	0.075	4
> 652 and <= 990	0.075	5
> 990 and <= 1154	0.075	6
> 1154 and <= 1319	0.075	7
> 1319 and <= 1484	0.075	8
> 1484	0.075	9
~~McKenzie River OR_SR_1709000407_02_103884~~	~~0.02~~	~~2~~
~~Columbia Slough OR_WS_170900120201_02_104554.2~~	~~0.225~~	~~3~~
~~Other Watershed AUs~~	~~0.075~~	~~1~~
~~Stone Quarry Lake OR_LK_1709000703_02_100809~~	~~0.15~~	~~2~~
~~Other natural lakes or ponds where the Natural Lakes temperature criterion apply (OAR 340-041-0028(6))~~*Additional 100-J registrants are allowed to discharge above the maximum if they do not increase stream temperature above the applicable temperature criteria or reserve capacity is assigned.		
~~*Assigned HUA is zero for AUs listed in **Table 9-15**.~~		

Table 9-15: AUs where new 100-J general permit registrants may not increase temperature above the applicable criteria.

AU ID	AU or GNIS Name	Assigned HUA (°C)
OR_LK_1709000107_02_100699	Dexter Reservoir	0.00
OR_LK_1709000402_02_100742	Trail Bridge Reservoir	0.00
OR_LK_1709000503_02_100770	Big Cliff Reservoir	0.00
OR_LK_1709001106_02_100850	Estacada Lake	0.00
OR_LK_1709001202_02_100858	Fairview Lake	0.00
OR_SR_1709000104_02_103719	Salmon Creek	0.00
OR_SR_1709000105_02_103720	Middle Fork Willamette River	0.00
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	0.00
OR_SR_1709000202_02_103765	Layng Creek	0.00
OR_SR_1709000301_02_103789	Long Tom River	0.00
OR_SR_1709000302_02_103807	Oliver Creek	0.00
OR_SR_1709000302_02_103813	Marys River	0.00
OR_SR_1709000402_02_103858	McKenzie River	0.00
OR_SR_1709000105_02_104580	Middle Fork Willamette River	0.00
OR_SR_1709000402_02_104587	McKenzie River	0.00
OR_SR_1709000402_02_104588	McKenzie River	0.00
OR_SR_1709000403_02_104590	South Fork McKenzie River	0.00
OR_SR_1709000405_02_103866	McKenzie River	0.00
OR_SR_1709000405_02_103868	McKenzie River	0.00
OR_SR_1709000405_02_103869	McKenzie River	0.00
OR_SR_1709000605_02_103971	Wiley Creek	0.00
OR_SR_1709000606_02_103974	Roaring River	0.00
OR_SR_1709000701_02_104591	Rickreall Creek	0.00
OR_SR_1709000703_02_104007	Mill Creek	0.00
OR_SR_1709000901_02_104595	Silver Creek	0.00
OR_SR_1709000902_02_104073	Pudding River	0.00
OR_SR_1709001105_02_104162	Eagle Creek	0.00
OR_WS_170900020403_02_104240	Unnamed tributary to Camas Swale Creek	0.00
OR_WS_170900030108_02_104250	Amazon Creek, Amazon Diversion Canal	0.00
OR_WS_170900030204_02_104256	Rock Creek	0.00
OR_WS_170900030511_02_104285	Ditch to Soap Creek tributary	0.00
OR_WS_170900030603_02_104290	Unnamed tributary to Flat Creek	0.00
OR_WS_170900030606_02_104294	Muddy Creek	0.00
OR_WS_170900030610_02_104298	Murder Creek	0.00
OR_WS_170900050203_02_104345	Horn Creek	0.00
OR_WS_170900070201_02_104409	Salem Ditch	0.00
OR_WS_170900070402_02_104419	Coffee Lake Creek	0.00
OR_WS_170900090107_02_104460	Unnamed tributary to Abiqua Creek	0.00
OR_WS_170900090502_02_104481	Mill Creek	0.00
OR_WS_170900090607_02_104488	Unnamed tributary to Molalla River	0.00
OR_WS_170900110605_02_104547	North Fork Deep Creek	0.00

9.1.4 Thermal load allocations for nonpoint sources

Load allocations are assigned to background sources and anthropogenic nonpoint sources on all waters, as defined in Section 2, in the Willamette Subbasins.

The allocation period is consistent with the critical period of each waterbody, which is presented in Section 5: Seasonal variation and critical period for temperature.

Load allocations for background sources are calculated using **Equation 9-2**.

$$LA_{BG} = (T_C) \cdot (Q_R) \cdot C_F$$ **Equation 9-2**

where,

$LA_{BG} =$ Load allocation to background sources (kilocalories/day), expressed as a rolling seven-day average.

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

$Q_R =$ The daily average river flow rate (cfs). For a lake, a dilution factor of 1 may be used for Q_R unless determined using another method.

$C_F =$ Conversion factor using flow in cfs: 2,446,665

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

Table 9-16 presents the load allocations assigned to background sources on temperature impaired Category 5 AUs that were modeled for the TMDL analysis. The load allocations are based on the 7Q10 low river flows and the minimum applicable criterion in the respective AUs. **Equation 9-2** shall be used to calculate the load allocations assigned to background sources on all other AUs or stream location in the Willamette Subbasins not identified in **Table 9-16**; or for any AUs identified in **Table 9-16** when river flows are greater than 7Q10.

If the applicable temperature criteria are updated and approved by EPA, the background load allocations assigned to any AU or stream location where the temperature criterion changed shall be recalculated using the updated criterion and **Equation 9-2**.

Table 9-16: 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 Year Round (kcal/day)	7Q10 LA Spawning (kcal/day)
Clackamas River OR_SR_1709001106_02_104597	671	16	13	4/1	11/15	26,267.4E+6	21,342.26E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18	13	4/1	11/15	1,673.52E+6	1,208.65E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18	13	4/1	11/15	5,813.28E+6	4,198.48E+6
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	16	13	5/1	11/30	978.67E+6	795.17E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18	13	2/15	11/15	484.44E+6	349.87E+6
Little North Santiam River OR_SR_1709000505_02_104564	21	16	13	5/1	10/31	822.08E+6	667.94E+6
Long Tom River OR_SR_1709000301_02_103791	22	24 18	~~18~~NA	4/1	11/15	1,291.84E+6 968.88E+6	NA~~968.88E+6~~
Luckiamute River OR_SR_1709000305_02_103829	16	18	13	5/1	10/31	704.64E+6	508.91E+6
McKenzie River OR_SR_1709000407_02_103884	1537	16	13	4/1	11/15	60,168.39E+6	48,886.81E+6

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion (°C)	Spawning Criterion (°C)	LA period start	LA period end	7Q10 LA Year Round (kcal/day)	7Q10 LA Spawning (kcal/day)
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16	13	4/1	11/15	39,224.93E+6	31,870.26E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16	13	4/1	11/15	50,029.41E+6	40,648.89E+6
Mohawk River OR_SR_1709000406_02_103871	16	16	13	3/15	11/15	626.35E+6	508.91E+6
Molalla River OR_SR_1709000904_02_104086	38	16	13	5/1	10/31	1,487.57E+6	1,208.65E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16	13	5/1	10/31	430.61E+6	349.87E+6
North Santiam River OR_SR_1709000504_02_103906	859	16	13	4/1	11/15	33,626.96E+6	27,321.91E+6
North Santiam River OR_SR_1709000506_02_103930	914	16	13	4/1	11/15	35,780.03E+6	29,071.27E+6
Pudding River OR_SR_1709000905_02_104088	10	18	NA	5/1	10/31	440.4E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18	13	4/1	11/15	50,381.73E+6	36,386.8E+6
South Santiam River OR_SR_1709000608_02_103925	615	16	13	4/1	11/15	24,075.18E+6	19,561.09E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18	NA	5/1	11/30	303.88E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18	13	4/1	11/15	170,742.96E+6	123,314.36E+6
Willamette River OR_SR_1709000701_05_104005	5684	18	13	4/1	11/15	250,323.19E+6	180,788.97E+6
Willamette River OR_SR_1709000703_88_104015	5734	20	NA	6/1	9/30	280,583.54E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20	NA	6/1	9/30	293,012.6E+6	NA
Willamette River OR_SR_1709001201_88_104019	6740	20	NA	6/1	9/30	329,810.44E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20	NA	6/1	9/30	329,810.44E+6	NA

Load allocations assigned to anthropogenic nonpoint sources on any AU or stream location in the Willamette Subbasins are calculated using **Equation 9-3**. The portions of the HUA (ΔT) assigned to nonpoint sources or source categories are presented in Section 9.1.1. When all of the load allocations assigned to a nonpoint source or source category have been achieved, the HUA allocation to that nonpoint source or source category is achieved.

$$LA_{NPS} = (\Delta T) \cdot (Q_R) \cdot C_F$$ **Equation 9-3**

where,

$LA_{NPS} =$ Load allocation to anthropogenic nonpoint sources (kilocalories/day), expressed as a rolling seven-day average.

$\Delta T =$ The portion of the HUA assigned to each nonpoint source category representing the maximum cumulative temperature increase (°C) from all source activity in the nonpoint source category. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

$Q_R =$ The daily average river flow rate (cfs). For a lake, a dilution factor of 1 may be used for Q_R unless determined using another method.

$C_F =$ Conversion factor using flow in cfs: 2,446,665

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

9.1.5 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.

9.1.5.1 Dam and reservoir operations

Dam and reservoir operations have been assigned ~~0.00 °C of the HUA, except for the PGE Willamette Falls Hydroelectric Project (Section 9.1.1), and the equivalent~~a thermal load allocation as calculated using the assigned HUA from Table 9-1 through Table 9-11 using **Equation 9-3**. 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.

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~~Release temperatures less than or equal 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. The estimated free flowing (no dam) temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations. The results may be applied as the temperature surrogate measure or to adjust the 7DADM temperatures monitored immediately upstream of the reservoirs. Use of the model approach for the surrogate measure must be approved by DEQ.

b) Additional adjustments to the surrogate temperature target calculated or measured under item a) may be allowed when all the following are true:

i. Monitoring data shows 7DADM temperatures do not exceed the applicable temperature criteria plus assigned HUA in the AU downstream of the dam;
ii. The protecting cold water criterion at OAR 340-041-0028(11) does not apply. DEQ has evaluated which dams the protecting cold water criterion likely apply in the TSD Section 9.4.1.1;
iii. A cumulative effects analysis, approved by DEQ, demonstrates that dam release water temperatures warmer than the surrogate measure calculated or measured under item a) will result in attainment of the dam and reservoir assigned HUA above the applicable criteria in downstream waters.

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

9.1.5.2 Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in **Table 9-17** and **Table 9-18** represent a surrogate for the amount of solar loading that will attain the HUA 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 DMA (**Equation 9-4**). **Equation 9-4** may be used to recalculate the mean effective shade targets if DMA boundaries change or the DMA boundary needs to be corrected. **Equation 9-4** may also be used to recalculate the mean effective shade targets based on an updated shade gap assessment following the process and methods outlined in the WQMP.

Changes in the target effective shade from the values presented in **Table 9-17** and **Table 9-18** 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, HUA, or the load allocations. They remain the same as presented in this TMDL.

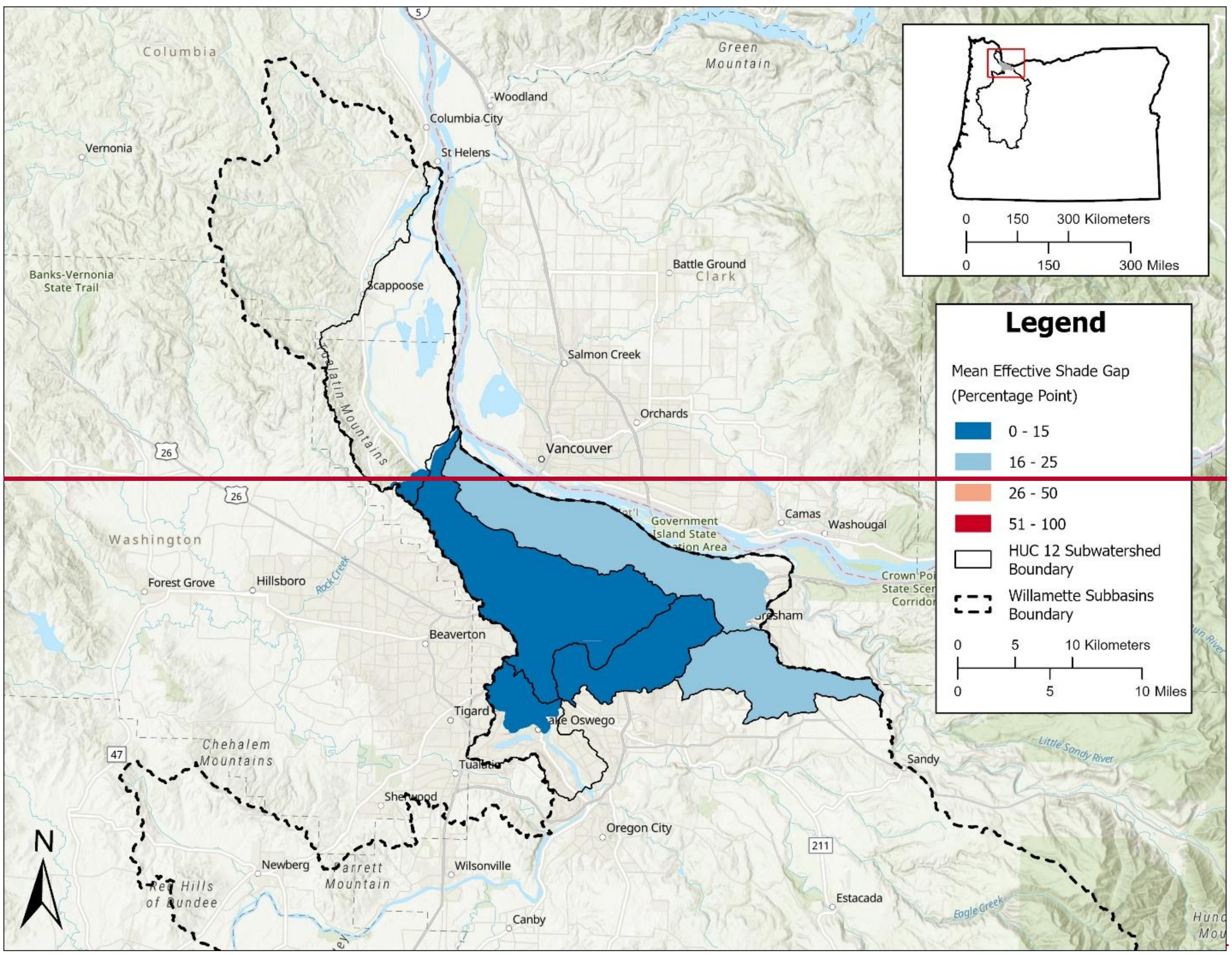
$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i}$$ **Equation 9-4**

Where,

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

Table 9-17: Site specific 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
Clackamas River	36.5	13	37	24
Coast Fork Willamette River	46.7	35	54	19
Fall Creek	11.5	29	47	18
Long Tom River	38.2	25	57	32
Middle Fork Willamette River	26.6	16	26	10
Molalla River	75.36	27	41	14
North Santiam River	79.6	19	34	15
Pudding River	85.55	44	52	8
Row River	12.2	24	54	30
Santiam River	19.5	11	19	8
South Santiam River	58.4	7	21	14
Willamette River	257.8	11	20	9



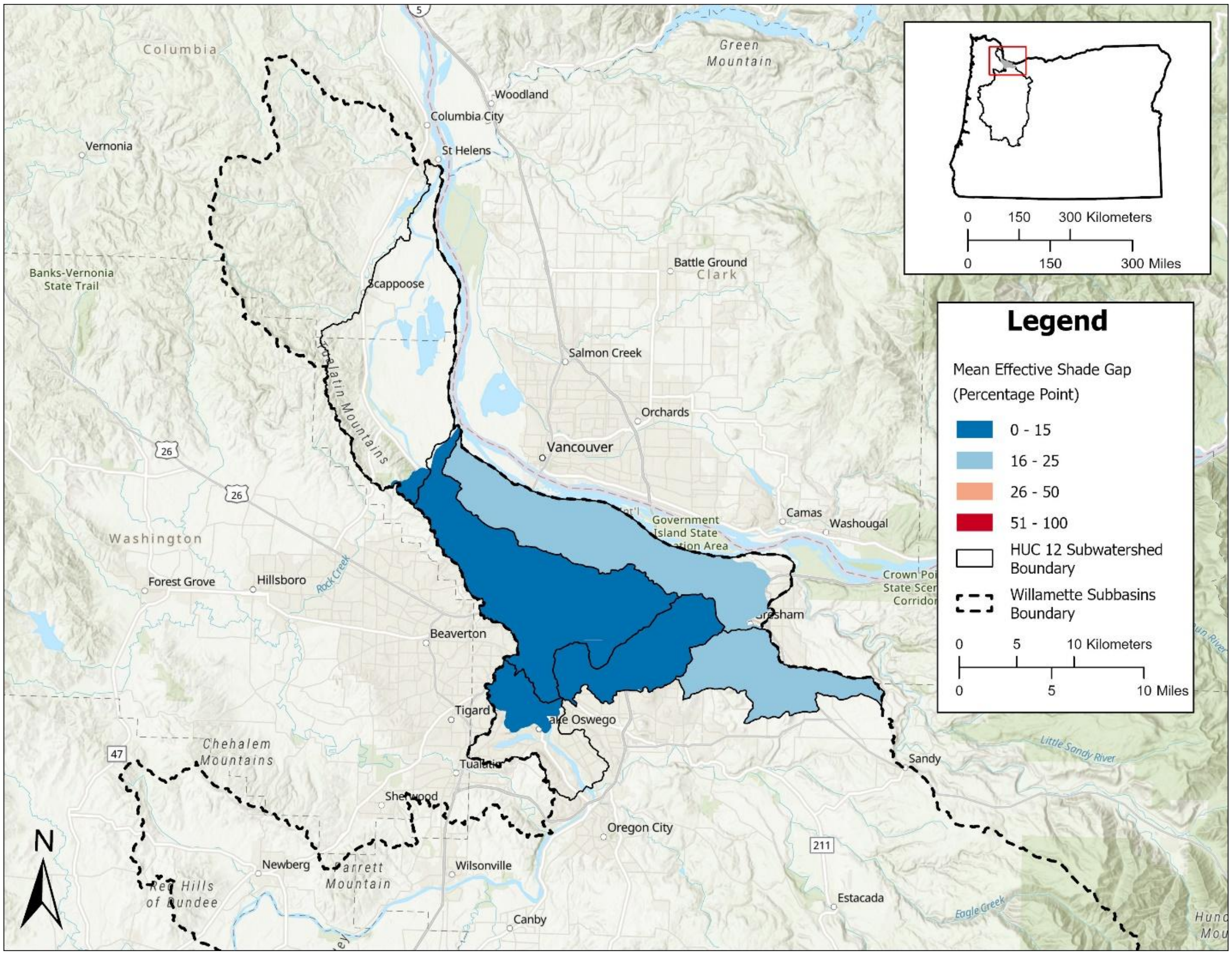
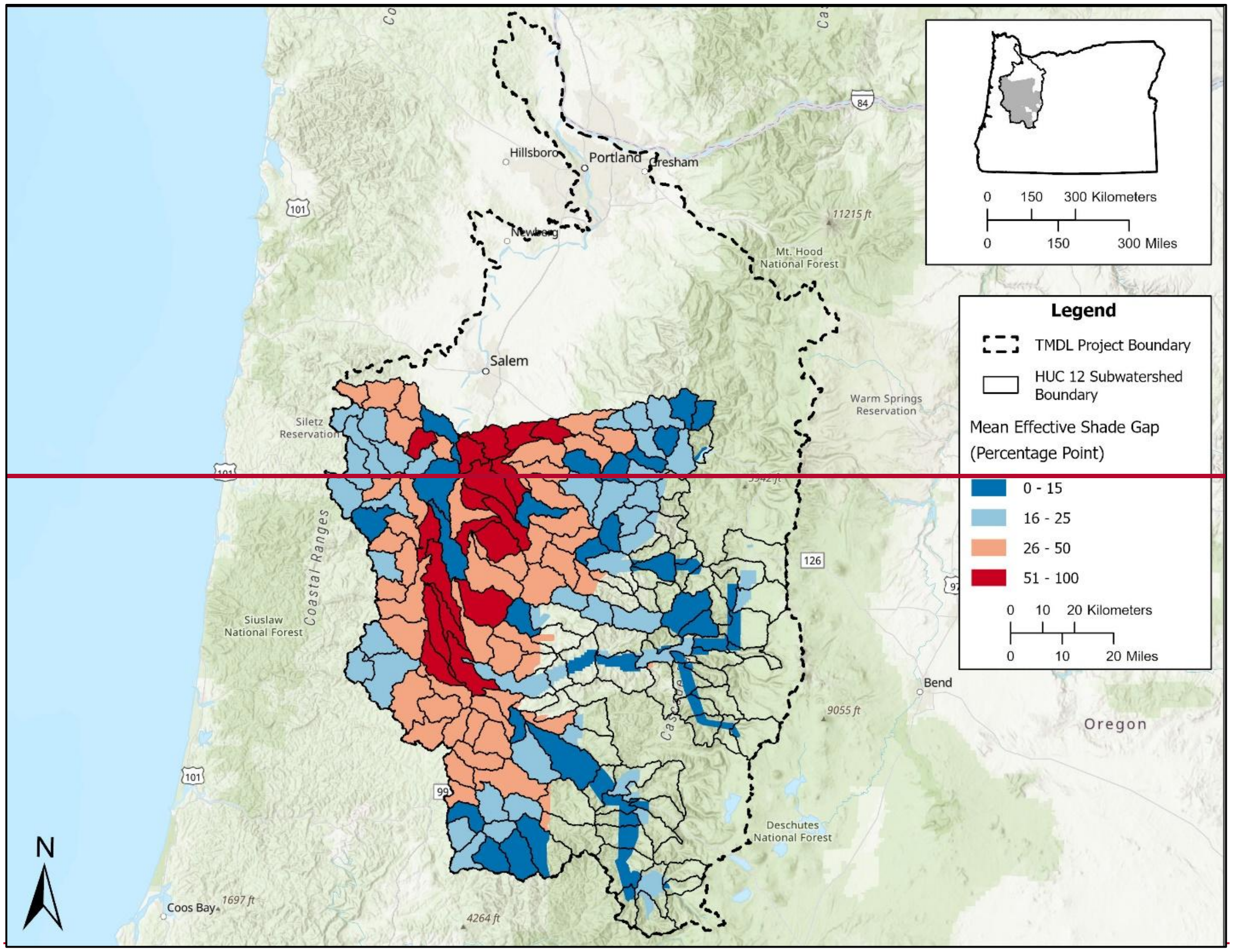


Figure 9-1: Lower Willamette Subbasin model area and mean effective shade gap for each HUC12 subwatershed within the model extent.



Legend
TMDL Project Boundary
HUC 12 Subwatershed Boundary
Mean Effective Shade Gap (Percentage Point)
0 - 15
16 - 25
26 - 50
51 - 100
0 10 20 Kilometers
0 10 20 Miles
0 150 300 Kilometers
0 150 300 Miles
Hillsboro
Portland
Gresham
Newberg
Salem
Mt. Hood National Forest
Warm Springs Reservation
Siletz Reservation
Siuslaw National Forest
Coastal Ranges
Bend
Oregon
Deschutes National Forest
Coos Bay
N

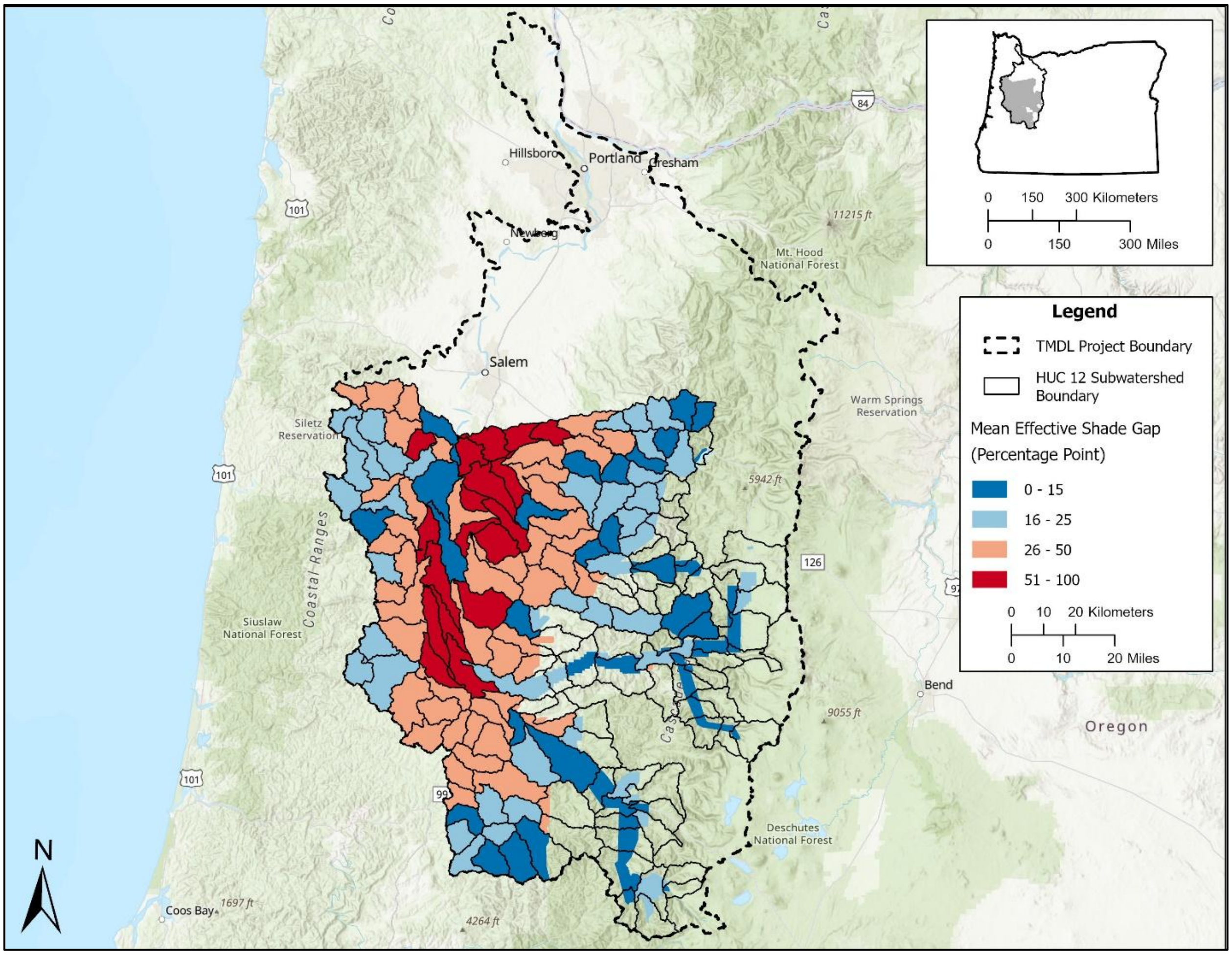


Figure 9-2: Southern Willamette model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-18: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in all model areas in the Willamette Subbasins.

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Albany & Eastern Railroad	0.3	71	74	3
BNSF	0.1	35	42	7
Benton County	122.3	54	85	31
Bonneville Power Administration	2.3	34	94	60
Central Oregon & Pacific Railroad	0.2	32	75	43
City of Adair Village	2	27	93	66
City of Albany	54.4	27	55	28
City of Aurora	0.2	28	33	5
City of Brownsville	4	28	67	39
City of Canby	3.9	23	38	15
City of Coburg	2.8	22	91	69
City of Corvallis	76.4	40	63	23

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
City of Cottage Grove	19.1	40	67	27
City of Creswell	5.3	19	77	58
City of Dundee	0.1	19	16	-3
City of Eugene	161.7	21	62	41
City of Fairview	0.1	21	54	33
City of Falls City	9	56	96	40
City of Gates	8.2	30	60	30
City of Gladstone	3.8	11	35	24
City of Gresham	16	63	81	18
City of Halsey	1.6	8	87	79
City of Happy Valley	2.7	36	58	22
City of Harrisburg	4.1	10	27	17
City of Independence	2.4	14	22	8
City of Jefferson	5.9	22	40	18
City of Junction City	11.6	9	85	76
City of Keizer	3.1	12	18	6
City of Lake Oswego	5.8	83	90	7
City of Lebanon	18.8	25	61	36
City of Lowell	2.7	33	90	57
City of Lyons	4.4	21	43	22
City of McMinnville	0.1	15	20	5
City of Mill City	8	20	53	33
City of Millersburg	19.5	21	59	38
City of Milwaukie	2.9	62	80	18
City of Molalla	0.1	5	29	24
City of Monmouth	0.5	82	89	7
City of Monroe	3.5	27	50	23
City of Newberg	0.7	5	19	14
City of Oakridge	9.2	28	75	47
City of Oregon City	0.7	2	12	10
City of Philomath	7.6	37	88	51
City of Portland	127.4	61	73	12
City of Salem	14.5	12	24	12
City of Scio	1.7	51	59	8
City of Springfield	55.4	21	59	38
City of Stayton	10.2	24	43	19
City of Sweet Home	34.3	17	50	33
City of Tangent	10.9	48	82	34
City of Veneta	8.7	50	95	45
City of Waterloo	0.5	27	46	19
City of West Linn	2.1	4	11	7
City of Westfir	3.1	29	80	51
City of Wilsonville	4.3	10	13	3
Clackamas County	27.8	42	62	20
Lane County	879.7	41	71	30
Lincoln County	0.2	9	96	87
Linn County	224.9	30	62	32
Marion County	60.8	30	53	23

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Multnomah County	9.7	75	90	15
Oregon Department of Agriculture	5505.7	28	69	41
Oregon Department of Aviation	0.2	4	66	62
Oregon Department of Fish and Wildlife	21.8	24	58	34
Oregon Department of Forestry - Private	8684.7	69	94	25
Oregon Department of Forestry - Public	530.1	84	96	12
Oregon Department of Geology and Mineral Industries	8.2	27	57	30
Oregon Department of State Lands	7	25	40	15
Oregon Department of Transportation	81.6	26	55	29
Oregon Military Department	0.2	0	86	86
Oregon Parks and Recreation Department	95.7	19	30	11
Polk County	65.9	47	87	40
Port of Coos Bay	1.9	56	93	37
Port of Portland	2.1	29	45	16
Portland & Western Railroad	2.6	37	52	15
State of Oregon	12.5	14	25	11
U.S. Army Corps of Engineers	83.5	46	70	24
U.S. Bureau of Land Management	2607.9	87	95	8
U.S. Department of Agriculture	1.2	29	49	20
U.S. Department of Defense	1.5	47	85	38
U.S. Fish and Wildlife Service	43.5	36	62	26
U.S. Forest Service	2985.4	84	95	11
U.S. Government	15.8	33	53	20
Union Pacific Railroad	7.5	35	52	17
Yamhill County	2.1	11	12	1

9.1.5.3 Effective shade curve surrogate measure

Effective shade surrogate measure targets represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for nonpoint sources managing streamside vegetation. Effective shade curves are applicable to any stream that does not have site specific shade targets (Section 9.1.5.2). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented within the effective shade curves (**Figure 9-5** to **Figure 9-26**) 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 is summarized in **Table 9-19**. See the TSD Appendix A: Heat Source Model Report and Appendix C: Potential Near-Stream Land Cover 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 this TMDL document provides tables of the plotted shade curve values. ~~A~~Links to a GIS map of all mapping units in the Willamette Basin can be found in the TSD Appendix H: Willamette Subbasins Interactive TMDL Map. This is an interactive HTML map that can be opened in an internet browser.

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. Where natural disturbances prevent achievement of the target effective shade, DEQ will work with the DMAs to develop plans to restore riparian vegetation.

Table 9-19: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets for each mapping unit.

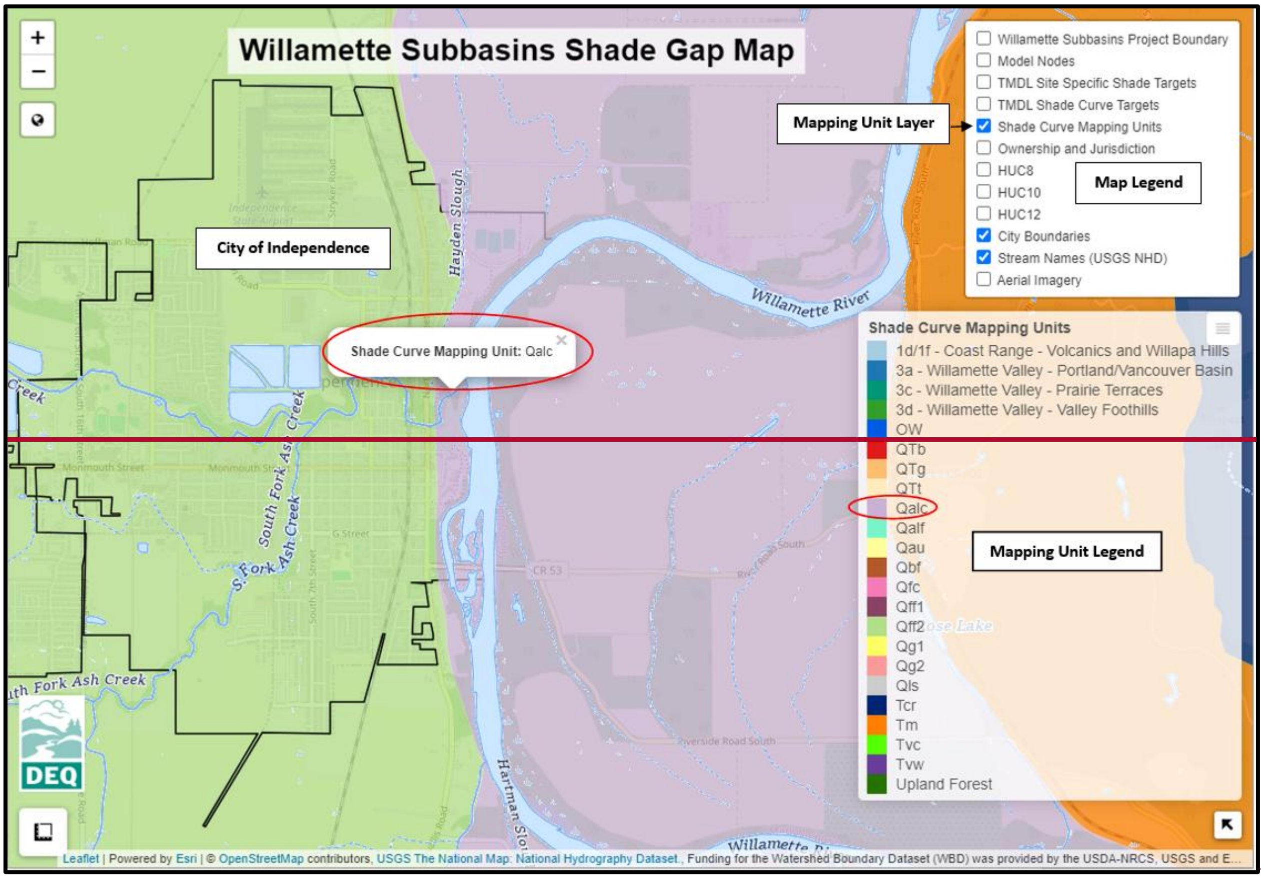
Mapping Unit	Height (m)	Height (ft)	Density (%)	Overhang (m)	Buffer Width (m)
Qff1	40.7	134	70	4.9	36.8
Qfc	37.7	124	64	4.5	36.8
Qalc	26.9	88	71	3.2	36.8
Qg1	21.6	71	64	2.6	36.8
Qau	22.6	74	69	2.7	36.8
Qalf	17.5	57	68	2.1	36.8
Qff2	21.5	71	66	2.6	36.8
Qbf	22.0	72	68	2.6	36.8
Tvc	27.8	91	65	3.3	36.8
Qtg	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 Creek watershed, in the City of Independence, along the west bank of a tributary to the Willamette River. Open the

Willamette Subbasins Interactive TMDL Map (TSD Appendix H) and select the Shade Curve Mapping Units Layer in the Map Legend to add it to the map. You may also want to select the City Boundaries Layer and the Stream Names Layer to help identify your site of interest. Once you have identified your site of interest, click that point on the map and you will see a pop-up box that identifies the Shade Curve Mapping Unit for that point. In this example, you identify the mapping unit at your site to be Qalc (Quaternary alluvium floodplain deposits) (**Figure 9-3**).



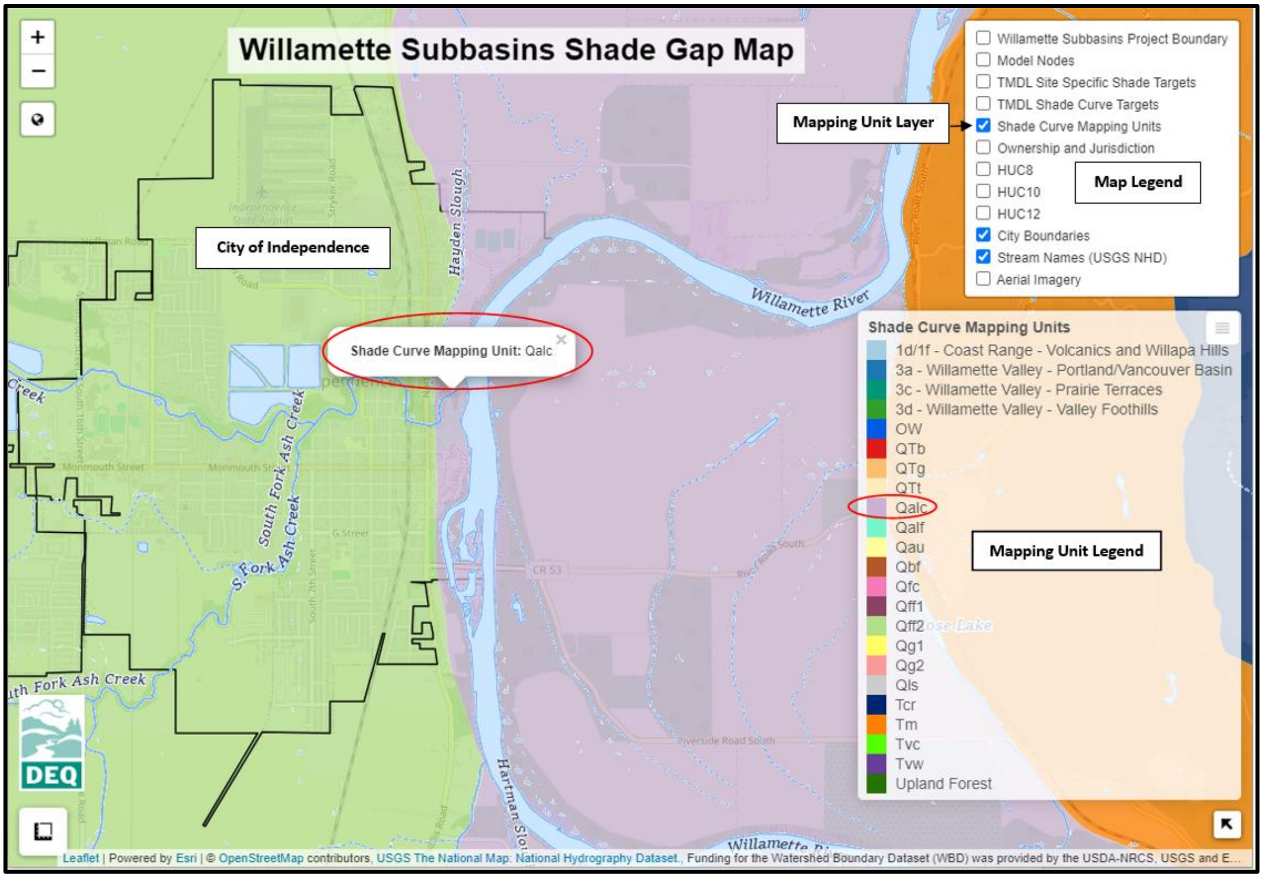


Figure 9-3: Mapping units in the example area of interest from the Willamette Subbasins Interactive TMDL Map.

2. Determine the stream aspect from north.

   Example: Standing in-stream mid-channel, facing north you 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 ft.

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 surrogate measure effective shade target of that stream reach location.

   Example: You have determined that the appropriate shade curve mapping unit for your site is Qalc (**Figure 9-4**). Since you are located on a tributary with an East-West stream aspect and an active channel width of 25 ft, you use the dotted 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 ft (26.9 m), and the stand density (canopy density) as 71%.

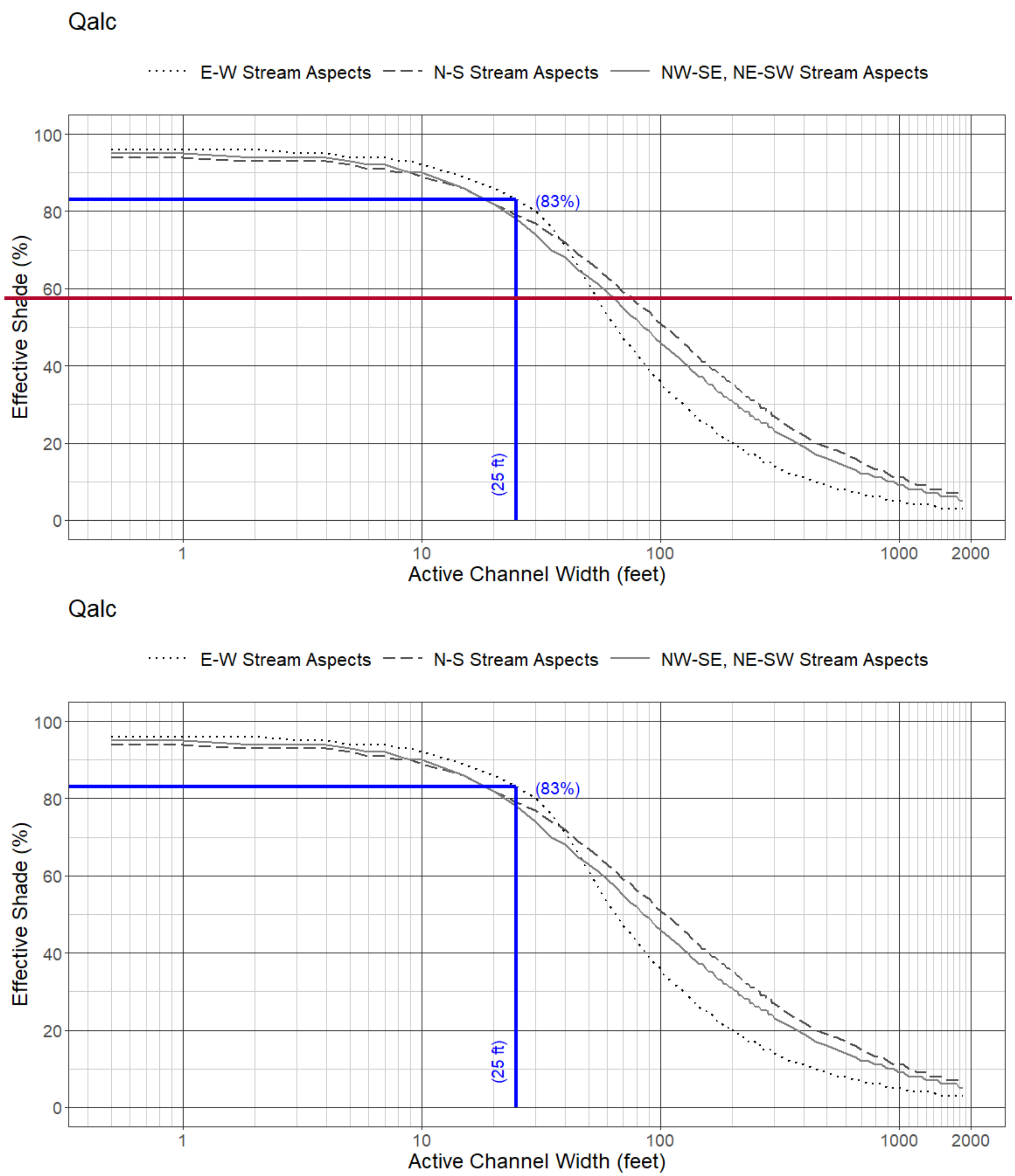
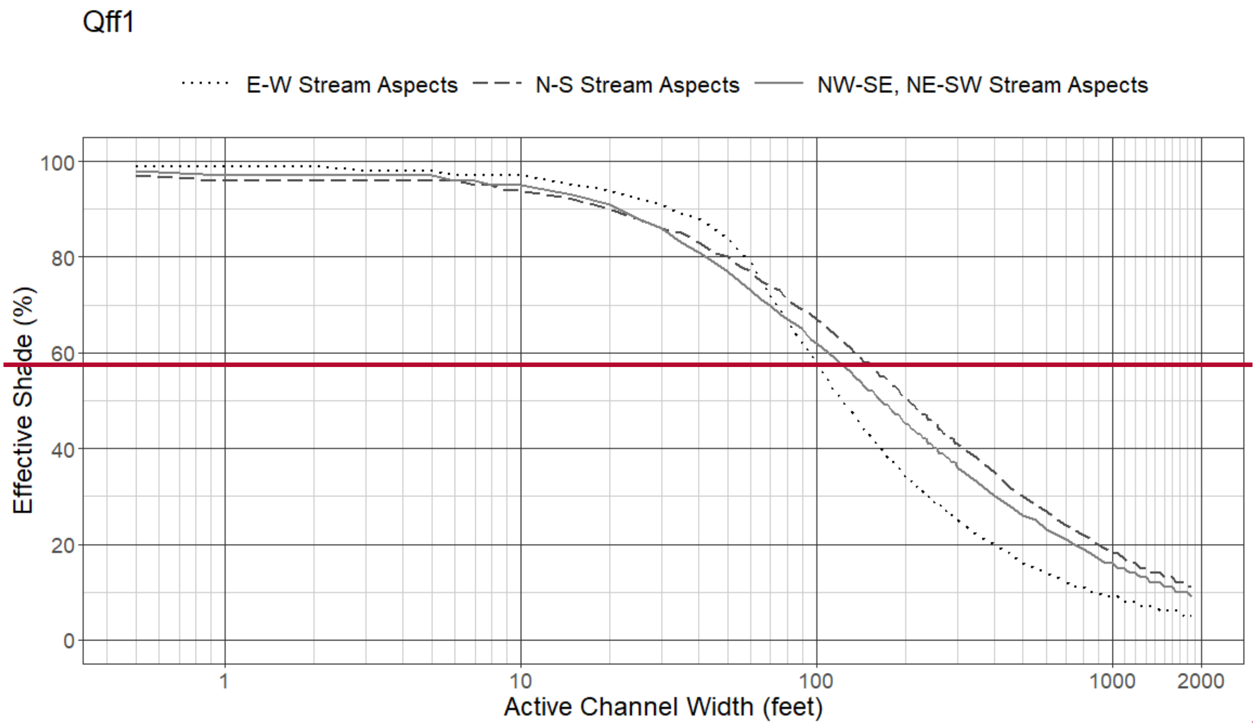


Figure 9-4: Example illustrating use of the shade curve for the Qalc mapping unit based on an east to west aspect and an active channel width of 25 ft.



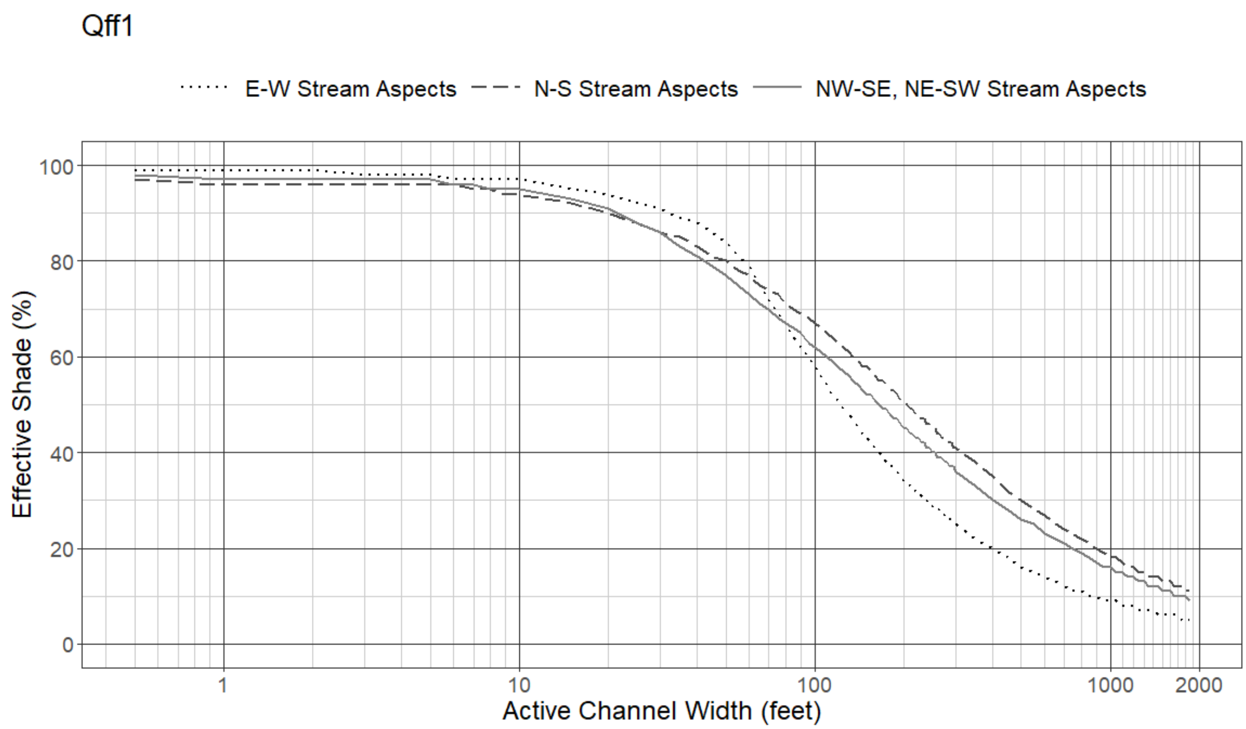
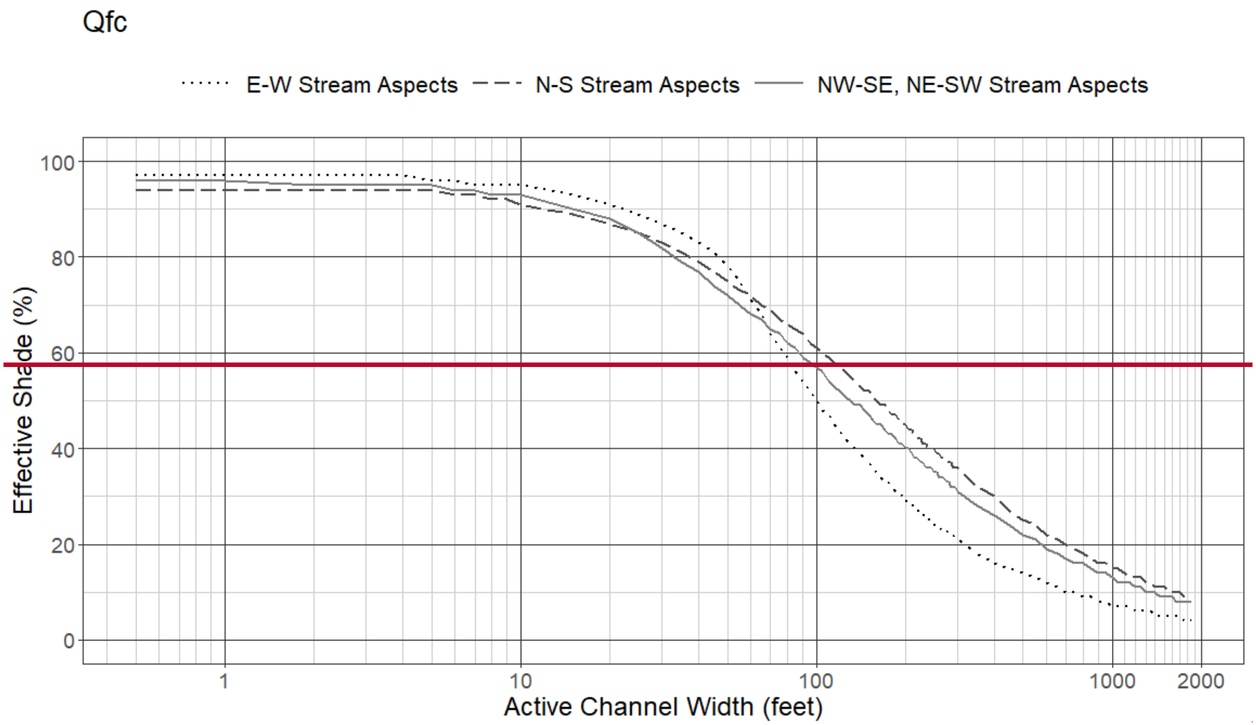


Figure 9-5: Effective shade targets for stream sites in the Qff1 mapping unit.



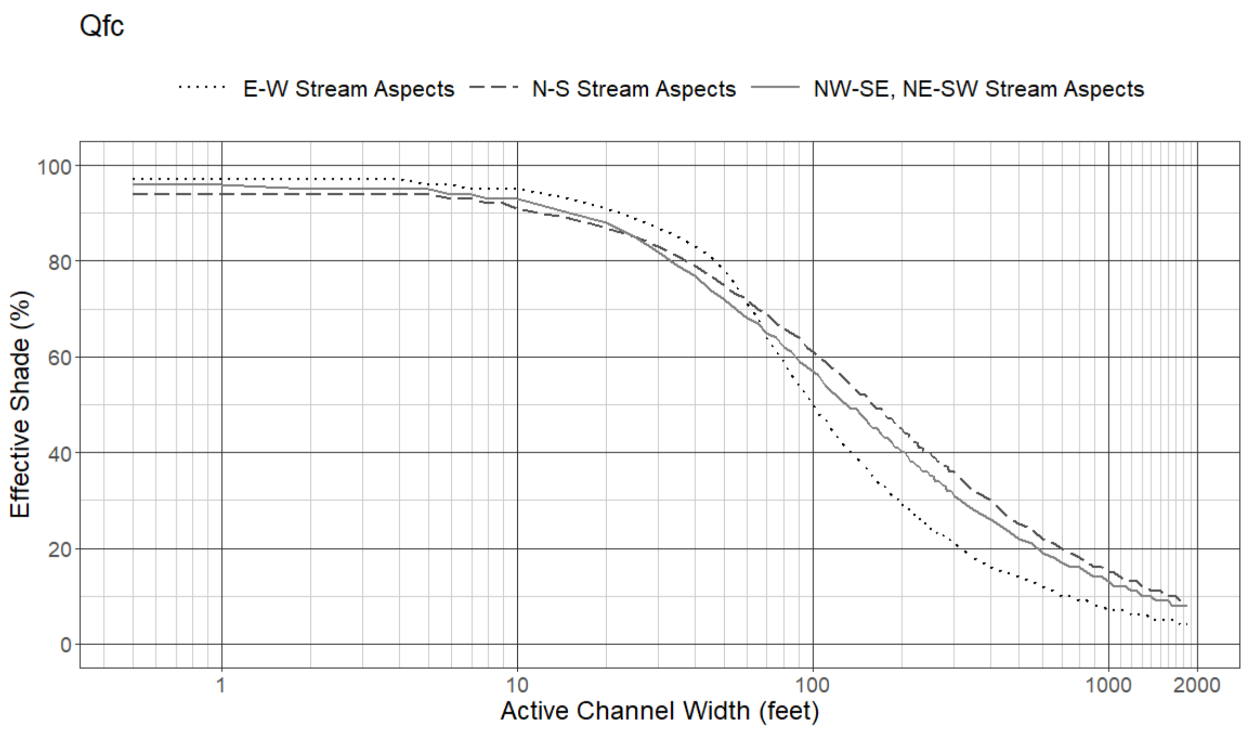
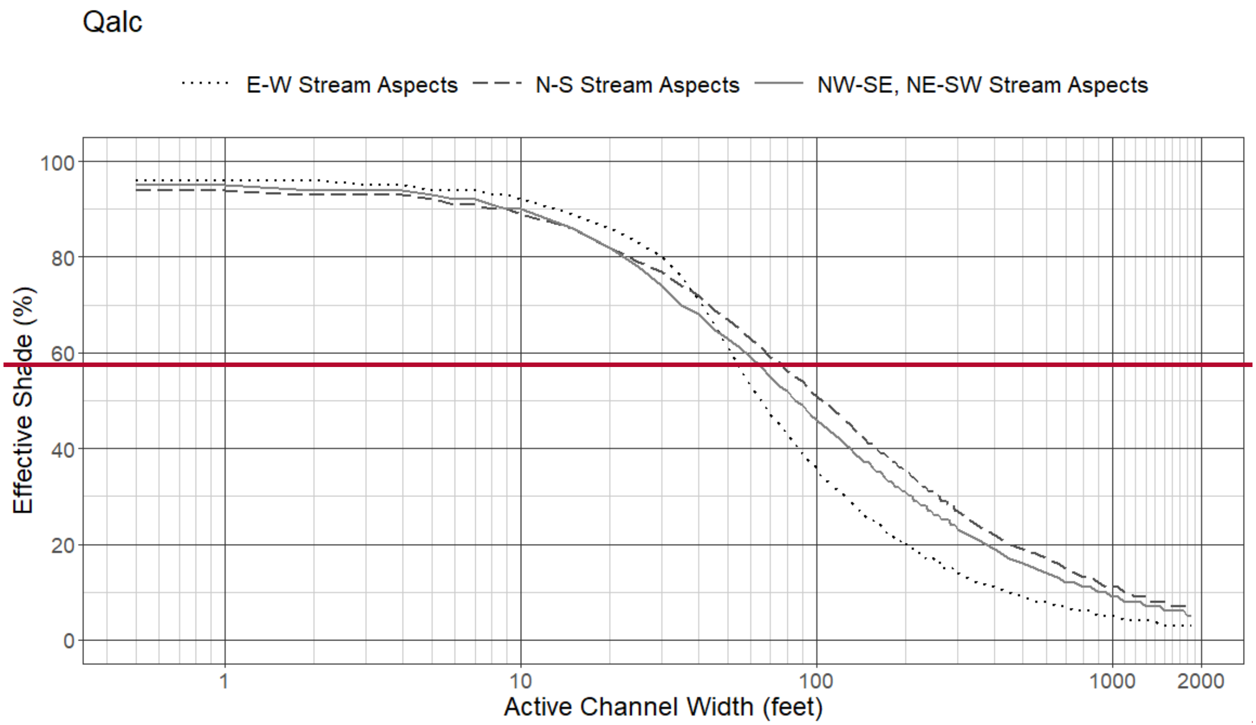


Figure 9-6: Effective shade targets for stream sites in the Qfc mapping unit.



