Draft Total Maximum Daily Loads for the Rogue River Basin

Temperature

Date (EQC adoption meeting month and year)

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Acknowledgments

(Note: This section will be completed as part of the final draft TMDL.)

The Rogue River Basin Temperature TMDL and Water Quality Management Plan would not be possible without the support, contributions, and review of the following:

Name	Association
Name	Association
Name	Association
Name	Association
Name	Association

In addition, we would like to thank the TMDL rule advisory committee members, Tribal Nations, and all the individuals or organizations who provided data or took time to review and provide comments to DEQ.

Executive summary

(Note: This section will be completed as part of the final draft TMDL.)

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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
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
GNIS	USGS Geographic Names Information System
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
IMD	Internal Management Directive
LA	Load Allocation
LC	Loading Capacity
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 project addresses temperature impairments in the Rogue River Basin, which includes the following subbasins: Upper Rogue River, Middle Rogue River, Lower Rogue River, Illinois, and Applegate subbasins. This TMDL will be adopted by reference in Oregon Administrative Rules 340-42-0090. OAR 340-42-0040(3) requires the Oregon Department of Environmental Quality or the Oregon Environmental Quality Commission to prioritize and schedule TMDLs for completion considering various factors outlined in the rule. The Temperature TMDL for the Rogue River Basin was identified as a medium priority on Oregon's TMDL priority ranking submitted with Oregon's 2022 Integrated Report. This priority ranking is primarily due to a court order requiring Oregon and the U.S. Environmental Protection Agency to establish TMDLs to replace previous temperature TMDLs (Table 1-1).

1.1 Previous TMDLs

From 1999 through 2004 DEQ issued, and EPA approved, six TMDL actions addressing temperature impairments within the project area for the Rogue River Basin Temperature TMDL (Table 1-1). Once approved by EPA, this Rogue River Basin TMDL for temperature will replace the temperature TMDLs listed in Table 1-1. TMDLs for other water quality impaired parameters listed in Table 1-1 remain effective.

Table 1-1: Summary of previous temperature TMDLs developed in the Rogue River Basin.

TMDL Action ID	TMDL Name	EPA Approval Date	Water Quality Impairments Addressed
35887	Rogue River Basin TMDL	12/29/2008	Temperature, Bacteria
10006	Applegate Subbasin TMDL	2/11/2004	Temperature, Sedimentation, Biological Criteria
2241	Lower Sucker Creek Illinois Subbasin TMDL	5/30/2002	Temperature
2034	Upper Sucker Creek Illinois Subbasin TMDL	5/4/1999	Temperature
2258	Lobster Creek Watershed TMDL (Lower Rogue Subbasin)	6/13/2002	Temperature
33829	Bear Creek Watershed TMDL (Middle Rogue Subbasin)	10/2/2007	Temperature, Bacteria, Sedimentation

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 Rogue River Basin is comprised of five 8-digit hydrologic unit code (HUC8) subbasins, including the Lower Rogue River Subbasin (HUC 17100310), the Middle Rogue River Subbasin (HUC 17100308), the Upper Rogue River Subbasin (HUC 17100307), the Illinois Subbasin (HUC 17100311), and the Applegate Subbasin (HUC 17100309) (Table 2-1).

The temperature TMDL for the Rogue River Basin addresses all Category 5-listed assessment units (AUs) impaired for temperature on Oregon's 2022 Section 303(d) list (Table 2-2) and, as applicable, any AUs identified as temperature-impaired in the future. In total, the TMDL applies

to 958 unique AUs, of which 258 are impaired for temperature. Some of these AUs have both year-round and spawning use designations impaired. If both use designations are impaired on a given AU, this 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 Rogue River Basin determined to be waters of the state as defined under Oregon Revised Statute ORS 468B.005(10), including all perennial and intermittent streams with surface flow or residual pools during the TMDL allocation period.

The TMDL implementation framework is presented in the Rogue River Basin TMDL Water Quality Management Plan (WQMP) and includes implementation activities and timeframes to improve water quality, and measures of success. These and other protection plan elements are further explained in Section 10.

The map in Figure 2-1 provides an overview of where the temperature TMDLs are applicable. Appendix D of the Rogue River Basin Technical Support Document provides a list of all AUs addressed by the TMDL.

Table 2-1: HUC8 codes and names in the Rogue River Basin.

HUC8	Subbasin Name
17100310	Lower Rogue River
17100308	Middle Rogue River
17100307	Upper Rogue River
17100311	Illinois
17100309	Applegate