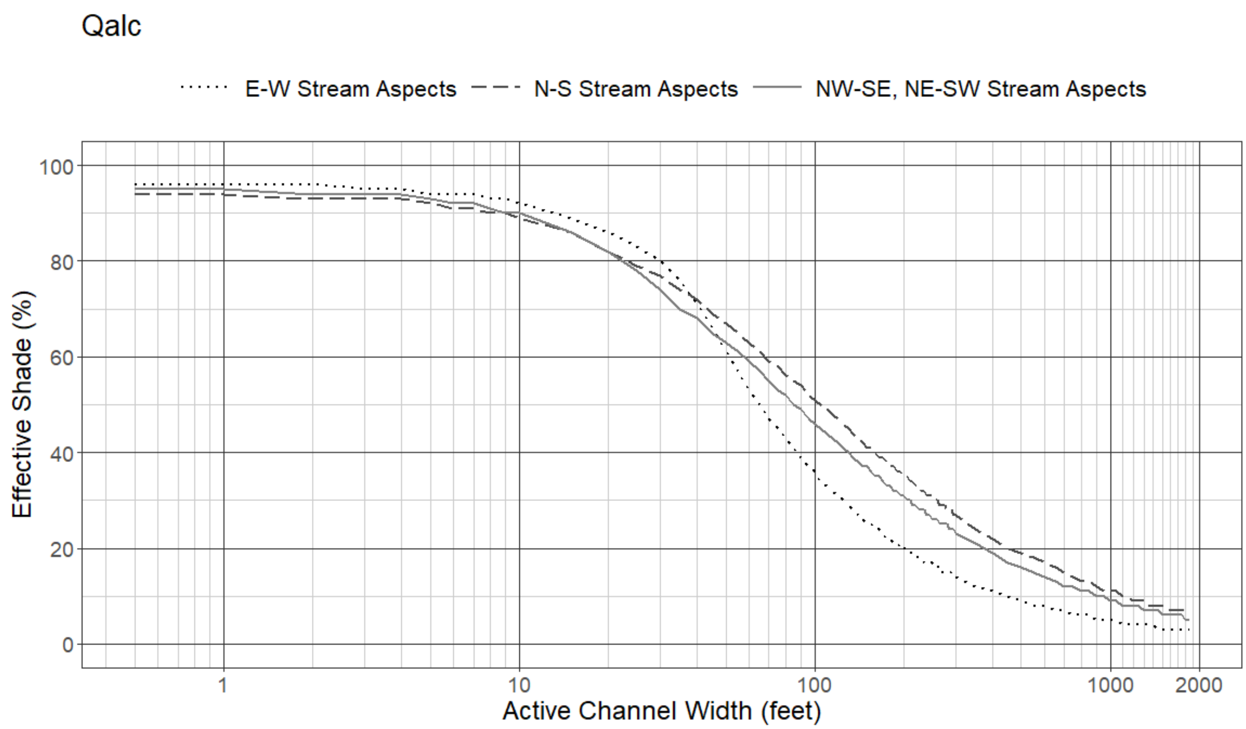
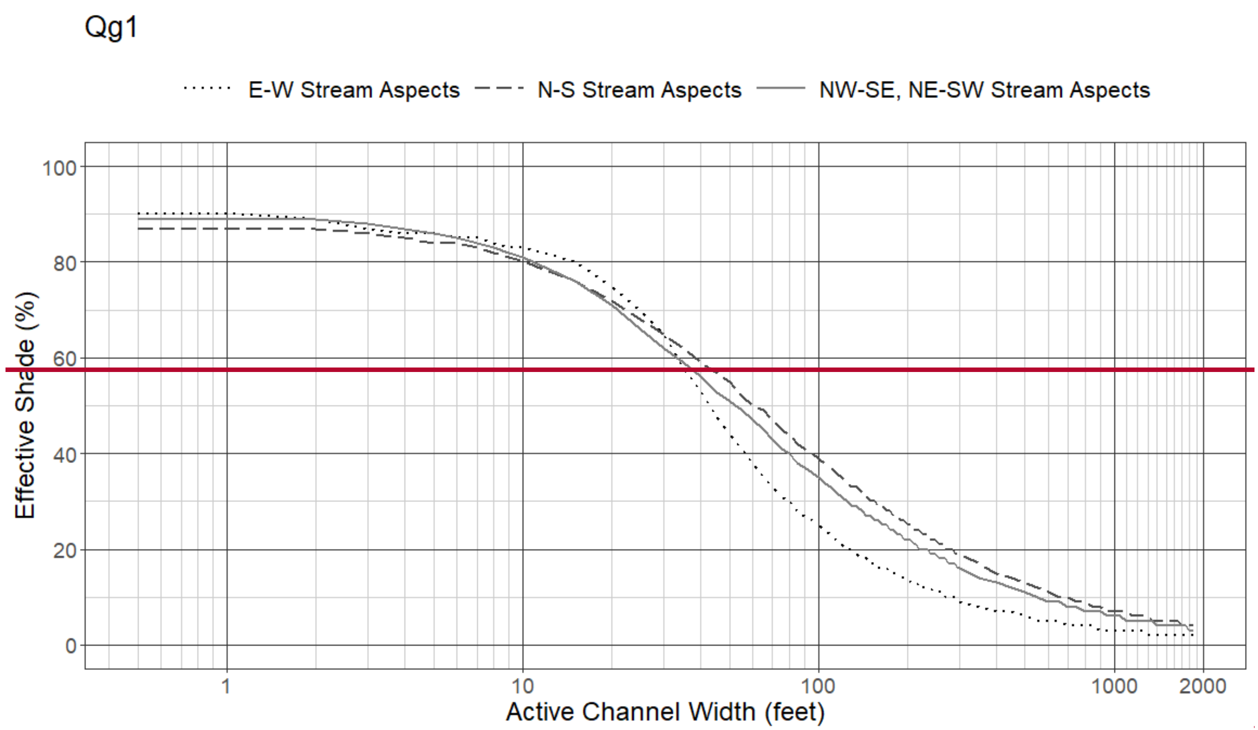


Figure 9-7: Effective shade targets for stream sites in the Qalc mapping unit.



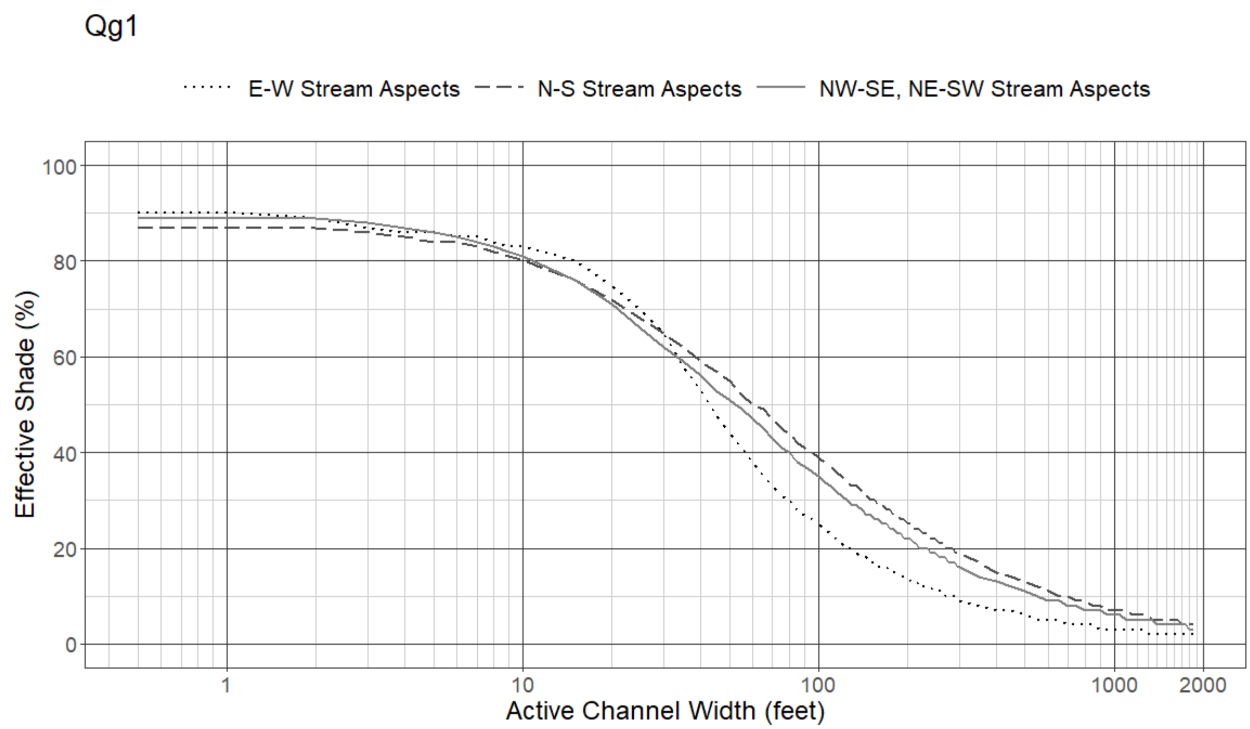
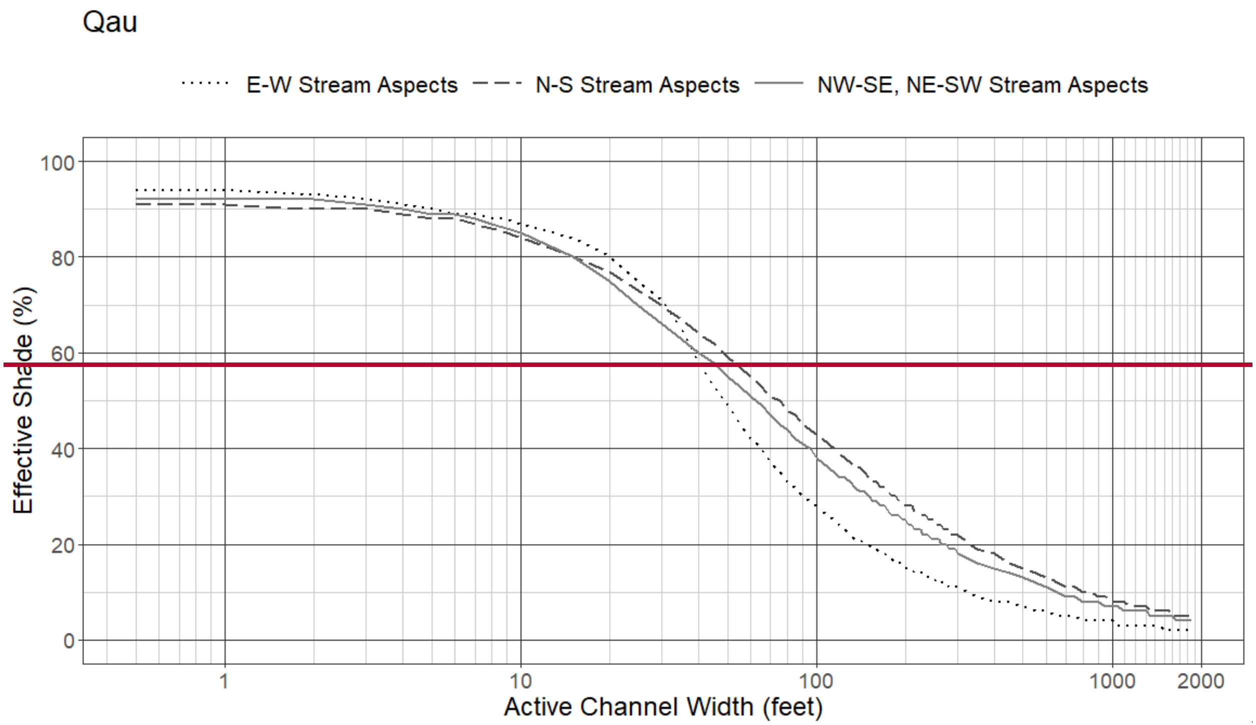


Figure 9-8: Effective shade targets for stream sites in the Qg1 mapping unit.



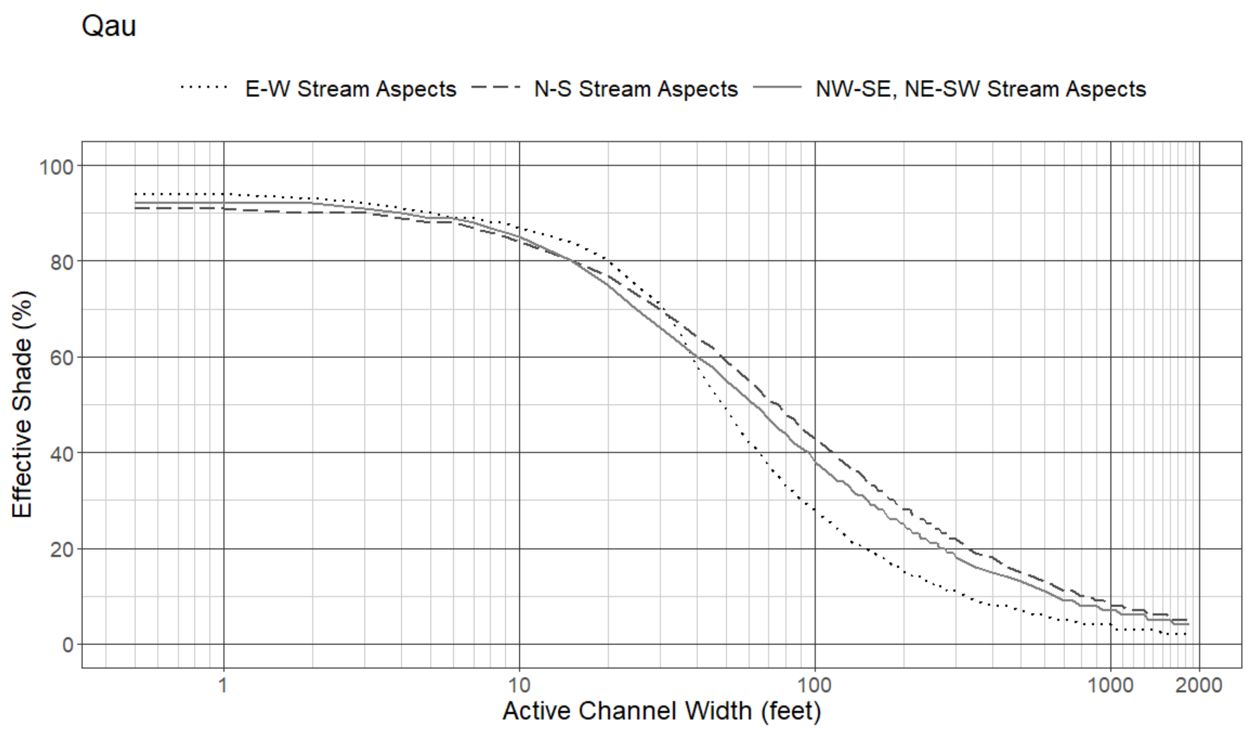


Figure 9-9: Effective shade targets for stream sites in the Qau mapping unit.

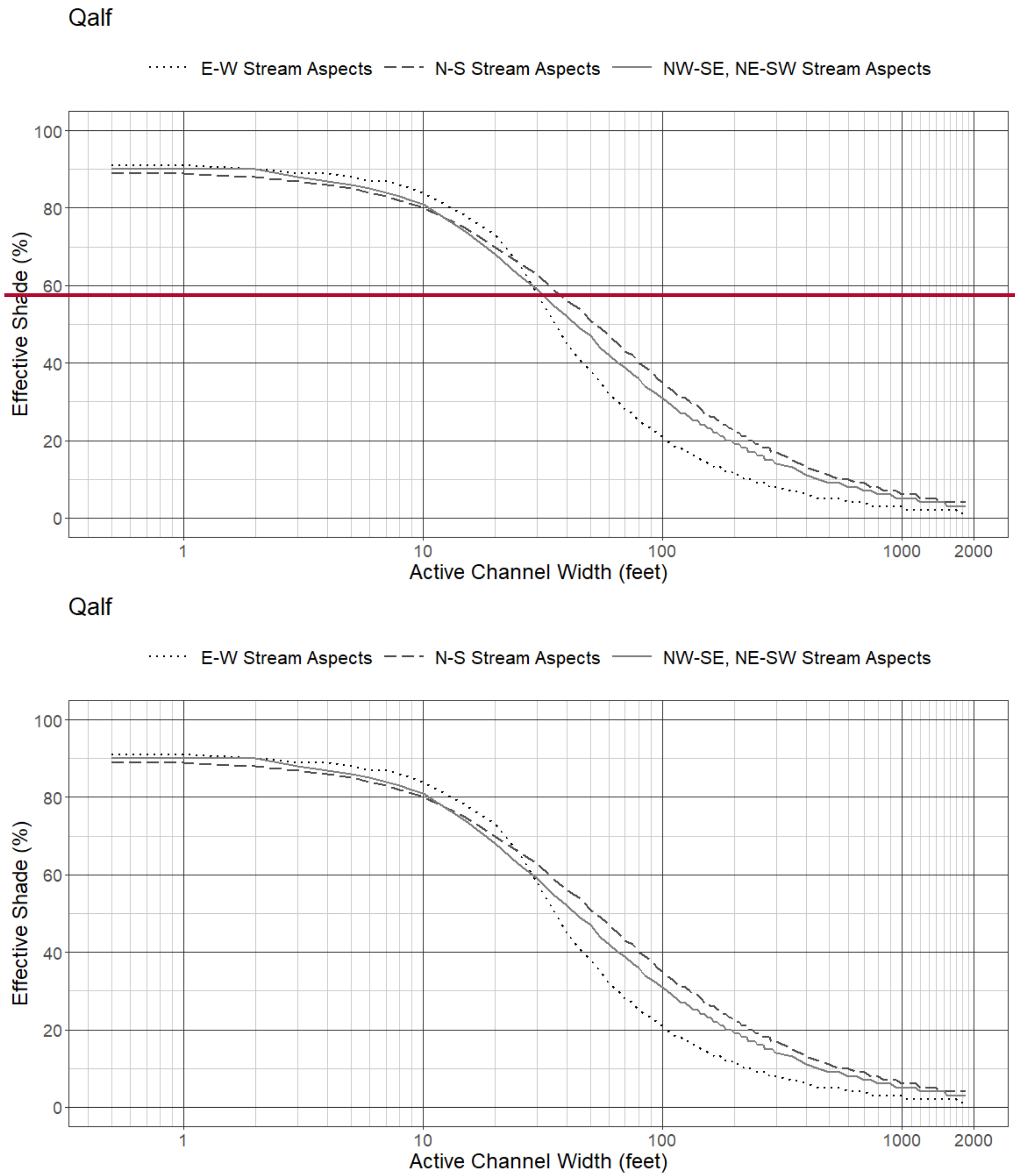
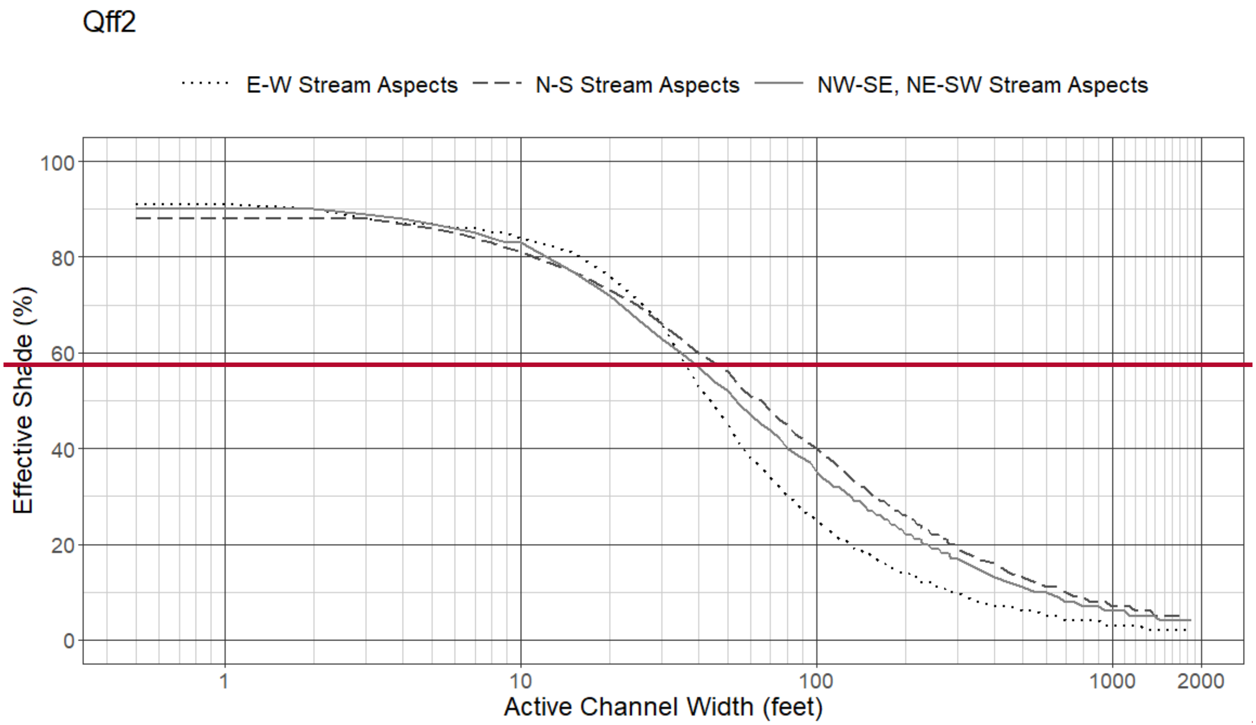


Figure 9-10: Effective shade targets for stream sites in the Qalf mapping unit.



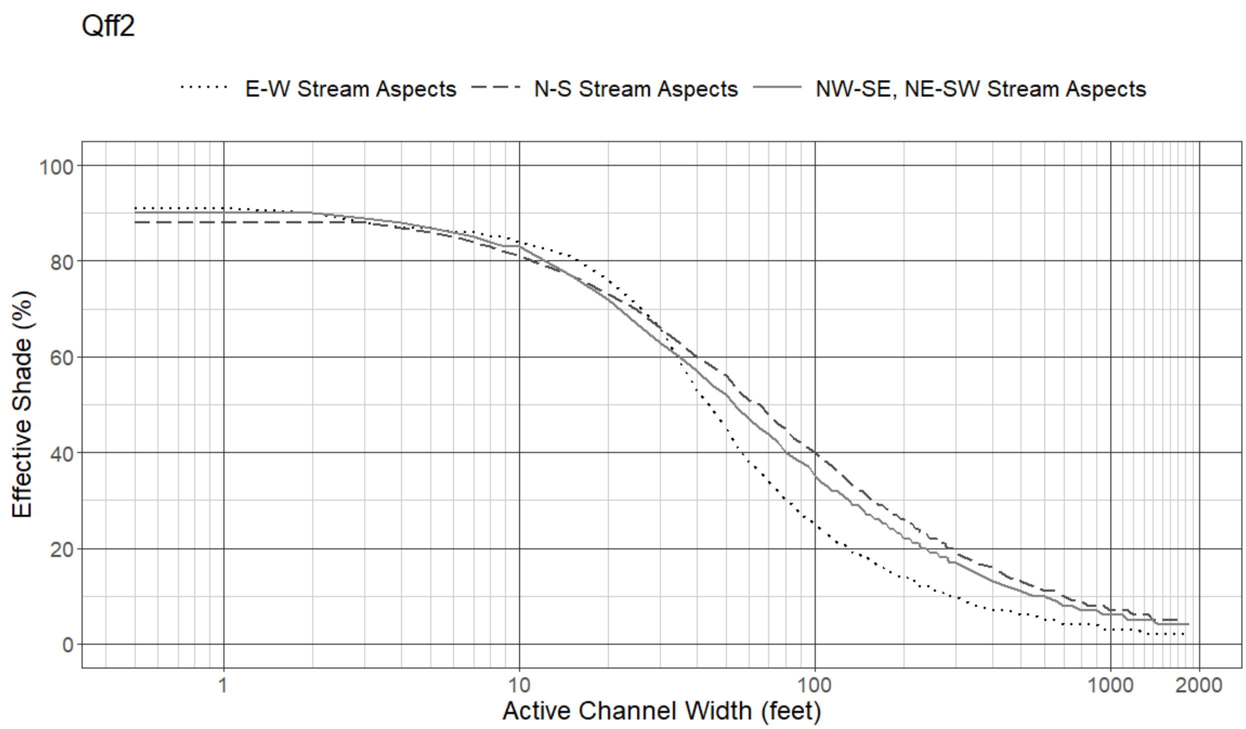


Figure 9-11: Effective shade targets for stream sites in the Qff2 mapping unit.

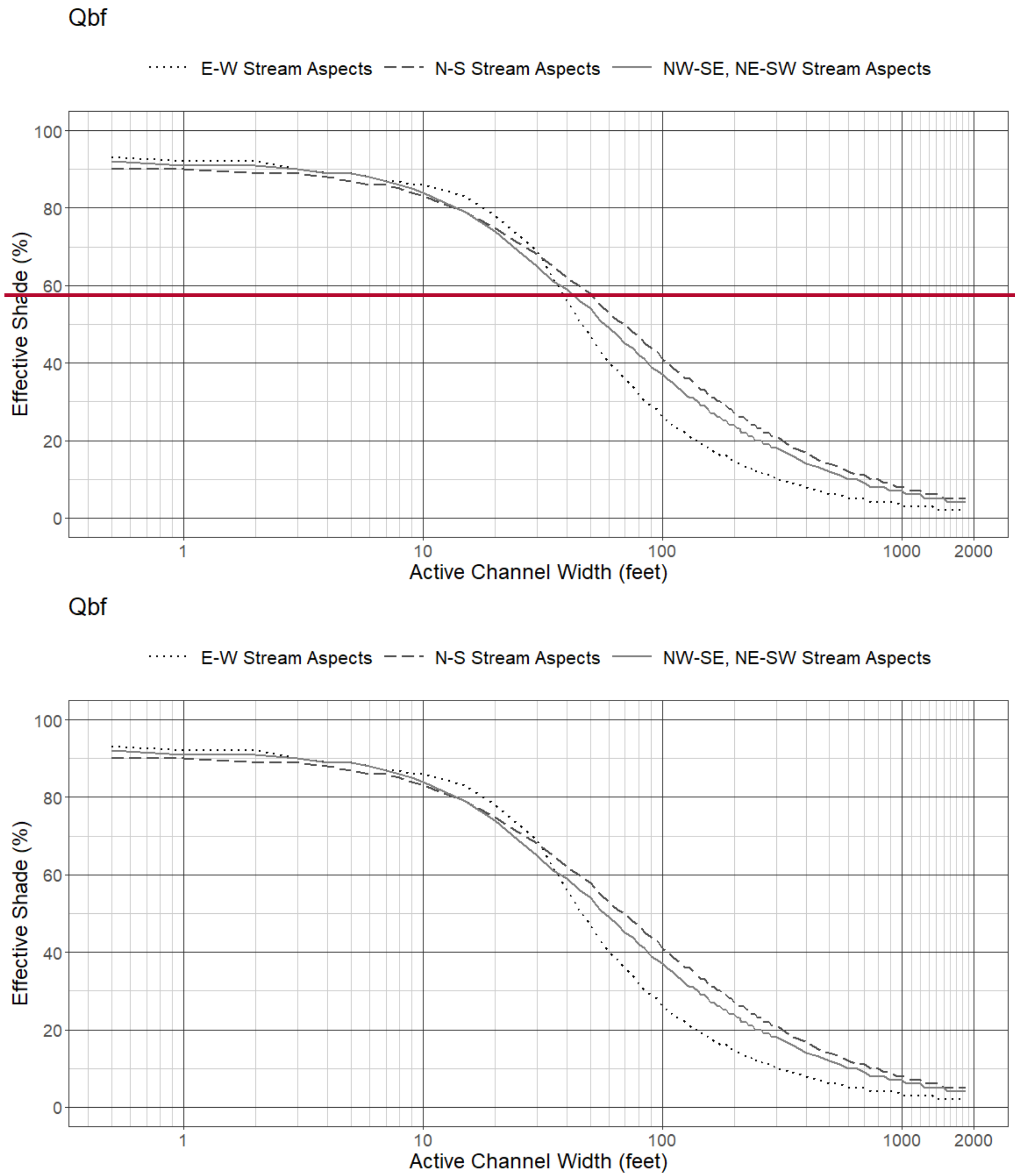
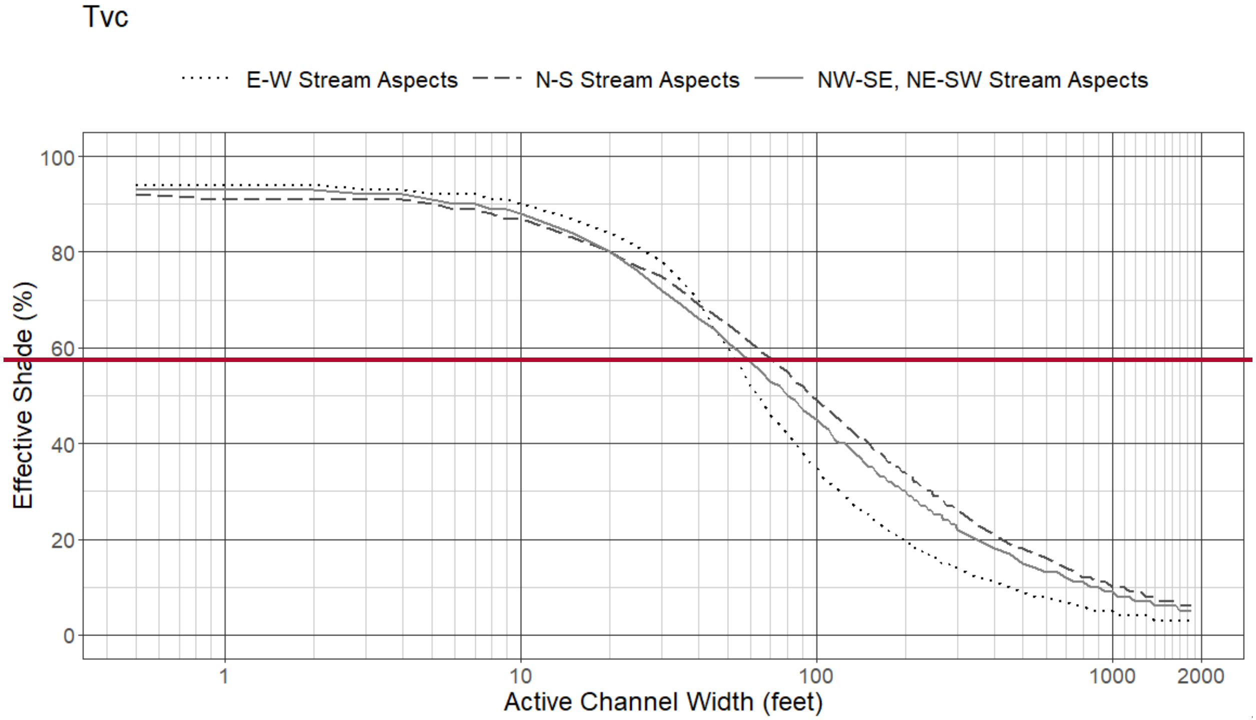


Figure 9-12: Effective shade targets for stream sites in the Qbf mapping unit.



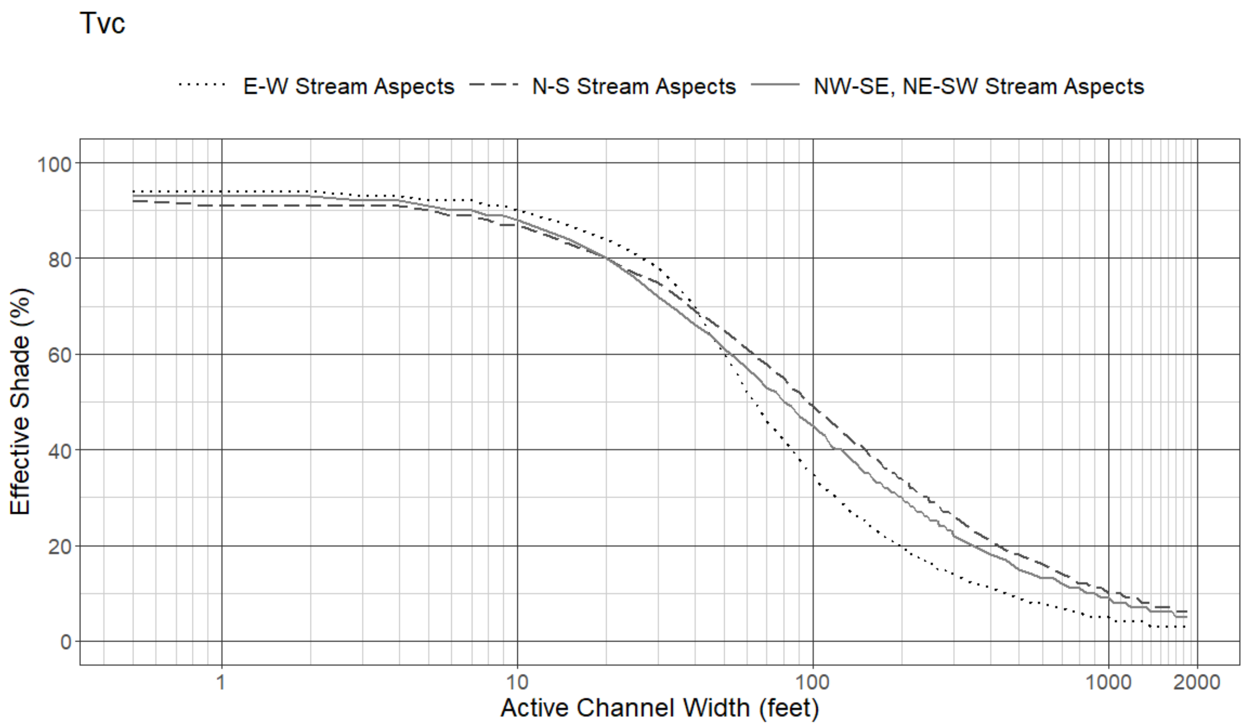
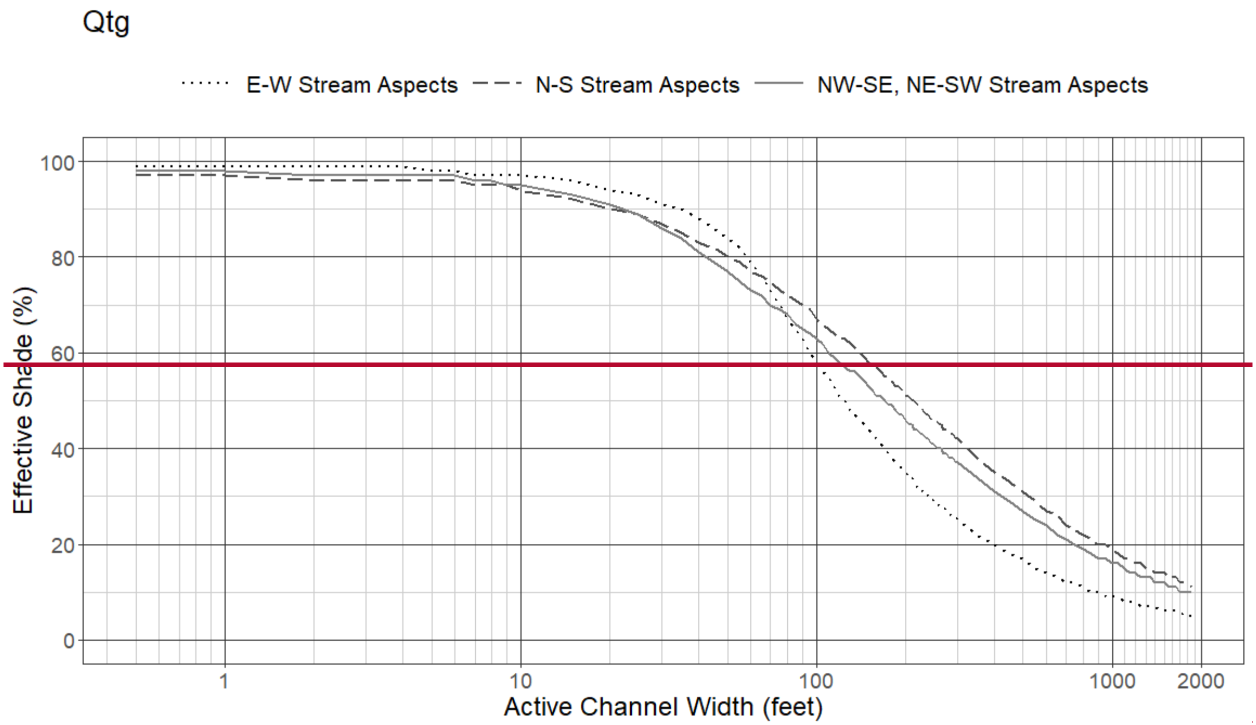


Figure 9-13: Effective shade targets for stream sites in the Tvc mapping unit.



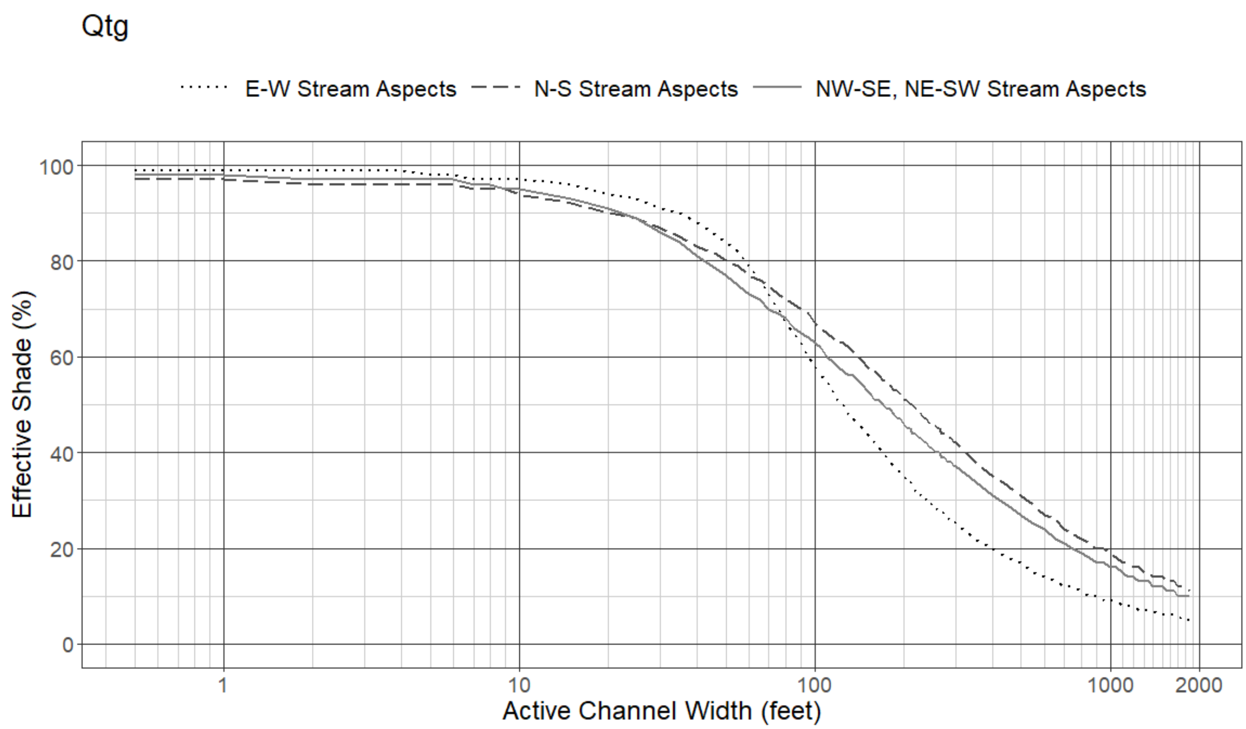


Figure 9-14: Effective shade targets for stream sites in the Qtg mapping unit.

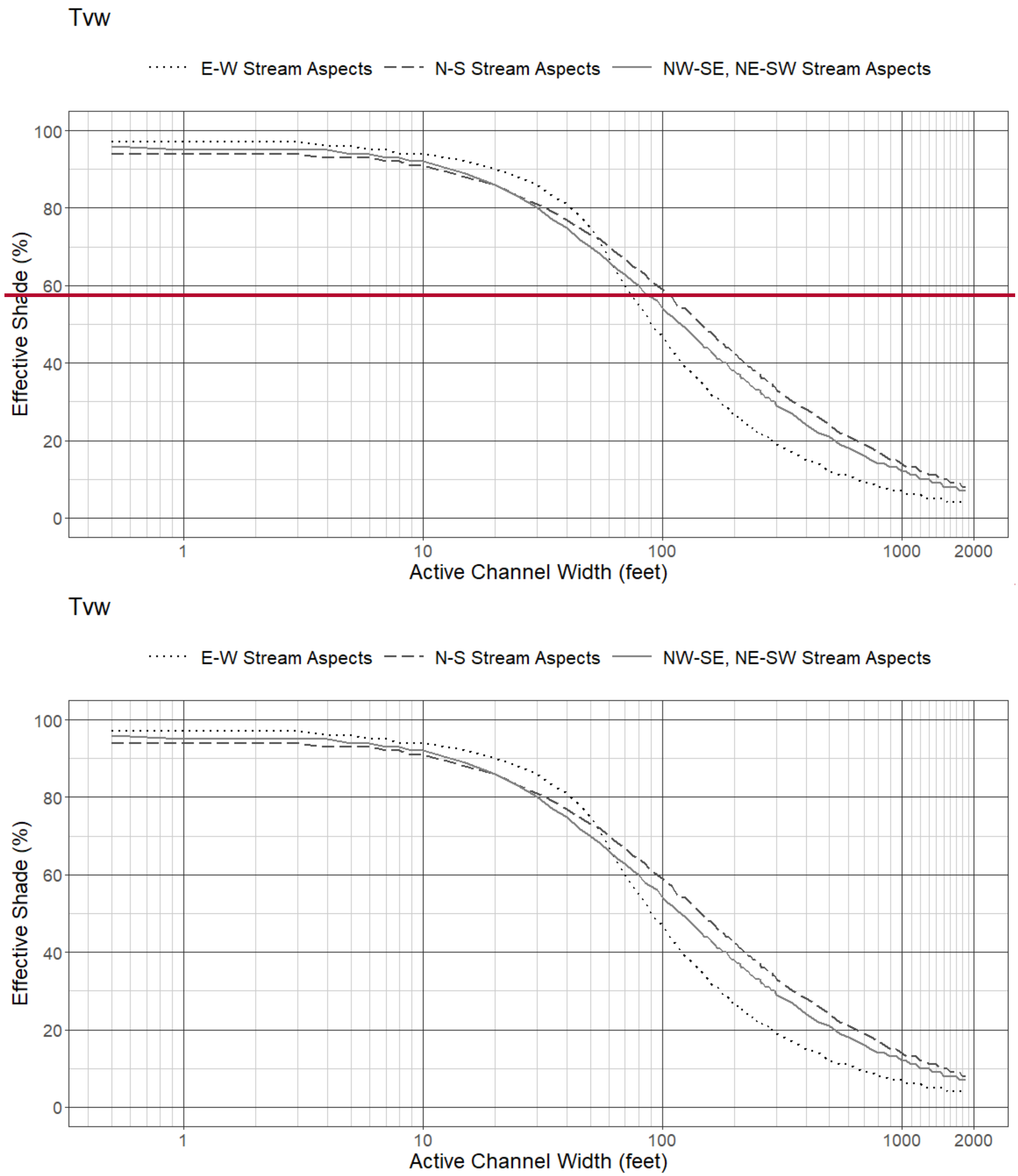


Figure 9-15: Effective shade targets for stream sites in the Tvw mapping unit.

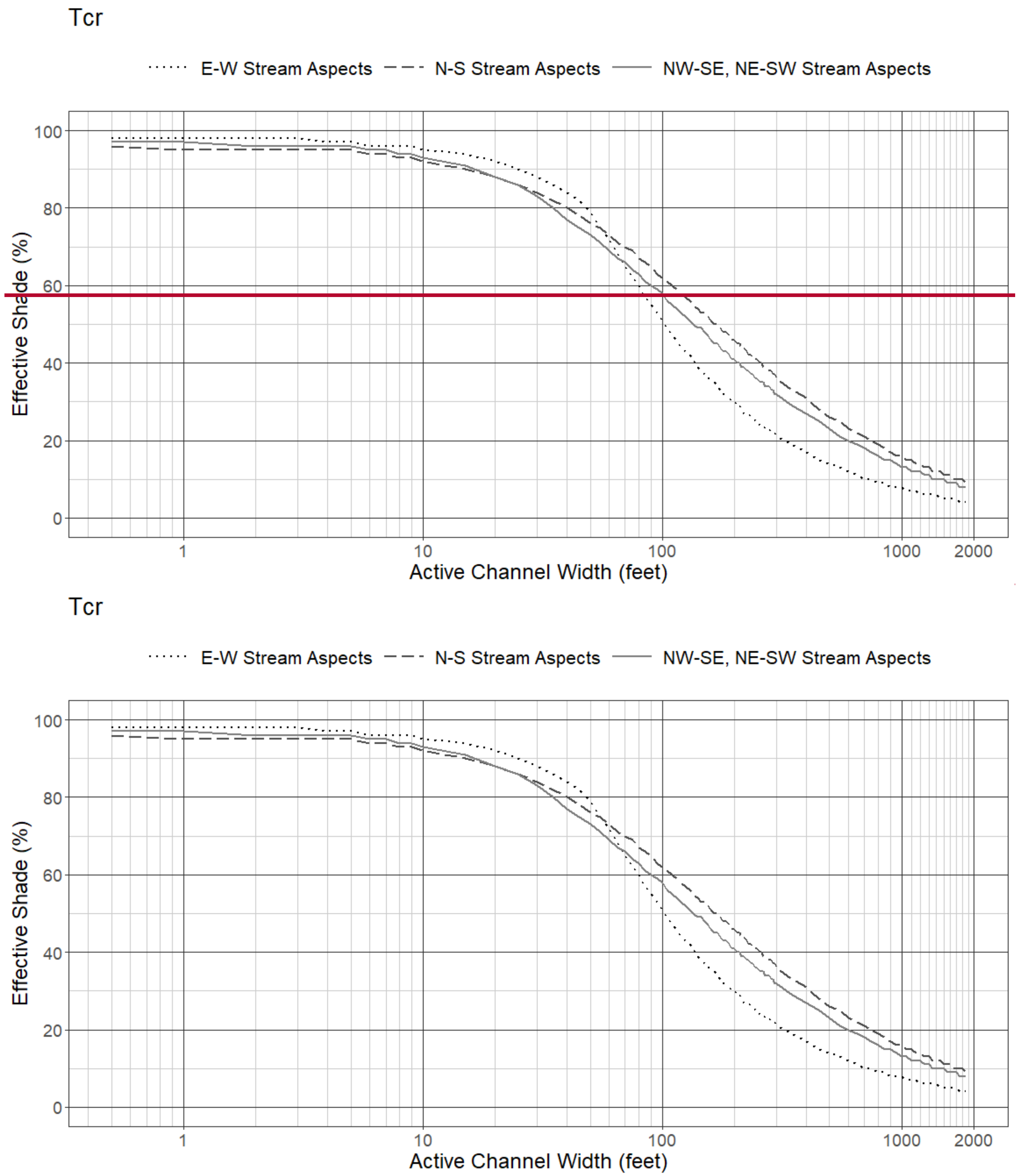
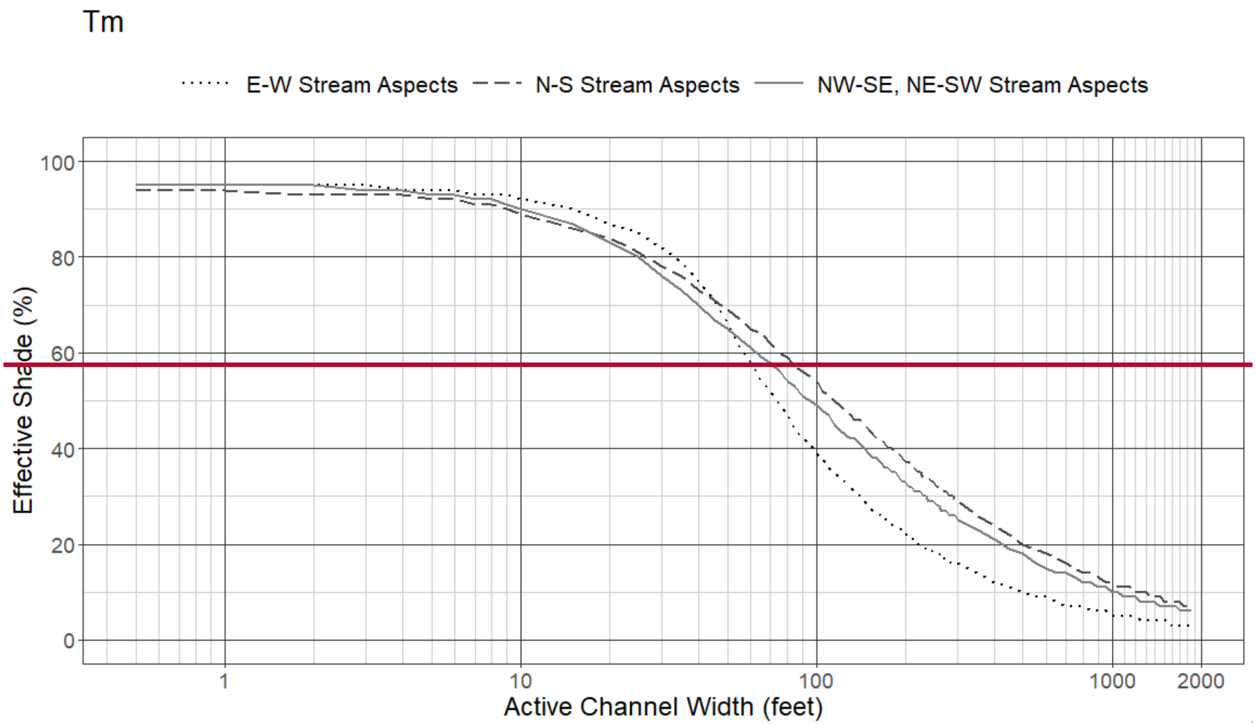


Figure 9-16: Effective shade targets for stream sites in the Tcr mapping unit.



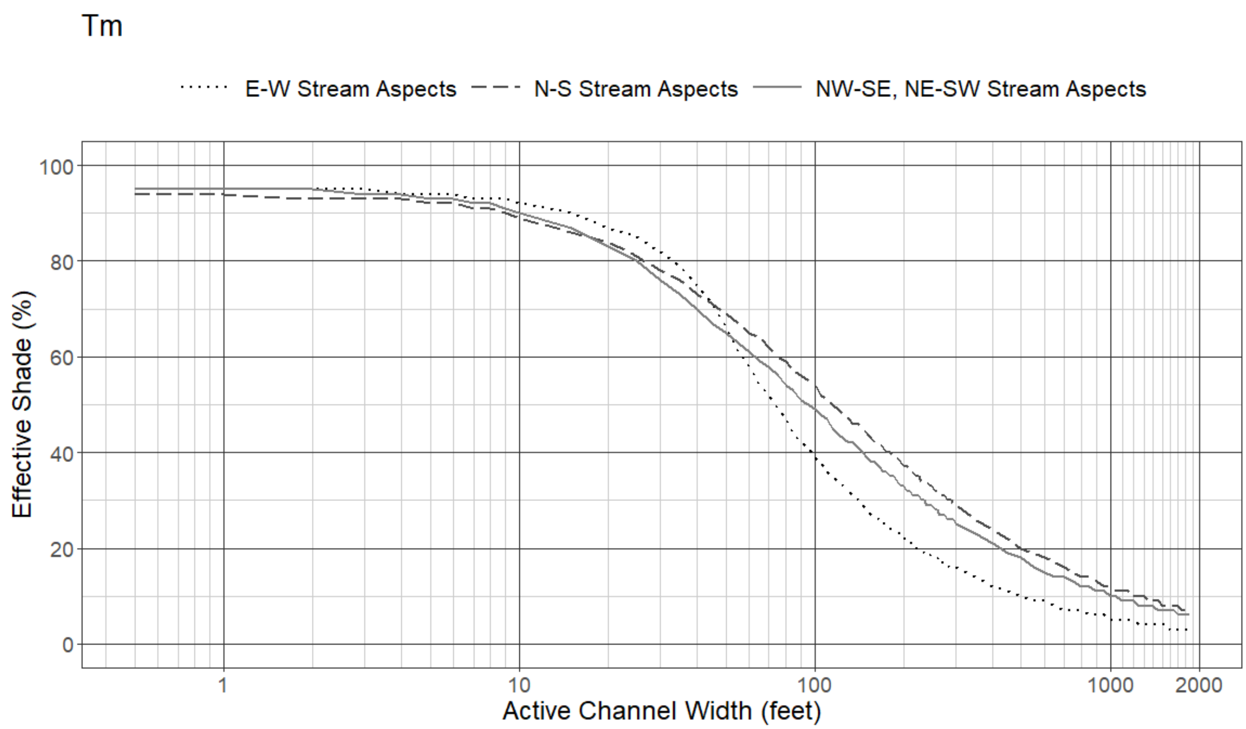
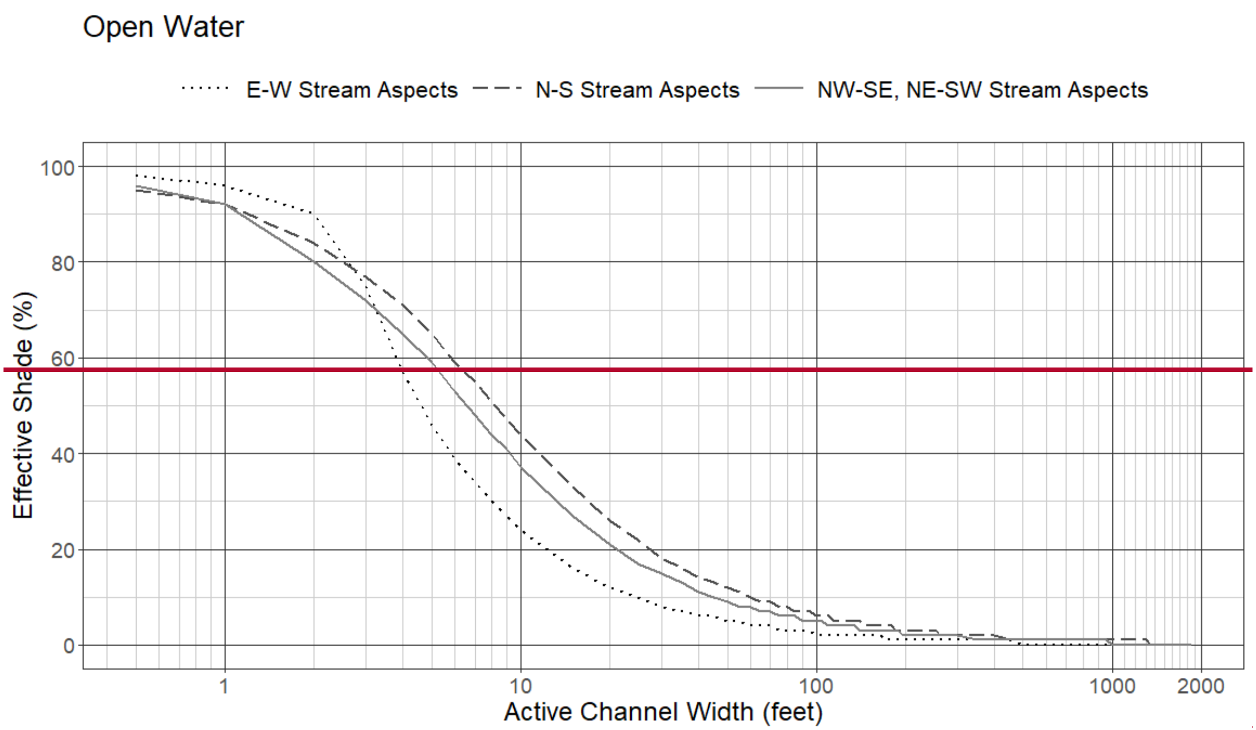


Figure 9-17: Effective shade targets for stream sites in the Tm mapping unit.