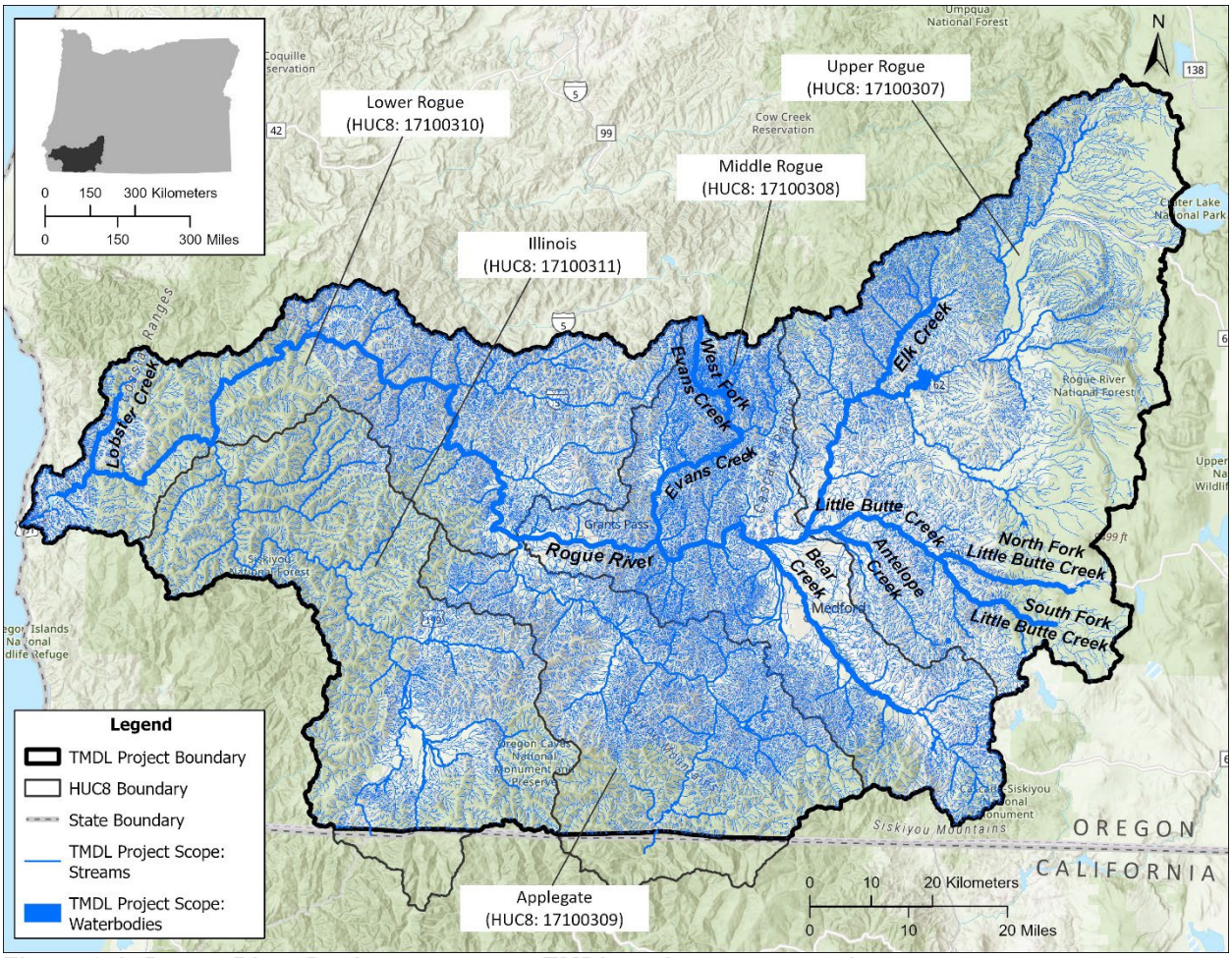

Figure 2-1: Rogue River Basin temperature TMDL project area overview.

2.1 Impaired waters on the 303(d) list

Table 2-2 presents AUs within the Rogue River Basin that were listed as temperature-impaired 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 a TMDL development. Figure 2-2 shows the locations of these listed segments.

Table 2-2: Rogue River Basin (117003) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU name	Use period
OR_SR_1710030701_02_105460	Abbott Creek	Year-round
OR_SR_1710031101_02_104822	Althouse Creek	Year-round
OR_SR_1710031105_02_104837	Anderson Creek	Year-round
OR_SR_1710030708_02_105509	Antelope Creek	Year-round
OR_SR_1710030708_02_105519	Antelope Creek	Year-round
OR_LK_1710030901_02_100274	Applegate Lake	Year-round
OR_SR_1710030902_02_105599	Applegate River	Spawning