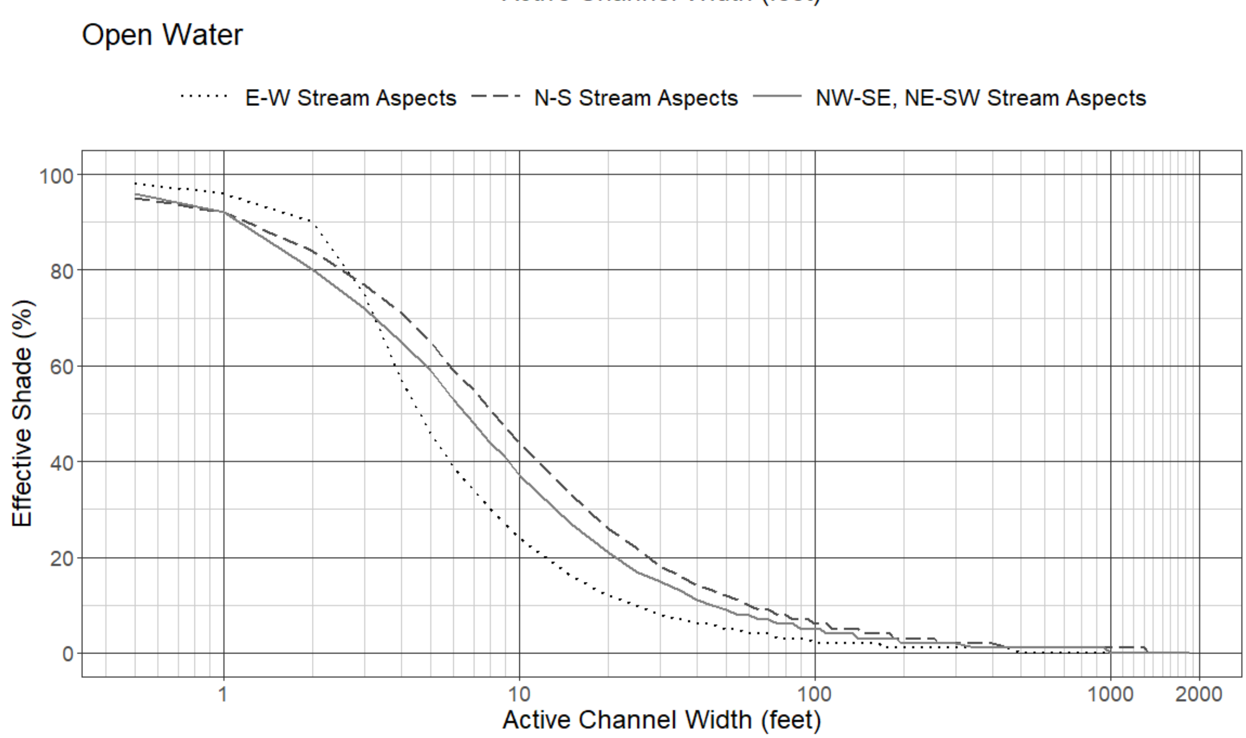
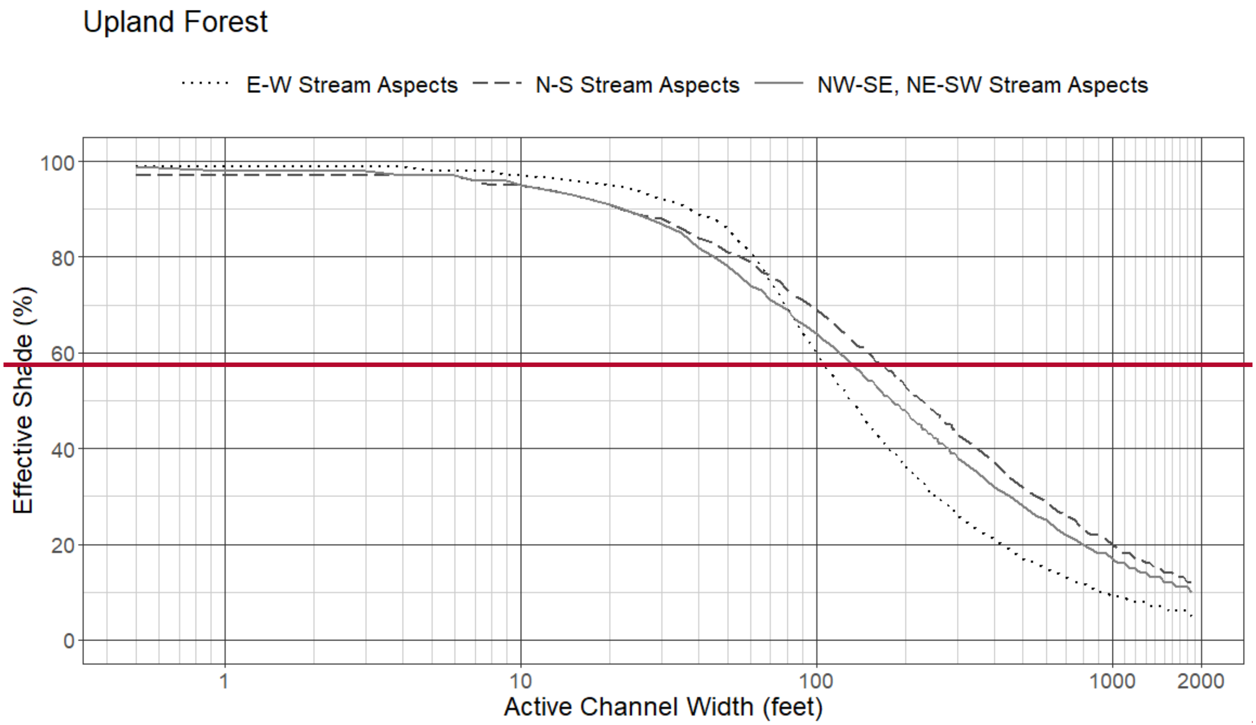


Figure 9-18: Effective shade targets for stream sites in the Open Water (OW) mapping unit.



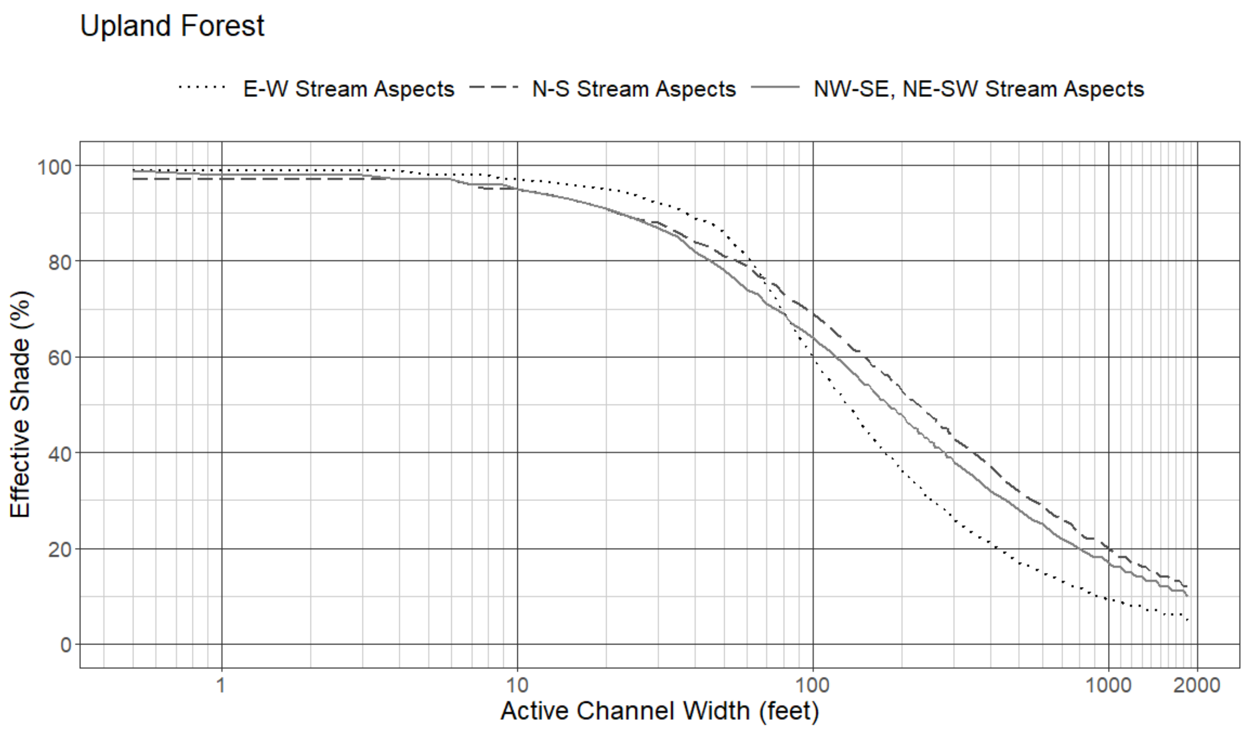
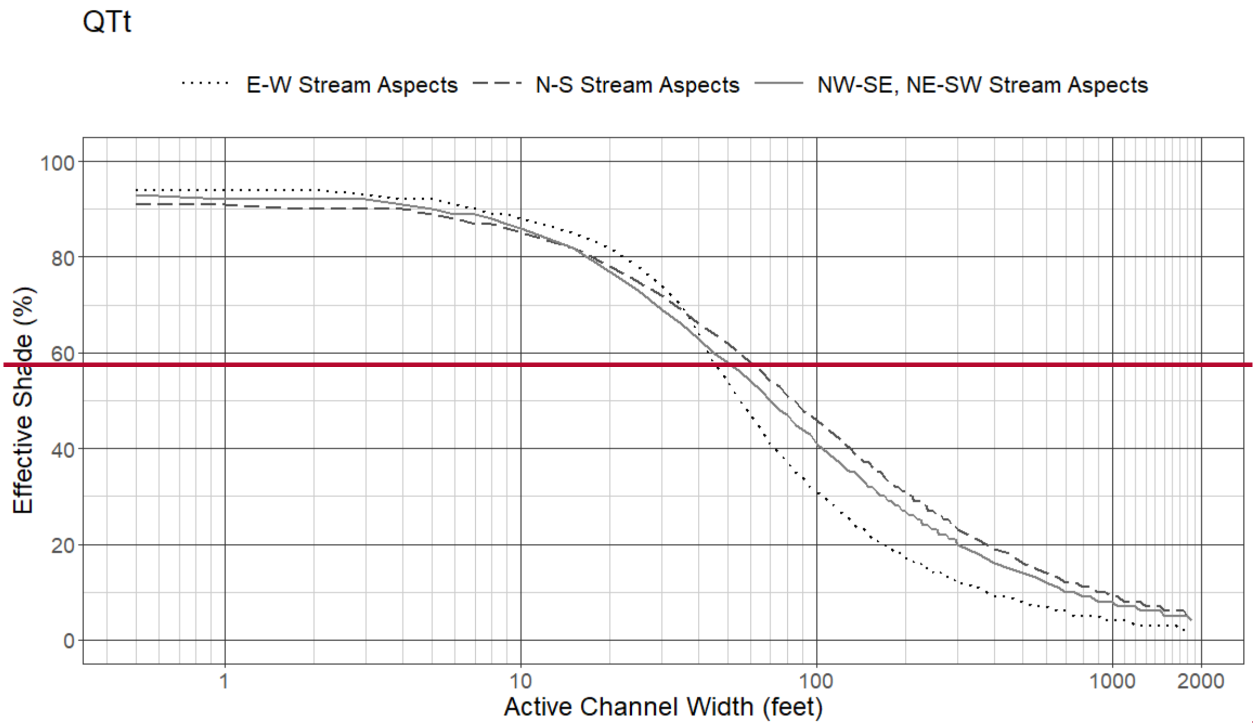


Figure 9-19: Effective shade targets for stream sites in the Upland Forest mapping unit.



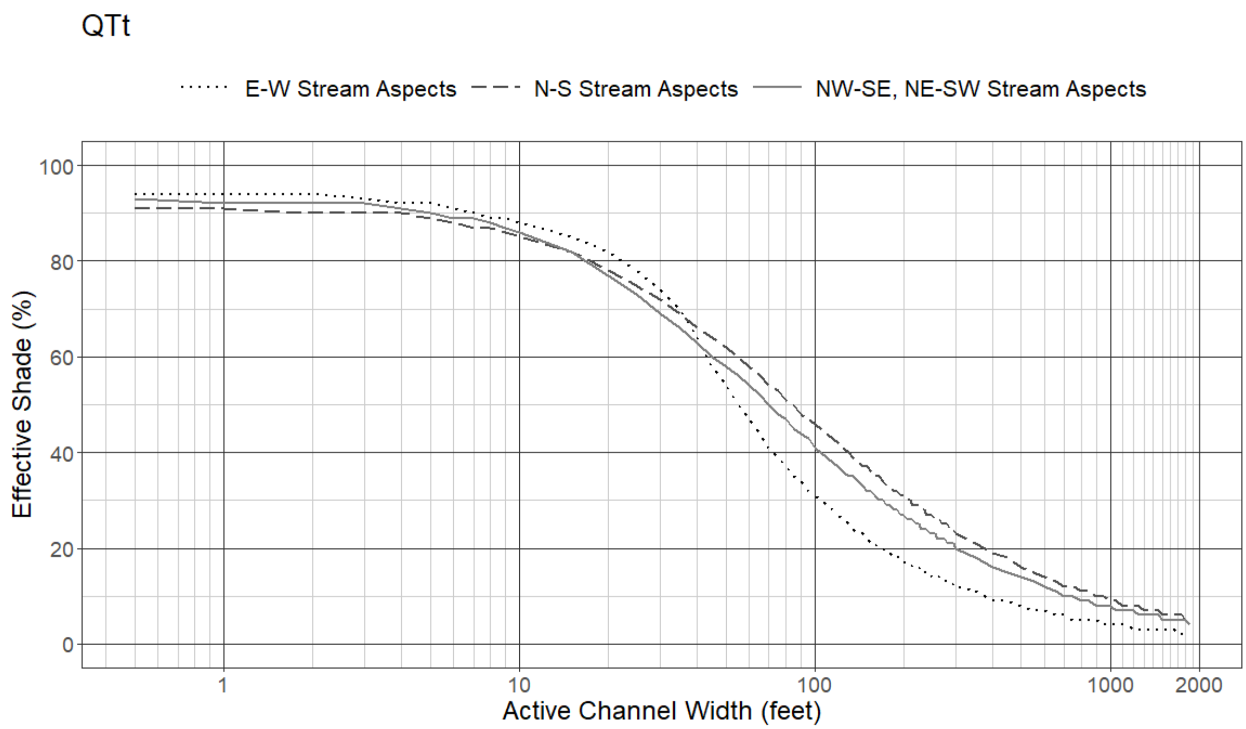
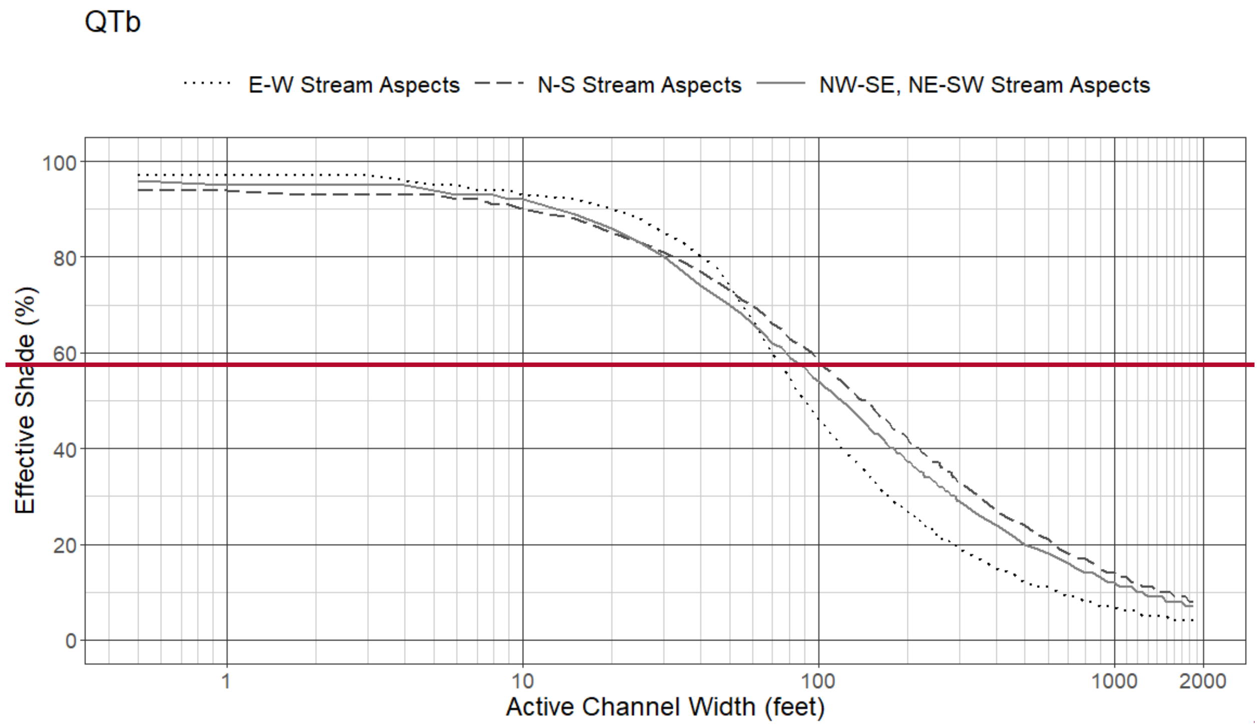


Figure 9-20: Effective shade targets for stream sites in the QTt mapping unit.



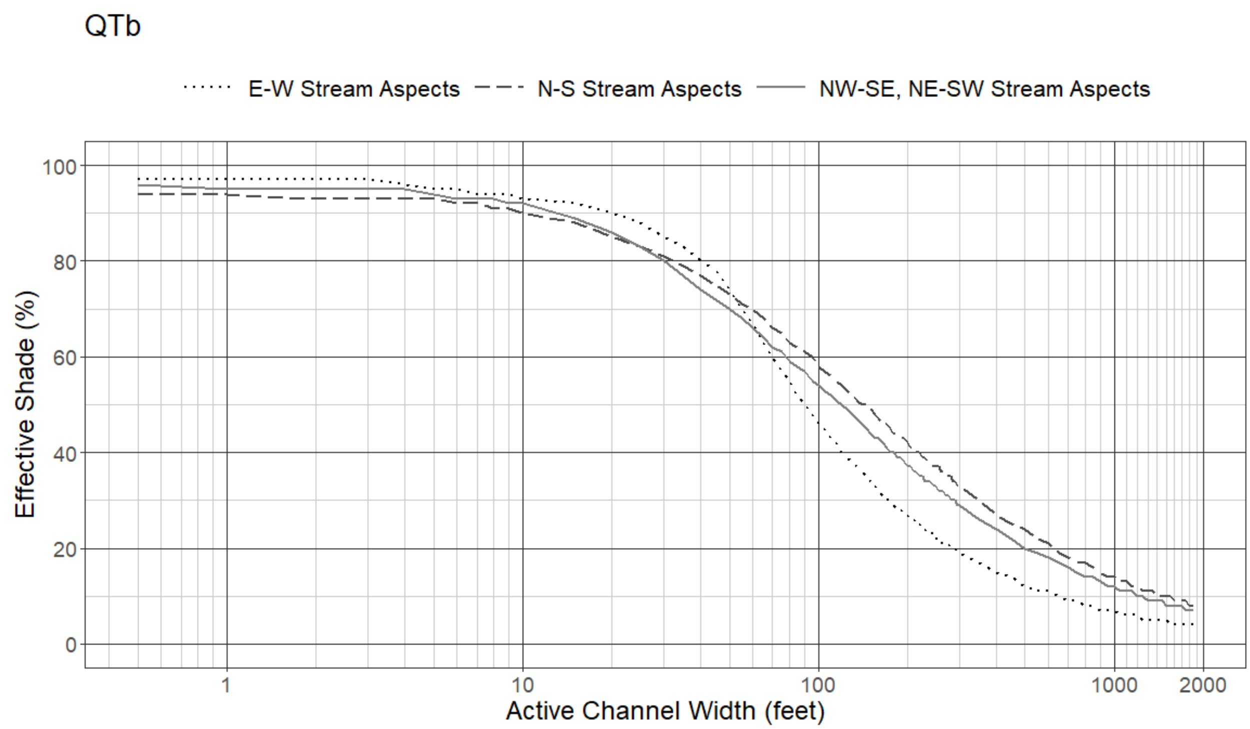


Figure 9-21: Effective shade targets for stream sites in the QTb mapping unit.

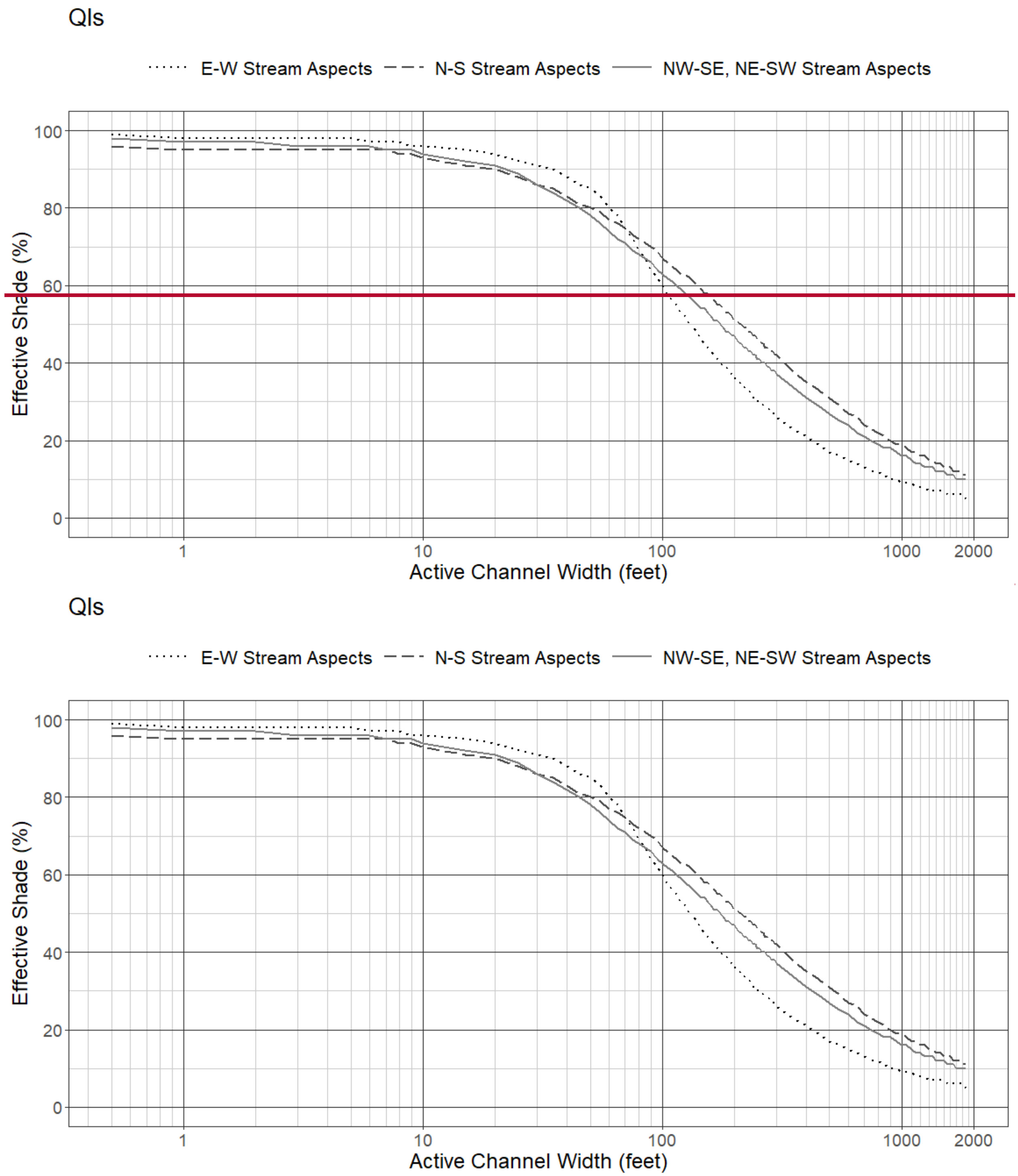
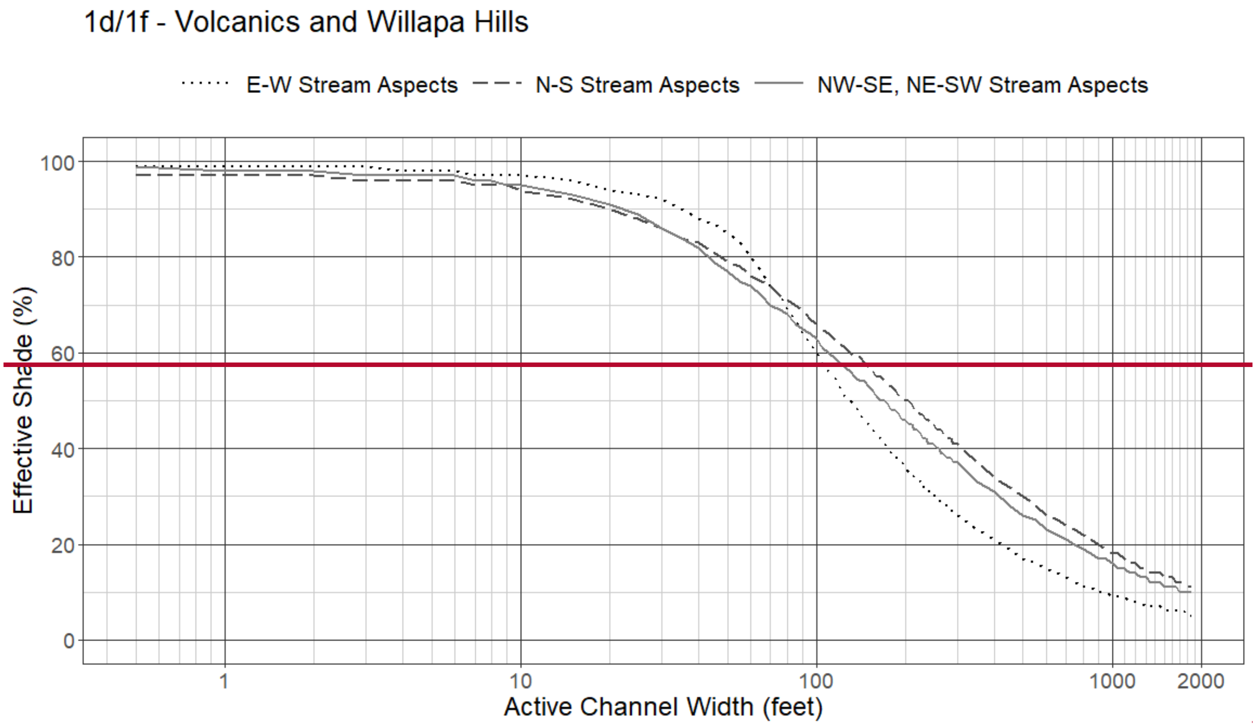


Figure 9-22: Effective shade targets for stream sites in the Qls mapping unit.



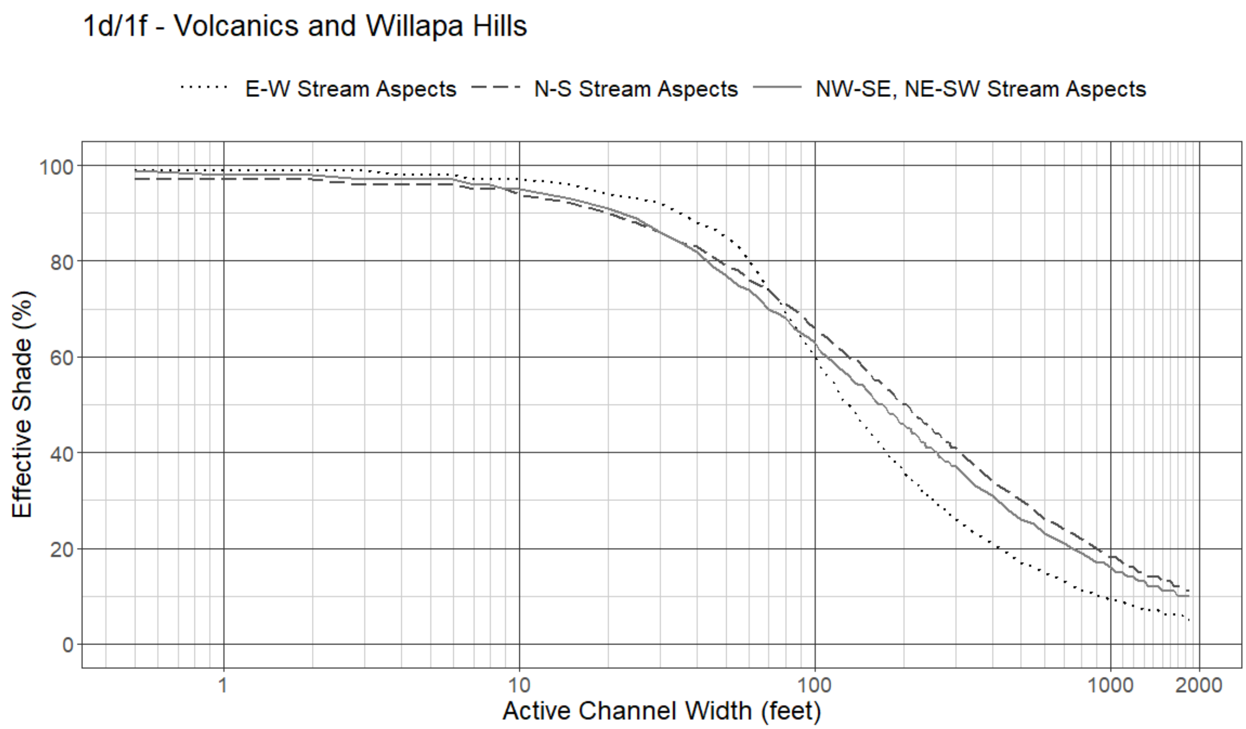
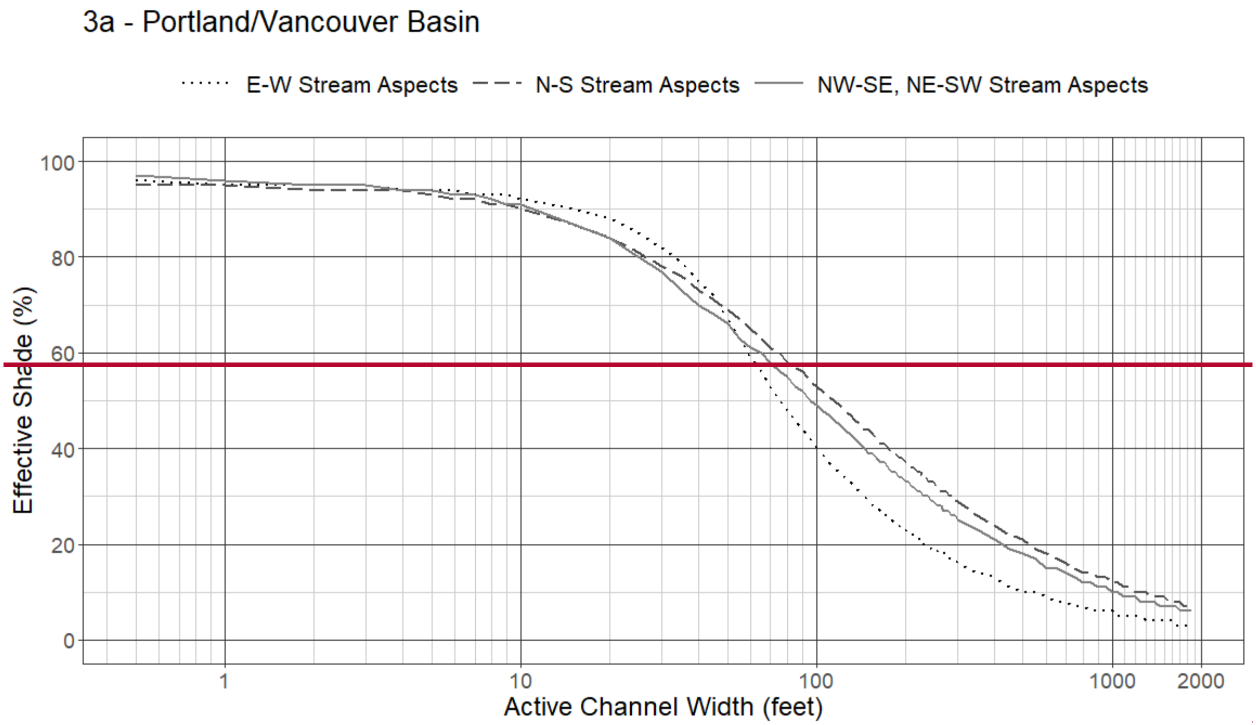


Figure 9-23: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.



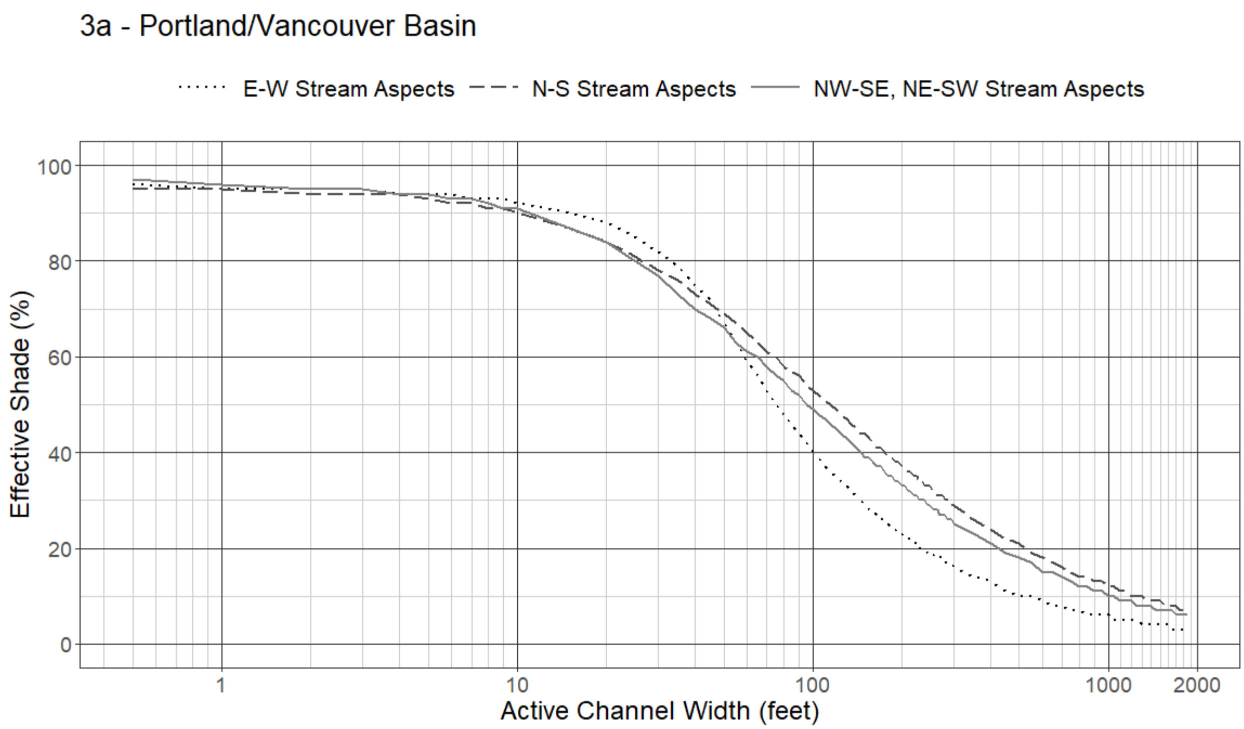


Figure 9-24: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

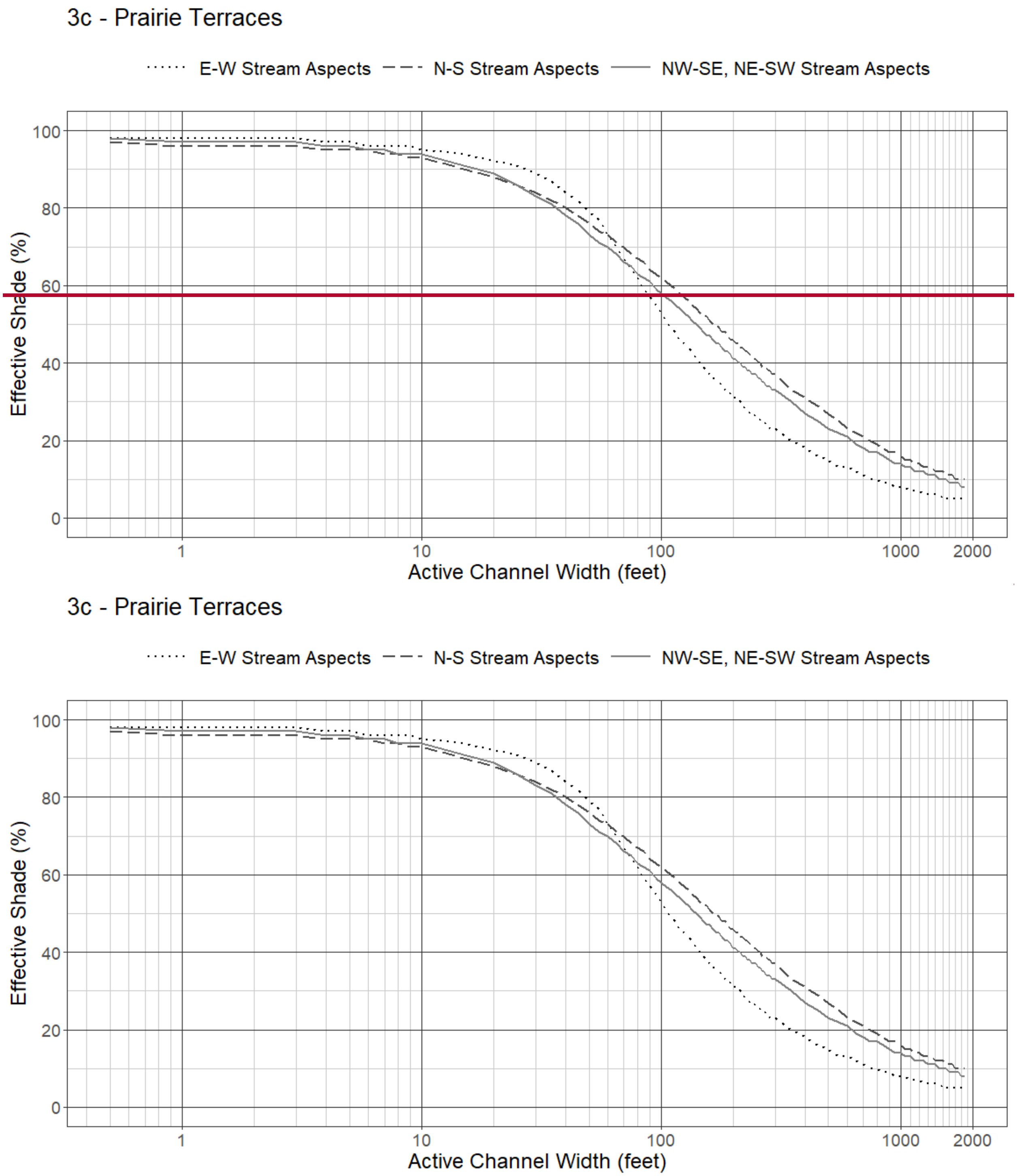
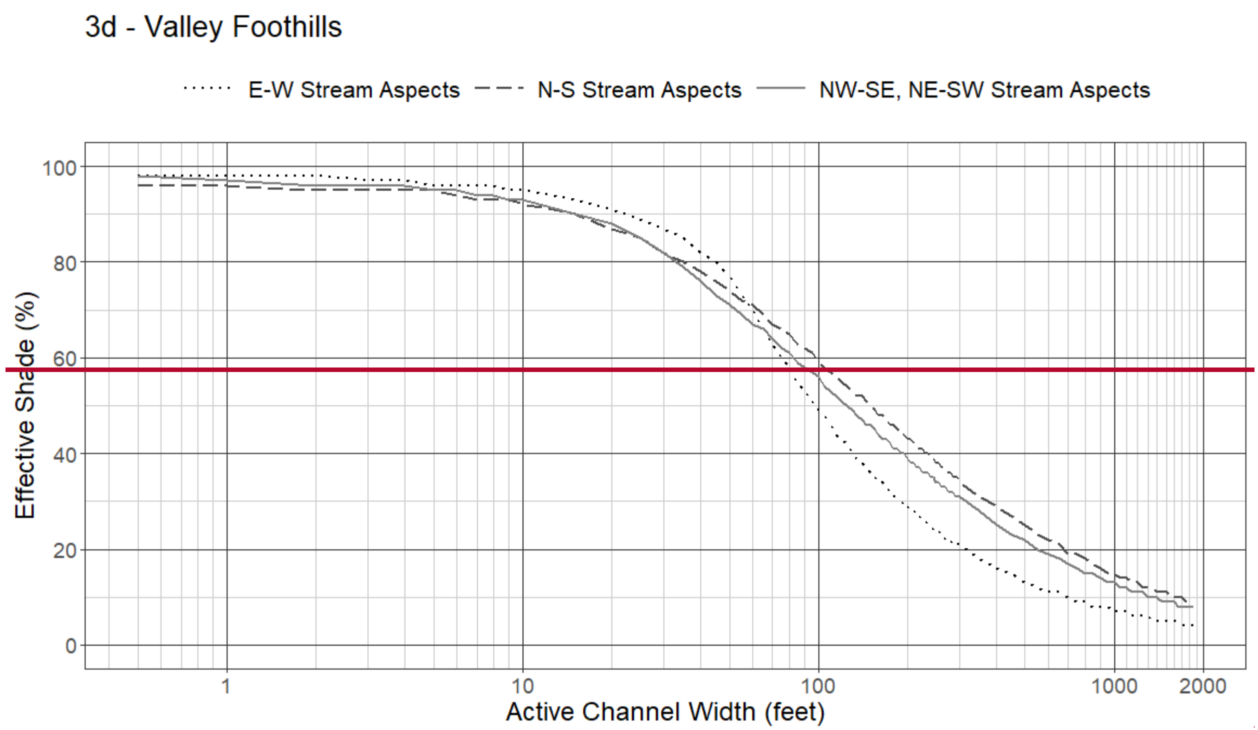


Figure 9-25: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.



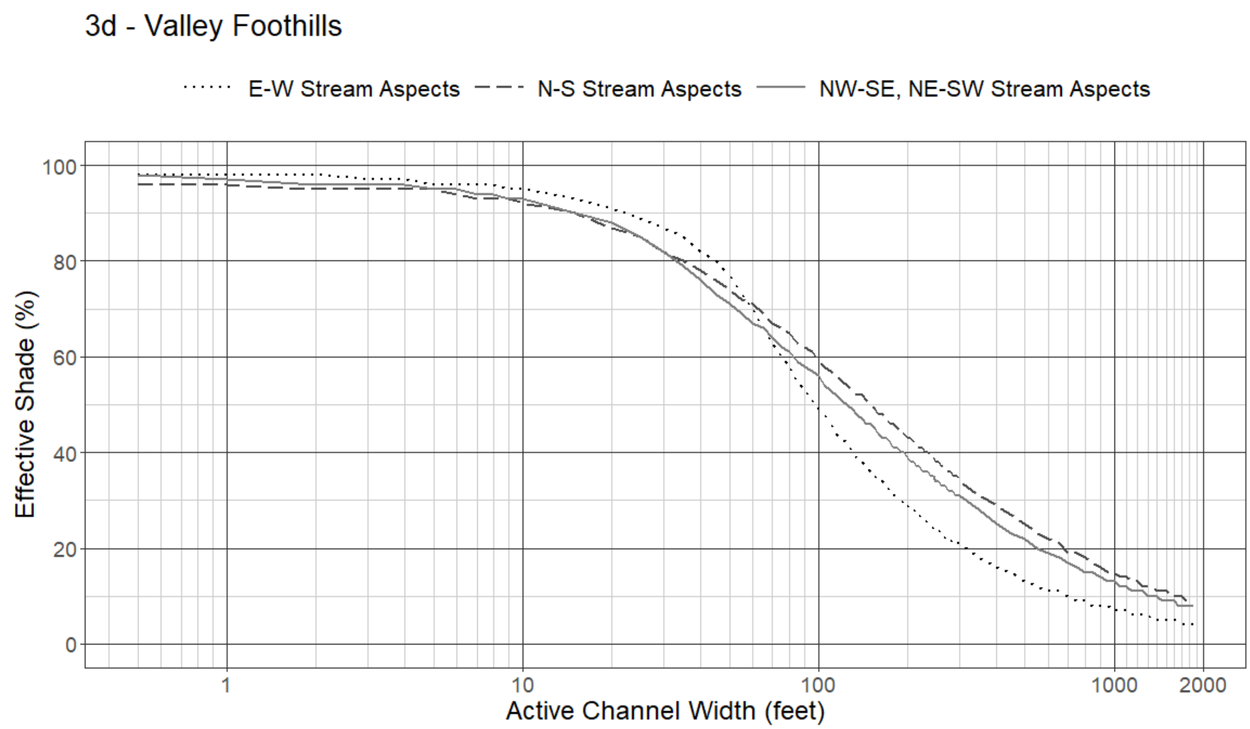


Figure 9-26: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

9.1.6 Reserve capacity

DEQ set aside explicit ~~allocations for~~portions of the HUA as reserve capacity ~~for providing~~that may be available to provide either point or nonpoint source allocation(s) to new or increased thermal loads, or to assign corrected allocations to any existing source(s) that were assigned an erroneous allocation or may not have been identified during the development of this TMDL. The portion of the HUA associated with the reserve capacity is described Section 9.1.1.

If DEQ determines the cumulative warming from all NPDES point sources is less than the assigned portion of the HUA, the remainder may be considered as reserve capacity for point sources.

Modeling analyses were performed to evaluate the impacts of wasteload and load allocations (WLAs and LAs) provided for the Willamette River and major tributaries as well as all tributaries to these reaches in order to ensure that cumulative impacts of WLAs and LAs do not exceed the 0.3°C HUA and to determine maximum amounts of the HUA that can be assigned as reserve capacity (see TSD Section 10.3). The analysis showed that for most AUs sufficient assimilative capacity is available to accommodate the reserve capacity summarized in human use allowance assignments tables (Table 9-1 to Table 9-11). However, for three Willamette River AUs from Champoeg Creek to the confluence with the Columbia River (RM 45-0), it was necessary to reduce reserve capacity by 0.01°C to account for cumulative impacts of assigned WLAs and LAs, including the LAs provided to the PGE Clackamas River and PGE Willamette Falls projects. Similarly, reserve capacity on the Row River AU downstream of Dorena Reservoir (OR_SR_1709000202_02_103779) was reduced by 0.04 °C due to cumulative impacts from assigned WLAs and LAs.

DEQ will consider requests for allocation of reserve capacity submitted in writing on a case-by-case basis. Except when DEQ is correcting an error or omission, DEQ may require requesters to demonstrate that there are no reasonable alternatives to an increased load and to prepare modeling or similar analysis to ensure that loading capacity is available at the discharge location(s) or in downstream waters. The HUA assigned to reserve capacity may not be available for allocation due to cumulative warming and points of maximum impact downstream. DEQ will use its discretion in making determinations on requests, based on the information available and priorities appropriate at the time of the request. DEQ will track allocation of reserve capacity over time and will not approve requests once reserve capacity is depleted. Allocations of reserve capacity must be approved by DEQ’s Director or designee.

9.2 Margin of safety

CFR 130.7(c)(1) and OAR 340-042-0040(4)(i) require a TMDL to include a margin of safety. The margin of safety accounts for lack of knowledge or uncertainty. This may result from limited data; an incomplete understanding of the exact magnitude or quantity of thermal loading from various sources; or the actual effect controls will have on loading reductions and receiving water. The margin of safety is intended to account for such uncertainties in a manner that is conservative and will result in environmental protection. A margin of safety can be achieved through two approaches: (1) implicitly using conservative analytical assumptions to develop allocations, or (2) explicitly specifying a portion of the TMDL loading capacity as a margin of safety.

In the Willamette Subbasins, an implicit margin of safety was used in derivation of the allocations. The primary conservative assumptions include:

- Setting effluent flow rates at average dry weather design flow (ADWDF) or a maximum flow obtained from discharge monitoring reports (DMRs) for the model scenario assessing the wasteload allocations and for assessments of current thermal loading. It is rare that actual discharges from point sources will reach design flows and sustain that discharge for long periods of time.

- Setting point source effluent temperatures as high as 32°C for the model scenario assessing the wasteload allocations. On days when the current thermal load was less than the wasteload allocation, the maximum effluent temperatures were increased above the actual temperatures up to either 32°C or the effluent temperature that would fully utilize the wasteload allocation. Actual maximum effluent temperatures are unlikely to get this warm or be sustained over multiple days or weeks.
- The cumulative effects analysis applied the maximum assigned HUA to each source category to assess cumulative allocation attainment. The modeling shows the maximum allowed temperature increase is limited to one or two days and ~~is~~ generally occurs less than 5% of the time. Additionally, the maximum temperature increase is geographically limited and focused to distinct locations. This means that a portion of the loading capacity reserved for human use will go unutilized most of the time. The cumulative effects analysis was performed for modeled reaches and is described in the TSD and modeling reports (TSD ~~Appendix~~Appendices A, ~~Appendix~~ J ~~and Appendix~~, K~~).~~, and M).
- Groundwater inflows were assumed to be zero in most models. Because groundwater directly cools stream temperatures via mixing, this means that actual instream temperatures would be lower than modeled temperatures anywhere that groundwater influences exist.
- ~~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.~~
- ~~The sum of individual human use allocations~~On unmodeled streams, the sum of individual human use allocations (HUAs) was used to assess cumulative attainment across the entirety of a given AU. This method does not account for longitudinal instream heat dissipation downstream from each thermal source. Thus, the total thermal load and corresponding temperature increase is likely to result in a maximum temperature increase of less than 0.3°C.
- ~~The nonpoint source HUA 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 HUA allocated to nonpoint sources.~~

10 Water quality management plan

As described in OAR 340-042-0040(4)(l)(A)-(O), an associated WQMP is a required element of a TMDL and must include the following components: (A) Condition assessment and problem description; (B) Goals and objectives; (C) Proposed management strategies design to meet the TMDL allocations; (D) Timeline for implementing management strategies; (E) Explanation of how TMDL implementation will attain water quality standards; (F) Timeline for attaining water quality standards; (G) Identification of persons, including DMAs, responsible for TMDL implementation; (H) Identification of existing implementation plans; (I) Schedule for submittal of implementation plans and revision triggers; (J) Description of reasonable assurance of TMDL implementation; (K) Plan to monitor and evaluate progress toward achieving TMDL allocations and water quality standards; (L) Plan for public involvement in TMDL implementation; (M) Description of planned efforts to maintain management strategies over time; (N) General discussion of costs and funding for TMDL implementation; and (O) citation of legal authorities relating to TMDL implementation.

DEQ sought and considered input from various persons, including DMAs, responsible for TMDL implementation and other interested public and prepared the Willamette Subbasins WQMP as a stand-alone document. DEQ intends to propose the draft WQMP as an element of Temperature TMDLs for the Willamette Subbasins for adoption as rule by the EQC.

11 Reasonable assurance

OAR 340-042-0030(9) defines Reasonable Assurance as "a demonstration that a TMDL will be implemented by federal, state or local governments or individuals through regulatory or voluntary actions including management strategies or other controls." OAR 340-042-0040(6)(g) states that "to establish reasonable assurance that the TMDL's load allocations will be achieved requires determination that practices capable of reducing the specified pollutant load: (1) exist; (2) are technically feasible at a level required to meet allocations; and (3) have a high likelihood of implementation." Likewise federal regulations (40 CFR § 130.2(i)) and EPA's TMDL guidance describes that when a TMDL is developed for waters impaired by both point and nonpoint sources and WLAs are based on an assumption that NPS load reductions will occur, the TMDL must provide "reasonable assurances" that NPS control measures will achieve expected load reductions (EPA, 1991). ~~Comprehensive explanations of reasonable assurances of implementation are provided in Section 7 of the Willamette Subbasins WQMP.~~

The Willamette Subbasins TMDLs were developed to address both point and nonpoint sources with TMDL load reductions set at a level estimated to attain the applicable temperature criteria with consideration of opportunities for effective measures to reduce those contributions. Reasonable assurance that Oregon's three-point test is met, needed load reductions will be achieved for nonpoint sources, and that antidegradation requirements and narrative water quality criteria will be attained is based primarily on an accountability framework incorporated into the WQMP. The accountability framework includes identification of pollutant reduction strategies by source and activity, identification of persons and agencies responsible to implement the strategies, timelines and measurable objectives, tracking implementation progress and water quality conditions, and DEQ action when responsible persons or agencies fail to implement. Section 7 of the WQMP (Reasonable Assurance of Implementation) discuss this framework directly.

The WQMP also includes a general discussion of implementation costs and available funding programs, identification of state legal authorities that aid in implementation of management strategies, and DEQ's adaptive management approach DMA implementation if sufficient progress towards TMDL attainment is not being made. The entirety of the WQMP and its execution along with the implementation plans of persons and agencies responsible for TMDL implementation represents reasonable assurance that NPS load reductions will be achieved.

12 Protection plan

The scope of these temperature TMDLs includes all waters of the state, including freshwater perennial and intermittent streams in the Willamette Subbasins. As such, these TMDLs also serve as a “protection plan” to prevent impairment in waters currently attaining the applicable water quality standards or for unassessed waters. The protection of these unimpaired waters has watershed-wide benefits such as:

- Clarity and consistency for implementation of management strategies throughout the watershed;
- Proactively applying management strategies and protections to waters where data are not available for establishing listing status;
- Improving TMDL outcomes by maintaining or improving water quality in streams that are tributary to listed streams;
- Creating efficiencies between TMDL and protection plan implementation (including monitoring, evaluating progress, adaptive management, enforcement, and leveraging partner entities’ efforts); and
- Assisting with funding opportunities for implementation when grants require projects to be part of a larger watershed plan.

Protection plan core elements, as described in materials available on EPA’s webpage (EPA, 2023a, 2023b), are fulfilled by the statements and references to specific sections of the TMDLs, WQMP, and TSD in the subsections that follow. A full list of AUs where the protection plan applies is in the TSD Appendix D.

12.1 Identification of specific waters to be protected and risks to their condition

Appendix D of the TMDL TSD lists all the assessments units within the Willamette Subbasins and their 2022 Integrated Report assessment status. Those AUs with the status of Category 2 or Category 3 are included in the protection plan, along with any unassessed waters that may be found to be unimpaired for temperature in the future. The same sources and processes described in Section 7 that have caused temperature impairments to some reaches in the watershed also pose a risk to unimpaired waters.

12.2 Quantification of loads and activities expected to resist degradation

Monitoring stations that provided data used in the TMDLs analyses are shown in the TSD Appendix A, Section 2.1. Water temperature data, along with flow measurements were used to calculate loading capacities of the pollutants and surrogates within the watershed. Applicable loading capacities for any unimpaired stream can be calculated using **Equation 8-1**.

Similar to loading capacities, relevant HUA assignments for anthropogenic sources are shown in **Table 9-1** through **Table 9-11**. Loads for nonpoint sources are calculated using **Equation 9-2**.

The implementation of management practices specified in Sections 2 and 5 of the WQMP also protect against risks to unimpaired waters.

12.3 Timeframes for protection

Timelines for watershed-wide implementation of the TMDLs are described in Section 5 of the WQMP and estimated timelines for attainment of water quality standards in the impaired stream reaches are provided in Section 4 of the WQMP. DEQ's watershed-wide approach ensures that the TMDLs and the protection plan will be implemented in a prioritized manner over the same timeframe that will be required to demonstrate effectiveness of management strategies in reducing excess pollutant loads.

12.4 Measures of success

The WQMP describes in detail DEQ's approach to quantitative and qualitative measures of progress in attaining and maintaining water quality standards, which is applied watershed-wide. Section 6 of the WQMP discusses quantitative and qualitative evaluation of implementation of management strategies, development of a plan for periodic monitoring and an approach to adaptive management. Section 7 of the WQMP details the interconnected framework for accountability of implementation, including: engaging with sources; setting measurable objectives; evaluating progress; conducting enforcement; and tracking status and trends.

13 References

Black, E.C. 1953. "Upper lethal temperature of some British Columbia freshwater fishes". Journal of the Fisheries Board of Canada. 10(4):196-210.

DEQ (Oregon Department of Environmental Quality). 2003. Staff report to the Environmental Quality Commission from Stephanie Hallock, Director. "Agenda Item D, Rule Adoption: Water Quality Standards, Including Temperature Criteria, OAR Chapter 340, Division 41, December 4, 2003, EQC Meeting."

DEQ (Oregon Department of Environmental Quality). 2006. "Willamette River Basin Total Maximum Daily Load (TMDL)."

DEQ (Oregon Department of Environmental Quality). 2008. ~~Temperature Water Quality Standard Implementation~~Temperature Water Quality Standard Implementation – A DEQ Internal Management Directive. ~~https://www.oregon.gov/deq/Filtered%20Library/IMDTemperature.pdf~~

DEQ (Oregon Department of Environmental Quality). 2020. "Lower Willamette River Cold-Water Refuge Narrative Criterion Interpretation Study."

DEQ (Oregon Department of Environmental Quality). 2023a. "Draft Temperature TMDLs for the Willamette Subbasins Technical Support Document."

DEQ (Oregon Department of Environmental Quality). 2023b. "Draft Temperature TMDLs for the Willamette Subbasins Water Quality Management Plan."

EPA. 1991. Guidance for Water Quality-based Decisions: The TMDL Process. EPA/440/4-91-001. Washington, D.C.

EPA (U.S. Environmental Protection Agency). 2003. "EPA Region 10 guidance for pacific northwest state and tribal temperature water quality standards". EPA 910-B-03-002.

EPA (United State Environmental Protection Agency). 2021. "Columbia and Lower Snake Rivers temperature Total Maximum Daily Load."

EPA. 2023a. Impaired Waters and TMDLs – Protection Approaches ~~webpage. https://www.epa.gov/tmdl/protection-approaches.~~webpage. Accessed July 20, 2023.

EPA. 2023b. ~~Draft Protection Frequently Asked Questions. https://www.epa.gov/sites/default/files/2021-06/documents/protection_faqs.pdf.~~Draft Protection Frequently Asked Questions. Accessed July 20, 2023.

14 Appendix of effective shade curve tables

14.1 Qff1 mapping unit

Table 14-1: Effective shade targets for stream sites in the Qff1 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	99
0.3	1	96	97	99
0.6	2	96	97	99
0.9	3	96	97	98
1.2	4	96	97	98
1.5	5	96	97	98
1.8	6	96	96	97
2.1	7	95	96	97
2.4	8	95	95	97
2.7	9	94	95	97
3	10	94	95	97
4.6	15	92	93	95
6.1	20	90	91	94
7.6	25	88	88	92
9.1	30	86	86	91
10.7	35	85	83	89
12.2	40	83	81	88
13.7	45	81	79	86
15.2	50	80	77	84
16.8	55	78	75	81
18.3	60	77	73	79
19.8	65	75	71	75
21.3	70	74	70	72
22.9	75	73	68	69
24.4	80	71	67	67
25.9	85	70	66	64
27.4	90	69	65	62
29	95	68	63	60

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
30.5	100	67	62	58
32	105	66	61	56
33.5	110	65	60	54
35.1	115	64	59	52
36.6	120	63	58	51
38.1	125	62	57	49
39.6	130	61	56	48
41.1	135	60	55	47
42.7	140	59	54	45
44.2	145	58	53	44
45.7	150	58	52	43
47.2	155	57	52	42
48.8	160	56	51	41
50.3	165	55	50	40
51.8	170	55	49	39
53.3	175	54	49	38
54.9	180	53	48	37
56.4	185	53	47	37
57.9	190	52	47	36
59.4	195	51	46	35
61	200	51	45	34
62.5	205	50	45	34
64	210	49	44	33
65.5	215	49	44	33
67.1	220	48	43	32
68.6	225	48	43	31
70.1	230	47	42	31
71.6	235	47	42	30
73.2	240	46	41	30
74.7	245	46	41	29
76.2	250	45	40	29
77.7	255	45	40	28
79.2	260	44	39	28
80.8	265	44	39	28
82.3	270	43	39	27
83.8	275	43	38	27
85.3	280	43	38	26
86.9	285	42	37	26

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
88.4	290	42	37	26
89.9	295	41	37	25
91.4	300	41	36	25
106.7	350	38	33	22
121.9	400	35	30	20
137.2	450	32	28	18
152.4	500	30	26	16
167.6	550	28	25	15
182.9	600	27	23	14
198.1	650	25	22	13
213.4	700	24	21	12
228.6	750	23	20	11
243.8	800	22	19	11
259.1	850	21	18	10
274.3	900	20	17	10
289.6	950	19	16	9
304.8	1000	18	16	9
320	1050	18	15	9
335.3	1100	17	15	8
350.5	1150	16	14	8
365.8	1200	16	14	8
381	1250	15	13	7
396.2	1300	15	13	7
411.5	1350	14	12	7
426.7	1400	14	12	7
442	1450	14	12	6
457.2	1500	13	11	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	10	6
518.2	1700	12	10	6
533.4	1750	12	10	5
548.6	1800	11	10	5
563.9	1850	11	9	5

14.2 Qfc mapping unit

Table 14-2: Effective shade targets for stream sites in the Qfc Quaternary geologic unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	96	97
0.6	2	94	95	97
0.9	3	94	95	97
1.2	4	94	95	97
1.5	5	94	95	96
1.8	6	93	94	96
2.1	7	93	94	95
2.4	8	92	93	95
2.7	9	92	93	95
3	10	91	93	95
4.6	15	89	90	93
6.1	20	87	88	91
7.6	25	85	85	89
9.1	30	83	82	87
10.7	35	81	79	85
12.2	40	79	77	83
13.7	45	77	74	81
15.2	50	75	72	78
16.8	55	73	70	75
18.3	60	72	68	71
19.8	65	70	67	68
21.3	70	69	65	64
22.9	75	67	64	61
24.4	80	66	62	59
25.9	85	65	61	56
27.4	90	64	59	54
29	95	62	58	52
30.5	100	61	57	50
32	105	60	56	48
33.5	110	59	54	47
35.1	115	58	53	45
36.6	120	57	52	44
38.1	125	56	51	42

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
39.6	130	55	50	41
41.1	135	54	49	40
42.7	140	53	49	39
44.2	145	52	48	38
45.7	150	52	47	37
47.2	155	51	46	36
48.8	160	50	45	35
50.3	165	49	45	34
51.8	170	49	44	33
53.3	175	48	43	33
54.9	180	47	43	32
56.4	185	47	42	31
57.9	190	46	41	31
59.4	195	45	41	30
61	200	45	40	29
62.5	205	44	40	29
64	210	44	39	28
65.5	215	43	38	28
67.1	220	42	38	27
68.6	225	42	37	27
70.1	230	41	37	26
71.6	235	41	36	26
73.2	240	40	36	25
74.7	245	40	36	25
76.2	250	40	35	24
77.7	255	39	35	24
79.2	260	39	34	24
80.8	265	38	34	23
82.3	270	38	34	23
83.8	275	37	33	23
85.3	280	37	33	22
86.9	285	37	32	22
88.4	290	36	32	22
89.9	295	36	32	21
91.4	300	36	31	21
106.7	350	32	28	18
121.9	400	30	26	16
137.2	450	27	24	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	25	22	14
167.6	550	24	21	13
182.9	600	22	19	12
198.1	650	21	18	11
213.4	700	20	17	10
228.6	750	19	16	10
243.8	800	18	16	9
259.1	850	17	15	9
274.3	900	16	14	8
289.6	950	16	14	8
304.8	1000	15	13	7
320	1050	15	12	7
335.3	1100	14	12	7
350.5	1150	13	12	7
365.8	1200	13	11	6
381	1250	13	11	6
396.2	1300	12	10	6
411.5	1350	12	10	6
426.7	1400	11	10	5
442	1450	11	9	5
457.2	1500	11	9	5
472.4	1550	10	9	5
487.7	1600	10	9	5
502.9	1650	10	8	5
518.2	1700	10	8	5
533.4	1750	9	8	4
548.6	1800	9	8	4
563.9	1850	9	8	4

14.3 Qalc mapping unit

Table 14-3: Effective shade targets for stream sites in the Qalc geomorphic region.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	95	96
0.3	1	94	95	96

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.6	2	93	94	96
0.9	3	93	94	95
1.2	4	93	94	95
1.5	5	92	93	94
1.8	6	91	92	94
2.1	7	91	92	94
2.4	8	90	91	93
2.7	9	90	90	93
3	10	89	90	92
4.6	15	86	86	89
6.1	20	82	82	86
7.6	25	79	78	83
9.1	30	77	74	80
10.7	35	74	70	76
12.2	40	72	68	71
13.7	45	69	65	66
15.2	50	67	63	61
16.8	55	65	61	57
18.3	60	63	59	53
19.8	65	61	57	50
21.3	70	59	55	47
22.9	75	58	53	45
24.4	80	56	52	43
25.9	85	55	50	41
27.4	90	54	49	39
29	95	52	47	37
30.5	100	51	46	36
32	105	50	45	34
33.5	110	49	44	33
35.1	115	48	43	32
36.6	120	47	42	31
38.1	125	46	41	30
39.6	130	45	40	29
41.1	135	44	39	28
42.7	140	43	38	27
44.2	145	42	37	26
45.7	150	41	37	25
47.2	155	41	36	25

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
48.8	160	40	35	24
50.3	165	39	35	24
51.8	170	39	34	23
53.3	175	38	33	22
54.9	180	37	33	22
56.4	185	37	32	21
57.9	190	36	32	21
59.4	195	36	31	20
61	200	35	31	20
62.5	205	35	30	20
64	210	34	30	19
65.5	215	34	29	19
67.1	220	33	29	18
68.6	225	33	28	18
70.1	230	32	28	18
71.6	235	32	28	17
73.2	240	31	27	17
74.7	245	31	27	17
76.2	250	31	26	17
77.7	255	30	26	16
79.2	260	30	26	16
80.8	265	29	25	16
82.3	270	29	25	15
83.8	275	29	25	15
85.3	280	28	25	15
86.9	285	28	24	15
88.4	290	28	24	15
89.9	295	27	24	14
91.4	300	27	23	14
106.7	350	24	21	12
121.9	400	22	19	11
137.2	450	20	17	10
152.4	500	19	16	9
167.6	550	18	15	8
182.9	600	17	14	8
198.1	650	16	13	7
213.4	700	15	12	7
228.6	750	14	12	6

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
243.8	800	13	11	6
259.1	850	13	11	6
274.3	900	12	10	5
289.6	950	11	10	5
304.8	1000	11	9	5
320	1050	11	9	5
335.3	1100	10	8	4
350.5	1150	10	8	4
365.8	1200	9	8	4
381	1250	9	8	4
396.2	1300	9	7	4
411.5	1350	8	7	4
426.7	1400	8	7	4
442	1450	8	7	3
457.2	1500	8	6	3
472.4	1550	8	6	3
487.7	1600	7	6	3
502.9	1650	7	6	3
518.2	1700	7	6	3
533.4	1750	7	6	3
548.6	1800	7	5	3
563.9	1850	6	5	3

14.4 Qg1 mapping unit

Table 14-4: Effective shade targets for stream sites in the Qg1 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	87	89	90
0.3	1	87	89	90
0.6	2	87	89	89
0.9	3	86	88	87
1.2	4	85	87	86
1.5	5	84	86	86

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
1.8	6	84	85	85
2.1	7	83	84	85
2.4	8	82	83	84
2.7	9	81	82	83
3	10	80	81	83
4.6	15	76	76	80
6.1	20	72	71	75
7.6	25	68	66	70
9.1	30	65	62	65
10.7	35	62	59	58
12.2	40	59	56	53
13.7	45	57	53	48
15.2	50	55	51	44
16.8	55	52	49	41
18.3	60	50	47	38
19.8	65	49	45	35
21.3	70	47	43	33
22.9	75	45	41	31
24.4	80	44	40	30
25.9	85	42	38	28
27.4	90	41	37	27
29	95	40	36	26
30.5	100	39	35	25
32	105	38	34	24
33.5	110	37	33	23
35.1	115	36	32	22
36.6	120	35	31	21
38.1	125	34	30	20
39.6	130	33	29	20
41.1	135	33	29	19
42.7	140	32	28	18
44.2	145	31	27	18
45.7	150	30	27	17
47.2	155	30	26	17
48.8	160	29	26	16
50.3	165	29	25	16
51.8	170	28	25	16
53.3	175	28	24	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
54.9	180	27	24	15
56.4	185	27	23	15
57.9	190	26	23	14
59.4	195	26	22	14
61	200	25	22	14
62.5	205	25	22	13
64	210	24	21	13
65.5	215	24	21	13
67.1	220	24	20	12
68.6	225	23	20	12
70.1	230	23	20	12
71.6	235	23	20	12
73.2	240	22	19	12
74.7	245	22	19	11
76.2	250	22	19	11
77.7	255	21	18	11
79.2	260	21	18	11
80.8	265	21	18	11
82.3	270	20	18	10
83.8	275	20	17	10
85.3	280	20	17	10
86.9	285	20	17	10
88.4	290	19	17	10
89.9	295	19	16	10
91.4	300	19	16	9
106.7	350	17	14	8
121.9	400	15	13	7
137.2	450	14	12	7
152.4	500	13	11	6
167.6	550	12	10	5
182.9	600	11	9	5
198.1	650	10	9	5
213.4	700	10	8	4
228.6	750	9	8	4
243.8	800	9	7	4
259.1	850	8	7	4
274.3	900	8	7	3
289.6	950	7	6	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
304.8	1000	7	6	3
320	1050	7	6	3
335.3	1100	7	5	3
350.5	1150	6	5	3
365.8	1200	6	5	3
381	1250	6	5	3
396.2	1300	6	5	2
411.5	1350	5	5	2
426.7	1400	5	4	2
442	1450	5	4	2
457.2	1500	5	4	2
472.4	1550	5	4	2
487.7	1600	5	4	2
502.9	1650	5	4	2
518.2	1700	4	4	2
533.4	1750	4	4	2
548.6	1800	4	3	2
563.9	1850	4	3	2

14.5 Qau mapping unit

Table 14-5: Effective shade targets for stream sites in the Qau mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	91	92	94
0.3	1	91	92	94
0.6	2	90	92	93
0.9	3	90	91	92
1.2	4	89	90	91
1.5	5	88	89	90
1.8	6	88	89	89
2.1	7	87	88	89
2.4	8	86	87	88
2.7	9	85	86	88

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
3	10	84	85	87
4.6	15	80	80	84
6.1	20	77	75	80
7.6	25	73	70	75
9.1	30	70	66	71
10.7	35	67	63	65
12.2	40	64	60	58
13.7	45	62	58	53
15.2	50	59	55	49
16.8	55	57	53	45
18.3	60	55	51	42
19.8	65	53	49	40
21.3	70	51	47	37
22.9	75	50	45	35
24.4	80	48	44	33
25.9	85	47	42	32
27.4	90	45	41	30
29	95	44	40	29
30.5	100	43	38	28
32	105	42	37	27
33.5	110	41	36	26
35.1	115	40	35	25
36.6	120	39	34	24
38.1	125	38	34	23
39.6	130	37	33	22
41.1	135	36	32	21
42.7	140	36	31	21
44.2	145	35	31	20
45.7	150	34	30	20
47.2	155	33	29	19
48.8	160	33	29	19
50.3	165	32	28	18
51.8	170	32	28	18
53.3	175	31	27	17
54.9	180	30	26	17
56.4	185	30	26	16
57.9	190	29	26	16
59.4	195	29	25	16

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
61	200	28	25	15
62.5	205	28	24	15
64	210	28	24	15
65.5	215	27	23	14
67.1	220	27	23	14
68.6	225	26	23	14
70.1	230	26	22	14
71.6	235	26	22	13
73.2	240	25	22	13
74.7	245	25	21	13
76.2	250	25	21	13
77.7	255	24	21	12
79.2	260	24	21	12
80.8	265	24	20	12
82.3	270	23	20	12
83.8	275	23	20	12
85.3	280	23	19	11
86.9	285	22	19	11
88.4	290	22	19	11
89.9	295	22	19	11
91.4	300	22	18	11
106.7	350	19	16	9
121.9	400	18	15	8
137.2	450	16	14	8
152.4	500	15	13	7
167.6	550	14	12	6
182.9	600	13	11	6
198.1	650	12	10	5
213.4	700	11	9	5
228.6	750	11	9	5
243.8	800	10	8	4
259.1	850	10	8	4
274.3	900	9	8	4
289.6	950	9	7	4
304.8	1000	8	7	4
320	1050	8	7	3
335.3	1100	8	6	3
350.5	1150	7	6	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
365.8	1200	7	6	3
381	1250	7	6	3
396.2	1300	7	6	3
411.5	1350	6	5	3
426.7	1400	6	5	3
442	1450	6	5	3
457.2	1500	6	5	2
472.4	1550	6	5	2
487.7	1600	5	5	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	5	4	2
548.6	1800	5	4	2
563.9	1850	5	4	2

14.6 Qalf mapping unit

Table 14-6: Effective shade targets for stream sites in the Qalf mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	89	90	91
0.3	1	89	90	91
0.6	2	88	90	90
0.9	3	87	88	89
1.2	4	86	87	89
1.5	5	85	86	88
1.8	6	84	85	87
2.1	7	83	84	87
2.4	8	82	83	86
2.7	9	81	82	85
3	10	80	81	84
4.6	15	75	74	78
6.1	20	70	68	73
7.6	25	66	63	66

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
9.1	30	63	59	58
10.7	35	59	55	51
12.2	40	56	52	45
13.7	45	54	49	41
15.2	50	51	47	38
16.8	55	49	44	35
18.3	60	47	42	32
19.8	65	45	40	30
21.3	70	43	39	28
22.9	75	42	37	27
24.4	80	40	36	25
25.9	85	39	34	24
27.4	90	38	33	23
29	95	36	32	22
30.5	100	35	31	21
32	105	34	30	20
33.5	110	33	29	19
35.1	115	32	28	18
36.6	120	31	27	18
38.1	125	31	27	17
39.6	130	30	26	17
41.1	135	29	25	16
42.7	140	29	25	16
44.2	145	28	24	15
45.7	150	27	24	15
47.2	155	27	23	14
48.8	160	26	23	14
50.3	165	26	22	13
51.8	170	25	22	13
53.3	175	25	21	13
54.9	180	24	21	12
56.4	185	24	20	12
57.9	190	23	20	12
59.4	195	23	20	12
61	200	22	19	11
62.5	205	22	19	11
64	210	22	19	11
65.5	215	21	18	11

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
67.1	220	21	18	10
68.6	225	21	18	10
70.1	230	20	17	10
71.6	235	20	17	10
73.2	240	20	17	10
74.7	245	19	17	9
76.2	250	19	16	9
77.7	255	19	16	9
79.2	260	19	16	9
80.8	265	18	16	9
82.3	270	18	15	9
83.8	275	18	15	9
85.3	280	18	15	8
86.9	285	17	15	8
88.4	290	17	15	8
89.9	295	17	14	8
91.4	300	17	14	8
106.7	350	15	13	7
121.9	400	13	11	6
137.2	450	12	10	5
152.4	500	11	9	5
167.6	550	10	9	5
182.9	600	10	8	4
198.1	650	9	8	4
213.4	700	9	7	4
228.6	750	8	7	3
243.8	800	8	6	3
259.1	850	7	6	3
274.3	900	7	6	3
289.6	950	7	5	3
304.8	1000	6	5	3
320	1050	6	5	2
335.3	1100	6	5	2
350.5	1150	6	5	2
365.8	1200	5	4	2
381	1250	5	4	2
396.2	1300	5	4	2
411.5	1350	5	4	2

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
426.7	1400	5	4	2
442	1450	4	4	2
457.2	1500	4	4	2
472.4	1550	4	3	2
487.7	1600	4	3	2
502.9	1650	4	3	2
518.2	1700	4	3	2
533.4	1750	4	3	1
548.6	1800	4	3	1
563.9	1850	4	3	1

14.7 Qff2 mapping unit

Table 14-7: Effective shade targets for stream sites in the Qff2 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	88	90	91
0.3	1	88	90	91
0.6	2	88	90	90
0.9	3	88	89	88
1.2	4	87	88	87
1.5	5	86	87	87
1.8	6	85	86	86
2.1	7	84	85	86
2.4	8	83	84	85
2.7	9	82	83	85
3	10	81	83	84
4.6	15	77	77	81
6.1	20	73	72	76
7.6	25	70	67	71
9.1	30	66	63	66
10.7	35	63	60	59
12.2	40	60	57	53
13.7	45	58	54	49

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
15.2	50	56	52	45
16.8	55	53	49	41
18.3	60	51	47	38
19.8	65	50	45	36
21.3	70	48	44	34
22.9	75	46	42	32
24.4	80	45	40	30
25.9	85	43	39	29
27.4	90	42	38	27
29	95	41	37	26
30.5	100	40	35	25
32	105	39	34	24
33.5	110	38	33	23
35.1	115	37	32	22
36.6	120	36	32	21
38.1	125	35	31	21
39.6	130	34	30	20
41.1	135	33	29	19
42.7	140	32	29	19
44.2	145	32	28	18
45.7	150	31	27	18
47.2	155	30	27	17
48.8	160	30	26	17
50.3	165	29	26	16
51.8	170	29	25	16
53.3	175	28	25	15
54.9	180	28	24	15
56.4	185	27	24	15
57.9	190	27	23	14
59.4	195	26	23	14
61	200	26	22	14
62.5	205	25	22	14
64	210	25	22	13
65.5	215	25	21	13
67.1	220	24	21	13
68.6	225	24	21	12
70.1	230	23	20	12
71.6	235	23	20	12

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
73.2	240	23	20	12
74.7	245	22	19	12
76.2	250	22	19	11
77.7	255	22	19	11
79.2	260	22	19	11
80.8	265	21	18	11
82.3	270	21	18	11
83.8	275	21	18	10
85.3	280	20	18	10
86.9	285	20	17	10
88.4	290	20	17	10
89.9	295	20	17	10
91.4	300	19	17	10
106.7	350	17	15	8
121.9	400	16	13	7
137.2	450	14	12	7
152.4	500	13	11	6
167.6	550	12	10	6
182.9	600	11	10	5
198.1	650	11	9	5
213.4	700	10	8	4
228.6	750	9	8	4
243.8	800	9	7	4
259.1	850	8	7	4
274.3	900	8	7	4
289.6	950	8	6	3
304.8	1000	7	6	3
320	1050	7	6	3
335.3	1100	7	6	3
350.5	1150	7	5	3
365.8	1200	6	5	3
381	1250	6	5	3
396.2	1300	6	5	2
411.5	1350	6	5	2
426.7	1400	5	5	2
442	1450	5	4	2
457.2	1500	5	4	2
472.4	1550	5	4	2

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
487.7	1600	5	4	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	4	4	2
548.6	1800	4	4	2
563.9	1850	4	4	2

14.8 Qbf mapping unit

Table 14-8: Effective shade targets for stream sites in the Qbf mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	90	92	93
0.3	1	90	91	92
0.6	2	89	91	92
0.9	3	89	90	90
1.2	4	88	89	89
1.5	5	87	89	89
1.8	6	86	88	88
2.1	7	86	87	87
2.4	8	85	86	87
2.7	9	84	85	86
3	10	83	84	86
4.6	15	79	79	83
6.1	20	75	74	78
7.6	25	71	69	73
9.1	30	68	65	69
10.7	35	65	61	62
12.2	40	62	59	56
13.7	45	60	56	51
15.2	50	58	54	47
16.8	55	55	51	43
18.3	60	53	49	40
19.8	65	51	47	38

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
21.3	70	50	45	36
22.9	75	48	44	34
24.4	80	47	42	32
25.9	85	45	41	30
27.4	90	44	39	29
29	95	43	38	28
30.5	100	41	37	26
32	105	40	36	25
33.5	110	39	35	24
35.1	115	38	34	23
36.6	120	37	33	23
38.1	125	36	32	22
39.6	130	36	31	21
41.1	135	35	31	20
42.7	140	34	30	20
44.2	145	33	29	19
45.7	150	33	29	19
47.2	155	32	28	18
48.8	160	31	27	18
50.3	165	31	27	17
51.8	170	30	26	17
53.3	175	30	26	16
54.9	180	29	25	16
56.4	185	29	25	16
57.9	190	28	24	15
59.4	195	28	24	15
61	200	27	24	15
62.5	205	27	23	14
64	210	26	23	14
65.5	215	26	22	14
67.1	220	26	22	13
68.6	225	25	22	13
70.1	230	25	21	13
71.6	235	24	21	13
73.2	240	24	21	12
74.7	245	24	20	12
76.2	250	23	20	12
77.7	255	23	20	12

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
79.2	260	23	20	12
80.8	265	22	19	11
82.3	270	22	19	11
83.8	275	22	19	11
85.3	280	22	19	11
86.9	285	21	18	11
88.4	290	21	18	11
89.9	295	21	18	10
91.4	300	21	18	10
106.7	350	18	16	9
121.9	400	17	14	8
137.2	450	15	13	7
152.4	500	14	12	6
167.6	550	13	11	6
182.9	600	12	10	5
198.1	650	11	10	5
213.4	700	11	9	5
228.6	750	10	8	4
243.8	800	10	8	4
259.1	850	9	8	4
274.3	900	9	7	4
289.6	950	8	7	4
304.8	1000	8	7	3
320	1050	8	6	3
335.3	1100	7	6	3
350.5	1150	7	6	3
365.8	1200	7	6	3
381	1250	6	5	3
396.2	1300	6	5	3
411.5	1350	6	5	3
426.7	1400	6	5	2
442	1450	6	5	2
457.2	1500	5	5	2
472.4	1550	5	4	2
487.7	1600	5	4	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	5	4	2

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
548.6	1800	5	4	2
563.9	1850	5	4	2

14.9 Tvc mapping unit

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

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	92	93	94
0.3	1	91	93	94
0.6	2	91	93	94
0.9	3	91	92	93
1.2	4	91	92	93
1.5	5	90	91	92
1.8	6	89	90	92
2.1	7	89	90	92
2.4	8	88	89	91
2.7	9	87	89	91
3	10	87	88	90
4.6	15	83	84	87
6.1	20	80	80	84
7.6	25	77	76	81
9.1	30	75	72	78
10.7	35	72	69	74
12.2	40	69	66	70
13.7	45	67	64	64
15.2	50	65	61	60
16.8	55	63	59	56
18.3	60	61	57	52
19.8	65	59	55	49
21.3	70	58	53	46
22.9	75	56	52	44
24.4	80	55	50	42
25.9	85	53	49	40

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
27.4	90	52	47	38
29	95	50	46	36
30.5	100	49	45	35
32	105	48	44	33
33.5	110	47	43	32
35.1	115	46	41	31
36.6	120	45	40	30
38.1	125	44	40	29
39.6	130	43	39	28
41.1	135	42	38	27
42.7	140	41	37	26
44.2	145	41	36	26
45.7	150	40	35	25
47.2	155	39	35	24
48.8	160	38	34	24
50.3	165	38	33	23
51.8	170	37	33	22
53.3	175	36	32	22
54.9	180	36	32	21
56.4	185	35	31	21
57.9	190	35	31	20
59.4	195	34	30	20
61	200	34	30	20
62.5	205	33	29	19
64	210	33	29	19
65.5	215	32	28	18
67.1	220	32	28	18
68.6	225	31	27	18
70.1	230	31	27	17
71.6	235	30	27	17
73.2	240	30	26	17
74.7	245	30	26	16
76.2	250	29	25	16
77.7	255	29	25	16
79.2	260	29	25	16
80.8	265	28	25	15
82.3	270	28	24	15
83.8	275	27	24	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
85.3	280	27	24	15
86.9	285	27	23	14
88.4	290	27	23	14
89.9	295	26	23	14
91.4	300	26	22	14
106.7	350	23	20	12
121.9	400	21	18	11
137.2	450	19	17	10
152.4	500	18	15	9
167.6	550	17	14	8
182.9	600	16	13	8
198.1	650	15	13	7
213.4	700	14	12	7
228.6	750	13	11	6
243.8	800	12	11	6
259.1	850	12	10	5
274.3	900	11	10	5
289.6	950	11	9	5
304.8	1000	10	9	5
320	1050	10	8	4
335.3	1100	10	8	4
350.5	1150	9	8	4
365.8	1200	9	7	4
381	1250	9	7	4
396.2	1300	8	7	4
411.5	1350	8	7	4
426.7	1400	8	6	3
442	1450	7	6	3
457.2	1500	7	6	3
472.4	1550	7	6	3
487.7	1600	7	6	3
502.9	1650	7	6	3
518.2	1700	6	5	3
533.4	1750	6	5	3
548.6	1800	6	5	3
563.9	1850	6	5	%

14.10 Qtg mapping unit

Table 14-10: Effective shade targets for stream sites in the Qtg mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	99
0.3	1	97	98	99
0.6	2	96	97	99
0.9	3	96	97	99
1.2	4	96	97	99
1.5	5	96	97	98
1.8	6	96	97	98
2.1	7	95	96	97
2.4	8	95	96	97
2.7	9	95	95	97
3	10	94	95	97
4.6	15	92	93	96
6.1	20	90	91	94
7.6	25	89	89	93
9.1	30	87	86	91
10.7	35	85	84	90
12.2	40	83	81	88
13.7	45	82	79	86
15.2	50	80	77	84
16.8	55	79	75	82
18.3	60	77	73	79
19.8	65	76	72	76
21.3	70	75	70	73
22.9	75	73	69	70
24.4	80	72	68	67
25.9	85	71	66	65
27.4	90	70	65	63
29	95	69	64	60
30.5	100	67	63	58
32	105	66	62	56
33.5	110	65	60	55
35.1	115	64	59	53
36.6	120	63	58	51
38.1	125	63	57	50

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
39.6	130	62	56	48
41.1	135	61	56	47
42.7	140	60	55	46
44.2	145	59	54	45
45.7	150	58	53	44
47.2	155	57	52	43
48.8	160	57	51	42
50.3	165	56	51	41
51.8	170	55	50	40
53.3	175	55	49	39
54.9	180	54	49	38
56.4	185	53	48	37
57.9	190	53	47	36
59.4	195	52	47	36
61	200	51	46	35
62.5	205	51	45	34
64	210	50	45	34
65.5	215	50	44	33
67.1	220	49	44	32
68.6	225	49	43	32
70.1	230	48	43	31
71.6	235	47	42	31
73.2	240	47	42	30
74.7	245	46	41	30
76.2	250	46	41	29
77.7	255	46	40	29
79.2	260	45	40	28
80.8	265	45	40	28
82.3	270	44	39	28
83.8	275	44	39	27
85.3	280	43	38	27
86.9	285	43	38	26
88.4	290	43	38	26
89.9	295	42	37	26
91.4	300	42	37	25
106.7	350	38	34	22
121.9	400	35	31	20
137.2	450	33	29	18

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	31	27	17
167.6	550	29	25	15
182.9	600	27	24	14
198.1	650	26	22	13
213.4	700	24	21	12
228.6	750	23	20	12
243.8	800	22	19	11
259.1	850	21	18	10
274.3	900	20	17	10
289.6	950	20	17	9
304.8	1000	19	16	9
320	1050	18	16	9
335.3	1100	17	15	8
350.5	1150	17	14	8
365.8	1200	16	14	8
381	1250	16	13	7
396.2	1300	15	13	7
411.5	1350	15	13	7
426.7	1400	14	12	7
442	1450	14	12	6
457.2	1500	14	12	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	13	11	6
518.2	1700	12	10	6
533.4	1750	12	10	5
548.6	1800	12	10	5
563.9	1850	11	10	5

14.11 Tvw mapping unit

Table 14-11: Effective shade targets for stream sites in the Tvw mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	95	97
0.6	2	94	95	97
0.9	3	94	95	97
1.2	4	93	95	96
1.5	5	93	94	96
1.8	6	93	94	95
2.1	7	92	93	95
2.4	8	92	93	94
2.7	9	91	92	94
3	10	91	92	94
4.6	15	88	89	92
6.1	20	86	86	90
7.6	25	83	83	88
9.1	30	81	80	86
10.7	35	79	77	83
12.2	40	77	75	81
13.7	45	75	72	78
15.2	50	73	70	75
16.8	55	72	68	71
18.3	60	70	66	67
19.8	65	68	64	63
21.3	70	67	63	60
22.9	75	65	61	57
24.4	80	64	60	55
25.9	85	63	58	53
27.4	90	61	57	50
29	95	60	56	48
30.5	100	59	54	47
32	105	58	53	45
33.5	110	57	52	43
35.1	115	55	51	42
36.6	120	54	50	40
38.1	125	54	49	39
39.6	130	53	48	38
41.1	135	52	47	37
42.7	140	51	46	36
44.2	145	50	45	35

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
45.7	150	49	44	34
47.2	155	48	44	33
48.8	160	48	43	32
50.3	165	47	42	31
51.8	170	46	41	31
53.3	175	45	41	30
54.9	180	45	40	29
56.4	185	44	40	29
57.9	190	44	39	28
59.4	195	43	38	27
61	200	42	38	27
62.5	205	42	37	26
64	210	41	37	26
65.5	215	41	36	25
67.1	220	40	36	25
68.6	225	40	35	24
70.1	230	39	35	24
71.6	235	39	34	24
73.2	240	38	34	23
74.7	245	38	33	23
76.2	250	37	33	22
77.7	255	37	33	22
79.2	260	36	32	22
80.8	265	36	32	21
82.3	270	36	31	21
83.8	275	35	31	21
85.3	280	35	31	20
86.9	285	35	30	20
88.4	290	34	30	20
89.9	295	34	30	19
91.4	300	33	29	19
106.7	350	30	27	17
121.9	400	28	24	15
137.2	450	26	22	14
152.4	500	24	21	12
167.6	550	22	19	11
182.9	600	21	18	11
198.1	650	20	17	10

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
213.4	700	19	16	9
228.6	750	18	15	9
243.8	800	17	14	8
259.1	850	16	14	8
274.3	900	15	13	7
289.6	950	15	13	7
304.8	1000	14	12	7
320	1050	13	12	6
335.3	1100	13	11	6
350.5	1150	13	11	6
365.8	1200	12	10	6
381	1250	12	10	5
396.2	1300	11	10	5
411.5	1350	11	9	5
426.7	1400	11	9	5
442	1450	10	9	5
457.2	1500	10	8	5
472.4	1550	10	8	4
487.7	1600	9	8	4
502.9	1650	9	8	4
518.2	1700	9	8	4
533.4	1750	9	7	4
548.6	1800	8	7	4
563.9	1850	8	7	4

14.12 Tcr mapping unit

Table 14-12: Effective shade targets for stream sites in the Tcr mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	97	98
0.3	1	95	97	98
0.6	2	95	96	98
0.9	3	95	96	98

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
1.2	4	95	96	97
1.5	5	95	96	97
1.8	6	94	95	96
2.1	7	94	95	96
2.4	8	93	94	96
2.7	9	93	94	96
3	10	92	93	95
4.6	15	90	91	94
6.1	20	88	88	92
7.6	25	86	86	90
9.1	30	84	83	88
10.7	35	82	80	86
12.2	40	80	77	84
13.7	45	78	75	82
15.2	50	76	73	79
16.8	55	75	71	75
18.3	60	73	69	72
19.8	65	71	67	68
21.3	70	70	66	65
22.9	75	69	64	62
24.4	80	67	63	60
25.9	85	66	61	57
27.4	90	65	60	55
29	95	63	59	53
30.5	100	62	58	51
32	105	61	56	49
33.5	110	60	55	47
35.1	115	59	54	46
36.6	120	58	53	44
38.1	125	57	52	43
39.6	130	56	51	42
41.1	135	55	50	41
42.7	140	54	49	39
44.2	145	53	49	38
45.7	150	53	48	37
47.2	155	52	47	36
48.8	160	51	46	36
50.3	165	50	45	35

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
51.8	170	50	45	34
53.3	175	49	44	33
54.9	180	48	43	32
56.4	185	48	43	32
57.9	190	47	42	31
59.4	195	46	41	30
61	200	46	41	30
62.5	205	45	40	29
64	210	45	40	29
65.5	215	44	39	28
67.1	220	44	39	27
68.6	225	43	38	27
70.1	230	42	38	27
71.6	235	42	37	26
73.2	240	41	37	26
74.7	245	41	36	25
76.2	250	41	36	25
77.7	255	40	35	24
79.2	260	40	35	24
80.8	265	39	35	24
82.3	270	39	34	23
83.8	275	38	34	23
85.3	280	38	34	23
86.9	285	38	33	22
88.4	290	37	33	22
89.9	295	37	32	22
91.4	300	36	32	21
106.7	350	33	29	19
121.9	400	31	27	17
137.2	450	28	25	15
152.4	500	26	23	14
167.6	550	25	21	13
182.9	600	23	20	12
198.1	650	22	19	11
213.4	700	21	18	10
228.6	750	20	17	10
243.8	800	19	16	9
259.1	850	18	15	9

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
274.3	900	17	15	8
289.6	950	16	14	8
304.8	1000	16	13	8
320	1050	15	13	7
335.3	1100	15	12	7
350.5	1150	14	12	7
365.8	1200	14	12	6
381	1250	13	11	6
396.2	1300	13	11	6
411.5	1350	12	10	6
426.7	1400	12	10	6
442	1450	12	10	5
457.2	1500	11	10	5
472.4	1550	11	9	5
487.7	1600	11	9	5
502.9	1650	10	9	5
518.2	1700	10	9	5
533.4	1750	10	8	4
548.6	1800	10	8	4
563.9	1850	9	8	4

14.13 Tm mapping unit

Table 14-13: Effective shade targets for stream sites in the Tm mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	95	95
0.3	1	94	95	95
0.6	2	93	95	95
0.9	3	93	94	95
1.2	4	93	94	94
1.5	5	92	93	94
1.8	6	92	93	94
2.1	7	91	92	93

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
2.4	8	91	92	93
2.7	9	90	91	93
3	10	89	90	92
4.6	15	86	87	90
6.1	20	84	83	87
7.6	25	81	80	85
9.1	30	78	76	82
10.7	35	76	73	79
12.2	40	73	70	75
13.7	45	71	67	71
15.2	50	69	65	66
16.8	55	67	63	61
18.3	60	65	61	58
19.8	65	64	59	54
21.3	70	62	58	52
22.9	75	60	56	49
24.4	80	59	54	47
25.9	85	57	53	44
27.4	90	56	51	42
29	95	55	50	41
30.5	100	54	49	39
32	105	52	48	38
33.5	110	51	47	36
35.1	115	50	45	35
36.6	120	49	44	34
38.1	125	48	43	33
39.6	130	47	42	32
41.1	135	46	42	31
42.7	140	46	41	30
44.2	145	45	40	29
45.7	150	44	39	28
47.2	155	43	38	27
48.8	160	42	38	27
50.3	165	42	37	26
51.8	170	41	36	25
53.3	175	40	36	25
54.9	180	40	35	24
56.4	185	39	35	24

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
57.9	190	39	34	23
59.4	195	38	33	23
61	200	37	33	22
62.5	205	37	32	22
64	210	36	32	21
65.5	215	36	31	21
67.1	220	35	31	20
68.6	225	35	31	20
70.1	230	34	30	20
71.6	235	34	30	19
73.2	240	34	29	19
74.7	245	33	29	19
76.2	250	33	29	18
77.7	255	32	28	18
79.2	260	32	28	18
80.8	265	32	27	17
82.3	270	31	27	17
83.8	275	31	27	17
85.3	280	30	26	17
86.9	285	30	26	16
88.4	290	30	26	16
89.9	295	29	26	16
91.4	300	29	25	16
106.7	350	26	23	14
121.9	400	24	21	12
137.2	450	22	19	11
152.4	500	20	18	10
167.6	550	19	16	9
182.9	600	18	15	9
198.1	650	17	14	8
213.4	700	16	14	7
228.6	750	15	13	7
243.8	800	14	12	7
259.1	850	14	12	6
274.3	900	13	11	6
289.6	950	12	11	6
304.8	1000	12	10	5
320	1050	11	10	5

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
335.3	1100	11	9	5
350.5	1150	11	9	5
365.8	1200	10	9	5
381	1250	10	8	4
396.2	1300	10	8	4
411.5	1350	9	8	4
426.7	1400	9	8	4
442	1450	9	7	4
457.2	1500	8	7	4
472.4	1550	8	7	4
487.7	1600	8	7	3
502.9	1650	8	7	3
518.2	1700	8	6	3
533.4	1750	7	6	3
548.6	1800	7	6	3
563.9	1850	7	6	3

14.14 QTt mapping unit

Table 14-14: Effective shade targets for stream sites in the QTt mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	91	93	94
0.3	1	91	92	94
0.6	2	90	92	94
0.9	3	90	92	93
1.2	4	90	91	92
1.5	5	89	90	92
1.8	6	88	89	91
2.1	7	87	89	90
2.4	8	87	88	89
2.7	9	86	87	89
3	10	85	86	88
4.6	15	82	82	85
6.1	20	78	77	82
7.6	25	75	73	78

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
9.1	30	72	69	74
10.7	35	69	66	70
12.2	40	66	63	64
13.7	45	64	60	58
15.2	50	62	58	54
16.8	55	60	56	50
18.3	60	58	54	47
19.8	65	56	52	44
21.3	70	54	50	41
22.9	75	53	48	39
24.4	80	51	47	37
25.9	85	50	45	35
27.4	90	48	44	34
29	95	47	43	32
30.5	100	46	41	31
32	105	45	40	30
33.5	110	44	39	29
35.1	115	43	38	28
36.6	120	42	37	27
38.1	125	41	36	26
39.6	130	40	35	25
41.1	135	39	35	24
42.7	140	38	34	23
44.2	145	37	33	23
45.7	150	37	32	22
47.2	155	36	32	21
48.8	160	35	31	21
50.3	165	35	30	20
51.8	170	34	30	20
53.3	175	33	29	19
54.9	180	33	29	19
56.4	185	32	28	18
57.9	190	32	28	18
59.4	195	31	27	18
61	200	31	27	17
62.5	205	30	26	17
64	210	30	26	17
65.5	215	29	26	16

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
67.1	220	29	25	16
68.6	225	29	25	16
70.1	230	28	24	15
71.6	235	28	24	15
73.2	240	27	24	15
74.7	245	27	23	15
76.2	250	27	23	14
77.7	255	26	23	14
79.2	260	26	22	14
80.8	265	26	22	14
82.3	270	25	22	13
83.8	275	25	22	13
85.3	280	25	21	13
86.9	285	24	21	13
88.4	290	24	21	13
89.9	295	24	21	12
91.4	300	23	20	12
106.7	350	21	18	11
121.9	400	19	16	9
137.2	450	18	15	9
152.4	500	16	14	8
167.6	550	15	13	7
182.9	600	14	12	7
198.1	650	13	11	6
213.4	700	12	10	6
228.6	750	12	10	5
243.8	800	11	9	5
259.1	850	11	9	5
274.3	900	10	8	5
289.6	950	10	8	4
304.8	1000	9	8	4
320	1050	9	7	4
335.3	1100	8	7	4
350.5	1150	8	7	4
365.8	1200	8	7	3
381	1250	8	6	3
396.2	1300	7	6	3
411.5	1350	7	6	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
426.7	1400	7	6	3
442	1450	7	6	3
457.2	1500	6	5	3
472.4	1550	6	5	3
487.7	1600	6	5	3
502.9	1650	6	5	3
518.2	1700	6	5	2
533.4	1750	6	5	2
548.6	1800	5	5	2
563.9	1850	5	4	2

14.15 QTb mapping unit

Table 14-15: Effective shade targets for stream sites in the QTb mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	95	97
0.6	2	93	95	97
0.9	3	93	95	97
1.2	4	93	95	96
1.5	5	93	94	95
1.8	6	92	93	95
2.1	7	92	93	94
2.4	8	91	93	94
2.7	9	91	92	94
3	10	90	92	93
4.6	15	88	89	92
6.1	20	85	86	90
7.6	25	83	83	88
9.1	30	81	80	85
10.7	35	79	77	83
12.2	40	77	74	80
13.7	45	75	72	78

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
15.2	50	73	70	74
16.8	55	71	68	70
18.3	60	70	66	67
19.8	65	68	64	63
21.3	70	66	62	60
22.9	75	65	61	57
24.4	80	63	59	55
25.9	85	62	58	52
27.4	90	61	57	50
29	95	60	55	48
30.5	100	58	54	46
32	105	57	53	45
33.5	110	56	52	43
35.1	115	55	51	42
36.6	120	54	50	40
38.1	125	53	49	39
39.6	130	52	48	38
41.1	135	51	47	37
42.7	140	50	46	36
44.2	145	50	45	35
45.7	150	49	44	34
47.2	155	48	43	33
48.8	160	47	43	32
50.3	165	46	42	31
51.8	170	46	41	30
53.3	175	45	40	30
54.9	180	44	40	29
56.4	185	44	39	28
57.9	190	43	39	28
59.4	195	43	38	27
61	200	42	37	27
62.5	205	41	37	26
64	210	41	36	26
65.5	215	40	36	25
67.1	220	40	35	25
68.6	225	39	35	24
70.1	230	39	34	24
71.6	235	38	34	23

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
73.2	240	38	34	23
74.7	245	37	33	23
76.2	250	37	33	22
77.7	255	37	32	22
79.2	260	36	32	21
80.8	265	36	32	21
82.3	270	35	31	21
83.8	275	35	31	21
85.3	280	35	30	20
86.9	285	34	30	20
88.4	290	34	30	20
89.9	295	33	29	19
91.4	300	33	29	19
106.7	350	30	26	17
121.9	400	27	24	15
137.2	450	25	22	14
152.4	500	24	20	12
167.6	550	22	19	11
182.9	600	21	18	11
198.1	650	19	17	10
213.4	700	18	16	9
228.6	750	17	15	9
243.8	800	17	14	8
259.1	850	16	14	8
274.3	900	15	13	7
289.6	950	14	12	7
304.8	1000	14	12	7
320	1050	13	11	6
335.3	1100	13	11	6
350.5	1150	12	11	6
365.8	1200	12	10	6
381	1250	11	10	5
396.2	1300	11	9	5
411.5	1350	11	9	5
426.7	1400	10	9	5
442	1450	10	9	5
457.2	1500	10	8	5
472.4	1550	10	8	4

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
487.7	1600	9	8	4
502.9	1650	9	8	4
518.2	1700	9	8	4
533.4	1750	9	7	4
548.6	1800	8	7	4
563.9	1850	8	7	4

14.16 Qls mapping unit

Table 14-16: Effective shade targets for stream sites in the Qls mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	98	99
0.3	1	95	97	98
0.6	2	95	97	98
0.9	3	95	96	98
1.2	4	95	96	98
1.5	5	95	96	98
1.8	6	95	96	97
2.1	7	95	95	97
2.4	8	94	95	97
2.7	9	94	95	96
3	10	93	94	96
4.6	15	91	92	95
6.1	20	90	91	94
7.6	25	88	89	92
9.1	30	86	86	91
10.7	35	85	84	90
12.2	40	83	82	88
13.7	45	81	80	86
15.2	50	80	78	85
16.8	55	79	76	83
18.3	60	77	74	80
19.8	65	76	72	78

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
21.3	70	75	71	75
22.9	75	73	69	72
24.4	80	72	68	69
25.9	85	71	67	67
27.4	90	70	66	64
29	95	69	64	62
30.5	100	67	63	60
32	105	66	62	58
33.5	110	65	61	56
35.1	115	64	60	55
36.6	120	63	59	53
38.1	125	63	58	52
39.6	130	62	57	50
41.1	135	61	56	49
42.7	140	60	55	48
44.2	145	59	54	46
45.7	150	58	54	45
47.2	155	58	53	44
48.8	160	57	52	43
50.3	165	56	51	42
51.8	170	55	51	41
53.3	175	55	50	40
54.9	180	54	49	39
56.4	185	53	48	39
57.9	190	53	48	38
59.4	195	52	47	37
61	200	51	47	36
62.5	205	51	46	36
64	210	50	45	35
65.5	215	50	45	34
67.1	220	49	44	34
68.6	225	49	44	33
70.1	230	48	43	33
71.6	235	48	43	32
73.2	240	47	42	31
74.7	245	47	42	31
76.2	250	46	41	30
77.7	255	46	41	30

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
79.2	260	45	40	30
80.8	265	45	40	29
82.3	270	44	40	29
83.8	275	44	39	28
85.3	280	43	39	28
86.9	285	43	38	27
88.4	290	43	38	27
89.9	295	42	38	27
91.4	300	42	37	26
106.7	350	38	34	23
121.9	400	35	31	21
137.2	450	33	29	19
152.4	500	31	27	17
167.6	550	29	25	16
182.9	600	27	24	15
198.1	650	26	22	14
213.4	700	24	21	13
228.6	750	23	20	12
243.8	800	22	19	12
259.1	850	21	18	11
274.3	900	20	18	10
289.6	950	19	17	10
304.8	1000	19	16	9
320	1050	18	16	9
335.3	1100	17	15	9
350.5	1150	17	14	8
365.8	1200	16	14	8
381	1250	16	13	8
396.2	1300	15	13	7
411.5	1350	15	13	7
426.7	1400	14	12	7
442	1450	14	12	7
457.2	1500	13	12	7
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	11	6
518.2	1700	12	10	6
533.4	1750	12	10	6

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
548.6	1800	11	10	6
563.9	1850	11	10	5

14.17 Open Water (OW)

Table 14-17: Effective shade targets for stream sites classified as Open Water (OW).

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	95	96	98
0.3	1	92	92	96
0.6	2	84	80	90
0.9	3	77	72	75
1.2	4	71	65	57
1.5	5	65	59	46
1.8	6	59	53	39
2.1	7	55	48	34
2.4	8	51	44	30
2.7	9	47	41	27
3	10	44	37	24
4.6	15	33	27	16
6.1	20	26	21	12
7.6	25	22	17	10
9.1	30	18	15	8
10.7	35	16	13	7
12.2	40	14	11	6
13.7	45	13	10	6
15.2	50	12	9	5
16.8	55	11	8	5
18.3	60	10	8	4
19.8	65	9	7	4
21.3	70	9	7	4
22.9	75	8	6	3
24.4	80	8	6	3
25.9	85	7	6	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
27.4	90	7	5	3
29	95	7	5	3
30.5	100	6	5	2
32	105	6	5	2
33.5	110	6	4	2
35.1	115	5	4	2
36.6	120	5	4	2
38.1	125	5	4	2
39.6	130	5	4	2
41.1	135	5	4	2
42.7	140	5	3	2
44.2	145	4	3	2
45.7	150	4	3	2
47.2	155	4	3	2
48.8	160	4	3	2
50.3	165	4	3	2
51.8	170	4	3	1
53.3	175	4	3	1
54.9	180	4	3	1
56.4	185	3	3	1
57.9	190	3	3	1
59.4	195	3	2	1
61	200	3	2	1
62.5	205	3	2	1
64	210	3	2	1
65.5	215	3	2	1
67.1	220	3	2	1
68.6	225	3	2	1
70.1	230	3	2	1
71.6	235	3	2	1
73.2	240	3	2	1
74.7	245	3	2	1
76.2	250	3	2	1
77.7	255	3	2	1
79.2	260	2	2	1
80.8	265	2	2	1
82.3	270	2	2	1
83.8	275	2	2	1

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
85.3	280	2	2	1
86.9	285	2	2	1
88.4	290	2	2	1
89.9	295	2	2	1
91.4	300	2	2	1
106.7	350	2	1	1
121.9	400	2	1	1
137.2	450	1	1	1
152.4	500	1	1	0
167.6	550	1	1	0
182.9	600	1	1	0
198.1	650	1	1	0
213.4	700	1	1	0
228.6	750	1	1	0
243.8	800	1	1	0
259.1	850	1	1	0
274.3	900	1	1	0
289.6	950	1	1	0
304.8	1000	1	0	0
320	1050	1	0	0
335.3	1100	1	0	0
350.5	1150	1	0	0
365.8	1200	1	0	0
381	1250	1	0	0
396.2	1300	1	0	0
411.5	1350	0	0	0
426.7	1400	0	0	0
442	1450	0	0	0
457.2	1500	0	0	0
472.4	1550	0	0	0
487.7	1600	0	0	0
502.9	1650	0	0	0
518.2	1700	0	0	0
533.4	1750	0	0	0
548.6	1800	0	0	0
563.9	1850	0	0	0

14.18 Upland Forest

Table 14-18: Effective shade targets for stream sites in the Upland Forest mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	99	99
0.3	1	97	98	99
0.6	2	97	98	99
0.9	3	97	98	99
1.2	4	97	97	99
1.5	5	97	97	98
1.8	6	97	97	98
2.1	7	96	96	98
2.4	8	95	96	98
2.7	9	95	96	97
3	10	95	95	97
4.6	15	93	93	96
6.1	20	91	91	95
7.6	25	89	89	94
9.1	30	88	87	92
10.7	35	86	85	91
12.2	40	84	82	89
13.7	45	83	80	88
15.2	50	81	78	86
16.8	55	80	76	83
18.3	60	79	74	81
19.8	65	77	73	78
21.3	70	76	71	75
22.9	75	75	70	72
24.4	80	73	69	69
25.9	85	72	67	67
27.4	90	71	66	64
29	95	70	65	62
30.5	100	69	64	60
32	105	68	63	58
33.5	110	67	62	56
35.1	115	66	61	55

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
36.6	120	65	60	53
38.1	125	64	59	52
39.6	130	63	58	50
41.1	135	62	57	49
42.7	140	61	56	48
44.2	145	61	55	46
45.7	150	60	54	45
47.2	155	59	54	44
48.8	160	58	53	43
50.3	165	58	52	42
51.8	170	57	51	41
53.3	175	56	51	40
54.9	180	56	50	39
56.4	185	55	49	39
57.9	190	54	49	38
59.4	195	54	48	37
61	200	53	48	36
62.5	205	52	47	36
64	210	52	46	35
65.5	215	51	46	34
67.1	220	51	45	34
68.6	225	50	45	33
70.1	230	50	44	33
71.6	235	49	44	32
73.2	240	49	43	31
74.7	245	48	43	31
76.2	250	48	42	30
77.7	255	47	42	30
79.2	260	47	41	30
80.8	265	46	41	29
82.3	270	46	41	29
83.8	275	45	40	28
85.3	280	45	40	28
86.9	285	45	39	27
88.4	290	44	39	27
89.9	295	44	39	27
91.4	300	43	38	26
106.7	350	40	35	23

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
121.9	400	37	32	21
137.2	450	34	30	19
152.4	500	32	28	17
167.6	550	30	26	16
182.9	600	29	25	15
198.1	650	27	23	14
213.4	700	26	22	13
228.6	750	25	21	12
243.8	800	23	20	12
259.1	850	22	19	11
274.3	900	22	18	10
289.6	950	21	18	10
304.8	1000	20	17	9
320	1050	19	16	9
335.3	1100	18	16	9
350.5	1150	18	15	8
365.8	1200	17	15	8
381	1250	17	14	8
396.2	1300	16	14	8
411.5	1350	16	13	7
426.7	1400	15	13	7
442	1450	15	13	7
457.2	1500	14	12	7
472.4	1550	14	12	6
487.7	1600	14	12	6
502.9	1650	13	11	6
518.2	1700	13	11	6
533.4	1750	13	11	6
548.6	1800	12	11	6
563.9	1850	12	10	5

14.19 1d/1f - Volcanics and Willapa Hills

Table 14-19: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	99	99
0.3	1	97	98	99
0.6	2	97	98	99
0.9	3	96	97	99
1.2	4	96	97	98
1.5	5	96	97	98
1.8	6	96	97	98
2.1	7	95	96	97
2.4	8	95	96	97
2.7	9	95	95	97
3	10	94	95	97
4.6	15	92	93	96
6.1	20	90	91	94
7.6	25	88	89	93
9.1	30	86	86	92
10.7	35	84	84	90
12.2	40	83	82	88
13.7	45	81	79	87
15.2	50	79	77	85
16.8	55	78	75	83
18.3	60	76	74	80
19.8	65	75	72	77
21.3	70	74	70	74
22.9	75	72	69	72
24.4	80	71	68	69
25.9	85	70	66	67
27.4	90	69	65	64
29	95	67	64	62
30.5	100	66	63	60
32	105	65	61	58
33.5	110	64	60	56
35.1	115	63	59	55
36.6	120	62	58	53
38.1	125	61	57	51

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
39.6	130	60	56	50
41.1	135	59	55	49
42.7	140	59	54	47
44.2	145	58	54	46
45.7	150	57	53	45
47.2	155	56	52	44
48.8	160	55	51	43
50.3	165	55	50	42
51.8	170	54	50	41
53.3	175	53	49	40
54.9	180	53	48	39
56.4	185	52	48	38
57.9	190	51	47	38
59.4	195	51	46	37
61	200	50	46	36
62.5	205	50	45	35
64	210	49	45	35
65.5	215	48	44	34
67.1	220	48	44	34
68.6	225	47	43	33
70.1	230	47	42	32
71.6	235	46	42	32
73.2	240	46	41	31
74.7	245	45	41	31
76.2	250	45	41	30
77.7	255	44	40	30
79.2	260	44	40	29
80.8	265	44	39	29
82.3	270	43	39	28
83.8	275	43	38	28
85.3	280	42	38	28
86.9	285	42	38	27
88.4	290	41	37	27
89.9	295	41	37	27
91.4	300	41	37	26
106.7	350	37	33	23
121.9	400	34	31	21
137.2	450	32	28	19

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	30	26	17
167.6	550	28	25	16
182.9	600	26	23	15
198.1	650	25	22	14
213.4	700	24	21	13
228.6	750	23	20	12
243.8	800	22	19	11
259.1	850	21	18	11
274.3	900	20	17	10
289.6	950	19	17	10
304.8	1000	18	16	9
320	1050	18	15	9
335.3	1100	17	15	9
350.5	1150	16	14	8
365.8	1200	16	14	8
381	1250	15	13	8
396.2	1300	15	13	7
411.5	1350	14	12	7
426.7	1400	14	12	7
442	1450	14	12	7
457.2	1500	13	11	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	11	6
518.2	1700	12	10	6
533.4	1750	12	10	6
548.6	1800	11	10	5
563.9	1850	11	10	5

14.20 3a - Portland/Vancouver Basin

Table 14-20: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	95	97	96
0.3	1	95	96	95
0.6	2	94	95	95
0.9	3	94	95	95
1.2	4	94	94	94
1.5	5	93	94	94
1.8	6	92	93	94
2.1	7	92	93	93
2.4	8	91	92	93
2.7	9	91	91	93
3	10	90	91	92
4.6	15	87	87	90
6.1	20	84	84	88
7.6	25	81	80	85
9.1	30	78	77	82
10.7	35	76	73	79
12.2	40	73	70	75
13.7	45	71	68	72
15.2	50	69	66	67
16.8	55	67	63	63
18.3	60	65	61	59
19.8	65	63	60	56
21.3	70	61	58	53
22.9	75	60	56	50
24.4	80	58	55	48
25.9	85	57	53	46
27.4	90	56	52	44
29	95	54	50	42
30.5	100	53	49	40
32	105	52	48	39
33.5	110	51	47	37
35.1	115	50	46	36
36.6	120	49	45	35
38.1	125	48	44	34
39.6	130	47	43	33
41.1	135	46	42	32
42.7	140	45	41	31
44.2	145	44	40	30

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
45.7	150	44	39	29
47.2	155	43	39	28
48.8	160	42	38	28
50.3	165	41	37	27
51.8	170	41	37	26
53.3	175	40	36	26
54.9	180	39	35	25
56.4	185	39	35	24
57.9	190	38	34	24
59.4	195	38	34	23
61	200	37	33	23
62.5	205	37	33	22
64	210	36	32	22
65.5	215	36	32	22
67.1	220	35	31	21
68.6	225	35	31	21
70.1	230	34	30	20
71.6	235	34	30	20
73.2	240	33	30	20
74.7	245	33	29	19
76.2	250	33	29	19
77.7	255	32	28	19
79.2	260	32	28	18
80.8	265	31	28	18
82.3	270	31	27	18
83.8	275	31	27	18
85.3	280	30	27	17
86.9	285	30	26	17
88.4	290	30	26	17
89.9	295	29	26	17
91.4	300	29	25	16
106.7	350	26	23	14
121.9	400	24	21	13
137.2	450	22	19	11
152.4	500	21	18	10
167.6	550	19	17	10
182.9	600	18	15	9
198.1	650	17	15	8

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
213.4	700	16	14	8
228.6	750	15	13	7
243.8	800	14	12	7
259.1	850	14	12	6
274.3	900	13	11	6
289.6	950	13	11	6
304.8	1000	12	10	6
320	1050	12	10	5
335.3	1100	11	9	5
350.5	1150	11	9	5
365.8	1200	10	9	5
381	1250	10	8	5
396.2	1300	10	8	4
411.5	1350	9	8	4
426.7	1400	9	8	4
442	1450	9	7	4
457.2	1500	9	7	4
472.4	1550	8	7	4
487.7	1600	8	7	4
502.9	1650	8	7	3
518.2	1700	8	6	3
533.4	1750	7	6	3
548.6	1800	7	6	3
563.9	1850	7	6	3

14.21 3c - Prairie Terraces

Table 14-21: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	98
0.3	1	96	97	98
0.6	2	96	97	98
0.9	3	96	97	98

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
1.2	4	95	96	97
1.5	5	95	96	97
1.8	6	95	95	96
2.1	7	94	95	96
2.4	8	94	94	96
2.7	9	93	94	96
3	10	93	94	95
4.6	15	90	91	94
6.1	20	88	89	92
7.6	25	86	86	91
9.1	30	84	83	89
10.7	35	82	81	87
12.2	40	80	78	84
13.7	45	78	76	82
15.2	50	76	73	79
16.8	55	74	71	77
18.3	60	73	70	73
19.8	65	71	68	70
21.3	70	70	66	67
22.9	75	68	65	64
24.4	80	67	63	62
25.9	85	66	62	59
27.4	90	64	61	57
29	95	63	59	55
30.5	100	62	58	53
32	105	61	57	51
33.5	110	60	56	49
35.1	115	59	55	48
36.6	120	58	54	46
38.1	125	57	53	45
39.6	130	56	52	44
41.1	135	55	51	43
42.7	140	54	50	41
44.2	145	53	49	40
45.7	150	52	48	39
47.2	155	52	47	38
48.8	160	51	47	37
50.3	165	50	46	36

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
51.8	170	50	45	36
53.3	175	49	45	35
54.9	180	48	44	34
56.4	185	48	43	33
57.9	190	47	43	33
59.4	195	46	42	32
61	200	46	41	31
62.5	205	45	41	31
64	210	45	40	30
65.5	215	44	40	30
67.1	220	44	39	29
68.6	225	43	39	28
70.1	230	43	38	28
71.6	235	42	38	27
73.2	240	42	37	27
74.7	245	41	37	27
76.2	250	41	37	26
77.7	255	40	36	26
79.2	260	40	36	25
80.8	265	39	35	25
82.3	270	39	35	25
83.8	275	39	34	24
85.3	280	38	34	24
86.9	285	38	34	23
88.4	290	37	33	23
89.9	295	37	33	23
91.4	300	37	33	23
106.7	350	33	30	20
121.9	400	31	27	18
137.2	450	29	25	16
152.4	500	27	23	15
167.6	550	25	22	13
182.9	600	23	21	13
198.1	650	22	19	12
213.4	700	21	18	11
228.6	750	20	17	10
243.8	800	19	17	10
259.1	850	18	16	9

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
274.3	900	17	15	9
289.6	950	17	14	8
304.8	1000	16	14	8
320	1050	15	13	8
335.3	1100	15	13	7
350.5	1150	14	12	7
365.8	1200	14	12	7
381	1250	13	12	6
396.2	1300	13	11	6
411.5	1350	13	11	6
426.7	1400	12	11	6
442	1450	12	10	6
457.2	1500	12	10	5
472.4	1550	11	10	5
487.7	1600	11	9	5
502.9	1650	11	9	5
518.2	1700	10	9	5
533.4	1750	10	9	5
548.6	1800	10	8	5
563.9	1850	10	8	5

14.22 3d - Valley Foothills

Table 14-22: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	98	98
0.3	1	96	97	98
0.6	2	95	96	98
0.9	3	95	96	97
1.2	4	95	96	97
1.5	5	95	95	96
1.8	6	94	95	96
2.1	7	93	94	96

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
2.4	8	93	94	96
2.7	9	93	93	95
3	10	92	93	95
4.6	15	90	90	93
6.1	20	87	88	91
7.6	25	85	85	89
9.1	30	82	82	87
10.7	35	80	79	85
12.2	40	78	76	82
13.7	45	76	73	80
15.2	50	74	71	77
16.8	55	72	69	73
18.3	60	71	67	70
19.8	65	69	66	66
21.3	70	67	64	63
22.9	75	66	62	60
24.4	80	65	61	58
25.9	85	63	59	55
27.4	90	62	58	53
29	95	61	57	51
30.5	100	59	56	49
32	105	58	54	48
33.5	110	57	53	46
35.1	115	56	52	44
36.6	120	55	51	43
38.1	125	54	50	42
39.6	130	53	49	40
41.1	135	52	48	39
42.7	140	52	47	38
44.2	145	51	46	37
45.7	150	50	46	36
47.2	155	49	45	35
48.8	160	48	44	34
50.3	165	48	43	34
51.8	170	47	43	33
53.3	175	46	42	32
54.9	180	46	41	31
56.4	185	45	41	31

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
57.9	190	44	40	30
59.4	195	44	40	29
61	200	43	39	29
62.5	205	43	38	28
64	210	42	38	28
65.5	215	42	37	27
67.1	220	41	37	27
68.6	225	41	36	26
70.1	230	40	36	26
71.6	235	40	36	25
73.2	240	39	35	25
74.7	245	39	35	24
76.2	250	38	34	24
77.7	255	38	34	24
79.2	260	37	33	23
80.8	265	37	33	23
82.3	270	37	33	22
83.8	275	36	32	22
85.3	280	36	32	22
86.9	285	35	32	21
88.4	290	35	31	21
89.9	295	35	31	21
91.4	300	34	31	21
106.7	350	31	28	18
121.9	400	29	25	16
137.2	450	27	23	15
152.4	500	25	22	13
167.6	550	23	20	12
182.9	600	22	19	11
198.1	650	21	18	11
213.4	700	19	17	10
228.6	750	19	16	9
243.8	800	18	15	9
259.1	850	17	15	8
274.3	900	16	14	8
289.6	950	15	13	8
304.8	1000	15	13	7
320	1050	14	12	7

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
335.3	1100	14	12	7
350.5	1150	13	11	6
365.8	1200	13	11	6
381	1250	12	11	6
396.2	1300	12	10	6
411.5	1350	12	10	5
426.7	1400	11	10	5
442	1450	11	9	5
457.2	1500	11	9	5
472.4	1550	10	9	5
487.7	1600	10	9	5
502.9	1650	10	8	5
518.2	1700	10	8	4
533.4	1750	9	8	4
548.6	1800	9	8	4
563.9	1850	9	8	4

Total Maximum Daily Loads for the Willamette Subbasins

Water Quality Management Plan

Temperature

May 2025~~Amended to include the Willamette River and major tributaries - DRAFT~~

State of Oregon
DEQ Department of Environmental Quality

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DEQ Department of Environmental Quality

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1. Introduction

DEQ provides this Water Quality Management Plan to guide implementation of the temperature Total Maximum Daily Load developed for ~~the~~10 subbasins of the Willamette River Basin and the mainstem Willamette River (Figure 1~~Figure 1~~;~~,~~ TMDL Rule, Figure 2-1).~~ DEQ will complete another temperature TMDL rulemaking for the mainstem Willamette and major tributaries following issuance of this TMDL.~~ A WQMP is an element of a TMDL, as described by Oregon Administrative Rule 340-042-0040(4)(l), to guide implementation of management strategies to attain and maintain water quality standards. Each WQMP will guide the preparation of detailed TMDL implementation plans prepared by responsible persons including Designated Management Agencies.

This~~ Willamette Subbasins~~ temperature WQMP will be proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule as OAR 340-042-0090(c)(B). This WQMP is intended to provide comprehensive information for implementation of the temperature TMDL, and will be amended, as needed, upon issuance of any future TMDLs within the Willamette Basin~~ including the Willamette Mainstem and Major Tributaries temperature TMDL.~~. Any subsequently amended or renumbered rules cited in this document are intended to apply.

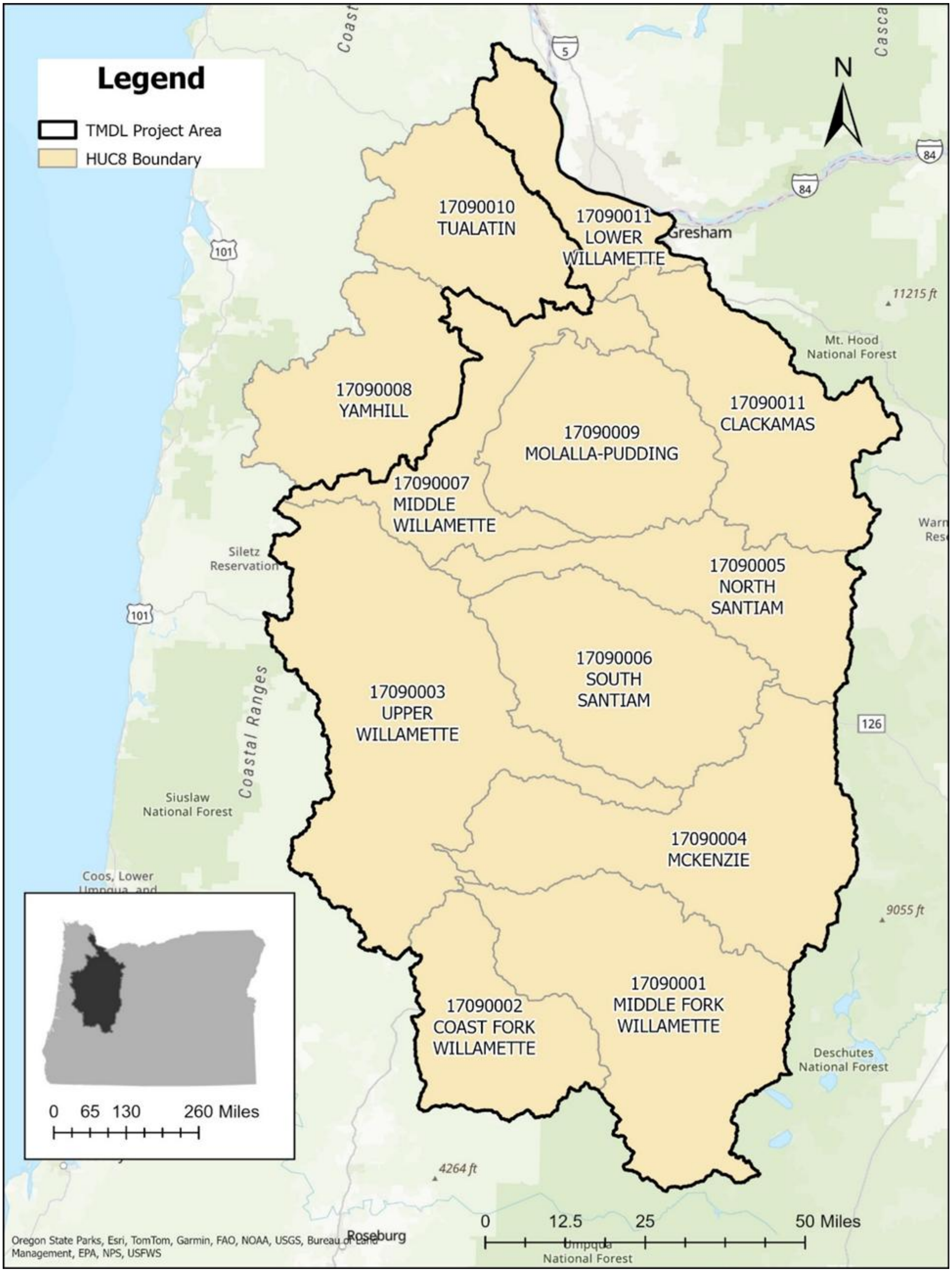


Figure 1: Map of Willamette HUC8 Subbasins.

The Willamette River Basin encompasses twelve subbasins. EPA previously approved three of DEQ's temperature TMDLs covering eleven of the twelve subbasins, as listed below in order of the issuance year. However, in 2013, EPA disapproved the Natural Conditions Criterion contained in Oregon's water quality standard for temperature due to the 2012 U.S. District Court decision for Northwest Environmental Advocates v. EPA. On October 4, 2019, the U.S. District Court issued a judgment in the lawsuit requiring EPA and DEQ to reissue 15 Oregon temperature TMDLs that were based on the Natural Conditions Criterion, including the Lower Columbia-Sandy Subbasin.

1. Molalla-Pudding Subbasin TMDL (2008)
2. Willamette Basin TMDL (2006)
    - Clackamas Subbasin
    - Coast Fork Willamette Subbasin
    - Lower Willamette Subbasin
    - McKenzie Subbasin
    - Middle Fork Willamette Subbasin
    - Middle Willamette Subbasin
    - North Santiam Subbasin
    - South Santiam Subbasin
    - Upper Willamette Subbasin
3. Tualatin Subbasin TMDL (2001)

This TMDL replaces the listed temperature TMDLs except for the Tualatin Subbasin TMDL, which remains in effect for temperature and other pollutants. The Tualatin TMDL did not use the natural conditions criteria to develop TMDL allocations and therefore is not required to be replaced as part of the federal court order to replace the 2006 and 2008 Willamette Basin and Molalla-Pudding temperature TMDLs. The Yamhill subbasin is the 12th subbasin and is not included in this TMDL because it was not included in the 2006 temperature TMDLs and is not under court order to be developed.

This TMDL applies to all waters of the state in the subbasins listed in Table 1~~Table 1~~. The subbasins and associated waterbodies listed in Table 1~~Table 1~~ will hereafter be referred to as the "Willamette Subbasins."

Table 1: Waterbodies included in Willamette Subbasins TMDL.

Subbasin	Waterbodies Included
1. Clackamas	All waters of the state in the Clackamas Subbasin ~~except the Clackamas River downstream of River Mill Dam (approximately river miles 0 - 26).~~
2. Coast Fork	All waters of the state in the Coast Fork Willamette Subbasin ~~except the Coast Fork Willamette River downstream of Cottage Grove Dam (approximately river miles 0- 30) and the Row River downstream of Dorena Dam (approximately river miles 0 -7.5).~~
3. Lower Willamette	All waters of the state in the Lower Willamette Subbasin ~~except the Willamette River and Multnomah Channel.~~
4. McKenzie	All waters of the state in the McKenzie Subbasin~~.~~
5. Middle Fork	All waters of the state in the Middle Fork Willamette Subbasin ~~except the Middle Fork Willamette River downstream of Dexter Dam~~

	~~(approximately river miles 0 - 17) and Fall Creek downstream of Fall Creek Dam (approximately river miles 0 - 7).~~
6. Middle Willamette	All waters of the state in the Middle Willamette Subbasin ~~expect for the Willamette River, Willamette Slough, Mission Lake, and Lambert Slough.~~
7. Molalla-Pudding	All waters of the state in the Molalla-Pudding Subbasin~~.~~
8. North Santiam	All waters of the state in the North Santiam Subbasin ~~except the North Santiam River downstream of Detroit Dam (approximately river miles 0 - 49), and the Santiam River.~~
9. South Santiam	All waters of the state in the South Santiam Subbasin ~~expect for the South Santiam River downstream of Foster Dam (approximately river miles 0 - 38).~~
10. Upper Willamette	All waters of the state in the Upper Willamette Subbasin
~~10. Upper~~11. Mainstem Willamette River	From the confluence of the Columbia River upstream to the confluence of the Coast Fork Willamette River and the Middle Fork Willamette River~~All waters of the state in the Upper Willamette Subbasin except for the Long Tom River downstream stream of Fern Ridge Dam (approximately river miles 0 - 26), and the Willamette River including the Bonneville Channel, Albany Channel, Curtis Slough, Third Slough, Marshall Slough, Curtis Creek, and Mill Race~~

Section ~~3~~2 of the Willamette Subbasins Temperature TMDL Rule contains a listing of all Category 5 temperature impairments from the 2022 Integrated Report (DEQ, 202~~4~~5). The TMDL Technical Support Document (TSD) contains a complete listing of all the Assessment Units included in this rulemaking (DEQ, 202~~4~~5a).

1.1 Condition assessment and problem description

The first element of the WQMP according to OAR 340-042-0040(4)(l)(A) is an assessment of water quality conditions in the Willamette Subbasins with a problem description. There are assessment units in the Willamette Subbasins listed as impaired (category 5 or 4A) for temperature in Oregon's 2022 Integrated Report, which was approved by the U.S. Environmental Protection Agency on September 1, 2022.

DEQ must develop TMDLs for pollutants causing temperature impairments of waters within the Willamette Subbasins, as required by Section 303(d) of the federal Clean Water Act. These pollutants are solar radiation and heat from various sources and conditions that cause water temperatures to exceed criteria established to support aquatic life beneficial uses.

1.2 Goals and objectives

OAR 340-042-0040(4)(l)(B) requires identification of the goals and objectives of the WQMP. The goal of this WQMP is to provide an implementation framework for this Willamette Subbasins temperature TMDL. Implementing the TMDL is designed to achieve and maintain the temperature water quality criteria, including narrative criteria, and meet antidegradation requirements in streams within the Willamette Subbasins. The primary objectives of this WQMP are to describe responsibilities for implementing TMDL management strategies and actions necessary to reduce excess pollutant loads to meet all TMDL allocations, and to provide a strategy to evaluate progress towards attaining water quality standards throughout the Willamette Subbasins.

2. Proposed Management Strategies

The following section presents proposed management strategies, by pollutant source and activity, that are designed to meet the load and wasteload allocations required by the Willamette Subbasins temperature TMDL, as required by OAR 340-042-0040(4)(l)(C).

OAR 340-042-0030(6) defines management strategies as "measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives."

2.1 Streamside vegetation management strategies

DEQ's water quality analysis and modeling show that streamside vegetation planting and management are the strategies necessary to meet water quality standards in the temperature impaired sections of streams in the Willamette Subbasins. Streamside overstory vegetation reduces solar radiation loads to streams by providing shade. Protecting and restoring streamside overstory vegetation is essential to achieving the TMDL surrogate measure of effective shade. More information about the physical and ecological factors affecting effective shade can be found in Section 9.~~3~~4 of the TMDL Technical Support Document.

The primary streamside vegetation planting and management strategies are summarized as follows:

1. **Vegetation planting and establishment**
   This strategy restores locations that have little or no shade producing overstory vegetation. These locations are important for streamside tree and shrub planting projects. These sites may currently be dominated by invasive species.

2. **Vegetation protection (enhancement, maintenance and growth)**
   This strategy addresses streamside areas that have existing vegetation that needs to be protected from removal to maintain current shade levels. In some cases, protection is needed because effective shade can only be achieved with additional growth. Protecting and maintaining existing vegetation ensures that it can grow and mature, enhances vegetation success and survival, and provides for optimal ecological conditions.

3. **Vegetation thinning and management**
   This strategy addresses streamside areas that might need vegetation density reduction to achieve optimal benefits of shade in the long term. Current site conditions at some riparian areas have been shown to be overly dense with trees or dominated by invasive species that inhibit a healthy streamside community, and thinning may be an option to promote development of a healthy mature streamside forest. However, it must be ensured that riparian thinning and management actions will result in limited (i.e., quantity, duration, and spatial extent) stream shade loss. TSD Appendix I presents material describing potential shade and temperature impacts resulting from riparian buffer management and actions to limit these effects.

2.2 Flow management strategies

DEQ's modeling and evaluation of water quality data and research (DEQ, 202~~4~~5; DEQ, 2025a) found that water withdrawals decrease the capacity of streams to assimilate pollutant loads. Because temperature is a flow-related parameter, water withdrawals can result in increased pollutant concentrations and warmer stream temperatures. In waterbodies where temperatures are already known to exceed standards, further withdrawals from the stream will reduce the stream's assimilative capacity and cause greater fluctuation in daytime and nighttime stream temperatures.

Water conservation is a best management practice that directly links the relationship between water quantity and water quality. Leaving water instream functions as a method to protect water quality from flow-related parameters of concern, such as temperature. Under state law, the first person to file for and obtain a water right on a stream is the last person to be denied water in times of low stream flows. Therefore, restoration of stream flows may require establishing instream water rights. One way this can be accomplished is by donating or purchasing out-of-stream rights and converting these rights to instream uses.

2.3 Hydromodification management strategies

Hydromodification refers to alterations of natural hydrological processes which affect characteristics of a waterbody and impact water quality. Examples of hydromodification in streams include human activities such as modifying stream channel morphologic attributes such as width, depth and course, construction and operation of dams and impoundments for flood control, drinking water, recreation, irrigation, and other uses, as well as activities meant to restore and protect streams. These activities can change the loading, timing, and delivery of nonpoint source pollutants, including thermal pollution (EPA, 2007).

Hydromodification activities that alter channel morphology can impact stream temperature (Galli and Dubose, 1990), e.g., wide, shallow streams allow solar radiation to increase stream temperature compared to narrower and deeper channels (Larson and Larson,1996). Activities that make streams more prone to erosion, such as uncontrolled livestock access, can also result in shallower streams and increased stream temperatures. As streambanks erode and slough, sediments can accumulate on the bottom of the stream, which reduces stream depth. Established riparian vegetation is frequently lost, reducing the shade provided to a stream (EPA, 2007). Channelization is another hydromodification activity that impacts channel morphology. Channelization disconnects streams from their floodplains through activities such as urban development or road construction. Streams that have been disconnected from floodplains are not able to slow and store floodwaters during the rainy season or recharge groundwater to support summer flows, factors that increase summer stream temperatures (EPA, 2017).

Management of hydromodification activities to prevent stream temperature increases can include BMPs for point and nonpoint source discharges like riparian restoration, livestock fencing, flow augmentation, reservoir operations, and projects including instream channel restoration. Note that permits are often needed to conduct stream restoration work involving removal and fill activities, and to ensure activities occur during the in-water work period to avoid harming fish. In addition, responsible persons including DMAs need to conduct site-specific evaluations of streams to determine what specific channel modifications are appropriate to meet the desired future condition. For more information about hydromodification sources and impacts, see EPA's *National Management Measures to Control Nonpoint Source Pollution from Hydromodification* (EPA, 2007), as well as a DEQ study, *Water Temperature Impacts from In-Channel Ponds in Portland Metro and Northwest Region* (DEQ, 2023b).

2.3.1 Large dam owners and reservoir management

There are approximately ~~202~~206 reservoirs located within the Willamette Subbasins temperature TMDL project area that are large enough to require evaluation for dam safety. DEQ compiled this basic list of ~~202~~206 dams from the U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department (OWRD), dam safety program (see Appendix ~~Appendix Appendix E~~D). The OWRD prescribes dam safety rules that apply to dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000). ~~-~~"Dam" means a hydraulic structure built above the natural ground line that is used to impound water. Dams include all appurtenant structures and together are sometimes referred to as "the works". Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals. Where possible, DEQ removed reservoirs from this list that were not relevant to the TMDL, such as treatment lagoons or reservoirs not connected to a waterbody.

Dams of all sizes can increase stream temperatures, depending on factors that include dam and stream characteristics, location, and density of dams in a watershed. For these reasons, DEQ expects all dam owners to manage their reservoirs to meet water quality standards, including standards for temperature. For details on reservoir operator implementation requirements, see Section 5.3.~~6~~7.

2.4 Summary of nonpoint source priority management strategies

Table 2~~Table 2~~ includes proven strategies (and practices within the strategies) summarized by pollutant source. These strategies and practices are adapted from published sources. DEQ used the categories and terminology from Oregon Watershed Enhancement Board's Oregon Aquatic Habitat Restoration and Enhancement Guide and Oregon Watershed Restoration Inventory Online List of Treatments. Additional strategies included in Table 2~~Table 2~~ are supported by Oregon Department of Agriculture, the U.S. Department of Agriculture Natural Resources Conservation Service, Oregon State University Extension Service, Oregon Plan for Salmon and Watersheds, and other available published sources. DEQ identified the strategies in Table 2~~Table 2~~ as appropriate for the conditions and sources within the subbasins. These are considered priority strategies and practices that should receive special focus during TMDL implementation plan development.

DEQ expects that entities identified in Section 5.1 will include strategies and practices listed in Table 2
~~Table 2~~ that are applicable to their jurisdiction in their implementation plans. Implementation plans must include specifics on where and when priority and other strategies and practices will be applied. Implementation plans must also include measurable objectives and milestones to document efficacy of each strategy and practice. See Section 5.3.4.1 for methods for determining where land conditions require restoration, protection, and enhancement.

Although not specifically detailed in this WQMP, climate change is another important factor affecting stream temperature. Potential climate change impacts to waterbodies in Oregon may include:

- higher air temperature;
- decreased snowpack leading to less water in reservoirs, streams and groundwater; and
- large-scale wildfires, which can reduce effective shade in streamside areas.

Continued efforts across multiple~~s~~ scales (including local, state, federal, and international) will be required to address the causes of, adapt to, and mitigate the impacts of climate change and support attainment of temperature water quality standards (Section 7.1).

Table 2: Priority temperature management strategies by source.

Pollutant	Source or Activity	Management Strategies
Heat or thermal loading	Insufficient riparian vegetation height, density or width	The primary goal is to increase site effective shade (combination of vegetation height, buffer width and canopy density) through streamside vegetation management strategies using regulatory programs and voluntary activities, including incentive-based projects.

Pollutant	Source or Activity	Management Strategies
		Streamside tree planting (conifer and hardwood); streamside vegetation planting (shrub or herbaceous cover); streamside vegetation management (invasive thinning, removal or other treatment); voluntary streamside tree retention; streamside invasive plant control; streamside fencing or other livestock streamside exclusion methods; identify and protect cold water refuges Maintain plants until free to grow; monitor survival rates. Develop, update and/or enforce streamside code/ordinance to ensure streamside native vegetation and intact bank conditions are protected or restored following site development; purchase, acquire, designate conservation easements along streamside areas.
	Water withdrawals, flow alteration	Pursue instream water right transfers and leases; water right application reviews; irrigation conservation and management; repair or replace leaking pipes and infrastructure; provide incentives for water conservation; implement water consumption restrictions during the summer months, such as lawn watering
	Channel modification and hydromodification	Conduct whole channel restorations (e.g., enhance channel, wetlands, and floodplain interactions, reduce width-to-depth channel ratios, bank stabilization, large wood placement, create/connect side channels, etc.); streamside road re-construction/obliteration activities; streamside fencing or other livestock exclusion methods; protect and enhance cold water refuges; remove in-channel ponds or modify pond structures to reduce temperature increases downstream; and protect areas that don't require restoration actions
	Dam and reservoir management	Modifications to the quantity and nature of water releases to meet water quality standards for temperature

2.5 Point source priority management strategies

Point sources may be assigned wasteload allocations and/or other requirements under the TMDL. These point sources are required to have National Pollutant Discharge Elimination System (NPDES) permits for any wastewater discharges. Under federal rules, effluent limits within NPDES permits are required to be consistent with the assumptions and requirements of any available wasteload allocation. Applicable wasteload allocations for point sources are available in the TMDL document (TMDL Rule, Section 9.1).

The primary way DEQ addresses numeric wasteload allocations is by including effluent limits in permits (though different mechanisms may be used if they are consistent with the TMDL). There are many ways to achieve compliance with these limits and requirements, which can be incorporated into NPDES permits during renewal or issuance. These include, but are not limited to, immediate compliance with the limits, the use of compliance schedules, water quality trading, and other pathways allowed under state and federal rules.

2.6 Water Quality Trading Opportunities

DEQ encourages Willamette Basin DMAs and NPDES-permitted point sources to develop water quality credit trading plans that meet the TMDL allocations for the Willamette ~~Mainstem and~~ Subbasins. Water quality trading is a well-established feature of TMDL implementation in Oregon that is designed to achieve water quality goals more efficiently and with enhanced outcomes. Trading is allowed statewide so long as the requirements of OAR 340-039 are met. Trading is based on a more holistic understanding that pollutant sources are distributed throughout a watershed, and that eliminating these pollutant sources benefits the entire watershed. Trading programs allow facilities to meet their regulatory obligations by exchanging environmentally equivalent (or greater) pollution reductions from sources elsewhere in a watershed. Trading in Oregon includes the use of green infrastructure, which has the additional benefits of enhancing the resilience of natural systems to the effects of climate change. Many trading plans can achieve ~~the~~ higher levels of heat load reduction at a lower cost. For more information, please refer to DEQ's web page on water quality credit trading at http://www.deq.state.or.us/wq/trading/faqs.htm.

3. Timelines for Implementing Strategies

OAR 340-042-0040(4)(l)(D) requires schedules for implementing management strategies including permit revisions, achieving appropriate incremental and measurable water quality targets, implementing control actions and completing measurable milestones. DEQ's water quality permitting program has responsibility for revising permits to comply with TMDLs. Timelines for implementation of management strategies by responsible persons including DMAs is discussed separately.

3.1 DEQ permit revisions

NPDES permits have five-year terms. DEQ incorporates any required TMDL wasteload allocations into NPDES permits when the permit is renewed. ~~Appendix D includes a list of permit holders located within the project area that have NPDES permits, as well as the next expected permit renewal date.~~ NPDES permittees with assigned wasteload allocations are available in the TMDL document (TMDL Rule, Section 9.1). ~~DEQ incorporates any required TMDL wasteload allocations into NPDES permits when the permit is renewed.~~

3.2 Management strategies implemented 2007- 2021 by responsible persons including DMAs

DEQ uses multiple sources to establish current conditions and track implementation progress in the Willamette Subbasins project area. One of these sources is the Oregon Watershed Enhancement Board's Oregon Watershed Restoration Inventory which is a repository for watershed restoration activities. OWRI contains project level information from watershed councils, landowners and other groups who have implemented restoration projects to improve aquatic habitat and water quality conditions. Stream temperature projects in OWRI that have been implemented in the Willamette Basin include riparian fencing, channel modification, voluntary riparian tree retention, dam management and others. The OWRI database reflects 183 total miles of riparian area planted in the Willamette Basin between 2007 and 2021 including 161.6 miles of conifer and hardwood, 13.9 miles of hardwood and 7.4 miles of conifer.

Another resource to track implementation progress is the Willamette Basin Year Five Report, which summarizes data and information submitted to DEQ by DMAs. DMA reporting during ~~for~~ the 2013-2018 period documented 17.3 total linear miles of streamside trees planted in the Willamette Basin. There were also 0.7 miles planted in the Molalla-Pudding Subbasin from 2016-2021, which had a separate Year Five Report ~~completed~~. DEQ did not collect total linear miles of streamside trees planted by DMAs in the 2013 Year Five Report. Additionally, DEQ did not collect information from DMAs on linear feet or acres of streamside land acquisitions, which is an important strategy in protecting water quality. Some of the data reported in the Year Five Reviews may have also been included in the OWRI data.

Note that the number of miles of streamside trees planted reported above in the Willamette Basin Year Five Report includes the Tualatin Basin, which is not included in the Willamette Subbasins TMDL.

DEQ also utilized effective shade gap modelling to assess current conditions within the project area. Where DEQ completed modeling for this TMDL, effective shade targets were calculated at 25-meter node intervals (Lower Willamette model area) and 200-meter node intervals (Southern Willamette model area) for each waterbody. A mean effective shade was then calculated for DMAs where this modeling occurred, and a shade gap assessment was completed. The shade gap results for the modeled areas include shade conditions that may have been impacted by streamside planting projects that were completed following the approval of the 2006 Willamette Basin Temperature TMDL.

While DEQ was not able to directly quantify the impact that planting projects documented in OWRI and the DEQ Willamette Basin Year Five Report had on modeled streamside shade gaps, available data indicate that the pace and scale of streamside planting will need to increase to meet the shade target timelines in Table 3~~Table 3~~.

3.3 Timeline for implementation of management strategies

This section of the WQMP includes an estimate of the timeline for implementation of management strategies that will be sufficient to attain water quality standards.

For solar radiation, excess pollutant load is quantified in kilocalories/day units (kcal/day), whereas effective shade percent is the primary surrogate measure used in this TMDL. DEQ developed timelines to meet water quality standards based on the assumptions that responsible persons including DMAs will consistently implement the three primary streamside vegetation strategies in Section 2.1 until the streamside vegetation class reaches a mid-seral stage conifer-deciduous mix or equivalent characteristics. For this timeline, DEQ also assumed:

- No measurable existing overstory vegetation is removed, thereby reducing the current shade condition;
- Overstory vegetation continues to grow, consistent with average conifer and deciduous growth curves for this portion of the Willamette Basin; and
- Associated effective shade is produced at a rate commensurate with tree growth without significant disturbance (Means and Helm, 1985).

Significant uncertainty exists in meeting timelines for establishing shade. DEQ completed a shade gap assessment covering approximately 21,483 stream kilometers of the Willamette Subbasins project area. This assessment showed that 9,607 stream kilometers currently have an effective shade gap between 15 and 100 percent. For this analysis, DEQ assumes that both current effective shade gaps and future implementation rates will be consistent across assessed and non-assessed areas of the Willamette Subbasins.

Estimating timeframes for meeting the percent effective shade targets across the project area is influenced by several factors:

- The project area is large and the percent effective shade targets to be met are developed at a small scale (i.e., 25- and 200-meter increments) or through shade curves.
- A shade gap analysis is unavailable for all streams in the Willamette Basin to gauge what percent of streamside areas across the Willamette Subbasins area are not currently meeting effective shade targets.
- DEQ is unable to determine whether the rate of planting that has occurred over the past 16 years would be similar to planting efforts following the adoption of this TMDL.
- DMAs that have a large percentage of private property within their jurisdiction will have challenges in meeting effective shade targets. It will likely take additional time to develop more protective streamside ordinances or regulations, work with landowners, or partner with other organizations to conduct streamside planting and restoration projects in these areas.
- It is unclear how much future planting will be targeted in priority shade gap areas given that some planting projects are opportunistic in nature.
- The scale of implementation, location, and water quality benefits from future in-stream restoration and flow augmentation projects are unknown.
- The effects of climate change and invasive species on streamside tree assemblages is unknown. For example, the emerald ash borer, which is now present in Oregon, could result in fewer ash species found in streamside areas.
- The fFrequency and magnitude of natural disturbances such as wildfires is unknown.

DEQ expects responsible persons including DMAs to consider the timeline projections and interim targets presented in Table 3Table 3 in establishing commitments for streamside planting and protection in TMDL implementation plans. Based on DEQ analysis of the number of stream miles that will need restoration, and the pace of restoration logged in OWRI over the previous years of implementation, restoration rates will need to accelerate to meet the targets below. Timelines for attainment of percent cumulative effective shade were estimated based on time for trees to grow to heights sufficient to provide effective shade, and considers the factors and assumptions described above. This equates to meeting 10 percent of shade targets across the basin every 10 years beginning in 2030 and meeting all shade targets in 90 years. Meeting shade targets on all waterbodies may not be possible due to various factors, for example natural disturbances, the built environment, and private streamside ownership.

Table 3: Timelines to meet percent shade targets in the Willamette Subbasins TMDL in 10-year increments.

Assessment Year	Percent Cumulative Shade Targets Met in Willamette Subbasins TMDL
2030	10%
2040	20%
2050	30%
2060	40%
2070	50%
2080	60%
2090	70%
2100	80%
2110	90%
2120	100%

4. Attaining Water Quality Standards

Based on TMDL analyses, achieving the excess load reductions identified will result in attainment of water quality standards. Each management strategy identified in this WQMP, and in implementation plans provided by responsible persons including DMAs, represents part of a system of measures and practices that collectively reduce pollutant loads and improve water quality.

4.1 How management strategies support attainment of water quality standards

OAR 340-042-0040(4)(l)(E) requires an explanation of how implementing the management strategies will result in attainment of water quality standards.

DEQ identified priority implementation management strategies and specific practices in
Table 2
~~Table 2~~ and Section 2.1. DEQ expects these strategies and practices to increase site effective shade and address the excess solar radiation and shade deficits calculated along streams within the Willamette Subbasins (TMDL Rule, Section 8). DEQ focused on the three vegetation strategies described in Section 2.1 to identify timelines for achieving surrogate effective shade targets in

Table 3

~~Table 3~~, and by extension solar radiation load reductions to meet temperature water quality standards.

DEQ developed site-specific effective shade targets and effective shade curves to meet temperature load allocations in the TMDL Rule (TMDL Rule, Section 9.1.5.2). Shade curves identify the relationship between stream width, orientation, and effective shade for specific streamside vegetation types. Effective shade curves are applicable to any stream that does not have site specific shade targets. Effective shade curves represent the maximum possible effective shade for a given vegetation type.

Landowners, foresters, restoration professionals and horticulturists have expertise and experience needed to develop site-specific planting prescriptions that will ensure that the best combination of streamside species are planted. These site-specific planting prescriptions will typically contain a higher diversity of shrub and overstory species than the vegetation types used in developing the shade curves. The overall goal is to establish and protect streamside vegetation to meet effective shade targets established for that site. Maintenance activities, such as removal of invasive species and watering newly established trees and shrubs will be important for trees to become fully established (free to grow).

In addition to streamside shading strategies, significant water quality benefits will be achieved through implementation of stream restoration and flow augmentation management strategies.

4.2 Timelines for attaining temperature water quality standards

OAR 340-042-0040(4)(l)(F) requires an estimated timeline for attaining water quality standards through implementation of the TMDL, WQMP and associated TMDL implementation plans. Based on DEQ's source assessment and TMDL analyses (~~Section 7 in the TSD~~TSD, Section 7), nonpoint sources contribute nearly all of the excess solar radiation pollutant loading associated with temperature impairments in the Willamette Subbasins TMDL. Therefore, it is critical for nonpoint sources to make timely progress toward reducing anthropogenic pollutant loads to meet the TMDL load allocations.

The TMDL calculates NPS load allocations using a percent effective shade surrogate. Therefore, estimated timelines to meet water quality standards are primarily based on streamside planting activities, although stream channel restoration and increasing instream flows would also improve stream temperature conditions. Based on the timeline to meet effective shade targets shown in

Table 3~~Table 3~~, temperature water quality standards for the Willamette Subbasins will be met by 2120. Any uncertainty associated with this date stems from unknowns related to current conditions, the potential for natural disturbances and the pace of future restoration activities. Achieving the identified timelines for cumulative effective shade and resulting water quality benefits will require active participation from all responsible persons including DMAs within the basin.

5. Implementation Responsibilities and Schedule

5.1 Identification of implementation responsibility

OARs 340-042-0040(4)(I)(G) and 340-042-0080(1) require identification of persons, including Designated Management Agencies, responsible for implementing management strategies and preparing and revising implementation plans.

OAR 340-042-0030(2) defines Designated Management Agency as a federal, state or local governmental agency that has legal authority over a sector or source contributing pollutants and is identified as such by DEQ in a TMDL.

The TMDL rule provides numerous mentions of the term ‘responsible person’ with associated requirements. OAR 340-042-0025(2) indicates that responsible sources must meet TMDL load allocations through strategies developed in implementation plans. OAR 340-042-0030(9) defines ‘reasonable assurance’ as a demonstration of TMDL implementation by governments or individuals. OARs 340-042-0040(4)(l)(G) requires identification of persons, including DMAs, responsible for developing and revising implementation plans. OAR 340-042-0040(4)(l)(I) requires a schedule for submittal and revision of implementation plans by responsible persons including DMAs. OAR 340-042-0080(4) reiterates the requirement for persons, including DMAs, responsible for development, submittal and revision of implementation plans, along with the required elements of those plans. For purposes of this Willamette Subbasins WQMP, for implementation of the temperature TMDLs, ‘responsible person’ is defined as any entity responsible for any source of pollution addressed by the TMDL.

Responsible persons including DMAs are organized by DMA type in the following subsections. These persons are responsible for developing or revising implementation plans and implementing management strategies to achieve the TMDL allocations. A complete list of responsible persons including DMAs for the Willamette Subbasins Temperature TMDL is in Appendix A~~Appendix A~~. There are ~~134~~1335 responsible persons including DMAs such as cities, counties, federal and state agencies, and other entities.

Appendix A~~Appendix A~~ is not an exhaustive list of every individual that bears responsibility for improving water quality in the Willamette Subbasins. It may be necessary for all people that live, work, and recreate in the basin to take steps to reduce pollution and protect or restore water quality to attain standards and protect the designated beneficial uses.

As shown in Figure 2~~Figure 2~~ and Figure 3~~Figure 3~~ four DMAs manage or own the bulk of the land area referenced in the Willamette Subbasins Temperature TMDL. Figure 2~~Figure 2~~ illustrates the estimated land area owned or managed by these entities, and Figure 3~~Figure 3~~ shows the percentage of estimated acres that are within 150 feet of a stream for these DMAs. Appendix A~~Appendix A~~ contains jurisdictional acres associated with many DMAs, however, that information was not available for all responsible persons including DMAs. Appendix B and Appendix C contain further information divided by subbasin and show jurisdictional area of each DMA by subbasin and within 150 feet of a stream.

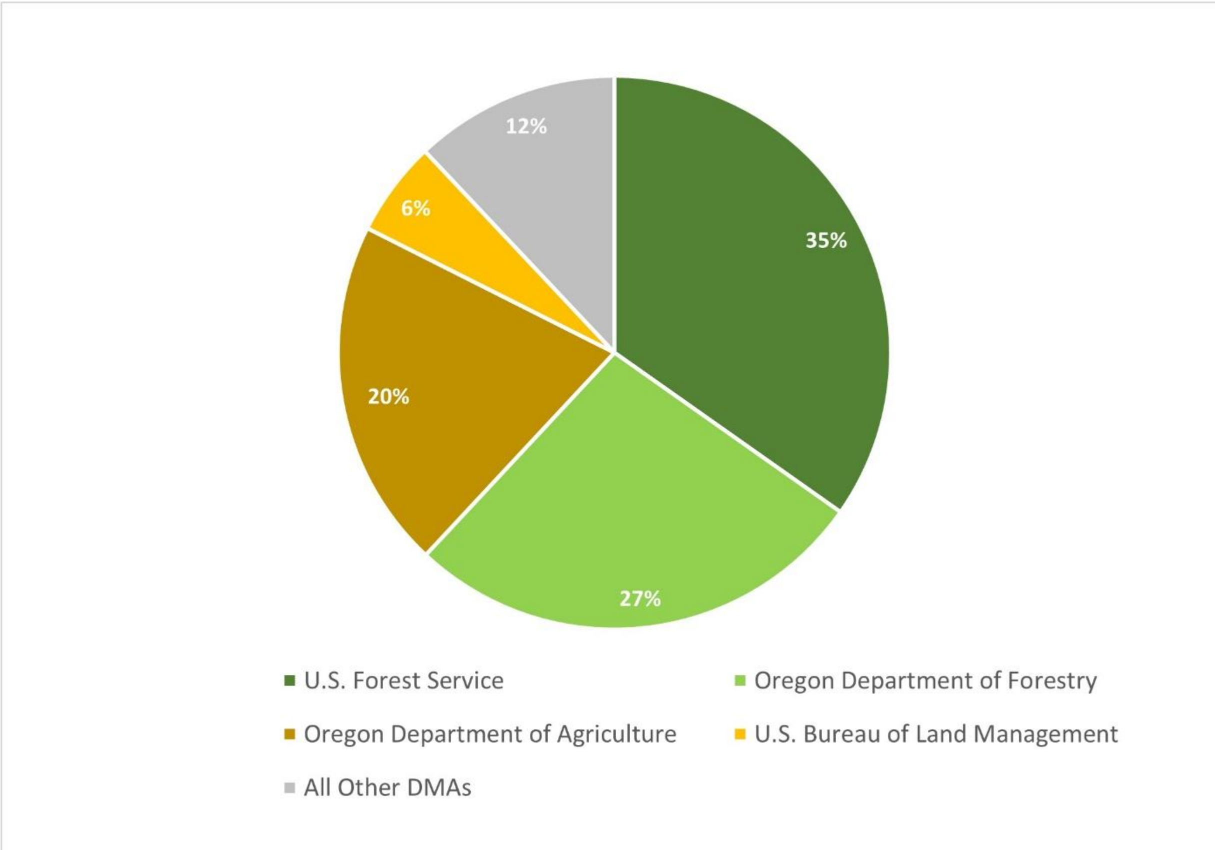


Figure 2: Percent estimated acres owned or managed by responsible persons including DMAs in Willamette Subbasins TMDL.

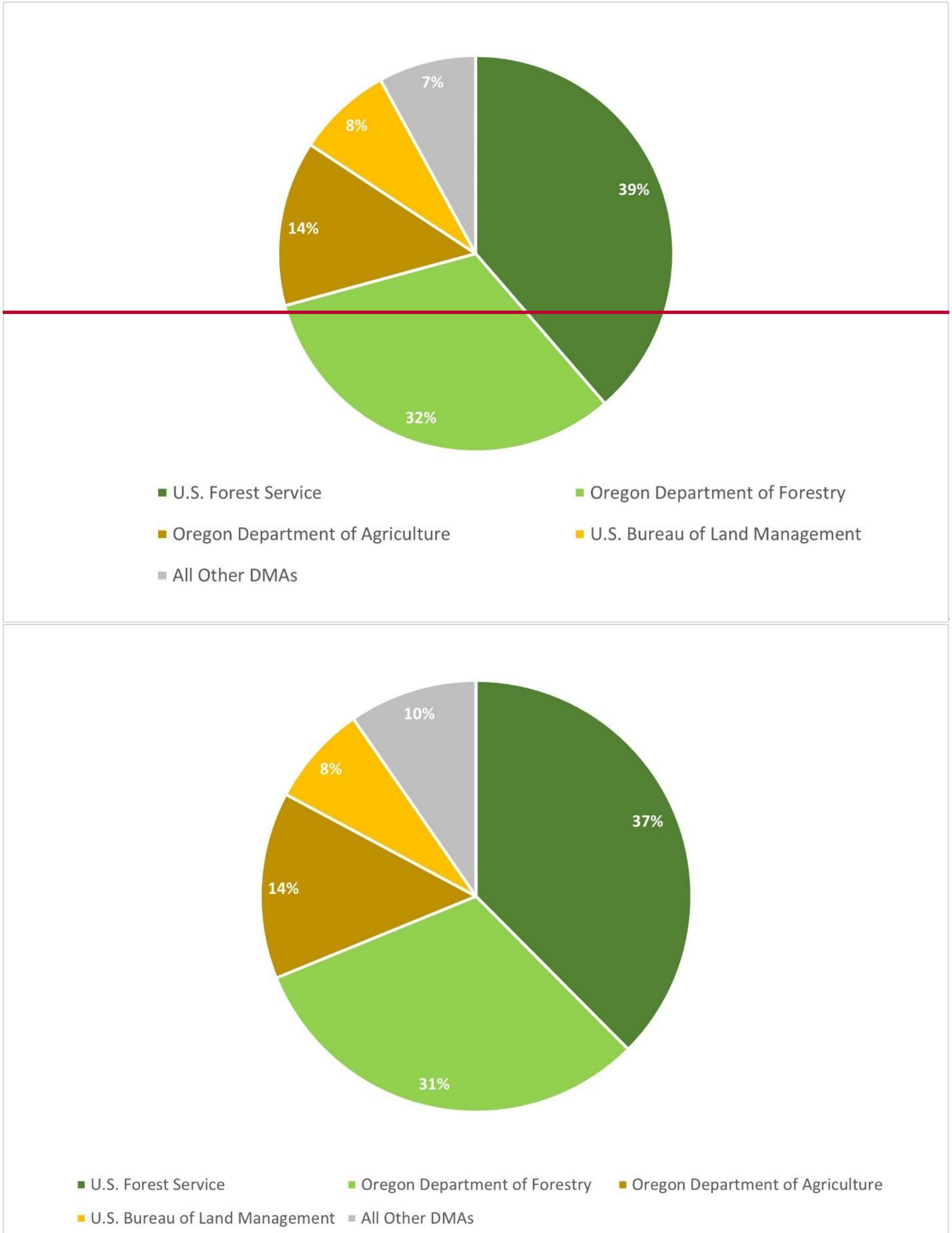


Figure 3: Percent estimated acres owned or managed by responsible persons including DMAs 150 feet from stream centerline.

5.1.1 Responsible persons including DMAs not required to develop a TMDL implementation plan

Some responsible persons including DMAs will not be required to submit implementation plans at this time for the following reasons:

1) Responsibilities are covered under the Tualatin Temperature TMDL.
2) Does not have ownership or jurisdiction over land management activities within the streamside area, so they are unable to implement actions identified in
~~2)~~3) Table 2~~Table 2~~ in this WQMP.
~~3)~~4) Other implementation pathway:
    a. Area is managed by other authorities already required to develop a plan.
    b. Water protection actions are implemented through permits (e.g., DOGAMI).
~~4)~~5) Has limited ability or opportunity to conduct stream restoration activities (e.g., railroads).
~~5)~~6) Has limited streamside area under its jurisdiction (generally less than 7 acres within 150 feet of a stream in the entire project area).

Table 4~~Table 4~~ identifies the entities that are named as responsible persons including DMAs in this TMDL that are not required to develop and submit an implementation plan at this time. DEQ may require implementation plans from these entities in the future if ownership or jurisdiction of streamside areas increases, or other data or information indicates a TMDL implementation plan is needed to achieve temperature allocations and shade targets identified in this TMDL. DEQ may revise the WQMP or issue individual orders to notify them of the required schedule for submitting an implementation plan.

Table 4: List of Responsible Persons including Designated Management Agencies for which no TMDL implementation plan is required at this time.

No.	Responsible Persons including Designated Management Agencies	DMA Type
1	Tualatin	City
2	McMinnville	City
~~2~~3	Curry County	County
~~3~~4	Lincoln County	County
~~4~~5	Washington County	County
~~5~~6	Bonneville Power Administration	Federal
~~6~~7	Pacific Power and Light	Private Utility
~~7~~8	Portland Terminal Railroad Company	Railroad
~~8~~9	Vennel Farms Railroad Company	Railroad
~~9~~10	Willamette Shore Trolley	Railroad
~~10~~11	Oregon Pacific Railroad	Railroad
~~11~~12	BNSF Railway	Railroad
~~12~~13	Central Oregon & Pacific Railroad	Railroad
~~13~~14	TriMet	Railroad
~~14~~15	Willamette Valley Railway	Railroad
~~15~~16	Albany & Eastern Railroad	Railroad
~~16~~17	Port of Coos Bay	Railroad
~~17~~18	Portland & Western Railroad	Railroad
~~18~~19	Union Pacific Railroad	Railroad
~~19~~20	Ash Creek Water Control District	Responsible Person

2021	East Valley Water District	Responsible Person
2122	Santiam Water Control District	Responsible Person
2223	West Labish Water Control District	Responsible Person
2324	Palmer Creek Water District Improvement Co.	Responsible Person
2425	G A Miller Drainage District No 1	Responsible Person
2526	Sidney Irrigation District	Responsible Person
2627	Hawn Creek District Improvement Co.	Responsible Person
2728	Creswell Water Control District	Responsible Person
2829	Creswell Irrigation District	Responsible Person
2930	East Valley Water District	Responsible Person
3031	Fertile Improvement District	Responsible Person
3132	Grand Prairie Water Control District	Responsible Person
3233	Junction City Water Control District	Responsible Person
3334	Lacomb Irrigation District	Responsible Person
3435	Lake Labish Water Control District	Responsible Person
3536	Muddy Creeks Irrigation Project	Responsible Person
3637	Multnomah County Drainage District	Responsible Person
37378	North Lebanon Water Control District	Responsible Person
3839	Peninsula Drainage District #1	Responsible Person
3940	Peninsula Drainage District #2	Responsible Person
404138	Sauvie Island Drainage Improvement Company	Responsible Person
414239	Scappoose Drainage Improvement Company	Responsible Person
40	Urban Flood Safety and Water Quality District	Responsible Person
42413	Oregon Department of Environmental Quality	State
43424	Oregon Department of State Lands	State
44435	Oregon Department of Geology and Mineral Industries	State

5.2 Existing implementation plans

OAR 340-042-0040(4)(l)(H) requires identification of any source or sector-specific implementation plans available at the time of TMDL issuance. Following the issuance of the 2006 Willamette Basin and 2008 Molalla-Pudding TMDLs and WQMPs, DEQ required responsible persons including DMAs to develop implementation plans that included specific management strategies and best management practices to meet load allocations for temperature. Reporting requirements for many of these entities included an annual progress report and a comprehensive assessment of activities every five years. For information on each DMA, including which DMAs are existing DMAs, see Appendix AAppendix A. DEQ notes that not all existing DMAs have DEQ-approved TMDL implementation plans. Existing DMAs will need to update their current implementation plans for temperature to ensure any new requirements in this WQMP are met.

In addition, certain statewide rules, programs and management plans for forestry and agriculture are intended, in part, to reduce or control nonpoint sources of pollution. The programs described in OAR 340-042-0080(2) and (3), respectively, represent existing implementation plans for non-federal forest and agricultural lands, and their sufficiency is discussed below.

5.2.1 Oregon Department of Forestry: Adequacy of Forest Practices Act to meet TMDL load allocations

Waterway protection measures were established in 1994 for state and private forest practices in Oregon, as codified in Oregon Revised Statutes 527.610 through 527.992, Oregon's Forest Practices Act (OAR 629-600 through 629-665) and Oregon's Plan for Salmon and Watersheds (Executive Order 99-01). As provided in ORS 527.770, forest operations conducted in accordance with the Forest Practices Act and other voluntary measures are generally considered to be in compliance with water quality standards. However, as provided in OAR 340-042-0080(2), revisions to the Forest Practices Act rules may be required when DEQ determines that these rules are not adequate to implement load allocations in an approved TMDL.

Periodic revisions to the Forest Practices Act rules occurred between the 1990s through 2022. With the publication of the Private Forest Accord Report and subsequent passage of Senate Bill 1501, 1502 and HB 4055, Forest Practices Act rule revisions were adopted by the Board of Forestry in October 2022 and additional amendments are anticipated through 2025. Implementation of these rules, including increased riparian widths and additional tree retention, may be effective at meeting shade allocations. The streamside vegetation retention and riparian management area distances in the current Forest Practices Act are summarized in Table 5Table 5 below. There are multiple other requirements or exceptions found in the forest practice rules not included in the table.

Table 5: Summary streamside vegetation retention riparian management area distances in Forest Practices Act rules OAR 629-643.

ODF Stream Type*	Standard Practice Vegetation Retention (Feet)	Small Forestland Option Vegetation Retention (Feet)
Large Type SSBT	110	100
Medium Type SSBT	110	80
Small Type SSBT	100	60
Large Type F	110	100
Medium Type F	110	70
Small Type F	100	50
Large Type N	75	70
Medium Type N	75	50
Small Type N	See Type Np	See Type Np
Small Type Np flows into to Type SSBT	75 feet vegetation retention for 500 feet upstream from the confluence with the Type SSBT, then 50 feet buffer retention for 650 feet upstream. Retention distance is the shorter of 1,150 feet (RH Max^{+}) or the uppermost flow feature.	35 feet vegetation retention from the confluence with the Type SSBT to the upper most flow feature or 1,150 feet upstream (RH Max), whichever is shorter.
Small Type Np flows into to Type F	75 feet vegetation retention from the confluence with the Type F to the upper most flow feature or 600 feet upstream (RH Max), whichever is shorter.	35 feet vegetation retention from the confluence with the Type F to the upper most flow feature or 600 feet upstream (RH Max), whichever is shorter.
Small Type Ns	35' Equipment Limitation Zone (ELZ)	

***ODF Stream Type Definitions:**
SSBT—salmon, steelhead, or bull trout
F—fish-bearing (non-SSBT)
N—non-fish-bearing, non-domestic
Np—perennial, Type-N

Ns—seasonal, Type-N

+ "RH Max" means the maximum distance described for any particular small Type Np stream.

DEQ finds the no-harvest vegetation retention buffers of 100-110 feet (e.g. large SSBT, Large F, small and medium SSBT/F standard practice) may be sufficient to meet some shade targets, depending on density of residual trees, stream orientation, topography, and other site-specific factors (TSD, Appendix I). However, based on the findings in Appendix I, it is probable that in some cases these buffers will not provide shade equivalent to 120-foot no-harvest buffer. Smaller no-harvest buffers are progressively less likely to meet shade targets and more likely to result in temperature increases beyond the assigned TMDL human use allowance of (0.0°C) and equivalent load allocation for all fish-bearing and perennial non-fish-bearing streams. This is more pronounced for the Small Forestland Option. Adoption of forest conservation tax credits on small forestlands to align protections with standard practice will increase the effectiveness. Overall, required riparian protections under the Forest Practices Act are unlikely to consistently meet shade targets and load allocations. For these reasons, ODF is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8~~Table 8~~ for the schedule.

As agreed~~,~~ in the 2021 Memorandum of Understanding between DEQ and ODF, DEQ will work with ODF to identify additional regulatory or non-regulatory measures that could be implemented by rule revisions, stewardship agreements, incentive programs or other means to provide reasonable assurance of achieving TMDL solar radiation load allocations. Collaboration on these additional measures may occur during development of ODF's implementation plan.

5.2.2 Oregon Department of Agriculture: 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 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 ODA Agricultural Water Quality Management Areas that each have an Area Plan (TSD, Section 11). DEQ participates in ODA's Area Plan review process by providing water quality status and trends for each management area, as well as assessments of land conditions, agricultural activities and implementation gaps that likely contribute to water quality impairments. The Area Plans for the eight management areas included in this TMDL were reviewed by DEQ within the last three years, however not all reviews resulted in Area Plan revisions.

Willamette Basin streams continue to be identified as impaired on Oregon's Section 303(d) list for temperature in part due to the lack of adequate streamside vegetation in agriculturally influenced streamside areas. DEQ's assessments of Area Plans identified protecting, maintaining and establishing streamside vegetation as a high priority to achieve TMDL load allocations. However, ODA's Area Plans lack specific measurable goals related to streamside conditions that will achieve TMDL shade measures.

The agricultural Area Rules and Area Plans that regulate and guide streamside management in the Willamette Subbasins TMDL project area do not identify quantitative targets for effective shade based on site specific factors, including stream width or orientation. DEQ also notes the disparity between ODA's implementation of their Area Rules for "site capable vegetation" in streamside areas and the streamside conditions needed to meet effective shade targets in this TMDL. ODA has not demonstrated that voluntary landowner implementation of Area Plans will bridge the gap between current conditions and what is needed to meet TMDL allocations.

DEQ concluded that current ODA WQ program Area Rules combined with implementation of Area Plans' voluntary measures are not adequate in all locations to meet the streamside vegetation requirements necessary to achieve TMDL effective shade targets, load allocations, and temperature water quality standards. Therefore, ODA is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8~~Table 8~~ for schedule.

5.2.3 U.S. Bureau of Land Management: Adequacy of streamside management strategies in attaining TMDL load allocations and effective shade surrogate measures

Streamside vegetation on BLM managed lands in the Willamette Subbasins are currently managed based on BLM's Northwestern and Coastal Oregon Resources Management Plan (BLM, 2016).

BLM defines riparian management areas called 'riparian reserves' using slope distance from the ordinary high water line on each side of a stream. Slope distance is specific to different types of waterbodies as summarized in Table 6~~Table 6~~. The slope distance or *riparian reserve distance* is defined based on site-potential tree height. Site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site's class. BLM states that site-potential tree heights generally range from 140 feet to 240 feet, depending on site productivity.

Management practices in riparian reserves vary~~ies~~, however, clearcut harvesting within the riparian reserve is prohibited. Some tree removal or thinning activities are allowed based on certain circumstances such as to protect public safety, or to keep roads and other infrastructure clear of debris. Tree removal for yarding corridors, skid trails, road construction, stream crossings and road maintenance or improvement are allowed where there is no operationally feasible and economically viable alternative. On fish bearing streams and perennial streams between 0- and 120-feet slope distance, there is no thinning except in cases of sudden oak death or for individual tree cutting or tipping that achieve restoration or habitat enhancement objectives. On intermittent, non-fish bearing streams, the same management strategy is applied but only from 0 to 50 feet.

Table 6: Summary of BLM riparian reserve buffer distance for different waterbody features.

Feature	Riparian Reserve Distance measured as slope distance
Fish-bearing streams and perennial streams	One site-potential tree height distance from the ordinary high water line or from the outer edge of the channel migration zone

Feature	Riparian Reserve Distance measured as slope distance
	for low-gradient alluvial shifting channels, whichever is greatest, on each side of the stream
Intermittent, non fish-bearing streams	Class I and II subwatersheds: One site-potential tree height distance from the ordinary high water line on each side of the stream
	Class III subwatersheds: 50 feet from the ordinary high water line on each side of a stream
Unstable areas that are above or adjacent to stream channels and are likely to deliver material such as sediment and logs to the stream if the unstable area fails	The extent of the unstable area; where there is stable area between such unstable areas and a stream, and the unstable area has the potential to deliver material such as sediment and logs to the stream, extend the Riparian Reserve from the stream to include the intervening stable area as well as the unstable area
Lakes, natural ponds and reservoirs > 1 acres, and wetland > 1 acres	100 feet extending from the ordinary high water line
Natural ponds < 1 acres, wetlands < 1 acres (including seeps and springs), and constructed water impoundments (e.g. canal ditches and pump chances) of any size	25 feet extending from the ordinary high water line

DEQ finds that BLM's streamside vegetation management strategies on fish-bearing streams and perennial streams are adequate and will likely lead to achievement of the TMDL load allocation and effective shade targets. Riparian reserves located on intermittent, non-fish bearing streams may not be adequate to achieve the load allocation or effective shade targets. Streamside management on intermittent streams is a concern because they may contain residual pools that support aquatic life; or be flowing during periods when the TMDL allocations apply. The classification and mapping of intermittent streams often do not account for these situations. See TSD Section 2.4 for additional details. In locations where an intermittent stream has surface flow in Class III subwatersheds, a riparian reserve distance of 50 feet is unlikely to provide sufficient shade and will result in stream warming. In Class I and Class II subwatersheds, thinning is authorized between 50- and 120-feet slope distance and must maintain at least 30 percent canopy cover and 60 trees per acre expressed as an average. Thinning at these levels within 120-foot slope-distance from the stream may reduce effective shade and contribute to stream warming (TSD, Appendix I). The amount of effective shade reduction and temperature response will depend on the thinning intensity and spacing of thinning treatments (Roon et. al., 2021).

For these reasons, BLM is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8~~Table 8~~ for schedule.

5.2.4 U.S. Forest Service: Adequacy of streamside management strategies in attaining TMDL load allocations and effective shade surrogate measures

Streamside vegetation on USFS lands in the Willamette Subbasins currently managed based on Northwest Forest Plan (USFS and BLM 1994). As part of the plan, the Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems, including salmon and steelhead habitat on federal lands managed by USFS. Maintaining and restoring water quality is one of the stated objectives of the Aquatic

Conservation Strategy. These aquatic ecosystems and the streamside adjacent areas are called *riparian reserves.* Like BLM, USFS defines many of the reserve distances using site-potential tree height. The Northwest Forest Plan states a site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class and is consistent with the BLM definition. The following text is a description of the riparian buffer distance for different types of waterbodies. The text was extracted from USFS and BLM (1994), Attachment A, Standards and Guidelines, Section C, pages C-3- through C-31.

> ***Fish-bearing streams*** *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.*
>
> ***Permanently flowing nonfish-bearing streams*** *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.*
>
> ***Constructed ponds and reservoirs, and wetlands greater than 1 acre*** *- Riparian Reserves consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.*
>
> ***Lakes and natural ponds*** *- Riparian Reserves consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.*
>
> ***Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas*** *- This category applies to features with high variability in size and site-specific characteristics. At a minimum, the Riparian Reserves must include:*
>
> - *The extent of unstable and potentially unstable areas (including earthflows),*
> - *The stream channel and extend to the top of the inner gorge,*
> - *The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and*
> - *Extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.*

DEQ finds that USFS's streamside vegetation management strategies on fish-bearing streams, perennial streams, non-fish bearing streams, constructed ponds and reservoirs, lakes and natural ponds, and wetlands greater than 1-acre are adequate and will likely lead to achievement of the TMDL load allocation and effective shade targets. Vegetation management strategies on intermittent streams, and wetlands less than 1-acre may not be adequate to achieve the load allocation or effective shade targets (TSD, Appendix I). Streamside management on intermittent streams is a concern because they may contain residual pools that support aquatic life; or be flowing during periods when the TMDL allocations apply. The classification and mapping of intermittent streams often do not account for these situations. See TSD Section 2.4 for additional details.

For these reasons, USFS is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8Table 8 for schedule.

5.3 Implementation plan requirements

Appendix AAppendix A lists the responsible persons including DMAs that are required to submit an implementation plan. As required in OAR 340-042-0080(4)(a), implementation plans must include:

- Management strategies that the entity will use to achieve load allocations and reduce pollutant loading;
- Timeline for strategy implementation and a schedule for completing measurable milestones;
- Performance monitoring and a plan for periodic review and revision of implementation plans;
- To the extent required by ORS 197.180 and OAR chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and,
- Any other analyses or information specified in this WQMP.

The following subsections provide detail on each component required by this WQMP that must be included in implementation plans. Some implementation plan requirements vary depending on the responsible person including DMAs.
TMDL implementation plans and annual reports must be posted to each DMA's website for public transparency. If a DMA does not have a website, these documents must be made available to the public in another manner.

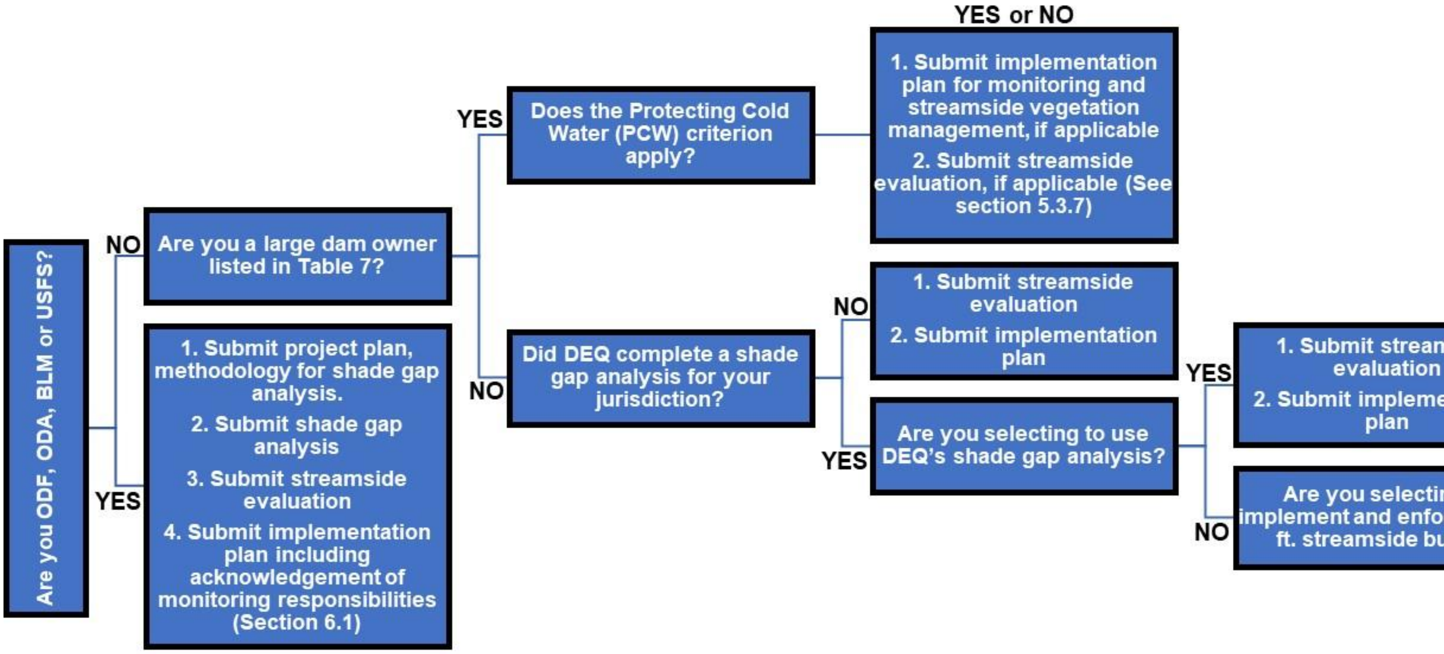
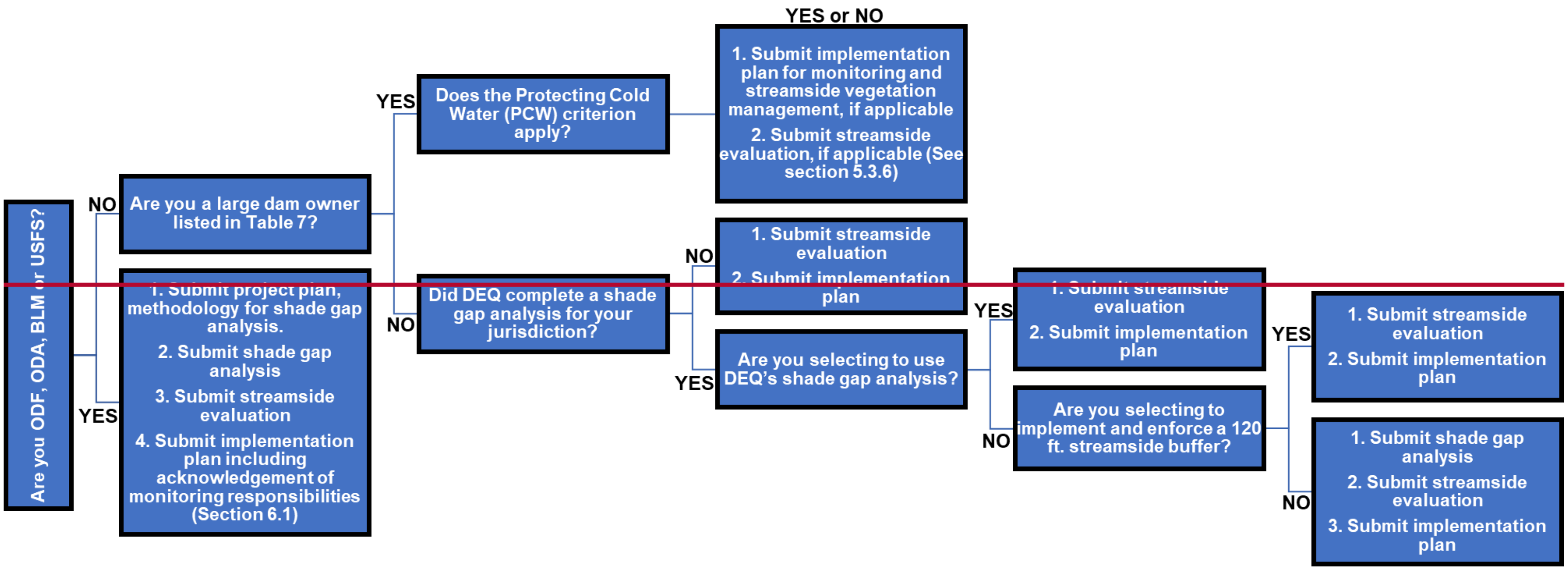


Figure 4Figure 4 is provided to help responsible persons including DMAs determine the information and analyses they are responsible for submitting to DEQ. DEQ will work with each entity required to develop a TMDL implementation plan to ensure that all required elements are included with sufficient detail for their plan to be approved on the schedule required in Section 5.3.78 (Table 8Table 8)


Are you ODF, ODA, BLM or USFS?
NO
Are you a large dam owner listed in Table 7?
YES
1. Submit project plan, methodology for shade gap analysis.
2. Submit shade gap analysis
3. Submit streamside evaluation
4. Submit implementation plan including acknowledgement of monitoring responsibilities (Section 6.1)
YES
Does the Protecting Cold Water (PCW) criterion apply?
YES or NO
1. Submit implementation plan for monitoring and streamside vegetation management, if applicable
2. Submit streamside evaluation, if applicable (See section 5.3.6)
NO
Did DEQ complete a shade gap analysis for your jurisdiction?
NO
1. Submit streamside evaluation
2. Submit implementation plan
YES
Are you selecting to use DEQ's shade gap analysis?
YES
1. Submit streamside evaluation
2. Submit implementation plan
NO
Are you selecting to implement and enforce a 120 ft. streamside buffer?
YES
1. Submit streamside evaluation
2. Submit implementation plan
NO
1. Submit shade gap analysis
2. Submit streamside evaluation
3. Submit implementation plan

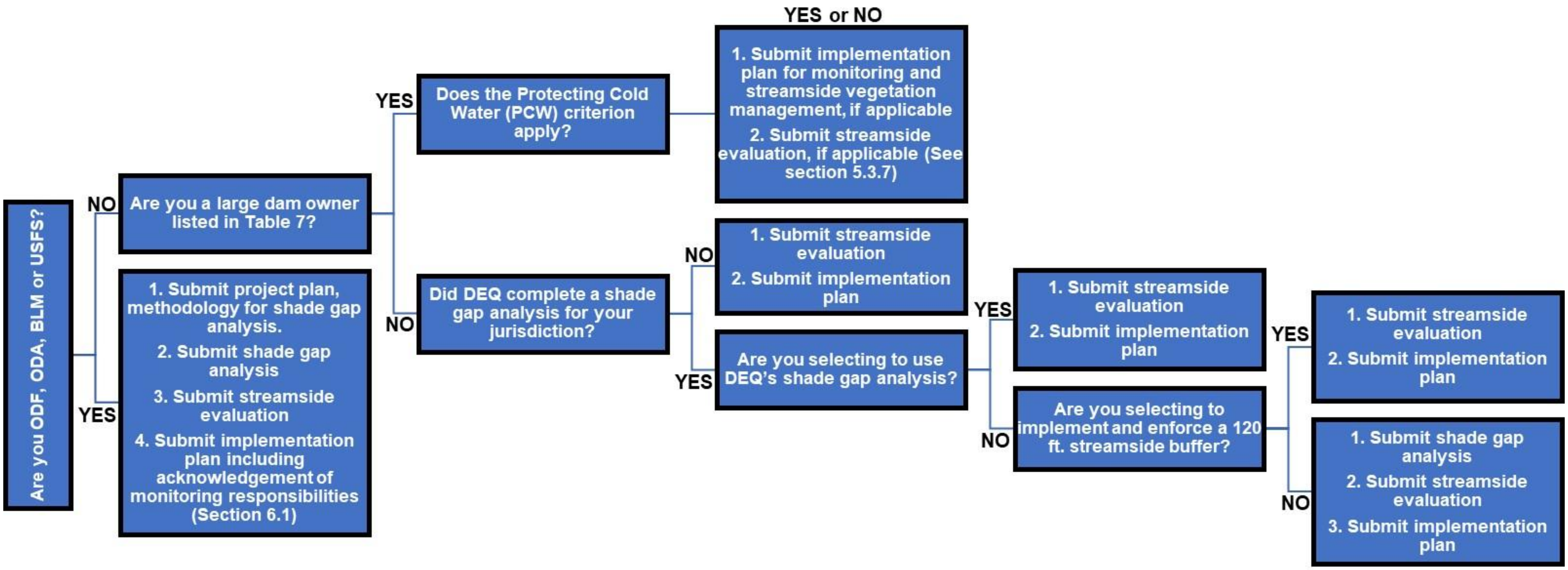


Figure 4: Decision support tree to help identify information and analyses requirements for different responsible persons including DMAs.

5.3.1 Management strategies

Responsible persons including DMAs in Appendix A~~Appendix A~~ that are required to develop a TMDL implementation plan must include applicable priority management strategies from Table 2
~~Table 2~~. Other practices and actions appropriate for activities and landscape conditions specific to their pollutant sources or source sectors should also be included. Implementation plans must identify all streamside areas or streamside activities within a responsible person's, including DMA's, jurisdiction or responsibility.

5.3.2 Streamside evaluation

Responsible persons including DMAs that are required to submit an implementation plan must complete a streamside evaluation. The streamside evaluation will use a review of current conditions to support implementation of measurable objectives and milestones. The streamside evaluation must be included in the TMDL implementation plan.

Entities that have a DEQ shade gap analysis, and entities that must complete a shade gap analysis (see Section 5.3.4), must include the shade gap analysis results in their streamside evaluation. The streamside evaluation must also include the following data and information:

- **a.** Quantify the streamside area in acres that needs enhancement (e.g., areas that do not currently meet shade targets, are comprised of non-native vegetation, need additional planting)
- **b.** Quantify the streamside area in acres that may not need action beyond protection.
- **c.** Quantify the streamside area in acres where physical constraints exist (e.g., buildings) that preclude implementation of vegetation management strategies that provide stream shade.
- **d.** Quantify the streamside area in acres where jurisdictional constraints (e.g., private ownership) limit implementation of vegetation management strategies that provide stream shade.
- **e.** Opportunities that may exist to address constraints to implementing vegetation management strategies that provide stream shade.
- **f.** Any areas within your jurisdiction where there is the potential to implement best management practices such as in-stream restoration, flow augmentation projects, experimental temperature management techniques, as well as enhancing and protecting cold water refuges where identified.
- **g.** An evaluation of the data from **a - f** to prioritize implementation. This evaluation must include a description of the rationale utilized to prioritize implementation in addition to a description of the data and analysis methods used to estimate quantities **a - d** and the reasoning specific areas will or will not be prioritized for implementation actions. It is expected that DMAs prioritize areas with the greatest shade gaps for implementation of riparian restoration, unless physical, jurisdictional, or other identified constraints exist.
    - i. Entities that have a DEQ shade gap analysis, and entities that must complete a shade gap analysis (i.e. ODA, ODF, USFS and BLM), must include the shade gap analysis results in their streamside evaluation.
    - ii. DEQ expects entities that do not have a DEQ shade gap analysis to use other available data to estimate the quantities outlined in items **a - d** and address these data in their streamside evaluation.

DEQ acknowledges that factors such as climate change and local geology, geography, soils, climate, legacy impacts, wildfires and floods may hinder achieving the target effective shade. No enforcement action will be taken by DEQ for reductions in effective shade caused by natural disturbances. Where natural disturbances have occurred, DEQ expects responsible persons including DMAs to assess and prioritize these areas for streamside restoration following an event.

The streamside evaluation must be completed according to the timeline assigned in Table 8~~Table 8~~. The streamside evaluation will be utilized during the year five review (see Section 5.3.~~8~~9.2) to help assess progress in meeting implementation timelines, milestones, and measurable goals in subsequent five-year implementation cycles.

5.3.3 120-foot slope streamside buffer as an alternative to a streamside shade gap analysis

The responsible persons including DMAs that are required to complete a shade gap analysis and those that choose not to use DEQ's shade gap analysis (where available) for their streamside evaluation (Section 5.3.4) may instead choose to establish and protect overstory, woody vegetation within a 120-foot slope buffer, as measured up-slope along the ground's contour from top of bank (TSD, Appendix I). The streamside buffer must be established through development of enforceable ordinances or regulations. The literature review presented in TSD Appendix I indicates that potential stream shade loss associated with a 120-foot buffer will not cause stream temperature increases for most waterbodies. For this option, responsible persons including DMAs must ensure that any activity occurring within this 120-foot slope buffer would result in limited stream shade reduction and ensure that stream shade targets are still achieved at that location following management actions. Entities that choose this option must also complete a streamside evaluation but do not have to complete a shade gap analysis. (Sec. 5.3.2).

5.3.4 Streamside shade gap analysis

DEQ conducted a vegetation height and shade gap analysis within approximately 150 feet of modeled waterbodies in the Lower Willamette (partial analysis completed) and Southern Willamette Subbasins, as detailed in Section 9.1.5.2 in the TMDL Rule. DEQ did not complete a shade gap analysis for all responsible persons including DMAs.

The shade gap analysis calculates the difference between current effective shade (i.e., assessed) versus the target effective shade. Where DEQ calculated a shade gap, DEQ averaged the percent shade gap across all waterbodies within a DMA's jurisdiction. DEQ will provide the site-specific shade gap results upon request.

5.3.4.1 Streamside shade gap analysis methods for responsible persons including DMAs

If DEQ did not provide a shade gap analysis for a jurisdiction then that DMA is not required to complete a shade gap analysis unless they are named in Section 5.3.4.2. If DEQ has provided a shade gap analysis for a jurisdiction, then DMAs must either use DEQ's analysis to inform their streamside evaluation (Sec. 5.3.2), or other methods, for example on the ground measurements and remote sensing, to assess the current effective shade within their jurisdiction and whether effective shade allocations along Willamette Subbasins assessment units are met. These methods are described below.

1. Measure current effective shade at the stream surface using monitoring equipment, such as the Solar Pathfinder™, or using a hemispherical camera system and imagery analysis software.
    a. Determine general vegetation category, canopy density, stream width and stream orientation.
    b. Compare current effective shade results to either target effective shade from DEQ's shade gap analysis, or to the target percent effective shade values derived from the shade curves in the TMDL to assess the percent effective shade gap.
    c. Entities choosing to use this methodology must submit their assessment strategy to DEQ for approval. Assessments should conform to guidelines outlined in OWEB's Addendum to Water Quality Monitoring Technical Guide Book, Ch. 14: https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf (OWEB, 1999).
2. Conduct modeling using the Heat Source model (as used in this TMDL).
3. Another method approved by DEQ through the TMDL implementation plan approval process.

A project plan which includes a description of the assessment methodology must be submitted to DEQ for review and approval according to the timeline assigned in Table 8Table 8. Method documentation for Solar Pathfinder™ can be accessed at https://www.solarpathfinder.com/pdf/pathfinder-manual.pdf.

5.3.4.2 Shade gap analysis requirements for ODF, ODA, BLM and USFS

Together, the ODF, ODA, BLM, and USFS either manage or regulate approximately 93 percent of the land area within 150 feet of streams within the Willamette Subbasins project area (Figure 3Figure 3). Increasing shade on streams within the extensive areas within their jurisdictions is important to achieving the surrogate shade measures of this TMDL. Therefore, ODF, ODA, BLM, and USFS must complete a streamside evaluation (Section 5.3.2) as well as a shade assessment for streamside areas within their jurisdiction. The assessment must use methods outlined in Section 5.3.4.1 for determining whether effective shade allocations along the Willamette Subbasins assessment units are met. A shade assessment is not needed for those streamside areas where DEQ has completed a shade gap analysis, or for streamside areas where DEQ has determined the streamside buffers are sufficient (Section 5.2). The shade gap analysis requirement includes intermittent streams as defined in the TMDL. For more information on intermittent streams and which are included in temperature TMDLs see TSD Section 2.4. A project plan, which includes a description of the shade gap assessment methodology including any methodology that proposes target effective shade values different from shade curves developed by DEQ, must be submitted to DEQ for review and approval according to the timeline assigned in Table 8Table 8.

5.3.5 Target Effective Shade Values and Shade Curves

Shade curves, which are charts that represent the mean effective shade target for different mapping units, stream aspects, and active channel widths (TMDL, Section 9.1.5.3), were developed to allow users to find target percent effective shade values for streams based on several stream characteristics. Unlike the site-specific shade targets and shade gap analysis (TMDL, Section 9.1.5.2), shade curves do not calculate current effective shade. Any responsible person including DMAs can use DEQ shade curves, site-specific shade targets or other DEQ-approved method to assess and recommend an effective shade target for their jurisdiction.

TMDL implementation plans must include the mean effective shade targets calculated by DEQ, if available, (Table 9-28 through Table 9-32 in the TMDL Rule, Section 9.1.5.2 Rule document), or any updated effective shade target assessment approved or performed by DEQ in the future.

5.3.6 Cold Water Refuge Requirements

Responsible persons, including DMAs who have jurisdiction along the lower 50 river miles of the Willamette River must include actions in their TMDL implementation plans to identify, enhance and protect cold water refuges. This reach extends from the mouth of the Willamette River at the confluence with the Columbia River to the confluence of the Willamette River and Chehalem Creek in the area of the Newberg pool. This reach of the river has been designated as a migration corridor in OAR 340-041-0028(4)(d):*The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 151A, 170A, 300A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit). In addition, these water bodies must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern.*

According to OAR 340-041-0002(10) “Cold Water Refugia” means those portions of a water body where, or times during the day when, the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body.

DEQ expects DMAs with jurisdiction along these lower 50 river miles of the Willamette River to reference DEQ’s *Lower Willamette River Cold-Water Refuge Narrative Criterion Interpretation Study*, or other cold water refuge studies, as a resource for protecting cold water refuges that have already been identified. This study identified a total of 48 cold water refuge locations within the migration corridor.

DMAs along this reach may protect existing refuges by:

1. Maintaining or enhancing vegetation for shade
2. Protecting the watersheds of cold tributaries
3. Protecting channel features that create cold water flows from physical alteration
4. Protecting sources of groundwater inflows
5. Removing or prohibiting barriers to fish access in areas of cold water

Potential cold-water refuges may also be restored by improving access or enhancing characteristics that form cold-water refuge where they have been altered by human activity.

DMAs not along this 50 river mile reach should also consider including best management practices in their implementation plans that support identifying, enhancing and protecting cold water refuges, which are important to fish seeking escape from warm stream temperatures, in other waterbodies within the Willamette Basin.

5.3.7 TMDL implementation plan requirements for dam owners

DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations. This means that reservoir operations must not contribute any additional warming above and beyond upstream water temperatures entering the reservoir. See Section 9.1.45.1 dam and reservoir operations in the TMDL Rule for more information.

All dam and reservoir operators named in Table 7Table 7 must submit an implementation plan that addresses the monitoring and assessment requirements described in Section 5.3.67.1. If monitoring and assessment show that dam operations contribute additional warming above upstream temperatures entering the reservoir, then the operator can choose to either:

1. Complete a cumulative effects analysis which demonstrates that releasing waters warmer than the surrogate measure would not contribute to downstream exceedances of water quality standards, or
2. Update their TMDL implementation plan to include structural and operational strategies for mitigating temperature increases.

If a cumulative effects analysis demonstrates that dam operations will contribute to additional downstream warming, then the operator must update their implementation plan to include specific mitigation strategies for temperature. If DEQ determines sufficient data are available to demonstrate that stream temperature does not increase between a reservoir's inflow and outflow, then the reservoir operator may not be required to update their implementation plan for structural and operational management strategies.

Dam and reservoir operators that have jurisdiction over streamside areas must also develop a TMDL implementation plan to implement streamside management strategies even if a future updated TMDL implementation plan is not required for dam and reservoir management. See Sections 5.3.2 through 5.3.4 for additional information regarding streamside management implementation plan requirements.

Given the large number of dams within the Willamette Basin, DEQ is not focusing implementation requirements on dams owned and operated by individuals or businesses (See Appendix DAppendix E for the entire list of dams in the Willamette Subbasins project area). Additionally, DEQ is not requiring reservoir management plans for dams that are operated to manage seasonal flow to sustain ecological benefits associated with wetlands and marshes. These individual, business, and ecological entities comprise only about 1.2 percent of the large reservoir storage capacity in the Willamette Basin. DEQ encourages partnerships between responsible persons including DMAs and individual dam operators within their jurisdictions to evaluate ways in which these dams could be managed to reduce temperature impacts.

Table 7: Large dam and reservoir owners responsible for monitoring. Owners may be required to submit an implementation plan that includes reservoir management strategies.

No.	Owner	Dam Name	Reservoir Storage (ac-ft)
1	City of Adair Village	Plywood Products Reservoir	39
2	City of Albany	Lebanon Dam	149
3	City of Corvallis	North Fork	305
4	City of Dallas	Mercer	1,550
5	City of Gresham	Binford Dam	30
6	City of Silverton	Silver Creek	2,500
7	City of St. Helens	Salmonberry Reservoir	61

8	Eugene Water and Electric Board	Carmen Diversion	260
9	Eugene Water and Electric Board	Leaburg	345
10	Eugene Water and Electric Board	Leaburg Canal and Forebay	459
11	Eugene Water and Electric Board	Smith	17,530
12	Eugene Water and Electric Board	Trail Bridge	2,263
13	Eugene Water and Electric Board	Walterville Forebay	275
14	Eugene Water and Electric Board	Walterville Storage Pond	345
15	Portland General Electric Company	Faraday Diversion	1,200
16	Portland General Electric Company	Faraday Forebay	550
17	Portland General Electric Company	Harriet Lake	400
18	Portland General Electric Company	North Fork	18,630
19	Portland General Electric Company	River Mill	2,300
20	Portland General Electric Company	Timothy Lake	69,000
21	USACE - Portland District	Big Cliff Dam	5,930
22	USACE - Portland District	Blue River Dam	89,000
23	USACE - Portland District	Cottage Grove Dam	50,000
24	USACE - Portland District	Cougar Dam	220,000
25	USACE - Portland District	Detroit Dam	455,000
26	USACE - Portland District	Dexter Dam	29,900
27	USACE - Portland District	Dorena Dam	131,000
28	USACE - Portland District	Fall Creek Dam	125,000
29	USACE - Portland District	Fern Ridge Dam	121,000
30	USACE - Portland District	Foster Dam	61,000
31	USACE - Portland District	Green Peter Dam	430,000
32	USACE - Portland District	Hills Creek Dam	356,000
33	USACE - Portland District	Lookout Point Dam	477,700

5.3.~~6~~7.1 Monitoring and assessment requirements for dam owners

Dams and reservoirs alter solar radiation flux and seasonally increase surface temperatures compared to free-flowing stream segments. Increased temperatures may lead to violations of water quality temperature standards and impact aquatic life. Water released from the hypolimnion of stratified reservoirs may cool downstream reaches during the summer leading to attainment of water quality standards. In the fall, a reservoir may become isothermal and warm stream reaches below a reservoir.

~~Section 9.1.4.1 of t~~The TMDL rule (Section 9.1.5.1) identifies a temperature surrogate measure target for dam and reservoir operations. Attainment of this target requires assessment of temperatures up and downstream of the dam and reservoir based on the seven-day average of the daily maximum temperature (7DADM).

Large dam and reservoir owners in Table 7~~Table 7~~ will collect temperature data and assess temperature dynamics associated with their dam and reservoir operations using a mechanistic model, empirical model, and/or analysis of continuous temperature data collected upstream, downstream, and in the reservoir. The assessment shall include:

1. Collection of continuous temperature data to characterize reservoir inflow and outflow temperatures. 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. The estimated free flowing (no dam)

temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations.

a. Continuous temperature data must be collected for four consecutive years and must be collected during the critical period as defined in the TMDL document. Previously collected data can be used as long as it meets DEQ QA/QC protocols and has been collected within the last five years.

2. Reservoir temperature profiles to sufficiently characterize timing and extent of thermal stratification, and

3. Measurement of reservoir water level fluctuations and outflow rates

Temperature data must be submitted to DEQ and uploaded to the Ambient Water Quality Monitoring System, or through another online publicly accessible database approved by DEQ. These data will be used for the following purposes:

1. establishing baseline conditions,
2. adaptive management, and
3. evaluation of site-specific approaches to reduce temperature impacts.

DEQ recommends dam owners develop a mechanistic or empirical model to predict and compare inflow and outflow temperatures. This model will be used to develop effective management strategies to reduce temperature impacts.

For reservoirs on reaches where DEQ has determined that the protecting cold water criterion does not apply, operators are required to select one of the two following options. The first option is to ensure that discharges meet the temperature target surrogate measure (TMDL Rule, Section 9.1.~~4~~5.1). The second option is to prepare a cumulative effects analysis to demonstrate that water releases that periodically exceed the ambient temperature criteria would not contribute to cumulative warming above water quality standards at downstream locations. Reservoir operators who choose this second option will be required to submit a Quality Assurance Project Plan (QAPP) to DEQ for review and approval. Required elements of the QAPP include descriptions of the dataset and cumulative effects approach that will be used to assess downstream temperature impacts.

5.3.~~6~~7.2 Protecting Cold Water Criterion

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. Reservoir operators on reaches where protecting cold water apply must meet the cold water criterion. DEQ’s current assessment shows that the protecting cold water criterion likely applies at the following three dams:

1. Carmen Diversion (McKenzie River)
2. Harriet Lake (Oak Grove River)
3. Trail Bridge and Trail Bridge Saddle Dike (McKenzie River)

Water flowing above these dams is likely to have cooler ambient temperatures than the temperature criteria. To meet the cold-water criterion, these dams cannot warm up ambient temperature to the applicable temperature criteria. Additional information on protecting cold water is found in the TMDL Rule (Section 9.1.~~4~~5.1). This list could change given updated assessments.

If DEQ determines sufficient data are available to demonstrate that stream temperature does not increase from upstream of dam to downstream of dam, then the reservoir operator may not be required to develop a TMDL implementation plan for dam management.

5.3.~~7~~8 Timeline and schedule

Each implementation plan must include a commitment to enact specific management strategies on a reasonable timeline, including a schedule for meeting measurable milestones to demonstrate progress. To meet the intent of this requirement and be useful for the requirement to track and report progress, entities should develop management strategies using the SMART elements: Specific, Measurable, Achievable, Relevant, Time-bound (Doran, 1981).

Timelines and milestone schedules should be informed by the Streamside Evaluation, as described in Section 5.3.2 above, and each entity should consider all factors relevant to their situation. The due dates and timelines for specific information and analyses discussed in Sections 5.3.2 and 5.3.4 are shown in Table 8~~Table 8~~ below. DMA timelines in TMDL implementation plans that differ from timelines stated below must be approved by DEQ.

Table 8: Due dates for implementation plans, information, and analyses. See sections 5.3.1 through 5.3.~~6~~7 for more details.

Requirement	Due Date / Timeframe
TMDL implementation plan (Appendix A)	18 months after EQC adoption of amendment to Willamette ~~Mainstem~~Subbasins TMDL~~*~~
Streamside Evaluation (Sec. 5.3.2)	Three years after EQC adoption of amendment to Willamette ~~Mainstem~~Subbasins TMDL~~*~~
Project plan and description of the assessment methodology to be used to complete a shade gap analysis (Sec. 5.3.4)	18 months after EQC adoption of amendment to Willamette ~~Mainstem~~ TMDL~~*~~
Streamside shade gap analysis (Sec. 5.3.4) and updated streamside evaluation OR 120 ft. streamside buffer that establishes and protects overstory, woody vegetation (sec. 5.3.3)	Four years after implementation plan submission deadline
Large dam and reservoir owners named in Table 7 (Sec. 5.3.~~6~~7):	18 months after EQC adoption of amendment to Willamette ~~Mainstem~~Subbasins TMDL~~*~~. Following the temperature

TMDL implementation plan for temperature monitoring and assessment requirements for each reservoir	assessment, the DMA will consult with DEQ on a timeframe for submitting a cumulative effects analysis, or updated TMDL implementation plan as needed. Some reservoir operators must also submit a streamside evaluation and implementation plan for streamside management. See section 5.3.2 for details.
ODA, ODF, USFS, BLM: Quality Assurance Project Plans or project-specific Sampling and Analysis Plans for temperature (Sec. 6.1)	As directed by DEQ following development of a Willamette Basin wide monitoring strategy.
~~*The Willamette Mainstem TMDL is a separate temperature TMDL to be developed and approved following the Willamette Subbasins TMDL.~~	

5.3.~~8~~9 Reporting of performance monitoring and plan review and revision

5.3.~~8~~9.1 Reporting on performance monitoring

Each implementation plan must include a commitment to prepare annual reports on performance monitoring and specify a day of the year they will be submitted to DEQ. These reports must include implementation tracking for each of the identified management strategies, progress toward timelines and measurable milestones specified in the implementation plan, and evaluation of the effectiveness of each strategy.

DMAs should track and report implementation actions including the number, type and location of projects, best management practices, education activities, or other actions taken to improve or protect water quality. Most DMAs will track implementation actions they are directly responsible for completing, and some may need to track and report on actions that they implement through their support of other land managers, e.g., private landowners.

Oregon Watershed Restoration Inventory Reporting Requirement

Projects designed to control thermal pollution that use practices listed in OWEB's Oregon Watershed Restoration Inventory (OWRI) Online List of Treatments must be reported by responsible persons including DMAs to the OWRI database (OWEB 2023, OWEB 2023a) upon project completion. DEQ utilizes OWRI's database to track implementation activities statewide and within watersheds for various reporting metrics. Responsible persons including DMAs must also report BMP implementation annually to DEQ to document progress and track actions over time.

Other publicly accessible databases may be used to document restoration activities when approved by DEQ.

Adaptive Management

Implementation plans must include a commitment to use adaptive management to evaluate the effectiveness of implementation activities in improving streamside conditions including stream shade. Annual reports must summarize the status and results of these evaluations on the relevant time scale. At a minimum, reports in year five must summarize implementation and effectiveness over the preceding four years.

5.3.~~8~~9.2 Implementation plan review and revision

Implementation plans must be reviewed by each responsible person including DMAs, revised to incorporate lessons learned, and approved by DEQ every five years. At a minimum, plans must be revised to reflect updated timelines for the continuation of implementation activities for the next five years. DEQ will use implementation and effectiveness evaluations from annual reports for this review. If implementation plan revisions are needed to correct deficiencies or otherwise ensure the plan is effective following the year five review, DEQ will identify a date for submission of the revised plan for DEQ approval.

5.3.~~9~~10 Public involvement

As required in OAR 340-042-0040(4)(l)(L), implementation plans prepared by designated management agencies must include a plan to involve the public in implementation of management strategies. Public engagement and education must be included to meet this requirement.

5.3.~~10~~11 Maintenance of strategies over time

As required in OAR 340-042-0040(4)(l)(M), implementation plans prepared by responsible persons including DMAs should include discussion of planned efforts to maintain management strategies over time.

5.3.~~11~~12 Implementation costs and funding

As required in OAR 340-042-0040(4)(l)(N), this section provides a general discussion of costs and funding for implementing management strategies. Implementation of management strategies to reduce or prevent pollution into waters of the state may incur financial capital or operating costs. These costs vary in relation to pollutant sources and loading, proximity to waterways and type or extent of preventative controls already in place. Certain management practices, such as preventative infrastructure maintenance, may result in long-term cost savings to responsible persons including DMAs, or landowners.

OAR 340-042-0040(4)(l)(N) also indicates that sector-specific or source-specific implementation plans may provide more detailed analyses of costs and funding for specific management strategies in the plan. DEQ requires each DMA to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs and projects described in implementation plans to the extent that these costs can be accounted for or estimated. DEQ recommends that all responsible persons including DMAs prepare the following level of economic analysis:

- Staff salaries, supplies, volunteer coordination and regulatory fees
- Installation, operation and maintenance of management measures
- Monitoring, data analysis and plan revisions
- Public education and outreach efforts
- Ordinance development (if needed to implement a management strategy)

This analysis should be in five-year increments to estimate costs, demonstrate sufficient funding is available to begin implementation and identify potential future funding sources to sustain management strategy implementation. DMAs may include actual costs spent on implementation activities as part of annual TMDL reporting. This information may help DEQ estimate actual costs associated with implementing current and future temperature TMDLs.

There are multiple sources of local, state, and federal funds available for implementation of pollutant management strategies and control practices. Table 9Table 9 provides a partial list of financial incentives, technical assistance programs, grant funding and low interest loans for public entities and with principal forgiveness available in Oregon that may be used to support implementation of assessment, pollution controls and watershed restoration actions or land condition improvements that improve water quality in the Willamette Basin. Soil and water conservation districts and watershed councils are additional resources that may support responsible persons including DMAs in implementation of pollutant management strategies and control practices through the programs listed in Table 9Table 9.

Table 9: Partial list of funding programs available in the Willamette Subbasins.

Program	General Description	Contact
Clean Water State Revolving Fund	Loan program for below-market rate loans for planning, design, and construction of various water pollution control activities.	DEQ
Conservation Reserve Enhancement Program (CREP)	Provides annual rent to landowners who enroll agricultural lands along streams. Also cost-shares conservation practices such as riparian tree planting, livestock watering facilities, and riparian fencing.	NRCS
Conservation Reserve Program (CRP)	Competitive CRP provides annual rent to landowners who enroll highly erodible lands. Continuous CRP provides annual rent to landowners who enroll agricultural lands along seasonal or perennial streams. Also cost-shares conservation practices such as riparian plantings.	NRCS
Conservation Stewardship Program (CSP)	Provides cost-share and incentive payments to landowners who have attained a certain level of stewardship and are willing to implement additional conservation practices.	NRCS
Drinking Water Source Protection Fund	These funds allow states to provide loans for certain source water assessment implementation activities, including source water protection land acquisition and other types of incentive-based source water quality protection measures.	OHA
Emergency Watershed Protection Program (EWP)	Available through the USDA-Natural Resources Conservation Service. Provides federal funds for emergency protection measures to safeguard lives and property from floods and the products of erosion created by natural disasters that cause a sudden impairment to a watershed.	NRCS
Emergency Forest Restoration Program (EFRP)	Available through the USDA-Natural Resources Conservation Service. Helps owners of non-industrial private forests restore forest health damaged by natural disasters.	USDA
Oregon 319 Nonpoint Source	Fund projects that reduce nonpoint source pollution, improve watershed functions and protect the quality of	DEQ

Program	General Description	Contact
Implementation Grants	surface and groundwater, including restoration and education projects.	
Environmental Quality Incentives Program (EQIP)	Cost-shares water quality and wildlife habitat improvement activities, including conservation tillage, nutrient and manure management, fish habitat improvements, and riparian plantings.	NRCS
Agriculture Water Quality Support Grant	Provides capacity to support voluntary agricultural water quality work in small watersheds and to meet the goals of the Agricultural Water Quality Management Area Plans and the SIA initiative.	ODA
Agricultural Conservation Easement Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.	NRCS
Farm and Ranchland Protection Program (FRPP)	Cost-shares purchases of agricultural conservation easements to protect agricultural land from development.	NRCS, SWCDs, ODF
Federal Reforestation Tax Credit	Provides federal tax credit as incentive to plant trees.	Internal Revenue Service
Grassland Reserve Program (GRP)	Provides incentives to landowners to protect and restore pastureland, rangeland, and certain other grasslands.	NRCS
Landowner Incentive Program (LIP)	Provides funds to enhance existing incentive programs for fish and wildlife habitat improvements.	U.S. Fish and Wildlife Service
Oregon Watershed Enhancement Board (OWEB)	Provides grants for a variety of restoration, assessment, monitoring, and education projects, as well as watershed council staff support. 25 percent local match requirement on all grants.	OWEB
Oregon Watershed Enhancement Board Small Grant Program	Provides grants up to $10,000 for priority watershed enhancement projects identified by local focus group.	OWEB
Partners for Wildlife Program	Provides financial and technical assistance to private and non-federal landowners to restore and improve wetlands, riparian areas, and upland habitats in partnership with the U.S. Fish and Wildlife Service and other cooperating groups.	U.S. Fish and Wildlife Service
Public Law 566 Watershed Program	Program available to state agencies and other eligible organizations for planning and implementing watershed improvement and management projects. Projects should reduce erosion, siltation, and flooding; provide for agricultural water management; or improve fish and wildlife resources.	NRCS
Resource Conservation & Development (RC & D) Grants	Provides assistance to organizations within RC & D areas in accessing and managing grants.	Resource Conservation and Development
ODF Small Forestland Investment in Stream Habitat (SFISH) Grants	Provides funding for Small Forestland Owners (SFO's) to improve road conditions and stream crossings as part of forest operations.	ODF
State Forestation Tax Credit	Provides for reforestation of under-productive forestland not covered under the Oregon Forest Practices Act.	ODF

Program	General Description	Contact
	Situations include brush and pasture conversions, fire damage areas, and insect and disease areas.	
Forest Stewardship Program	Provides cost share dollars through USFS funds to family forest landowners to have management plans developed.	ODF
Western Bark Beetle Mitigation	ODF administers a cost share program for forest management practices pertaining to bark beetle mitigation for forest health and is funded through the USFS.	ODF
State Tax Credit for Fish Habitat Improvements	Provides tax credit for part of the costs of voluntary fish habitat improvements and required fish screening devices.	ODFW
Wetlands Reserve Program (WRP)	Provides cost-sharing to landowners who restore wetlands on agricultural lands.	NRCS
Wildlife Habitat Tax Deferral Program	Maintains farm or forestry deferral for landowners who develop a wildlife management plan with the approval of the Oregon Department of Fish and Wildlife.	ODFW
Funding Resources for Watershed Protection and Restoration	EPA's Funding Resources for Watershed Protection and Restoration (EPA, 2023) contains links to multiple funding sources	Various

5.4 Schedule for implementation plan submittal

OAR 340-042-0040(4)(l)(I) specifies that the WQMP contain a schedule for submittal of implementation plans. As stated in OAR 340-042-0080(4)(a), entities identified in the WQMP with responsibility for developing implementation plans are required to prepare and submit an implementation plan for DEQ approval according to the schedule in the WQMP.

Within 18 months of EQC adoption of the amendment to the Willamette Basin ~~mainstem~~Subbasins TMDL ~~(planned for February 2025),~~ persons, including DMAs, responsible for developing implementation plans must submit implementation plans to DEQ for review and approval (See Table 8~~Table 8~~).

OAR 340-012-0055(2)(e) identifies failure to timely submit or implement a TMDL implementation plan, as required by DEQ order or rule, as a Class II violation. OAR 340-012-0053(1) identifies failure to report by the reporting deadline, as required by DEQ order or rule, as a Class I violation.

Should a sector or sector-wide DMA fail to submit an approvable TMDL implementation plan or fail to timely implement the plan, DEQ may pursue enforcement under OAR 340-012-0055(2)(e) or identify individual sources (landowners/operators) as persons responsible for developing and implementing TMDL implementation plans to address the load allocations relevant for the sector. DEQ may revise the WQMP or issue individual orders to identify additional responsible persons including DMAs and notify them of the required schedule for submitting source-specific implementation plans.

Following the issuance of this TMDL and WQMP, DEQ may determine that nonpoint source implementation plans are not necessary for certain entities identified in the WQMP based on available information or new information provided by those entities. For these entities, DEQ will provide a written determination for why a plan is not required. This determination could be based on a variety of factors, such as inaccurate identification within the geographic scope of the TMDLs, or documentation that an entity is not a source of pollution or does not discharge pollutants to a waterbody within the geographic scope of a TMDL.

Once approved, DEQ expects implementation plans to be fully implemented according to the timelines and schedules for achieving measurable milestones specified within the plans. Implementation plans must be reviewed and revised as appropriate for DEQ approval every five years and submitted on the date specified in DEQ's approval letter for an implementation plan.

6. Monitoring and Evaluation of Progress

OAR 340-042-0040(4)(l)(K) requires that the WQMP include a plan to monitor and evaluate progress toward achieving the TMDL allocations and associated water quality standards for the impairments addressed in the TMDL. Additional objectives of monitoring efforts are to assess progress towards reducing excess pollutant loads and to better understand variability associated with environmental or anthropogenic factors. This section summarizes DEQ's approach, including the required elements of identification of monitoring responsibilities and the plan and schedule for reviewing monitoring information to make TMDL revisions, as appropriate.

There are two fundamental components to DEQ's approach to monitoring and evaluating TMDL progress:

1. Tracking the implementation and effectiveness of activities committed to by responsible persons including DMAs in DEQ-approved implementation plans, and
2. Periodically monitoring the physical, chemical and biological parameters necessary to assess water quality status and trends for the impairments that constitute the basis for this TMDL.

All responsible persons including DMAs are responsible for tracking the implementation and effectiveness of their actions and meeting milestones where established. The streamside evaluation (Section 5.3.2) will provide a baseline for DMA implementation plans against which DMA progress will be assessed. DEQ acknowledges that it will take decades for restored streamside areas to provide mature, overstory woody vegetation that shades streams, so DEQ will rely on tracking implementation compliance through DEQ approved implementation plans, annual reports, and comprehensive year five reviews (Sections 5.3.~~8~~9 and 5.3.~~9~~10) in the coming years.

DEQ effective shade targets are regulatory and can be used to assess implementation progress in the future. In areas where stream temperature criteria are not met, DEQ will assess the status of current conditions and effective shade targets as part of the adaptive management process (Section 6). DEQ will also evaluate other restoration efforts that have been implemented to improve stream temperature, for example channel morphology and stream flow restoration, protection and enhancement of cold water refuges, etc. In cases where DEQ determines implementation actions are not making sufficient progress, DEQ will rely on the adaptive management process and our enforcement authority to assess compliance with the load allocations.

With input from partners, DEQ will develop overarching water column sampling and analysis plans to finalize the first iteration of the Willamette Basin Temperature Monitoring Strategy after the issuance of the amendment to the Willamette ~~Mainstem~~Subbasins Temperature TMDL and WQMP. DEQ will continue to work with partners to implement the sampling and analysis plan and periodically refine the strategy as needed. Although DEQ encourages responsible persons including DMAs to conduct physical, chemical or biological monitoring to better evaluate how implementation actions may impact water quality conditions, DEQ is only requiring the DMAs listed under section 6.1 to conduct water column monitoring associated with this TMDL.

6.1 Persons responsible for water quality monitoring

Section 5.1 identifies responsible persons including DMAs that are responsible for developing TMDL implementation plans and implementing the management strategies described on the timelines committed to in approved plans. Section 5.3 details the content required in implementation plans and annual reports, as well as the schedules for their submittal.

DEQ is requiring ODA, ODF, BLM, and USFS to undertake monitoring actions in areas within their jurisdiction or ownership to help determine the status of instream water quality and landscape conditions associated with water quality. These four agencies have jurisdiction over approximately 93 percent of streamside areas in the Willamette Subbasins TMDL. For this reason, DEQ considers it appropriate for these large agencies to collaborate with DEQ on the Monitoring Strategy. DEQ encourages and invites other DMAs to collaborate with DEQ on collecting water quality data, especially DMAs that have been collecting temperature data as part of TMDL implementation or other related programs.

This effort will be iterative, beginning with review of existing data and monitoring locations, then adjusted as needed to improve understanding of current water quality status and develop a temperature trend monitoring network. DEQ expects to refine this monitoring strategy over time and modify as necessary.

The objectives for monitoring and assessment will be described in DMA implementation plans and will include, but are not limited to:

1. Provide information necessary to determine locations for applying management strategies or to assess the effectiveness of those strategies.
2. Refine information on source-specific or sector-specific pollutant loading.
3. Provide information necessary to demonstrate progress towards meeting load allocations.
4. Provide information used to identify roles and participate in collaborative effort among responsible persons including DMAs to characterize water quality status and trends.
5. Provide information integral to an adaptive management approach to inform and adjust management strategies over time.

Environmental media and water column monitoring activities conducted by ODA, ODF, BLM, USFS, or other DMAs to meet TMDL objectives, data collection and management must be performed in adherence to Quality Control procedures and Quality Assurance protocols established by DEQ, U.S. EPA or other appropriate organizations. This requirement will be met through developing or adapting Quality Assurance Project Plans or project-specific Sampling and Analysis Plans, and submitting to DEQ for review and approval based on a schedule determined by DEQ once development of the Monitoring Strategy has been initiated. ODA, ODF, BLM, USFS or other DMAs can also agree to participate in a collaborative monitoring plan under an umbrella QAPP. DEQ staff will coordinate QAPP development with ODA, ODF, BLM, and USFS upon request in advance of submission. Resources for developing quality assurance project plans and sampling and analysis plans are available on DEQ's water quality monitoring website (DEQ, 2023a).

At a minimum, ODA, ODF, BLM, and USFS must acknowledge in their implementation plans their responsibility in collaborating with DEQ to develop the Willamette Basin Temperature Monitoring Strategy. DEQ encourages these agencies to begin evaluating their existing temperature monitoring networks, if any, and explore opportunities to establish future long-term monitoring sites. Data collected by DMAs participating in the monitoring strategy must be in a format accessible to DEQ.

6.2 Plan and schedule for reviewing monitoring information and revising the TMDL

DEQ recognizes that it will take time before management practices identified in a WQMP are fully implemented and effective in reducing and controlling pollution. DEQ also recognizes that despite best efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL. Such events include, but are not limited to, floods, fire, insect infestations and drought. In addition, DEQ recognizes that technology and practices for controlling nonpoint source pollution will continue to develop and improve over time. DEQ will use adaptive management to refine implementation as technology, and knowledge about these approaches progress.

Adaptive management is a process that acknowledges and incorporates improved technologies and practices over time to refine implementation. A conceptual representation of the TMDL adaptive management process is presented in Figure 5~~Figure 5~~.

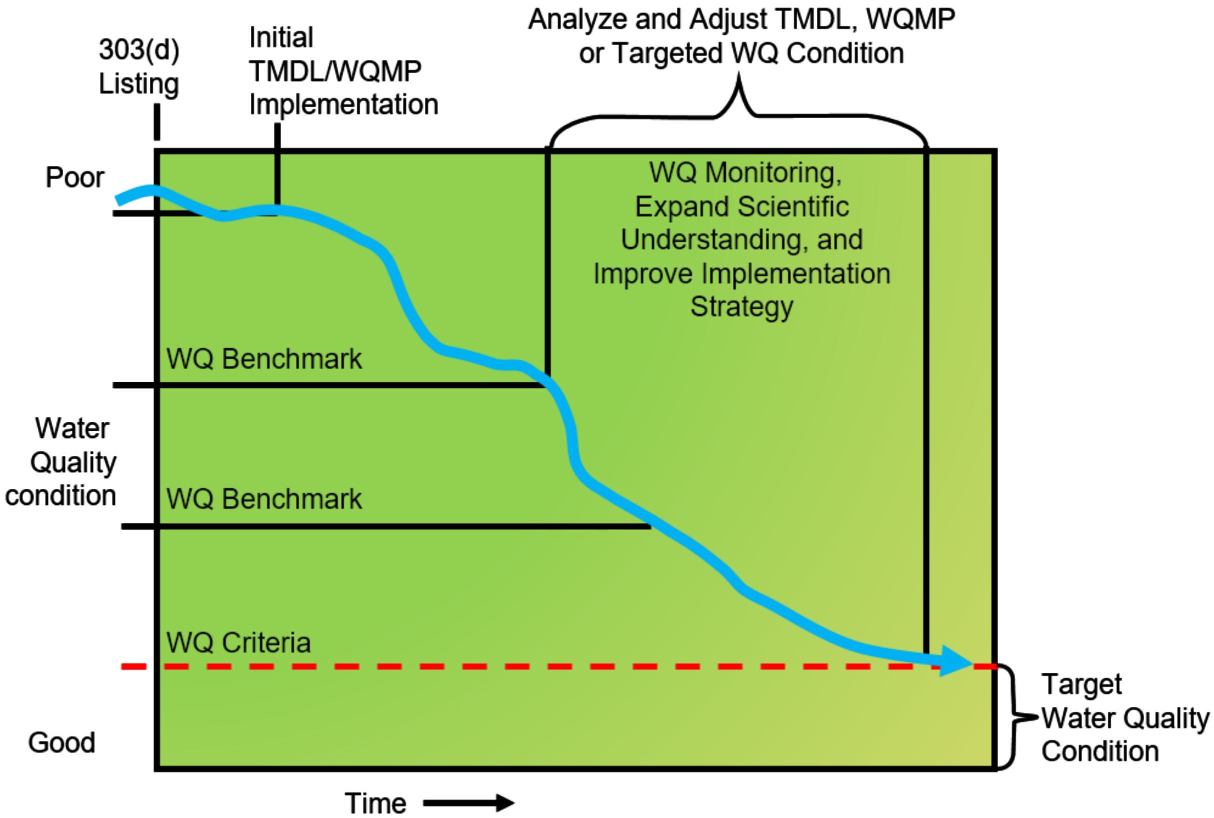


Figure 5: Conceptual representation of adaptive management.

DEQ considers entities complying with DEQ-approved TMDL implementation plans to be in compliance with their respective requirements contained in the TMDLs. The annual reports and Year Five Reviews submitted to DEQ by each of the responsible persons including DMAs in the Willamette Basin will be evaluated individually and collectively. DEQ will use this information to determine whether management actions are supporting progress towards TMDL objectives, or if changes in management actions and/or TMDLs are needed.

DEQ will review annual reports, participate with responsible persons including DMAs in review of monitoring information, and participate in implementing the Willamette Basin Monitoring Strategy.

Every five years, DEQ will collectively evaluate annual reports and all available monitoring data and information to assess progress on meeting the goals of the TMDLs and WQMP.

- DEQ will require responsible persons including DMAs to revise their implementation plans to address deficiencies where DEQ determines that implementation plans or effectiveness of management strategies are inadequate.
- DEQ and partners will revise sampling and analysis plans or other aspects of the Monitoring Strategy where progress toward meeting Monitoring Strategy objectives is not being made.
- DEQ will consider TMDL revisions if DEQ's evaluation of water monitoring data and supporting information indicate that the TMDL load allocations for a given pollutant-impairment are insufficient to meet state numeric criteria or narrative criteria, or insufficient to protect the designated beneficial uses.

- DEQ will follow all public participation requirements, including convening a local technical or rulemaking advisory committee to provide input on TMDL revisions per OAR 340-042-0040(7).

7. Reasonable ~~Assurance~~ assurance of ~~Implementation~~implementation

OAR 340-042-0030(9) defines Reasonable Assurance as “a demonstration that a TMDL will be implemented by federal, state or local governments or individuals through regulatory or voluntary actions including management strategies or other controls.” OAR 340-042-0040(4)(l)(J) requires a description of reasonable assurance that management strategies and sector-specific or source-specific implementation plans will be carried out through regulatory or voluntary actions. As a factor in consideration of allocation distribution among sources, OAR 340-042-0040(6)(g) states that “to establish reasonable assurance that the TMDL’s load allocations will be achieved requires determination that practices capable of reducing the specified pollutant load: (1) exist; (2) are technically feasible at a level required to meet allocations; and (3) have a high likelihood of implementation.” This three-point test is consistent with EPA past practice on determining reasonable assurance in the Chesapeake Bay TMDL (EPA, 2010) and supports federal antidegradation rules and Oregon’s antidegradation policy (OAR 340-041-0004).

The Clean Water Act S~~s~~ection 303(d) requires that a TMDL be “established at a level necessary to implement the applicable water quality standard.” Federal regulations define a TMDL as “the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background” [40 CFR 130.2(i)]. For TMDL approval, EPA guidance documents and memos on the TMDL process requires determinations that allocations are appropriate to implement water quality standards and reasonable assurance that nonpoint source controls will achieve load reductions, when WLAs are based on an assumption that nonpoint source load reductions will occur (EPA, 1991, 2002 and 2012).

Although TMDL implementation is anticipated to improve rather than lower water quality, federal antidegradation rules at 40 CFR 131.12(a)(2), require states to “assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and cost-effective and reasonable best management practices for nonpoint source control,” when allowing any lowering of water quality.

When a TMDL is developed for waters impaired by point sources only, the existence of the NPDES regulatory program and the issuance of NPDES permits provide the reasonable assurance that the wasteload allocations in the TMDL will be achieved. That is because federal regulations implementing the Clean Water Act require that water quality-based effluent limits in permits be consistent with “the assumptions and requirements of any available wasteload allocation” in an approved TMDL [40 CFR 122.44(d)(1)(vii)(B)].

Where a TMDL is developed for waters impaired by both point and nonpoint sources, it is the state's best professional judgment as to the three-point test in OAR 340-042-0040(6)(g) on reasonable assurance that the TMDL's load allocations will be achieved.

Where there is a demonstration that nonpoint source load reductions can and will be achieved; a determination that reasonable assurance exists and allocation of greater loads to point sources is appropriate. Without a demonstration of reasonable assurance that relied-upon nonpoint source reductions will occur, reductions to point sources wasteload allocations are needed.

The Willamette SubbBasins TMDLs were developed to address both point and nonpoint sources with TMDL load reduction allocations set at levels that will attain the applicable temperature criteria. Allocations were developed withproportional to estimated source contributions and in consideration of source contributions and opportunities for effective measures to reduce those contributions. There are several elements that combine to provide the reasonable assurance to meet federal and state requirements, including for antidegradation. Education, outreach, technical and financial assistance, permit administration, permit enforcement, responsible persons' including DMAs' implementation and DEQ enforcement of TMDL implementation plans will all be used to ensure that the goals of this TMDL are met.

7.1 Accountability framework

Reasonable assurance that needed load reductions will be achieved for nonpoint sources and antidegradation requirements and narrative water quality criteria will be met is based primarily on an accountability framework incorporated into the WQMP, together with the implementation plans of persons responsible for implementation. This approach is similar to the accountability framework adopted by EPA for the Chesapeake Bay TMDL, which was adopted in 2010 (EPA, 2010). Figure 6Figure 6 presents the accountability framework elements, which are intended to work in concert to demonstrate reasonable assurance of implementation.

Figure 6: Representation of the reasonable assurance accountability framework led by DEQ.

Pollutant reduction strategies are identified in Section 2 and more specific strategies, practices and actions will be detailed in each required implementation plan, to be submitted per the timelines in Section 5.4. These strategies and actions are comprehensively implemented through a variety of regulatory and non-regulatory programs. Many of these are existing strategies and actions that are already being implemented within the watershed and demonstrate reduced pollutant loading. These strategies are technically feasible at an appropriate scale to meet the allocations. A high likelihood of implementation is demonstrated because DEQ reviews the individual implementation plans and proposed actions for adequacy and establishes a monitoring and reporting system to track implementation and respond to any inadequacies.

In Oregon, forestry and agricultural related nonpoint source best management strategies are implemented through the state Forest Practices Act and agricultural Water Quality Management Area Plans and Rules. In Sections 5.2.1 and 5.2.2 DEQ determined that ODF and ODA must also develop and implement TMDL implementation plans that describe strategies specific to the Willamette River Subbasins. This adds to the accountability for implementation of cost-effective and reasonable best management and further assures that antidegradation requirements and narrative criteria will be met.

Approximately 1334 responsible persons including DMAs in Appendix AAppendix A are responsible for implementation of pollutant reduction strategies. General timelines, milestones and measurable objectives are identified in Sections 3 and 4.2, respectively. More specific timelines, milestones and measurable objectives will be specified in each required implementation plan. Attaining the relevant water quality criteria are provided in Sections 3 and 4.2, respectively. These elements support timely action by both DEQ and other entities responsible for implementation so that enforcement and adaptive management actions can be triggered and evaluation of attainment of TMDL goals occurs.

DEQ periodically reviews reporting by persons and agencies responsible for implementing pollutant reduction strategies to track the management strategies being implemented and evaluate achievements against established timelines and milestones.

Following up on reviews to track progress of implementation plans, DEQ will take appropriate action if responsible persons including DMAs fail to develop or effectively implement their implementation plan or fulfill milestones. DEQ's actions can include enforcement or engagement in voluntary initiatives. DEQ uses both, as appropriate within the process, to achieve optimal pollutant reductions. In some cases, DEQ will also take enforcement actions where necessary based on authorities listed in Section 8 or raise the issue to the Environmental Quality Commission as provided in OAR 340-042-0080.

DEQ tracks water quality status and trends concurrently with implementation of management strategies. DEQ relies on a system of interconnected evaluations, which include DMAs meeting measurable objectives, effectiveness demonstration of pollutant management strategies, accountability of implementation, periodically assessing progress on Oregon's Nonpoint Source Program Five-Year Plan Goals (approved by EPA), discharge monitoring and instream monitoring. DEQ also periodically evaluates water quality data collected through ambient and specific monitoring programs, including monitoring plans developed specifically for the Willamette Basin, as presented in Section 6. The *Assessment and Monitoring Strategy to Support Implementation of Mercury Total Maximum Daily Loads for the Willamette Basin* is one such plan, which was developed in partnership with EPA. DEQ regularly prepares Status and Trends reports and conducts water quality assessments on status of all waterways in Oregon every two years, as required by the Clean Water Act for submittal to EPA for approval as DEQ's Integrated Report. Together, these data and evaluations allow refinement of focus on specific geographic areas or discharges and appropriate implementation of adaptive management actions to attain, over time, the objectives of the TMDL.

~~Releases of greenhouse gases that result from human activities influence the warming of the planet~~Human alteration of the earth's atmosphere has changed the timing, amounts, temperature, and quality of precipitation worldwide, ~~. Warming of the atmosphere and land surface can produce effects collectively referred to as climate change~~This global phenomenon may produce localized changes to water quality in the Willamette Valley. Implementing policies and projects that reduce and mitigate GHG releases will support efforts to adapt to climate change ~~as well as~~and ~~help to support~~ the goals of this temperature TMDL.

Oregon has goals to reduce GHG emissions ~~10 percent below 1990 levels by 2020 and by~~ 75 percent below 1990 levels by 2050. The Oregon Climate Action Commission is responsible for preparing detailed forecasts of GHG emissions and submits these data in a biennial report to the Legislature. The OCAC uses data provided from DEQ, and other state agencies, to track trends in GHG emissions and recommend strategies for meeting the state's emissions reduction goals.

Oregon Governor Kate Brown signed Executive Order 20-04 in 2020, directing state agencies to take action to reduce and regulate GHG emissions. Following this executive order, 24 state agencies participated in developing the 2021 State Agency Climate Change Adaptation Framework. This framework is meant to support planning and coordination between state agencies, and in collaboration with local government and community partners, ~~support~~ in implementing ~~taking~~ actions to achieve climate change adaptation in Oregon. ~~Collaboration is key; however, climate change adaptation projects also need to be implemented by individual agencies.~~

DEQ continues to work toward the goals of Executive Order 20-04, and in 2024 DEQ's Environmental Quality Commission adopted the Climate Protection Program. The CPP is a climate mitigation program that sets an enforceable declining cap on ~~greenhouse gas~~GHG emissions from fossil fuels used throughout Oregon, including diesel, gasoline, and natural gas. The program is designed to reduce ~~these~~fossil fuel emissions by 50 percent by 2035 and 90 percent by 2050. As part of this program, DEQ is developing carbon emissions intensity targets for energy-intensive trade-exposed industries (EITEs are primarily manufacturing industries that release high amounts of GHG and face a lot of national and global competition for their products), and direct natural gas sources. The program also prioritizes equity by promoting benefits and alleviating burdens for communities of color, tribal communities, rural communities, and communities experiencing lower incomes. More information about this program and other DEQ Office of Greenhouse Gases programs can be accessed on DEQ's website: https://www.oregon.gov/deq/ghgp. A comprehensive summary of Oregon's efforts related to climate change mitigation and adaption can be found in OCAC reports: https://climate.oregon.gov/reports

While state level programs will reduce GHG emissions from within Oregon, the complex impacts of climate change on temperature loadings to Willamette Basin rivers and streams will require concurrent actions at multiple scales to address the causes and mitigate the effects of global climate change. Urgent and ongoing action is required at the federal level to support large scale and long-term reductions of GHG emissions. ~~-~~DEQ also recognizes that ~~federal administration~~ work around climate change can shift depending on the political environment and priorities of the federal administration.

7.2 Reasonable assurance conclusions

DEQ's implementation approach is multi-faceted and requires many targeted management practices across the entire basin to reduce anthropogenic pollutants, regardless of source origination.

The management strategies and practices that must be employed to reduce excess solar radiation loading are spatially distributed and involve multiple responsible persons including DMAs. Also, highly variable lag times are anticipated following the establishment of shade-producing vegetation to decrease solar radiation reaching streams. For these reasons, there is some uncertainty about the pace of achieving the needed reductions necessary in the Willamette Subbasins to attain water quality criteria. DEQ's WQMP addresses this uncertainty by including an extensive monitoring, reporting, and adaptive component that is designed to match the accountability framework used by EPA in its Chesapeake Bay TMDL (2010).

The rationale described in this document stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. In addition, DMAs and other groups have been continuing to implement on-the-ground actions since the establishment of the 2006 Willamette Basin Temperature TMDL. Together this approach provides reasonable assurance to meet state and federal requirements, including for antidegradation, and attain the goals of the TMDL.

8. Legal Authorities

As required in Oregon Administrative Rule 340-042-0040(4)(l)(O), this section cites legal authorities relating to implementation of management strategies.

Clean Water Act, Section 303(d)

The DEQ is the Oregon state agency responsible for implementing the Clean Water Act in Oregon. Section 303(d) of the 1972 Federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. These waters are referred to as "water quality limited." Water quality limited waterbodies must be identified by the EPA or by a state agency which has this authority. In Oregon, the responsibility to delegate water quality limited waterbodies rests with DEQ and DEQ's list of water quality limited waters is updated every two years. The list is referred to as the 303(d) list. Section 303 of the Clean Water Act further requires that TMDLs be developed for all waters on the 303(d) list. The Oregon Environmental Quality Commission granted DEQ authority to implement TMDLs through OAR 340-042, with special provisions for agricultural lands and nonfederal forestland as governed by the Agriculture Water Quality Management Act and the Forest Practices Act, respectively. The EPA has the authority under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must issue a TMDL within 30 days. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A WQMP is developed to describe a strategy for reducing water pollution to the level of the load allocations and waste load allocations prescribed in the TMDL, which is designed to restore the water quality and result in compliance with the water quality standards. In this way, the designated beneficial uses of the water will be protected for all users.

Endangered Species Act, Section 6

Section 6 of the 1973 federal Endangered Species Act, as amended, encourages states to develop and maintain conservation programs for federally listed threatened and endangered species. In addition, Section 4(d) of the ESA requires the National Marine Fisheries Service to list the activities that could result in a "take" of species they are charged with protecting. With regard to this TMDL, NMFS' protected species are salmonid fish. NMFS also described certain precautions that, if followed, would preclude prosecution for take even if a listed species were harmed inadvertently. Such a provision is called a limit on the take prohibition. The intent is to provide local governments and other entities greater certainty regarding their liability for take.

NMFS published their rule in response to Section 4(d) in July of 2000 (see 65 FR 42421, July 10, 2000). The NMFS 4(d) rule lists 12 criteria that will be used to determine whether a local program incorporates sufficient precautionary measures to adequately conserve fish. The rule provides for local jurisdictions to submit development ordinances for review by NMFS under one, several or all of the criteria. The criteria for the Municipal, Residential, Commercial and Industrial Development and Redevelopment limit are listed below:

1. Avoid inappropriate areas such as unstable slopes, wetlands, and areas of high habitat value;
2. Prevent stormwater discharge impacts on water quality;
3. Protect riparian areas;
4. Avoid stream crossings – whether by roads, utilities, or other linear development;
5. Protect historic stream meander patterns;
6. Protect wetlands, wetland buffers, and wetland function;
7. Preserve the ability of permanent and intermittent streams to pass peak flows (hydrologic capacity);
8. Stress landscaping with native vegetation;
9. Prevent erosion and sediment run-off during and after construction;
10. Ensure water supply demand can be met without affecting salmon needs;
11. Provide mechanisms for monitoring, enforcing, funding and implementing; and
12. Comply with all other state and federal environmental laws and permits.

Oregon Revised Statute Chapter 468B

DEQ is authorized by law to prevent and abate water pollution within the State of Oregon. Particularly relevant provisions of this chapter include:

ORS 468B.020 Prevention of pollution

(A) Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State or Oregon, as set forth in ORS 468B.015.

(B) In order to carry out the public policy set forth in ORS 468B.015, the Department of Environmental Quality shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:

   a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and
   b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

ORS 468B.110 provides DEQ and the EQC with authority to take actions necessary to achieve and maintain water quality standards, including issuing TMDLs and establishing wasteload allocations and load allocations.

NPDES and WPCF Permits

DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the NPDES permits for waste discharge into waters of the

United States; and Water Pollution Control Facilities permits for waste disposal on land. The NPDES permit is also a federal permit and is required under the Clean Water Act. The WPCF permit is a state program.

401 Water Quality Certification

Section 401 of the CWA requires that any applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the state must provide the licensing or permitting agency a certificate from DEQ that the activity complies with water quality requirements and standards. These include certifications for hydroelectric projects and for 'dredge and fill' projects. The legal citations are: 33 U.S.C. 1341; ORS 468B.035 – 468B.047; and OAR 340-048-0005 – 340-048-0040.

USACE Dam Operation and Management

In association with other federal statues, including House Document No. 531 Volume V, the River and Harbor Act, the Flood Control Act, and the Water Resources Development Act, the USACE is charged with operating its projects in compliance with the federal Clean Water Act, and in accordance with all federal, State, interstate and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water quality pollution as per Title 1 Section 313 (33 U.S.C. 1323).

Oregon Forest Practices Act

The Oregon Department of Forestry is the designated management agency for regulating land management actions on non-federal forestry lands that impact water quality (ORS 527.610 to 527.992, and OAR 629 Divisions 600 through 665). The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 625, 630, and 635-660, which describe best management practices for forest operations. The Oregon Environmental Quality Commission, Board of Forestry, DEQ, and ODF have agreed that these pollution control measures will primarily be relied upon to result in achievement of state water quality standards. Statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, OAR 629-035-0100, and OAR 340-042-0080.

Agricultural Water Quality Management Act

The Oregon Department of Agriculture is responsible for the prevention and control of water pollution from agricultural activities as directed and authorized through the Agricultural Water Quality Management Act, adopted by the Oregon legislature in 1993 (ORS 568.900 to ORS 568.933). It is the lead state agency for regulating agriculture for water quality (ORS 561.191). The Agricultural Water Quality Management Plan Act directs the ODA to work with local communities to develop water quality management plans for specific watersheds that have been identified as violating water quality standards and have agriculture water pollution contributions. The agriculture water quality management plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct the problems. Water Quality area rules for areas within the Willamette Basin include OAR 603-095-2100 to 1160, OAR 603-095-2300 to 2360, OAR 603-095-2600 to 2660, and OAR 603-095-3700 to 3760.

Local Ordinances

Local governments are expected to describe in their implementation plans their specific legal authorities to carry out the management strategies necessary to meet the TMDL allocations. If new or modified local codes or ordinances are required to implement the plan, the DMA will identify code development as a management strategy. Legal authority to enforce the provisions of a city's NPDES permit would be a specific example of legal authority to carry out specific management strategies.

9. References

DEQ. 2014. Willamette Basin Five Year Review. https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Implementation.aspx

DEQ. 2022. Water Quality Status and Trends. https://www.oregon.gov/deq/wq/programs/Pages/wqstatustrends.aspx

DEQ. 2022. EPA approved Integrated Report. https://www.oregon.gov/deq/wq/Pages/WQ-Assessment.aspx

DEQ. 2023. Willamette Subbasins Interactive Map. https://www.oregon.gov/deq/wq/Documents/tmdlWillSubMap.html

DEQ. 2023a. Volunteer Monitoring Resources webpage. https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Resources.aspx. Accessed January 20, 2023.

DEQ. 2023b. Water Temperature Impacts from In-Channel Ponds in Portland Metro and Northwest Region.

DEQ. 202~~4~~5. Willamette Subbasins Temperature TMDL. ~~Technical Support Document.~~ Oregon Department of Environmental Quality.

DEQ. 202~~4~~5a. Willamette Subbasins ~~Temperature TMDL~~Technical Support Document. Oregon Department of Environmental Quality.

Doran, George T. 1981. There's a S.M.A.R.T. way to write management's goals and objectives. Management Review. 70. Pages 35-36. https://community.mis.temple.edu/mis0855002fall2015/files/2015/10/S.M.A.R.T-Way-Management-Review.pdf. Accessed January 20, 2023.

EPA. 1991. Guidance for Water Quality-based Decisions: The TMDL Process. EPA/440/4-91-001. Washington, D.C.

EPA. 2002. Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992. May 20, 2002.

EPA. 2007. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. EPA 841-B-07-002. National Management Measures to Control Nonpoint Source Pollution from Hydromodification (epa.gov)

EPA. 2010. Chesapeake Bay TMDL. December 29, 2010. https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document.

EPA. 2012. Supplemental Information for Reviewing Reasonable Assurance in TMDLs. Office of Wetlands, Oceans and Watersheds. February 15, 2012.

EPA. 2017. Causal Analysis/Diagnosis Decision Information System (CADDIS): *Vol. 2: Sources, Stressors, and Responses - Temperature*.

https://www.epa.gov/caddis-vol2/temperature

EPA. 2021. Columbia and Lower Snake River Temperature TMDL. August 13, 2021. https://www.epa.gov/columbiariver/tmdl-temperature-columbia-and-lower-snake-rivers.

EPA. 2023. Funding Resources for Watershed Protection and Restoration webpage. https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration. Accessed January 20, 2023.

Galli J., and R. Dubose. 1990. Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices. Metropolitan Washington Council of Governments, Department of Environmental Programs, Washington DC.

Larson, L.L., and S.L. Larson. 1996. Riparian Shade and Stream Temperature: A Perspective. Rangelands, 18(4):149-152.

NRCS. 2009. Stream Visual Assessment Protocol Version 2. National Biology Handbook. Subpart B – Conservation Planning. Part 614. US Department of Agriculture – Natural Resources Conservation Service. December 2009. https://www.nrcs.usda.gov/sites/default/files/2022-10/SVAP2%20National%20Bio%20Handbook%20Part%20614.pdf

Oregon Plan for Salmon and Watersheds. 1999. Oregon Aquatic Habitat Restoration and Enhancement Guide. Restoration_Enhancement_Guide.pdf (oregon.gov)

OWEB. 1999. Addendum to Water Quality Monitoring Technical Guide Book: Chapter 14 Stream Shade and Canopy Cover Monitoring Methods. https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf

OWEB. 2023. Oregon Watershed Restoration Inventory. https://www.oregon.gov/oweb/data-reporting/Pages/owri.aspx. Accessed March 15, 2023.

OWEB. 2023a. Oregon Watershed Restoration Inventory Online. https://apps.wrd.state.or.us/apps/oweb/owrio/default.aspx. Accessed March 15, 2023.

BLM (U.S. Department of the Interior, Bureau of Land Management). 2016. *Northwestern & Coastal Oregon record of decision and resource management plan.*

USFS and BLM (U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management). 1994. *Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl*.

The White House. 2021. U. S. long-term strategy to reduce greenhouse gas emissions: Pathways to net-zero by 2050.

Appendix A: List of responsible persons including designated management agencies

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed?
1	Adair Village	City	483	55	existing	yes
2	Albany	City	11,237	1,~~041~~139	existing	yes
3	Aumsville	City	788	103	existing	yes
4	Aurora	City	315	45	existing	yes
5	Brownsville	City	834	96	existing	yes
6	Canby	City	3,185	~~122~~123	existing	yes
7	Coburg	City	653	68	existing	yes
8	Corvallis	City	14,020	1,~~508~~695	existing	yes
9	Cottage Grove	City	2,403	~~127~~408	existing	yes
10	Creswell	City	1,432	~~114~~123	existing	yes
11	Dallas	City	3,998	757	existing	yes
12	Detroit	City	661	132	existing	yes
13	Donald	City	283	18	existing	yes
14	Dundee	City	848	~~33~~51	existing	yes
15	Estacada	City	1,434	207	existing	yes
16	Eugene	City	31,614	3,~~019~~606	existing	yes
17	Fairview	City	1,773	343	existing	yes
18	Falls City	City	787	241	existing	yes
19	Gates	City	399	~~106~~175	existing	yes
20	Gervais	City	308	19	existing	yes
21	Gladstone	City	1,578	~~30~~163	existing	yes
22	Gresham	City	11,952	1,594	existing	yes
23	Halsey	City	259	36	existing	yes
24	Happy Valley	City	7,402	1,~~508~~569	existing	yes
25	Harrisburg	City	826	~~98~~129	existing	yes
26	Hubbard	City	444	29	existing	yes
27	Idanha	City	530	147	existing	yes
28	Independence	City	1,908	~~165~~263	existing	yes
29	Jefferson	City	529	~~77~~118	existing	yes
30	Junction City	City	1,992	280	existing	yes
31	Keizer	City	4,298	~~171~~257	existing	yes

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed ?
32	Lake Oswego	City	5,807	~~962~~990	existing	yes
33	Lebanon	City	4,306	~~383~~431	existing	yes
34	Lowell	City	534	76	existing	yes
35	Lyons	City	544	~~56~~83	existing	yes
36	McMinnville	City	9.1	3	new	no
~~36~~37	Mill City	City	526	~~52~~158	existing	yes
~~37~~38	Millersburg	City	2,804	~~401~~423	existing	yes
~~38~~39	Milwaukie	City	3,241	~~284~~330	existing	yes
~~39~~40	Molalla	City	1,642	74	existing	yes
~~40~~41	Monmouth	City	1,462	135	existing	yes
~~41~~42	Monroe	City	342	~~23~~78	existing	yes
~~42~~43	Mt. Angel	City	677	18	existing	yes
~~43~~44	Newberg	City	3,692	~~312~~318	existing	yes
~~44~~45	Oakridge	City	1,241	153	existing	yes
~~45~~46	Oregon City	City	6,437	~~440~~597	existing	yes
~~46~~47	Philomath	City	1,597	165	existing	yes
~~47~~48	Portland	City	73,674	~~9,339~~10,876	existing	yes
~~48~~49	Salem	City	31,373	~~2,942~~3,576	existing	yes
~~49~~50	Sandy	City	1,768	197	existing	yes
~~50~~51	Scappoose	City	2,098	212	new	yes
~~51~~52	Scio	City	262	40	existing	yes
~~52~~53	Scotts Mills	City	225	46	existing	yes
~~53~~54	Silverton	City	2,455	597	existing	yes
~~54~~55	Springfield	City	10,323	1,~~004~~154	existing	yes
~~55~~56	St. Helens	City	1,973	368	new	yes
~~56~~57	St. Paul	City	184	6	existing	yes
~~57~~58	Stayton	City	1,923	~~241~~439	existing	yes
~~58~~59	Sublimity	City	595	25	existing	yes
~~59~~60	Sweet Home	City	3,441	~~616~~753	existing	yes
~~60~~61	Tangent	City	2,230	252	existing	yes
~~61~~62	Tualatin	City	401	7	existing	no
~~62~~63	Turner	City	911	124	existing	yes
~~63~~64	Veneta	City	1,658	207	existing	yes
~~64~~65	West Linn	City	4,335	~~629~~933	existing	yes
~~65~~66	Westfir	City	192	68	existing	yes
~~66~~67	Wilsonville	City	4,869	~~420~~549	existing	yes
~~67~~68	Woodburn	City	3,596	276	existing	yes
~~68~~69	Benton County	County	27,798	3,456	existing	yes
~~69~~70	Clackamas County	County	79,838	13,~~597~~994	existing	yes
~~70~~71	Columbia County	County	15,374	3,~~409~~499	new	yes

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed?
~~71~~72	Curry County	County	3	0.5	new	no
~~72~~73	Lane County	County	121,090	~~19,240~~21,545	existing	yes
~~73~~74	Lincoln County	County	89	43	new	no
~~74~~75	Linn County	County	35,141	~~5,962~~6,781	existing	yes
~~75~~76	Marion County	County	43,290	~~5,978~~6,267	existing	yes
~~76~~77	Multnomah County	County	4,089	1,~~170~~172	existing	yes
~~77~~78	Polk County	County	20,855	4,~~029~~102	existing	yes
~~78~~79	Washington County	County	2,130	156	new	no
~~79~~80	Yamhill County	County	10,131	1,~~355~~401	new	yes
~~80~~81	Bonneville Power Administration	Federal	1,018	~~252~~270	new	no
~~81~~82	U.S. Bureau of Land Management	Federal	351,837	110,~~202~~432	existing	yes
~~82~~83	U.S. Fish and Wildlife Service	Federal	10,912	1,~~568~~604	existing	yes
~~83~~84	U.S. Forest Service	Federal	2,201,208	549,814	existing	yes
~~84~~85	~~US~~U.S. Army Corps of Engineers	Federal	29,289	5,~~884~~980	existing	yes
~~85~~86	Pacific Power and Light	Private Utility	35	1	new	no
~~86~~87	Eugene Water and Electric Board	Public Utility	not assessed	not assessed	existing	yes
~~87~~88	Portland General Electric	Public Utility	not assessed	not assessed	new	yes
~~88~~89	Albany & Eastern Railroad	Railroad	304	~~52~~61	new	no
~~89~~90	BNSF Railway	Railroad	148	9	new	no
~~90~~91	Central Oregon & Pacific Railroad	Railroad	182	~~32~~51	new	no
~~91~~92	Oregon Pacific Railroad	Railroad	44	2	new	no
~~92~~93	Port of Coos Bay	Transportation	315	57	new	no
~~93~~94	Portland & Western Railroad	Railroad	1,898	~~261~~279	new	no
~~94~~95	Portland Terminal Railroad Company	Railroad	0.1	0.1	new	no
~~95~~96	TriMet	Railroad	102	38	new	no
~~96~~97	Union Pacific Railroad	Railroad	3,788	~~630~~677	new	no
~~97~~98	Vennel Farms Railroad Company	Railroad	2	0.2	new	no
~~98~~99	Willamette Shore Trolley	Railroad	6	1	new	no
~~99~~100	Willamette Valley Railway	Railroad	255	51	new	no

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed?
~~100~~101	Ash Creek Water Control District	Responsible Person	not assessed	not assessed	new	no
~~101~~102	Creswell Water Control District	Responsible Person	not assessed	not assessed	new	no
~~102~~103	Creswell Irrigation District	Responsible Person	not assessed	not assessed	new	no
~~103~~104	East Valley Water District	Responsible Person	not assessed	not assessed	new	no
~~104~~105	Fertile Improvement District	Responsible Person	not assessed	not assessed	new	no
~~105~~106	G A Miller Drainage District No 1	Responsible Person	not assessed	not assessed	new	no
~~106~~107	Grand Prairie Water Control District	Responsible Person	not assessed	not assessed	new	no
~~107~~108	Hawn Creek District Improvement Co.	Responsible Person	not assessed	not assessed	new	no
~~108~~109	Junction City Water Control District	Responsible Person	not assessed	not assessed	new	no
~~109~~110	Lacomb Irrigation District	Responsible Person	not assessed	not assessed	new	no
~~110~~111	Lake Labish Water Control District	Responsible Person	not assessed	not assessed	new	no
~~111~~112	Muddy Creeks Irrigation Project	Responsible Person	not assessed	not assessed	new	no
~~112113~~	~~Multnomah County Drainage District~~	~~Responsible Person~~	~~not assessed~~	~~not assessed~~	~~new~~	~~no~~
~~113~~113~~4~~	North Lebanon Water Control District	Responsible Person	not assessed	not assessed	new	no
~~114~~114~~5~~	Palmer Creek Water District Improvement Co.	Responsible Person	not assessed	not assessed	new	no
~~115116~~	~~Peninsula Drainage District #1~~	~~Responsible Person~~	~~not assessed~~	~~not assessed~~	~~new~~	~~no~~
~~116117~~	~~Peninsula Drainage District #2~~	~~Responsible Person~~	~~not assessed~~	~~not assessed~~	~~new~~	~~no~~
115	Urban Flood Safety and Water Quality District	Responsible Person	not assessed	not assessed	new	no
~~117~~116~~8~~	Santiam Water Control District	Responsible Person	not assessed	not assessed	new	no
~~118~~117~~9~~	Sauvie Island Drainage Improvement Company	Responsible Person	not assessed	not assessed	new	no
~~119~~118~~20~~	Scappoose Drainage Improvement Company	Responsible Person	not assessed	not assessed	new	no
~~120~~119~~21~~	Sidney Irrigation District	Responsible Person	not assessed	not assessed	new	no

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed?
1211202	West Labish Water Control District	Responsible Person	not assessed	not assessed	new	no
1221213	Metro (Portland Metropolitan Government)	Special District	not assessed	not assessed	existing	yes
1231224	Water Environment Services	Special District	not assessed	not assessed	existing	yes
1241235	Oak Lodge Water Services	Special District	not assessed	not assessed	existing	yes
1251246	Department of Geology and Mineral Industries	State	2,055	258357	existing	no
1261257	Oregon Department of Agriculture	State	1,296,2182 24	191,934205,1 35	existing	yes
1271268	Oregon Department of Environmental Quality	State	0	0	existing	no
1281279	Oregon Department of Fish & Wildlife	State	10,080	1,359588	new	yes
1291283 0	Oregon Department of Forestry	State	1,721,0830 90	456,567458,2 57	existing	yes
1301293 1	Oregon Department of State Lands	State	336	37124	existing	no
1311303 2	Oregon Department of Transportation	State	30,99731,0 07	4,8565,525	existing	yes
1321313	Oregon Parks and Recreation Department	State	19,440	3,2194,692	existing	yes
1331324	Port of Columbia County	Transportation	619	71	new	yes
1341335	Port of Portland	Transportation	5,497	556558	existing	yes

Appendix B: Acres of jurisdiction, by HUC, within 150 feet of stream centerline for each entity

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Molalla-Pudding Subbasin - HUC 17090009			
Oregon Department of Forestry	State Agency	207,747	56,523
Oregon Department of Agriculture	State Agency	237,200	35,970
U.S. Bureau of Land Management	Federal Agency	54,013	16,403
Marion County	County	19,780	2,733
Clackamas County	County	11,823	2,594
Oregon Parks and Recreation Department	State Agency	9,197	2,073
U.S. Forest Service	Federal Agency	2,796	762
Water	Water	819	738
City of Silverton	Municipality	2,455	597
City of Salem	Municipality	3,245	388
City of Woodburn	Municipality	3,596	276
Oregon Department of Transportation	State Agency	2,255	252
U.S. Government	Federal Agency	315	108
State of Oregon	State Agency	569	85
City of Molalla	Municipality	1,642	74
City of Canby	Municipality	1,081	65
City of Scotts Mills	Municipality	225	46
City of Aurora	Municipality	315	45
City of Hubbard	Municipality	444	29
Willamette Valley Railway	Private	196	25
City of Gervais	Municipality	308	19
City of Mt. Angel	Municipality	677	18
Union Pacific Railroad	Private	276	18
Portland & Western Railroad	Private	51	2
Oregon Pacific Railroad	Private	41	2
City of Barlow	Municipality	33	0
City of Donald	Municipality	70	0

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Oregon Department of Fish and Wildlife	State Agency	215	0
Middle Willamette Subbasin - HUC 17090007			
Oregon Department of Agriculture	State Agency	265,372	~~28,059~~29,797
Oregon Department of Forestry	State Agency	40,322	12,~~637~~687
Water	Water	6,007	~~3755~~5,346
Clackamas County	County	20,406	3,~~678~~695
City of Salem	Municipality	27,830	~~2,539~~3,023
Polk County	County	11,325	~~1,982~~2,054
Marion County	County	18,823	1,~~805~~910
U.S. Bureau of Land Management	Federal Agency	3,787	1,~~380~~413
Yamhill County	County	10,131	1,~~355~~401
City of Dallas	Municipality	3,998	757
Oregon Parks and Recreation Department	State Agency	3,699	~~263~~591
Oregon Department of Transportation	State Agency	4,810	~~546~~590
U.S. Fish and Wildlife Service	Federal Agency	5,092	549
City of Wilsonville	Municipality	4,869	~~420~~549
City of Oregon City	Municipality	5,559	~~440~~487
U.S. Forest Service	Federal Agency	1,033	363
City of West Linn	Municipality	2,191	~~146~~362
City of Newberg	Municipality	3,692	~~312~~318
City of Independence	Municipality	1,908	~~165~~263
City of Keizer	Municipality	4,298	~~171~~257
Washington County	County	2,094	152
City of Stayton	Municipality	1,200	146
State of Oregon	State Agency	306	~~7~~145
City of Turner	Municipality	911	124
City of Monmouth	Municipality	1,433	120
City of Aumsville	Municipality	788	103
Union Pacific Railroad	Private	251	~~68~~73
Portland & Western Railroad	Private	524	59~~49~~
City of Canby	Municipality	2,102	57
City of Dundee	Municipality	848	~~33~~51
U.S. Government	Federal Agency	91	~~7~~29
Oregon Department of Geology and Mineral Industries	State Agency	329	~~4~~26
Willamette Valley Railway	Private	59	26

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
City of Sublimity	Municipality	595	25
Oregon Department of Fish and Wildlife	State Agency	357	~~7~~22
City of Donald	Municipality	213	18
City of Gladstone	Municipality	20	~~0~~14
City of Tualatin	Municipality	327	7
City of St. Paul	Municipality	184	6
Bonneville Power Administration	Special District	22	5
City of McMinnville	Municipality	9	~~0~~3
Oregon Military Department	State Agency	14	2
TriMet	Special District	10	1
City of Tigard	Municipality	15	0
Oregon Department of Aviation	State Agency	15	0
SP Fiber Technologies Railway	Private	1	0
North Santiam Subbasin - HUC 17090005			
U.S. Forest Service	Federal Agency	293,610	92,924
Oregon Department of Forestry	State Agency	94,279	33,~~282~~850
Oregon Department of Agriculture	State Agency	57,498	~~13,009~~15,423
U.S. Bureau of Land Management	Federal Agency	20,455	7,~~860~~967
Marion County	County	4,648	1,~~433~~618
U.S. Army Corps of Engineers	Federal Agency	4,060	1,~~192~~223
Linn County	County	3,607	~~760~~999
Water	Water	911	~~122~~848
Oregon Department of Transportation	State Agency	1,877	~~590~~693
City of Stayton	Municipality	723	~~96~~293
Oregon Department of Fish and Wildlife	State Agency	419	~~26~~222
City of Gates	Municipality	399	~~106~~175
City of Salem	Municipality	298	~~15~~165
Oregon Department of Geology and Mineral Industries	State Agency	420	~~83~~159
City of Mill City	Municipality	526	~~52~~158
City of Idanha	Municipality	530	147
City of Detroit	Municipality	661	132
City of Jefferson	Municipality	529	118 ~~77~~
State of Oregon	State Agency	237	~~29~~101
City of Lyons	Municipality	544	~~56~~83
Oregon Parks and Recreation Department	State Agency	183	~~32~~78

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Bonneville Power Administration	Special District	153	42
U.S. Government	Federal Agency	98	~~31~~33
Union Pacific Railroad	Private	61	31
Albany & Eastern Railroad	Private	94	~~16~~25
Portland & Western Railroad	Private	12	~~3~~5
Pacific Power and Light	Private	1	0
Confederated Tribes of Warm Springs	Tribal	717	0
Jefferson County	County	0	0
South Santiam Subbasin - HUC 17090006			
Oregon Department of Forestry	State Agency	310,035	98,~~310~~467
U.S. Forest Service	Federal Agency	155,242	69,455
Oregon Department of Agriculture	State Agency	113,371	~~25,977~~27,567
U.S. Bureau of Land Management	Federal Agency	59,501	21,~~584~~585
Linn County	County	13,621	3,~~121~~586
Water	Water	5,254	1,~~917~~923
City of Sweet Home	Municipality	3,441	~~616~~753
Oregon Department of Transportation	State Agency	1,519	~~467~~492
City of Lebanon	Municipality	1,762	~~230~~279
U.S. Army Corps of Engineers	Federal Agency	1,068	~~252~~257
Oregon Parks and Recreation Department	State Agency	254	77
City of Scio	Municipality	262	40
State of Oregon	State Agency	49	~~14~~37
Albany & Eastern Railroad	Private	164	~~29~~30
Oregon Department of Geology and Mineral Industries	State Agency	107	25
Oregon Department of Fish and Wildlife	State Agency	41	19
City of Waterloo	Municipality	81	~~9~~16
U.S. Government	Federal Agency	81	14
Pacific Power and Light	Private	1	0
Bonneville Power Administration	Special District	0	0
City of Sodaville	Municipality	7	0
Upper Willamette Subbasin - HUC 17090003			
Oregon Department of Forestry	State Agency	419,332	84,~~984~~994
Oregon Department of Agriculture	State Agency	497,249	~~68,015~~74,131
U.S. Bureau of Land Management	Federal Agency	48,530	14,~~527~~570
Lane County	County	50,389	7,~~237~~618

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
U.S. Forest Service	Federal Agency	14,684	4,164
Benton County	County	27,798	3,~~456~~524
City of Eugene	Municipality	30,202	~~2,873~~3,459
Water	Water	3,511	~~315~~2,453
Linn County	County	17,912	2,~~081~~196
Polk County	County	9,530	2,048
City of Corvallis	Municipality	14,020	1,~~508~~695
U.S. Army Corps of Engineers	Federal Agency	11,988	1,~~363~~423
Oregon Department of Transportation	State Agency	7,953	1,~~092~~206
City of Albany	Municipality	11,237	1,~~041~~139
U.S. Fish and Wildlife Service	Federal Agency	5,696	~~957~~993
Oregon Parks and Recreation Department	State Agency	3,247	~~377~~954
City of Springfield	Municipality	5,302	~~339~~437
City of Millersburg	Municipality	2,804	~~401~~423
Oregon Department of Fish and Wildlife	State Agency	2,551	292
City of Junction City	Municipality	1,992	280
City of Tangent	Municipality	2,230	252
City of Falls City	Municipality	787	241
City of Veneta	Municipality	1,658	207
City of Philomath	Municipality	1,597	165
City of Lebanon	Municipality	2,545	153
Portland & Western Railroad	Private	989	~~132~~137
City of Harrisburg	Municipality	826	~~98~~129
City of Brownsville	Municipality	834	96
Oregon Department of State Lands	State Agency	222	~~19~~88
City of Monroe	Municipality	342	~~23~~78
City of Coburg	Municipality	653	68
U.S. Government	Federal Agency	404	~~58~~60
Union Pacific Railroad	Private	719	~~39~~60
Port of Coos Bay	Special District	315	57
City of Adair Village	Municipality	483	55
Lincoln County	County	89	43
City of Halsey	Municipality	259	36
Bonneville Power Administration	Special District	118	35
U.S. Department of Defense	Federal Agency	601	35
State of Oregon	State Agency	219	~~24~~26

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
City of Monmouth	Municipality	29	15
Oregon Department of Geology and Mineral Industries	State Agency	231	13
Albany & Eastern Railroad	Private	46	7
Oregon Military Department	State Agency	34	4
Central Oregon & Pacific Railroad	Private	22	~~0~~3
Oregon Department of Aviation	State Agency	18	3
Pacific Power and Light	Private	24	0
Vennel Farms Railroad Company	Private	2	0
City of Sodaville	Municipality	182	0
Coos Bay Rail Link	Private	3	0
U.S. Department of Agriculture	Federal Agency	43	0
Clackamas Subbasin - HUC 17090011			
U.S. Forest Service	Federal Agency	413,482	87,423
Oregon Department of Forestry	State Agency	74,558	~~18,900~~19,446
Oregon Department of Agriculture	State Agency	37,321	~~5,806~~6,157
Clackamas County	County	33,208	5,~~442~~790
U.S. Bureau of Land Management	Federal Agency	14,103	3,~~838~~854
City of Happy Valley	Municipality	4,214	~~796~~857
Water	Water	605	~~110~~588
Oregon Department of Transportation	State Agency	1,630	~~367~~392
Oregon Parks and Recreation Department	State Agency	1,179	~~207~~374
City of Estacada	Municipality	1,434	207
City of Sandy	Municipality	1,768	197
U.S. Government	Federal Agency	518	~~143~~152
City of Gladstone	Municipality	878	~~5~~111
City of Oregon City	Municipality	878	~~0~~110
U.S. Fish and Wildlife Service	Federal Agency	124	62
State of Oregon	State Agency	165	~~24~~51
Union Pacific Railroad	Private	28	14
Confederated Tribes of Warm Springs	Tribal	17,168	11
Marion County	County	40	7
Bonneville Power Administration	Special District	209	~~0~~6
City of Portland	Municipality	6	0
Wasco County	County	247	0
Coast Fork Willamette Subbasin - HUC 17090002			

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Oregon Department of Forestry	State Agency	198,134	49,~~040~~201
U.S. Forest Service	Federal Agency	86,827	27,997
U.S. Bureau of Land Management	Federal Agency	67,685	18,~~110~~130
Lane County	County	31,815	~~4,863~~5,976
Oregon Department of Agriculture	State Agency	32,053	~~4,822~~5,438
Water	Water	3,194	~~719~~1,052
City of Cottage Grove	Municipality	2,403	~~127~~408
Oregon Department of Transportation	State Agency	1,535	~~164~~310
Oregon Parks and Recreation Department	State Agency	523	~~42~~251
U.S. Government	Federal Agency	486	~~62~~128
City of Creswell	Municipality	1,432	~~114~~123
City of Eugene	Municipality	811	52
Central Oregon & Pacific Railroad	Private	160	~~32~~48
State of Oregon	State Agency	54	~~7~~35
Bonneville Power Administration	Special District	42	~~24~~26
Oregon Department of Aviation	State Agency	19	~~0~~5
Oregon Department of Fish and Wildlife	State Agency	3	3
Oregon Department of State Lands	State Agency	3	3~~0~~
Pacific Power and Light	Private	2	0
U.S. Army Corps of Engineers	Federal Agency	2	0
U.S. Department of Agriculture	Federal Agency	1	0
McKenzie Subbasin - HUC 17090004			
U.S. Forest Service	Federal Agency	545,195	123,717
Oregon Department of Forestry	State Agency	210,320	58,662
U.S. Bureau of Land Management	Federal Agency	52,470	16,244
Lane County	County	20,905	3,~~670~~677
Oregon Department of Agriculture	State Agency	16,823	3,~~268~~272
U.S. Army Corps of Engineers	Federal Agency	2,356	717
Water	Water	2,140	~~507~~509
City of Springfield	Municipality	3,809	456
Oregon Department of Transportation	State Agency	1,864	281
City of Eugene	Municipality	601	94
U.S. Government	Federal Agency	315	68
Oregon Parks and Recreation Department	State Agency	86	29
Oregon Department of State Lands	State Agency	66	9
Bonneville Power Administration	Special District	22	6

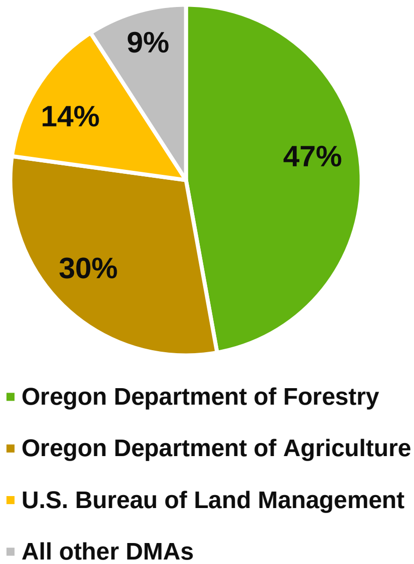
Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Oregon Department of Fish and Wildlife	State Agency	5	1
Linn County	County	1	0
U.S. Department of Agriculture	Federal Agency	19	0
Union Pacific Railroad	Private	2	0
Lower Willamette Subbasin - HUC 17090012			
Oregon Department of Forestry	State Agency	57,427	16,392
City of Portland	Municipality	73,669	~~9,339~~10,876
Oregon Department of Agriculture	State Agency	27,227	5,~~148~~217
Columbia County	County	15,374	3,~~409~~499
Clackamas County	County	14,401	1,~~884~~915
U.S. Bureau of Land Management	Federal Agency	6,432	1,636
City of Gresham	Municipality	11,952	1,594
Water	Water	2,867	~~187~~1,305
Multnomah County	County	4,089	1,~~170~~172
Oregon Department of Fish and Wildlife	State Agency	6,491	1,~~010~~029
City of Lake Oswego	Municipality	5,807	~~962~~990
City of Happy Valley	Municipality	3,188	712
Oregon Department of Transportation	State Agency	5,141	678
City of West Linn	Municipality	2,144	~~483~~571
Port of Portland	Special District	5,536	~~556~~558
City of St. Helens	Municipality	1,973	368
City of Fairview	Municipality	1,773	343
City of Milwaukie	Municipality	3,241	~~284~~330
City of Scappoose	Municipality	2,098	212
City of Troutdale	Municipality	1,230	166
Bonneville Power Administration	Special District	427	~~133~~143
Oregon Department of Geology and Mineral Industries	State Agency	967	134
Portland & Western Railroad	Private	323	75
Union Pacific Railroad	Private	560	~~71~~72
Port of St. Helens	Special District	619	71
Oregon Parks and Recreation Department	State Agency	495	~~46~~52
City of Gladstone	Municipality	679	~~25~~38
TriMet	Special District	92	36
City of Wood Village	Municipality	563	18
City of Johnson City	Municipality	43	13

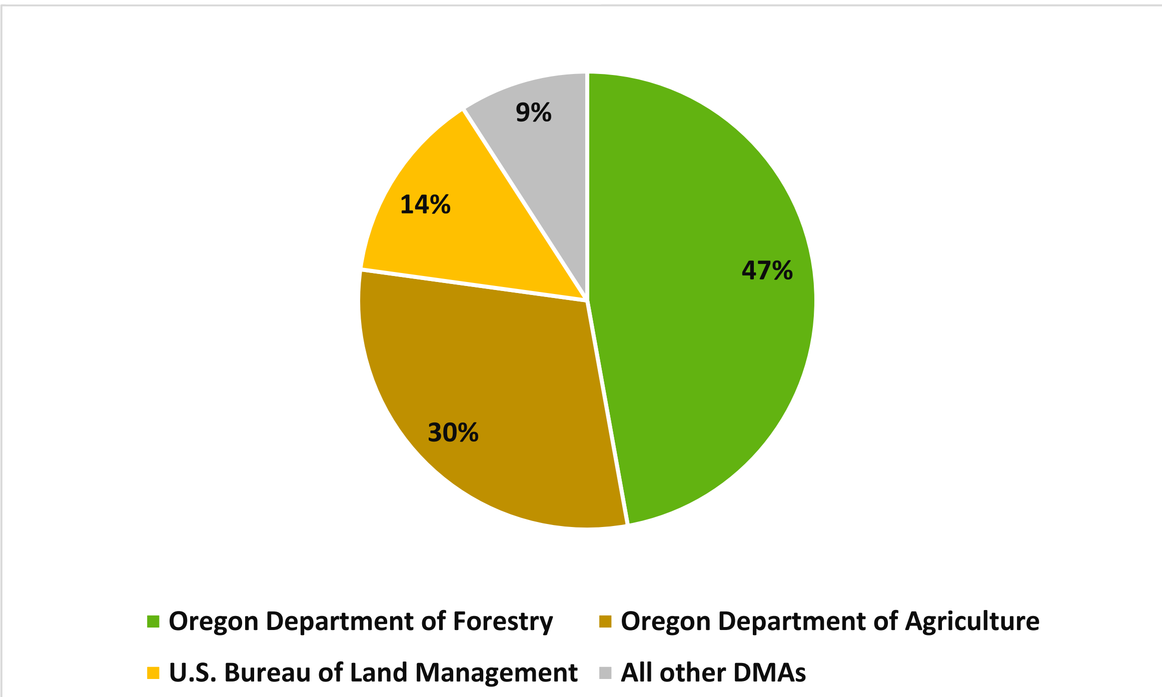
Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
State of Oregon	State Agency	99	11
BNSF Railway	Private	148	9
Washington County	County	35	4
U.S. Government	Federal Agency	11	3
Willamette Shore Trolley	Private	6	1
City of Canby	Municipality	2	1
Curry County	County	3	0
Pacific Power and Light	Private	7	0
Oregon Pacific Railroad	Private	3	0
Portland Terminal Railroad Company	Private	0	0
City of Clatskanie	Municipality	1	0
City of Maywood Park	Municipality	83	0
City of Tualatin	Municipality	74	0
Peninsula Terminal Company	Private	13	0
Middle Fork Willamette Subbasin - HUC 17090001			
U.S. Forest Service	Federal Agency	688,782	143,011
Oregon Department of Forestry	State Agency	108,936	~~27,839~~28,037
U.S. Bureau of Land Management	Federal Agency	24,864	8,~~621~~631
Lane County	County	17,982	~~3,469~~4,273
U.S. Army Corps of Engineers	Federal Agency	9,815	2,360
Oregon Department of Agriculture	State Agency	12,110	~~1,860~~2,163
Water	Water	3,695	1,~~156~~638
Oregon Department of Transportation	State Agency	2,422	~~418~~631
Union Pacific Railroad	Private	1,891	~~389~~410
City of Springfield	Municipality	1,212	~~209~~261
Oregon Parks and Recreation Department	State Agency	577	~~78~~213
City of Oakridge	Municipality	1,241	153
City of Lowell	Municipality	534	76
City of Westfir	Municipality	192	68
U.S. Government	Federal Agency	102	~~14~~40
State of Oregon	State Agency	69	~~13~~40
Oregon Department of State Lands	State Agency	45	~~8~~23
U.S. Department of Agriculture	Federal Agency	36	16
Bonneville Power Administration	Special District	25	8
Oregon Department of Aviation	State Agency	18	0

Appendix C: Percent of acres by HUC, within 150 feet of stream centerline

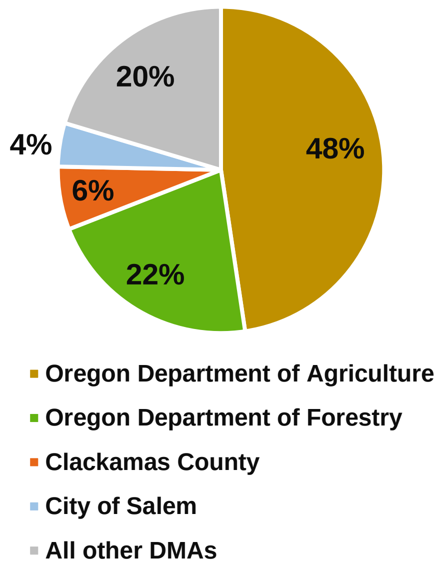
~~Appendix C: Graphs showing designated management agency jurisdiction by subbasin and within 150 feet of a stream~~

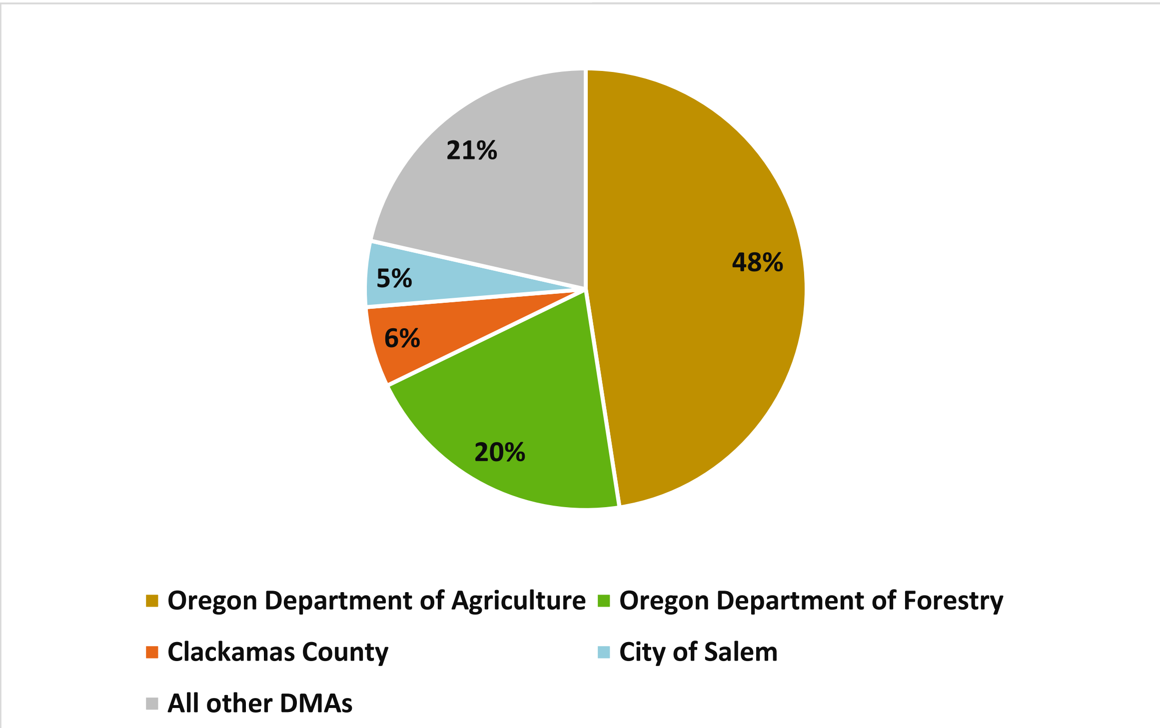
~~Percent of jurisdiction within 150 feet of stream center line~~	~~Percent of jurisdiction in subbasin compared to percent of jurisdiction within 150 feet of stream center line~~
Molalla-Pudding Subbasin – HUC 17090009	



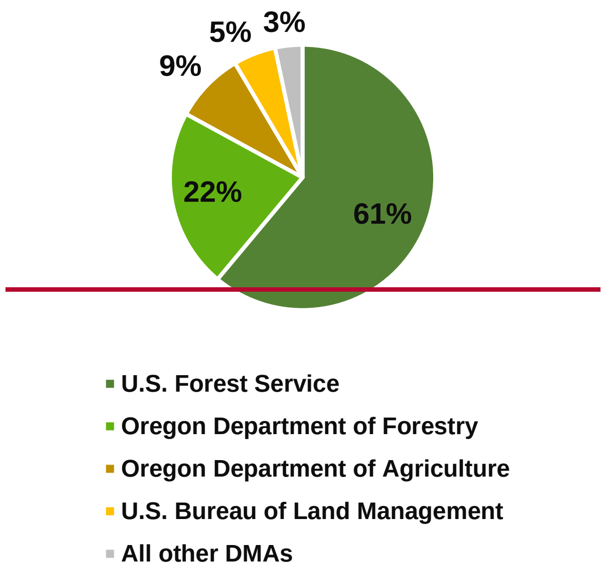


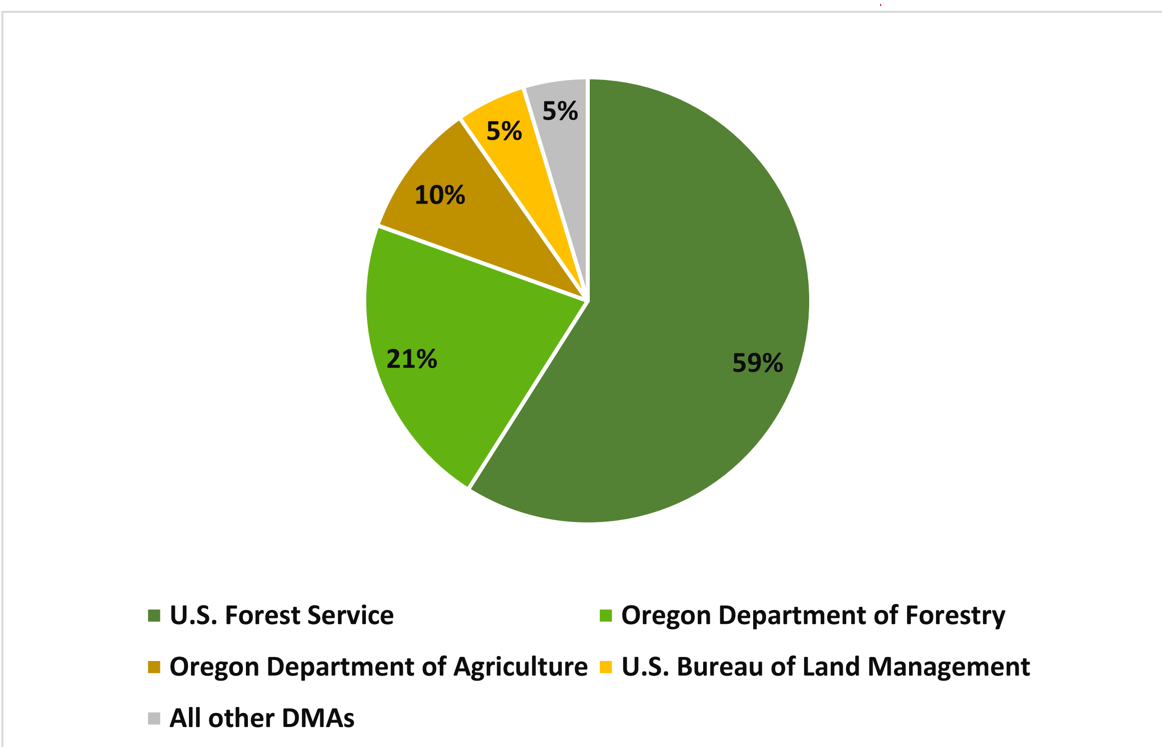
Middle Willamette Subbasin – HUC ~~19070007~~17090007



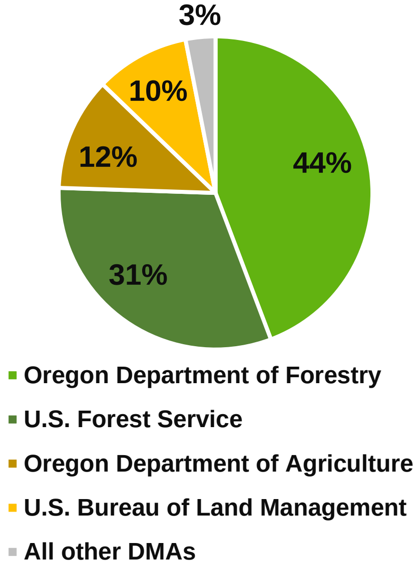


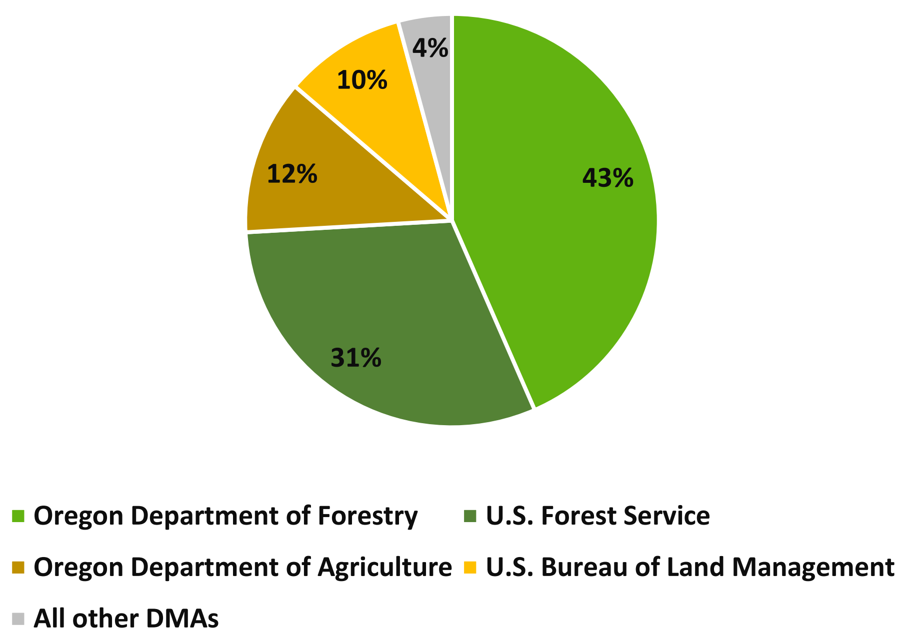
North Santiam Subbasin – HUC 17090005



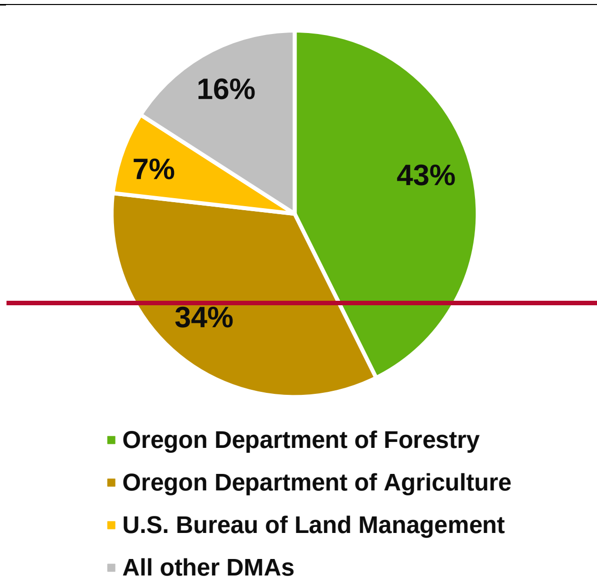


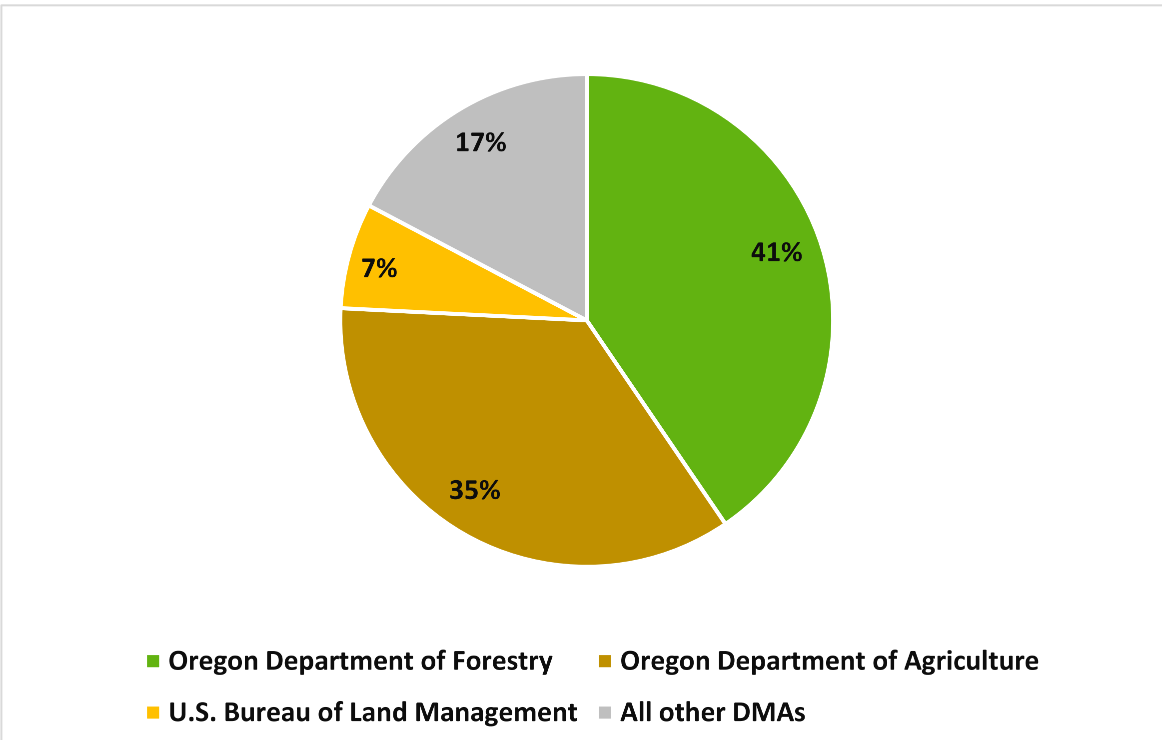
South Santiam Subbasin – HUC 17090006



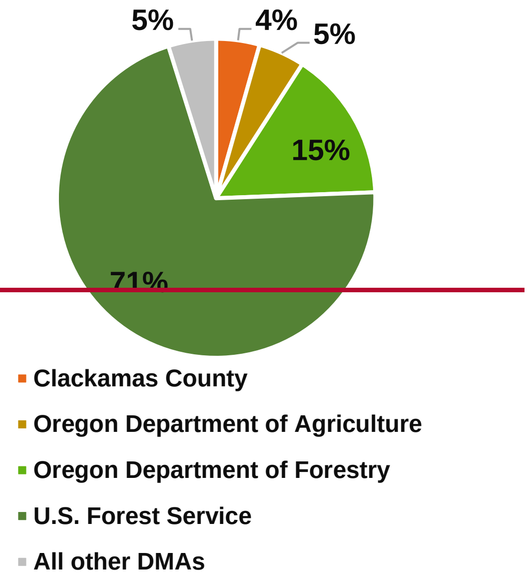


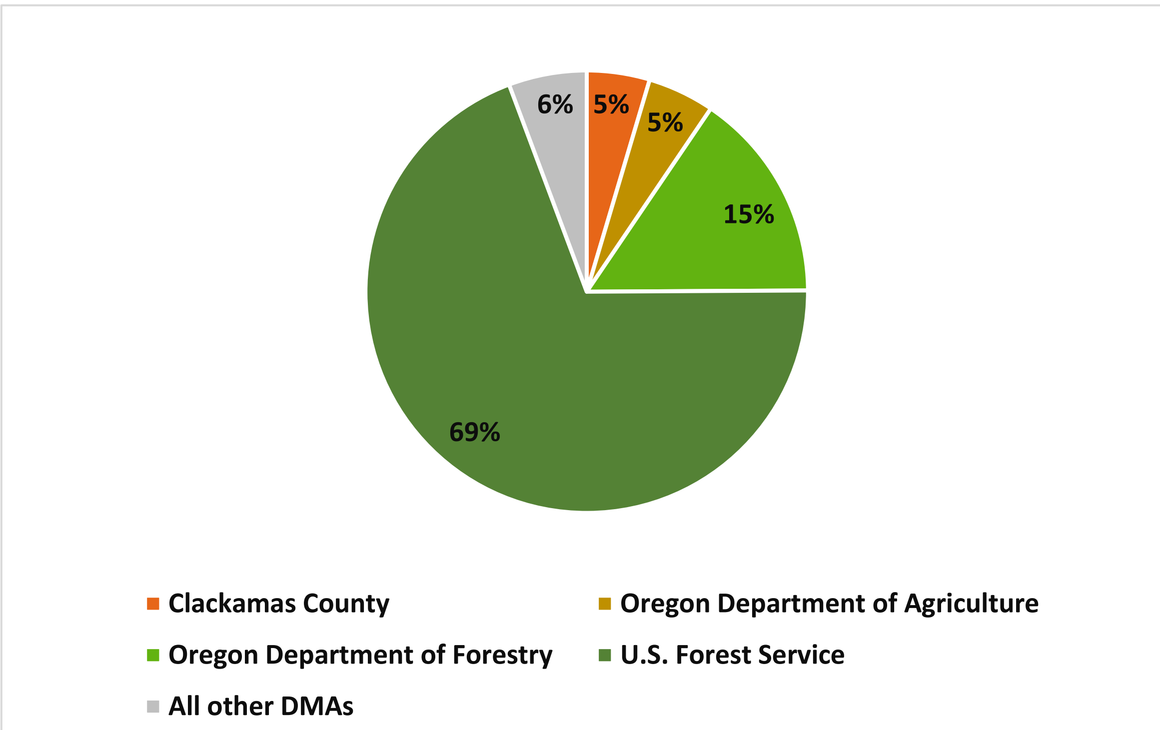
Upper Willamette Subbasin – HUC 17090003



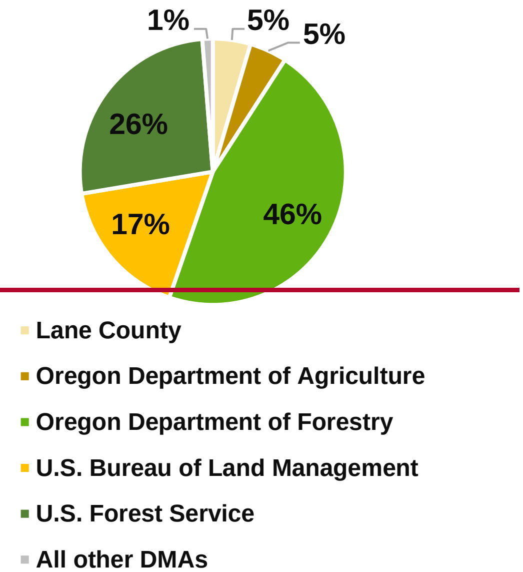


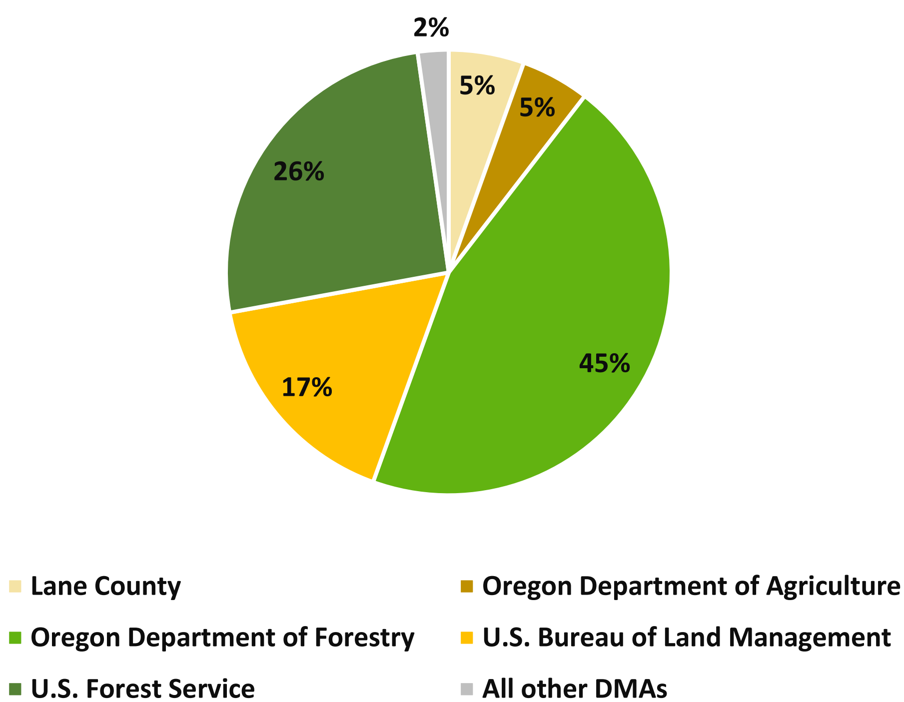
Clackamas Subbasin – HUC 17090011



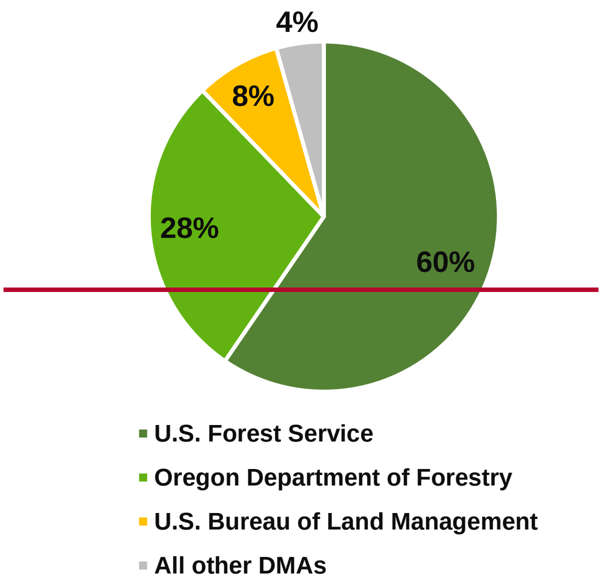


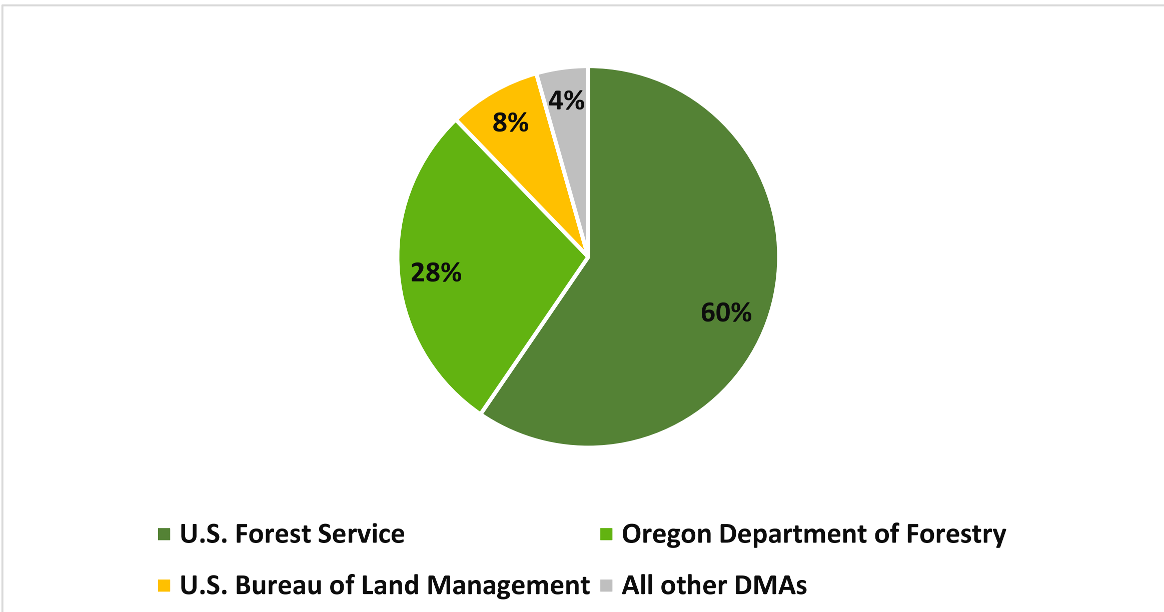
Coast Fork Willamette Subbasin – HUC 17090002



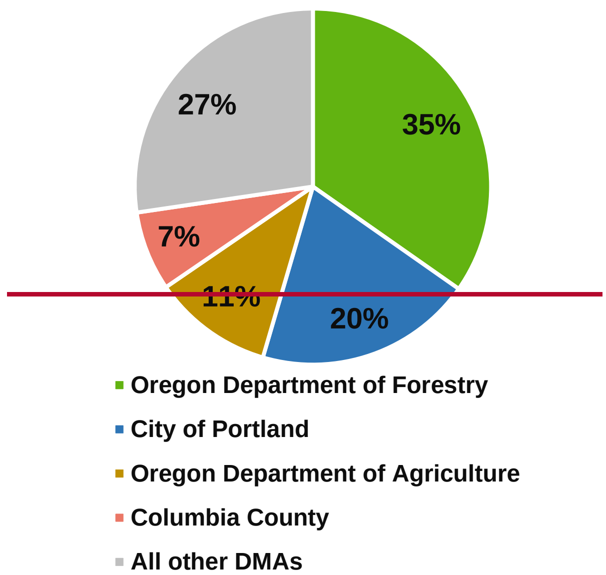


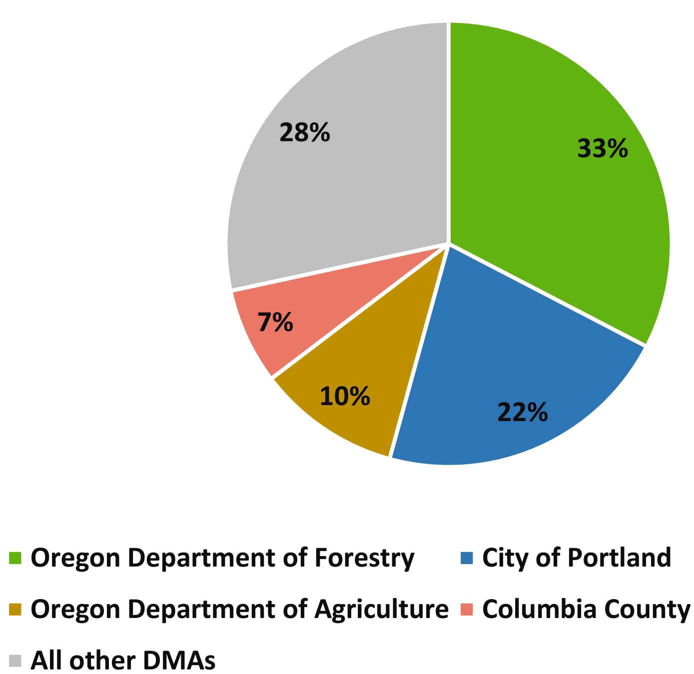
~~McKenzie~~Mckenzie **Subbasin – HUC 17090004**



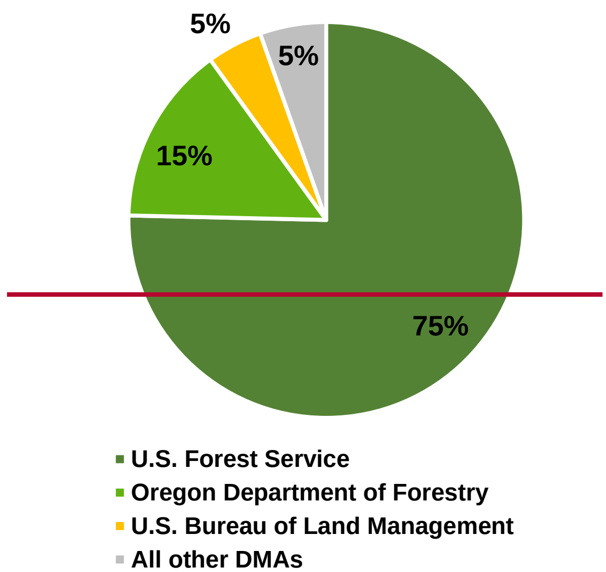


Lower Willamette Subbasin – HUC 17090012





Middle Fork Willamette Subbasin – HUC 17090001


5%
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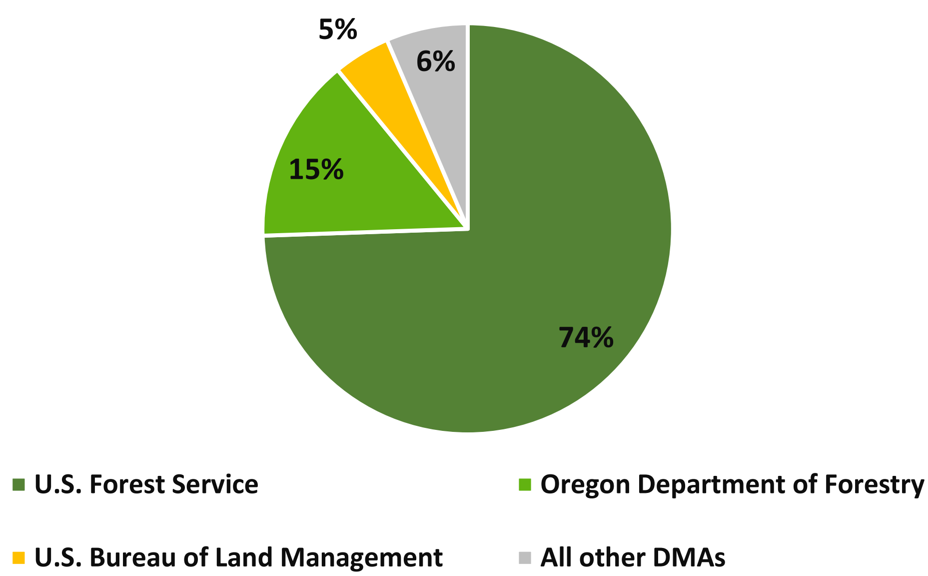
U.S. Forest Service
Oregon Department of Forestry
U.S. Bureau of Land Management
All other DMAs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U.S. Forest Service
Oregon Department of Forestry
U.S. Bureau of Land Management
All other DMAs

Appendix D: NPDES Permit Issuance Dates

Note: This appendix does not currently include general permittees within the Willamette Mainstem project area who may receive updated WLAs

Permit Type	Planned Issuance Date	Legal Name	Common Name	WQ File No.	Permit No.	EPA No.
NPDES-IW-B21	2026	J.H. Baxter & Co., Inc.	J.H. Baxter & Co., Inc.	6553	102432	OR0021911
NPDES-IW-B21	2026	Mcfarland Cascade Pole & Lumber Company	Mcfarland Cascade Pole & Lumber Co	54370	102392	OR0031003
NPDES-IW-B20	2024	Arauco North America, Inc	Duraflake	97047	100668	OR0000426
NPDES-IW-B20	2025	Kingsford Manufacturing Company	Kingsford Manufacturing Company - Springfield Plant	46000	102153	OR0031330
NPDES-IW-B20	2026	Murphy Company	Murphy Veneer, Foster Division	97070	101777	OR0021741
NPDES-IW-B19	2024	Hull-Oakes Lumber Co.	Hull-Oakes Lumber Co.	107228	101466	OR0038032
NPDES-IW-B19	2025	Sanders Wood Products, Inc.	RSG Forest Products - Liberal	72596	100929	OR0021300
NPDES-IW-B19	2027	Seneca Sawmill Company	Seneca Sawmill Company	80207	101893	OR0022985
NPDES-IW-B17	2027	Oregon Department of Fish & Wildlife	ODFW - Marion Forks Hatchery	64495	101917	OR0027847
NPDES-IW-B17	2023	USDOI; Fish & Wildlife Service	USFW - Eagle Creek National Fish Hatchery	91035	101522	OR0000710
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Clackamas River Hatchery	64442	102663	OR0034266
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Leaburg Hatchery	64500	101914	OR0027642
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Mckenzie River Hatchery	64490	101918	OR0029769
NPDES-IW-B16	2024	Arclin U.S.A. LLC	Arclin	16037	101235	OR0021857

NPDES-IW-B16	2025	Blount, Inc.	Blount Oregon Cutting Systems Division	63545	101162	OR0032298
NPDES-IW-B16	2025	Boeing Company, The	Boeing of Portland - Fabrication Division	9269	101761	OR0031828
NPDES-IW-B16	2026	Columbia Helicopters, Inc.	Columbia Helicopters	100541	101906	OR0033391
NPDES-IW-B16	2027	Eugene Water & Electric Board	EWEB Carmen-Smith	28393	101329	OR0000680
NPDES-IW-B16	2024	Georgia-Pacific Chemicals LLC	Georgia-Pacific Chemicals LLC	32864	101474	OR0002101
NPDES-IW-B16	2025	Georgia-Pacific Chemicals LLC	GP Millersburg Resin Plant	32650	102603	OR0032107
NPDES-IW-B16	2027	Covanta Marion, Inc	Covanta Marion County Solid Waste-To-Energy Facility	89638	101240	OR0031305
NPDES-IW-B15	2027	Fujimi Corporation	Fujimi Corporation - SW Commerce Circle	107178	103033	OR0040339
NPDES-IW-B15	2025	Oregon Department of Corrections	ODC - Oregon State Penitentiary	109727	101619	OR0043770
NPDES-IW-B15	2024	Port of Portland & Co-Applicants	Portland International Airport	107220	101647	OR0040291
NPDES-IW-B15	2027	SFPP, L.P.	SFPP, L.P.	103159	103042	OR0044661
NPDES-IW-B15	2023	Sunstone Circuits, LLC	Sunstone Circuits	26788	101015	OR0031127
NPDES-IW-B15	2027	Valley Landfills, Inc.	Coffin Butte Landfill	104176	101545	OR0043630
NPDES-IW-B15	2025	Starlink Logistics Inc.	Slli	74995	101180	OR0001741
NPDES-IW-B14	2025	Arkema, Inc	Arkema	68471	103075	OR0044695
NPDES-IW-B14	2024	Siltronic Corporation	Siltronic Corporation	93450	101128	OR0030589
NPDES-IW-B14	2028	Northwest Natural	NW Natural Gas Site Remediation	120589	103061	OR0044687
NPDES-IW-B10	2027	Arclin Surfaces, Inc.	Arclin	81714	101544	OR0000892
NPDES-IW-B08	2026	Oregon Metallurgical, LLC	ATI Albany Operations	64300	102223	OR0001716
NPDES-IW-B08	2026	Evraz Inc. Na	Evraz Oregon Steel	64905	101007	OR0000451
NPDES-IW-B07	2024	TDY Industries, LLC	Teledyne Wah Chang Albany	87645	100522	-
NPDES-IW-B05	2026	JLR, LLC	JLR, LLC	32536	101253	OR0001015

NPDES-IW-B04	2023	Foster Poultry Farms, Inc.	Foster Farms	97246	101590	OR0026450
NPDES-IW-B04	2023	Norpac Foods, Inc.	Norpac Foods - Brooks Plant No. 5	84791	100907	OR0021261
NPDES-IW-B04	2024	Norpac Foods, Inc.	Norpac Foods- Plant #1, Stayton	84820	101265	OR0001228
NPDES-IW-B01	2024	West Linn Paper Company	West Linn Paper Company	21489	100976	OR0000787
NPDES-DOM-Db	2025	Alpine County Service District	Alpine Community	100101	101923	OR0032387
NPDES-DOM-Db	2026	Aumsville, City of	Aumsville STP	4475	101784	OR0022721
NPDES-DOM-Db	2027	Aurora, City of	Aurora STP	110020	101772	OR0043991
NPDES-DOM-Db	2027	Brownsville, City of	Brownsville STP	11770	102206	OR0020079
NPDES-DOM-Db	2025	Corvallis MHC LLC	Knoll Terrace MHC	46990	102611	OR0026956
NPDES-DOM-Db	2027	Creswell, City of	Creswell STP	20927	101639	OR0027545
NPDES-DOM-Db	2027	Diamond Hill L.L.C.	Sherman Bros. Trucking	36646	101557	OR0021954
NPDES-DOM-Db	2026	Gervais, City of	Gervais STP	33060	101665	OR0027391
NPDES-DOM-Db	2025	Halsey, City of	Halsey STP	36320	101297	OR0022390
NPDES-DOM-Db	2027	Junction City, City of	Junction City STP	44509	102396	OR0026565
NPDES-DOM-Db	2026	Lane Community College	Lane Community College	48854	102116	OR0026875
NPDES-DOM-Db	2023	Molalla, City of	Molalla STP	57613	101514	OR0022381
NPDES-DOM-Db	2027	Philomath, City of	Philomath WWTP	103468	102060	OR0032441
NPDES-DOM-Db	2026	Scio, City Of	Scio STP	79633	101503	OR0029301
NPDES-DOM-Db	2027	Tangent, City of	Tangent STP	87425	102247	OR0031917
NPDES-DOM-Db	2025	Veneta, City of	Veneta STP	92762	102480	OR0020532
NPDES-DOM-Db	2024	Water Environment Services	Wes (Boring STP)	16592	100968	OR0031399
NPDES-DOM-Db	2025	Willamette Leadership Academy	Willamette Leadership Academy	34040	101441	OR0027235
NPDES-DOM-Db	2027	Monroe, City of	Monroe STP	57951	101692	OR0029203
NPDES-DOM-Db	2027	Independence, City of	Independence STP	41513	101217	OR0020443
NPDES-DOM-Db	2025	Monmouth, City of	Monmouth STP	57871	101919	OR0020613
NPDES-DOM-Db	2026	Marion County and Brooks Community Sewer District	Brooks Sewage Treatment Plant	100077	101397	OR0033049

NPDES-DOM-Db	2027	Dundee, City of	Dundee STP	25567	101722	OR0023388
NPDES-DOM-Da	2025	Coburg, City of	Coburg Wastewater Treatment Plant	115851	102979	OR0044628
NPDES-DOM-Da	2026	Estacada, City of	Estacada STP	27866	101542	OR0020575
NPDES-DOM-Da	2025	Falls City, City of	Falls City STP	28830	101808	OR0032701
NPDES-DOM-Da	2027	Hubbard, City of	Hubbard STP	40494	101640	OR0020591
NPDES-DOM-Da	2025	Lakewood Homeowners, Inc.	Lakewood Utilities, Ltd	96110	101781	OR0027570
NPDES-DOM-Da	2027	Mt. Angel, City of	Mt. Angel STP	58707	101802	OR0028762
NPDES-DOM-Da	2027	Oakridge, City of	Oakridge STP	62886	102443	OR0022314
NPDES-DOM-Da	2023	Sandy, City of	Sandy WWTP	78615	102492	OR0026573
NPDES-DOM-Da	2026	US Forest Service	Timberlake STP	90948	101498	OR0023167
NPDES-DOM-Da	2027	Westfir, City of	Westfir STP	94805	100811	OR0028282
NPDES-DOM-Da	2028	Lowell, City of	Lowell STP	51447	101384	OR0020044
NPDES-DOM-Da	2027	Jefferson, City of	Jefferson STP	43129	101780	OR0020451
NPDES-DOM-Da	2025	Adair Village, City of	Adair Village STP	500	101701	OR0023396
NPDES-DOM-Da	2025	Century Meadows Sanitary System, Inc.	Century Meadows Sanitary System (CMSS)	96010	101721	OR0028037
NPDES-DOM-Da	2027	Regency of Oregon, Inc.	Canby Regency Mobile Home Park	97612	101644	OR0026280
NPDES-DOM-Da	2024	Forest Park Mhp, Llc	Forest Park Mobile Village	30554	102323	OR0031267
NPDES-DOM-Da	2028	Scappoose, City of	Scappoose STP	78980	100677	OR0022420
NPDES-DOM-C2a	2026	Cottage Grove, City of	Cottage Grove STP	20306	101300	OR0020559
NPDES-DOM-C2a	2026	Stayton, City of	Stayton STP	84781	101601	OR0020427
NPDES-DOM-C2a	2025	Sweet Home, City of	Sweet Home STP	86840	101657	OR0020346
NPDES-DOM-C1a	2023	Dallas, City of	Dallas STP	22546	101518	OR0020737
NPDES-DOM-C1a	2026	Silverton, City of	Silverton STP	81395	101720	OR0020656
NPDES-DOM-C1a	2025	Woodburn, City of	Woodburn WWTP	98815	101558	OR0020001
NPDES-DOM-C1a	2025	Lebanon, City of	Lebanon WWTP	49764	101771	OR0020818
NPDES-DOM-C1a	2026	Newberg, City of	Newberg - Wynooski Road STP	102894	100988	OR0032352

NPDES-DOM-C1a	2025	Wilsonville, City of	Wilsonville STP	97952	101888	OR0022764
NPDES-DOM-C1a	2028	Canby, City of	Canby STP	13691	101063	OR0020214
NPDES-DOM-C1a	2027	Oak Lodge Water Services District	Oak Lodge Water Services Water Reclamation Facility	62795	100986	OR0026140
NPDES-DOM-Ba	2028	Corvallis, City of	Corvallis STP	20151	101714	OR0026361
NPDES-DOM-Ba	2024	Albany-Millersburg Water Reclamation Facility	AM WRF - Albany-Millersburg Water Reclamation Facility	1098	102024	OR0028801
NPDES-DOM-Ba	2026	Portland, City of	Tryon Creek WWTP	70735	101614	OR0026891
NPDES-DOM-A3	2024	Water Environment Services	Wes Tri-City WPCP	89700	101168	OR0031259
NPDES-DOM-A3	2024	Water Environment Services	Wes Kellogg Creek WWTP	16590	100983	OR0026221
NPDES-DOM-A2	2027	Metropolitan Wastewater Management Commission	MWMC - Eugene/Springfield STP	55999	102486	OR0031224
NPDES-DOM-A2	2026	Salem, City of	Salem Willow Lake STP	78140	101145	OR0026409
GEN03	2024	Oregon Department of Fish & Wildlife	ODFW - Roaring River Hatchery	64525		
GEN03	2024	Oregon Department of Fish & Wildlife	ODFW - Willamette Fish Hatchery	64585		
GEN01	2023	Americold Logistics, LLC	Americold Logistics, LLC	87663		
GEN01	2023	First Premier Properties	Spinnaker Ii Office Building	110603		
GEN01	2023	Forrest Paint Co.	Forrest Paint Co.	100684		
GEN01	2023	Herbert Malarkey Roofing Company	Malarkey Roofing	52638		
GEN01	2023	Holiday Retirement Corp	Holiday Plaza	108298		
GEN01	2023	Hydro Extrusion Portland, Inc.	Hydro Main Plant	3060		

~~GEN01~~	~~2023~~	~~Miller Paint Co Inc~~	~~Miller Paint Company~~	~~103774~~		
~~GEN01~~	~~2023~~	~~Owens-Brockway Glass Container Inc.~~	~~Owens-Brockway Glass Container Plant~~	~~65610~~		
~~GEN01~~	~~2023~~	~~PCC Structurals, Inc.~~	~~PCC Structurals, Inc. - (SSB) Small Structurals Bus. Ops.~~	~~71920~~		
~~GEN01~~	~~2023~~	~~Sundance Lumber Company, Inc.~~	~~Sundance Lumber Company, Inc.~~	~~107401~~		
~~GEN01~~	~~2023~~	~~Ventura Foods, LLC~~	~~Ventura Foods, LLC~~	~~103832~~		

Appendix ~~E~~D: List of ~~l~~Large ~~Reservoirs~~ reservoirs in the Willamette Subbasins TMDL ~~Project~~ project ~~Area~~area

DEQ compiled this list of ~~202~~206 dams located within the Willamette Subbasins temperature TMDL project area from the U.S. Army Corps of Engineers National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department, dam safety program (i.e. large dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000)). DEQ requires the ~~32~~33 **bolded** dams in the table below to conduct monitoring related to temperature (see Section 5.3.7). Depending on analytical or modeling results, reservoir owners or operators may be required to develop a TMDL plan for temperature.

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
1	**Big Cliff Dam**	OR00003	U.S. Army Corps of Engineers	Federal	Hydroelectric	5930
2	**Blue River Dam**	OR00013	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	89000
3	**Cottage Grove Dam**	OR00005	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	50000
4	**Cougar Dam**	OR00015	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	220000
5	**Detroit Dam**	OR00004	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	455000
6	**Dexter Dam**	OR00006	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	29900
7	**Dorena Dam**	OR00008	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	131000
8	**Fall Creek Dam**	OR00007	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	125000

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
9	**Fern Ridge Dam**	OR00016	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	121000
10	Fern Ridge Dam - Dike 1	OR00016	U.S. Army Corps of Engineers	Federal	unknown	9774
11	Fern Ridge Dam - Dike 2	OR00016	U.S. Army Corps of Engineers	Federal	unknown	56647
12	**Foster Dam**	OR00012	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	61000
13	**Green Peter Dam**	OR00010	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	430000
14	**Hills Creek Dam**	OR00014	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	356000
15	**Lookout Point Dam**	OR00009	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	477700
16	Cackler Marsh Dam/Basket Slough - South	OR03834	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	964
17	Dusky Marsh Dam	OR03835	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	299
18	Moffitti Marsh Dam	OR04062	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	184
19	Morgan Brothers Dam	OR00576	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	720
20	Parvipes Marsh Dam	OR04063	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	250
21	Taverner Marsh Dam	OR03852	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	287
22	Upper Display Pond	OR03774	U.S. Fish & Wildlife Service	Federal	unknown	17.3
23	Findlay Reservoir-Ankeny Natl. Wildlife Refuge	OR00971	U.S. Fish & Wildlife Service	Federal	unknown	9.5
24	Timber Lake	OR00281	U.S. Forest Service	Federal	Recreation	390
25	**Plywood Products Reservoir**	OR02700	City of Adair Village	Local Government	unknown	39

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
26	**North Fork**	OR00348	City of Corvallis	Local Government	Water Supply	305
27	**Mercer**	OR00524	City of Dallas	Local Government	Water Supply	1550
28	**Binford Dam**	OR00725	City of Gresham	Local Government	Irrigation	30
29	Gresham Stormwater Retention Basin (Lagoon)	OR04021	City of Gresham	Local Government	Stormwater Treatment	38
30	Oakridge Mill Log Pond	OR00168	City of Oakridge	Local Government	Other	380
31	Smith-Bybee Lakes	OR00680	City of Portland	Local Government	Fish and Wildlife Pond	4100
32	**Silver Creek**	OR00622	City of Silverton	Local Government	Water Supply	2500
33	**Salmonberry Reservoir**	OR02958	City of St. Helens	Local Government	Water Supply	61.22
34	Three Creeks Natural Area	OR04083	Clackamas Water Environment Services	Local Government	unknown	57
35	Sullivan Pond 3	OR04077	A & D Sullivan Enterprises Inc.	Private	unknown	65
36	Spada Reservoir #1 (Champoeg)	OR00462	A&R Spada Nursery and Farms	Private	Irrigation	329
37	Fisher, James O Reservoir	OR00515	A.F. Grabhorn	Private	Irrigation	36
38	Aamodt Flashboard Dam	OR00645	Aamodt Dairy Inc.	Private	Irrigation	120
39	Stevens	OR03191	Allen E. Stevens	Private	unknown	11
40	Siegmund Parcel No. 1	OR03058	Andrew Seigmund	Private	unknown	25
41	Qualey Reservoir 1	OR02750	Arthur Qualey	Private	unknown	14
42	Zehner	OR03369	Arthur R. Zehner	Private	unknown	14.3
43	Funrue	OR00519	Aurora; Dan Funrue	Private	Irrigation	126
44	Walker (Bryan Creek)	OR00289	Bailey Nurseries, Inc.	Private	Irrigation	209

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
45	Baker West Nursery Dam	OR03789	Baker West, Inc.	Private	Fish and Wildlife Pond	16.8
46	Barkdoll Dam	OR03803	Barkdol, Inc.	Private	unknown	9.917
47	Sherman Stock Reservoir #2	OR03041	Bart Grabhorn	Private	unknown	14
48	Mompano	OR00500	Beaverlake Owners Assoc.	Private	Other	780
49	Elmer Farms Dam	OR03367	Ben Elmer Farms	Private	unknown	28.4
50	Polehn Dam	OR03377	Bernard Vancil	Private	unknown	9.5
51	Beyer Reservoir	OR00476	Beyer Lake, Inc	Private	Irrigation	280
52	Rose Reservoir	OR00708	Bill Rose	Private	Irrigation	550
53	Carroll Reservoir	OR01340	Black Berry Hills Ranch LLC	Private	Irrigation	355
54	Herring Reservoir	OR00821	Bland Herring	Private	unknown	12
55	Robert Kuenzi	OR03998	Bob Simmons	Private	unknown	22
56	Stadeli	OR03394	Brooke Craeger-Stadeli	Private	Irrigation	167
57	Hendrickson	OR03728	Bruce & Gayle Farmer	Private	Recreation	24.5
58	Baker, Er	OR00507	Camp Tillicum	Private	Irrigation	250
59	Orchard Heights	OR03165	Carl R. Staats	Private	unknown	12
60	Hills Reservoir (Polk)	OR01925	Chuck & Maxime Dehn	Private	Irrigation	73
61	Koinenia Lake Dam	OR00621	Cindy Jerger	Private	Irrigation	125
62	Bentz Bros. Pond 3	OR01157	Clint Bentz	Private	unknown	31.7
63	S-M-S No. 1	OR00417	Cody & Barbara Duerst	Private	Recreation	57
64	Meridian Reservoir	OR03725	Columbia Trust Co.	Private	Irrigation	95
65	Eola Hills Reservoir	OR01657	Contact Allen Holstein	Private	Irrigation	37
66	Cooper Creek Vineyards	OR04065	Cooper Creek LLC	Private	unknown	100
67	Porter Cc Reservoir (Clackamas)	OR00644	Dan Myrick	Private	Recreation	80
68	Hays Reservoir	OR01894	Daniel & Stacee Hurst	Private	unknown	25
69	Mt. Pisgah	OR03964	David And Bette Mckibben Trust	Private	unknown	45

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
70	Neil Creek Reservoir	OR00266	Dean Yeager	Private	Irrigation	81
71	P.M. Delaubenfelds Dam	OR00494	Delaubenfeld And Osu Found	Private	Recreation	130
72	Bottem Reservoir #5	OR03779	Dennis & Judy Bottem	Private	unknown	19.9
73	Murry Pond #3	OR03860	Dennis Bottem	Private	unknown	35.7
74	Hickory Hill Farm	OR00231	Dick Day	Private	Irrigation	65
75	Stewart Reservoir #2	OR03799	Don & Alberta Stewart	Private	unknown	16.6
76	Teasel Creek	OR00489	Don Deardorff	Private	Other	90
77	Henderer Reservoir	OR01905	Dorothy Fairchild	Private	unknown	13.9
78	Deardorff, Betty Jane	OR00497	Doubletrees Farms	Private	Other	1300
79	Case Creek Dam 1	OR00504	Douglas & Patricia Krahmer	Private	Irrigation	352
80	Duck Pond Dam	OR03816	Douglas Fries	Private	Recreation	94.6
81	Schewnke	OR00939	Dr. Glenn Schwenke	Private	unknown	10
82	Pettit Reservoir	OR00396	Dr. Virgil E. Pettit	Private	Other	290
83	Abe Ediger Reservoir	OR01009	Dudley And Lauri Walters	Private	Irrigation	85
84	Neil Reservoir	OR02514	E.R. Neil	Private	unknown	9.5
85	Kennel Reservoir	OR00617	Earl Kennel	Private	Irrigation	160
86	Eder	OR03967	Eder Farms Inc	Private	unknown	30.1
87	Kronke	OR03961	Elke Kronke	Private	unknown	14.5
88	Barnes Bros. Reservoir	OR00392	Eric And Pamela Barnes	Private	Irrigation	100
89	Thompson (Benton)	OR00294	Eric Thompson	Private	Recreation	450
90	Peterson, Floyd	OR02665	Erik Rodgers	Private	Recreation	19
91	Fairview Lake	OR03713	Fairview Lake Property Owners Association (FLPOA)	Private	unknown	411
92	Tangen-A. L. Irig Reservoir	OR03256	Flying Feather Orchards, Inc.	Private	unknown	25
93	Ford Farms Reservoir	OR00251	Ford Farms, Inc.	Private	Irrigation	60
94	Silver Falls Log Pond (Marion)	OR00273	Gelco Investment LLC	Private	Irrigation	68

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
95	Gibson and Gibson Waste Lagoon	OR01793	Gibson & Gibson	Private	unknown	36
96	Whispering Winds	OR00527	Girls Scouts of Oregon & SW Washington	Private	Recreation	100
97	Marcott Reservoir	OR02331	Goldie Marcott	Private	unknown	24.3
98	Circle S Reservoir	OR01383	Gordon and Catherine Tibbitts	Private	unknown	16
99	Lorence Lake	OR00384	Greg & Kara Pilcher	Private	Other	160
100	Skylane Farms Reservoir 3	OR03079	Gregory R & Deborah D Cochell	Private	unknown	13.5
101	Mulkey, Gryland Reservoir	OR02485	Gylan Mulkey	Private	Irrigation	50
102	Bryant Dam (Marion)	OR03786	H. Richard Bryant	Private	unknown	27.7
103	Winters (Lower)	OR03764	H.E. Winters Sanders Family Farm LLC	Private	unknown	9.4
104	Kuehne Dam	OR00216	Harold Kuehne	Private	Irrigation	110
105	Golliday, Paul	OR00954	Harold Schipporeit	Private	unknown	13
106	Buche (Clackamas)	OR00766	Harvey Buche	Private	Recreation	81
107	Deep Creek Reservoir	OR01518	Hays/Shainsky and Judas Crop	Private	unknown	10
108	Schindler Reservoir	OR02980	Henry & Albert Schindler	Private	unknown	15
109	Kyllo Reservoir	OR02124	Henry Kyllo	Private	unknown	44
110	Berger Lake	OR01158	Hidden Lakes Recreation Association Attn: Dan Schlottmann	Private	Irrigation	45
111	Hull-Oakes Lumber Company Reservoir	OR01986	Hull-Oakes Lumber Company	Private	unknown	
112	Kreder Reservoir	OR00478	Jack Platt	Private	Irrigation	162
113	Maple Grove	OR03773	Jackson Family Wines	Private	Irrigation	210
114	Payne Lake No. 1	OR02137	James L. Payne	Private	unknown	30
115	River Bend No. 2	OR00434	James L. Payne	Private	Irrigation	50
116	Heater Reservoir #2	OR00729	James M. Heater	Private	Irrigation	42.5

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
117	Borris Reservoir	OR01234	James Swanek	Private	unknown	22
118	Sherman Stock Reservoir #1	OR03040	Jeff Heller	Private	Irrigation	36
119	Moore-Emory	OR00382	Jerald and Carol Bush	Private	Irrigation	166
120	Isakson Reservoir	OR00674	Jerry Isakson	Private	Recreation	29
121	Mission Creek Dam and Reservoir Company	OR00520	Jerry Mullen	Private	Irrigation	1590
122	Heater Dam	OR01899	Jim Heater	Private	Irrigation	32
123	Evans Pro. Company Sawmill Reservoir	OR00927	Jimmy W. Evans	Private	unknown	11
124	Drescher Reservoir	OR01574	John Drescher	Private	Irrigation	21
125	Schwartz Reservoir	OR02978	John Inda	Private	Irrigation	20
126	Jyn Dam	OR03807	Jyn Inc	Private	unknown	13.8
127	Adkins "B" Reservoir	OR03749	Kathryn J Adkins	Private	unknown	12
128	Tribbett Reservoir	OR00687	Kelly Farms	Private	Recreation	31
129	Knudsen Reservoir #2	OR03775	Knudson Vineyards	Private	unknown	11.5
130	Kraemer Farms Dam	OR03781	Kraemer Farms, Inc.	Private	Irrigation	125
131	Waldo Lake	OR00349	Krautmann Family Nursery, LLC	Private	Irrigation	56
132	Westbrook Dam	OR03805	Krautmann Family Nursery, LLC	Private	Fish and Wildlife Pond	141.2
133	Youngblood Dam	OR00811	Kyle R & Lori J Sherman	Private	unknown	30
134	Little Pudding	OR04073	Lake Labish Water Control Dist	Private	unknown	
135	Oswego Lake Dam	OR00237	Lake Oswego Corporation	Private	Hydroelectric	9800
136	Lakewood Estates	OR03731	Lakewood Homeowners, Inc.	Private	unknown	78
137	Lakewood Estates Sewage Lagoon	OR03918	Lakewood Utilities, Ltd.	Private	unknown	17
138	O.E.Loe Dam 2 Porter Place	OR02721	Larie Loe	Private	Irrigation	25
139	Kuenzi, Lee A.	OR03392	Lee A. Kuenzi	Private	unknown	15
140	Ed Zach A	OR01635	Lee Wallace	Private	unknown	33.5

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
141	Veterans Reservoir	OR00102	Lincoln Memorial Cemetery	Private	Irrigation	18
142	Griffith Reservoir	OR01832	LSH Investments	Private	unknown	45
143	Manton Carl Dam	OR03987	Manton Carl	Private	unknown	11.5
144	Fredericks Pond	OR00620	Maple Leaf Lake Homeowners Association	Private	Irrigation	48
145	Johnson Creek Reservoir (Linn)	OR02051	Marion Cota	Private	unknown	10.5
146	Gehring Reservoir (Towery Dam)	OR00314	Mark Gehring	Private	Irrigation	50
147	Mueller	OR04018	Mark Herkamp	Private	unknown	12.7
148	Mckay Acres Dam	OR00484	Mark Mckay	Private	Irrigation	510
149	Peyralans Reservoir	OR02671	Marpol Ridge HOA	Private	esthetics	12
150	Anderson - Roy Reservoir	OR00710	MBK 35803 LLC	Private	Recreation	32
151	Powell Reservoir (Lane)	OR00829	Michael Fix	Private	unknown	24
152	Rogers - Joseph Reservoir	OR00492	Michael P. Warn	Private	Irrigation	40
153	Marx Reservoir #1	OR00389	Mike Sweeney, Cherry Hill Winery	Private	Irrigation	85
154	Helms Reservoir	OR00455	Miller Forests, Inc.	Private	Irrigation	120
155	Marx, Emil #2	OR02340	Mountain Spring Farms, LLC	Private	unknown	35
156	Foster Log Pond	OR00159	Murphy Company Foster Veneer	Private	Other	375
157	Neal Miller	OR03395	Neal Miller	Private	unknown	31.3
158	Haberlach Dam	OR00880	Old North State Trust, LLC	Private	Irrigation	15
159	Fleshman Reservoir 2	OR01722	Orval & Margaret Fleshman	Private	unknown	10.6
160	Forcia and Larsen Log Pond	OR00099	Peggy Kraft, Don Merkle	Private	Other	90
161	Bye Reservoir	OR01317	Perl Bye	Private	unknown	13
162	Zenczak Reservoir	OR03637	Piotr Zenczak	Private	unknown	13
163	**Faraday Diversion**	OR00551	Portland General Electric Company	Private	Hydroelectric	1200
164	**Faraday Forebay**	OR00245	Portland General Electric Company	Private	Hydroelectric	550

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
165	**Harriet Lake**	OR00546	Portland General Electric Company	Private	Hydroelectric	400
166	**North Fork**	OR00550	Portland General Electric Company	Private	Hydroelectric	18630
167	**River Mill**	OR00552	Portland General Electric Company	Private	Hydroelectric	2300
168	**Timothy Lake**	OR00545	Portland General Electric Company	Private	Hydroelectric	69000
169	Bull Frog Lake	OR01296	Ray Derby, President	Private	unknown	21.5
170	Schaefer, Ray Reservoir	OR03380	Ray Schaefer	Private	Irrigation	18
171	Mitchell - Stanley Reservoir	OR00706	Richard Satnick	Private	Irrigation	42
172	Vandecoevering	OR03863	Ron Vandecoevering	Private	Irrigation	87
173	Vaughn Log Gibson Reservoir Pond	OR00198	Rosboro, LLC	Private	Other	132
174		OR00672	Roserock West 2, LLC	Private	unknown	32
175	Cedar Grove Lake	OR01351	Ryan J Dissen	Private	Irrigation	14.2
176	Sandy Farms No. 1-A	OR00709	Sandy Farms, C/O Bob Underwood	Private	Irrigation	49
177	Spring Lake Estates	OR00532	Spring Lake Estates	Private	Recreation	120
178	Delaubenfels	OR03944	Starker Forests, Inc	Private	Irrigation	84
179	Tadmore Lake Dam	OR03252	Steve Ellingboe	Private	unknown	29
180	Alderwood	OR01020	Swanson Bros. Lumber Company	Private	unknown	12
181	Willards Pool	OR00179	Terry Caster	Private	Recreation	680
182	Devers Reservoir 1	OR01538	Todd Bartlem	Private	unknown	9.7
183	FOX NO. 2	OR01756	Tom Fox	Private	unknown	21
184	Fox Reservoir	OR00236	Tom Fox	Private	Irrigation	120
185	Croft	OR00415	Waldensee LLC	Private	Irrigation	137
186	Zielinski Farm Reservoir	OR00711	Wally Zelinski	Private	Irrigation	41

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
187	Bremer Reservoir	OR01253	Warren W. Bremer	Private	unknown	27
188	Bohemia Pond C	OR02715	Weyerhaeuser Company	Private	unknown	47
189	Day Reservoir	OR03411	William Day	Private	Irrigation	12.2
190	Fry Reservoir	OR01775	William Fry	Private	unknown	15.7
191	Woodburn Nursery	OR03862	Woodburn Nursery And Azaleas, Inc.	Private	Other	40
192	Serres Reservoir	OR03010	Woodburn Organic Farms, LLC	Private	unknown	10
193	**Carmen Diversion**	OR00539	Eugene Water and Electric Board	Public Utility	Hydroelectric	260
194	**Leaburg**	OR00553	Eugene Water and Electric Board	Public Utility	Hydroelectric	345
195	**Leaburg Canal and Forebay**	OR00553	Eugene Water and Electric Board	Public Utility	Hydroelectric	459
196	**Smith**	OR00541	Eugene Water and Electric Board	Public Utility	Hydroelectric	17530
197	**Trail Bridge**	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric	2263
198	Trail Bridge Saddle Dike	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric	2263
199	**Walterville Forebay**	OR00600	Eugene Water and Electric Board	Public Utility	Hydroelectric	275
200	**Walterville Storage Pond**	OR00267	Eugene Water and Electric Board	Public Utility	Hydroelectric	345
201	Adair Pond	OR01012	Oregon Dept. of Fish & Wildlife	State	unknown	43
202	Petes Slough	OR00643	Oregon Dept. of Fish & Wildlife	State	Recreation	2000
203	**Lebanon Dam**	OR04067	City of Albany	Local Government	Water Supply	149
204	Multnomanh Channel Dam #2	OR03823	Metro Parks & Greenspaces	Private	Fish and Wildlife Pond	240
205	Willamette Falls	OR00596	Portland General Electric Company	Private	Hydroelectric	17000
206	Willamette Falls Locks	OR00596	USACE - Portland District	Federal	Navigation	17000