AU ID	AU name	Use period
OR_SR_1710030902_02_105603	Applegate River	Year-round
OR_SR_1710030904_02_105618	Applegate River	Year-round
OR_SR_1710030904_02_105618	Applegate River	Spawning
OR_SR_1710030906_02_106343	Applegate River	Year-round
OR_SR_1710030906_02_106343	Applegate River	Spawning
OR_SR_1710030801_02_105548	Ashland Creek	Spawning
OR_SR_1710030803_02_105589	Battle Creek	Year-round
OR_SR_1710030801_05_105552	Bear Creek	Year-round
OR_SR_1710030801_05_105552	Bear Creek	Spawning
OR_SR_1710030902_02_105600	Beaver Creek	Year-round
OR_SR_1710030704_02_105477	Big Butte Creek	Year-round
OR_SR_1710030704_02_105477	Big Butte Creek	Spawning
OR_SR_1710030802_02_105555	Birdseye Creek	Year-round
OR_SR_1710030705_02_105491	Bitter Lick Creek	Year-round
OR_SR_1710031107_02_104843	Briggs Creek	Year-round
OR_SR_1710030801_02_105542	Carter Creek	Year-round
OR_SR_1710030803_02_105577	Cold Creek	Year-round
OR_SR_1710031003_02_104797	Coyote Creek	Year-round
OR_SR_1710030708_02_105520	Dead Indian Creek	Year-round
OR_SR_1710031105_02_104834	Deer Creek	Year-round
OR_SR_1710031105_02_104835	Deer Creek	Year-round
OR_SR_1710031105_02_104835	Deer Creek	Spawning
OR_SR_1710031103_02_104825	East Fork Illinois River	Year-round
OR_SR_1710031103_02_104825	East Fork Illinois River	Spawning
OR_SR_1710031103_02_104827	East Fork Illinois River	Year-round
OR_SR_1710031103_02_104828	East Fork Illinois River	Year-round
OR_SR_1710030705_02_105484	Elk Creek	Year-round
OR_SR_1710030705_02_105485	Elk Creek	Year-round
OR_SR_1710030705_02_105485	Elk Creek	Spawning
OR_SR_1710030801_02_105541	Emigrant Creek	Year-round
OR_SR_1710030801_02_105550	Emigrant Creek	Year-round
OR_SR_1710030801_02_105823	Emigrant Creek	Year-round
OR_SR_1710030801_02_105823	Emigrant Creek	Spawning
OR_SR_1710030801_02_105824	Emigrant Creek	Year-round
OR_LK_1710030801_02_100257	Emigrant Lake	Year-round
OR_SR_1710030803_02_105576	Evans Creek	Year-round
OR_SR_1710030803_02_105583	Evans Creek	Year-round
OR_SR_1710030701_02_105457	Foster Creek	Year-round
OR_SR_1710030701_02_105469	Foster Creek	Year-round
OR_SR_1710030802_02_105560	Galls Creek	Year-round
OR_SR_1710031003_02_104796	Grave Creek	Spawning
OR_SR_1710031003_02_104800	Grave Creek	Spawning
OR_SR_1710031003_02_106346	Grave Creek	Year-round
OR_SR_1710031003_02_106346	Grave Creek	Spawning
OR_WS_171003070110_02_105719	HUC12 Name: Abbott Creek	Year-round
OR_WS_171003080109_02_105767	HUC12 Name: Anderson Creek-Bear Creek	Year-round
OR_WS_171003070501_02_105736	HUC12 Name: Bitter Lick Creek-Elk Creek	Year-round
OR_WS_171003070107_02_105717	HUC12 Name: Flat Creek	Year-round
OR_WS_171003110801_02_104896	HUC12 Name: Florence Creek-Illinois River	Year-round
OR_WS_171003100602_02_104676	HUC12 Name: Foster Bar-Rogue River	Year-round
OR_WS_171003090403_02_105791	HUC12 Name: Humbug Creek-Applegate River	Year-round

AU ID	AU name	Use period
OR_WS_171003080112_02_105770	HUC12 Name: Jackson Creek-Bear Creek	Spawning
OR_WS_171003110602_02_104891	HUC12 Name: Josephine Creek	Year-round
OR_WS_171003110802_02_104897	HUC12 Name: Klondike Creek	Year-round
OR_WS_171003070807_02_105753	HUC12 Name: Lake Creek-Little Butte Creek	Year-round
OR_WS_171003080110_02_105768	HUC12 Name: Larson Creek-Bear Creek	Year-round
OR_WS_171003100301_02_105794	HUC12 Name: Last Chance Creek-Grave Creek	Spawning
OR_WS_171003100301_02_105794	HUC12 Name: Last Chance Creek-Grave Creek	Year-round
OR_WS_171003100103_02_106361	HUC12 Name: Louse Creek	Year-round
OR_WS_171003070408_02_105735	HUC12 Name: Lower Big Butte Creek	Year-round
OR_WS_171003110702_02_104895	HUC12 Name: Lower Briggs Creek	Year-round
OR_WS_171003110504_02_104890	HUC12 Name: Lower Deer Creek	Year-round
OR_WS_171003110303_02_104903	HUC12 Name: Lower East Fork Illinois River	Year-round
OR_WS_171003100104_02_104864	HUC12 Name: Lower Jumpoff Joe Creek	Year-round
OR_WS_171003070802_02_105748	HUC12 Name: Lower North Fork Little Butte Creek	Year-round
OR_WS_171003070404_02_105731	HUC12 Name: Lower South Fork Big Butte Creek	Year-round
OR_WS_171003070806_02_105752	HUC12 Name: Lower South Fork Little Butte Creek	Year-round
OR_WS_171003080303_02_105804	HUC12 Name: Lower West Fork Evans Creek	Year-round
OR_WS_171003070805_02_105751	HUC12 Name: Middle South Fork Little Butte Creek	Year-round
OR_WS_171003070102_02_105712	HUC12 Name: Muir Creek	Year-round
OR_WS_171003080107_02_105765	HUC12 Name: Myer Creek-Bear Creek	Year-round
OR_WS_171003080104_02_105762	HUC12 Name: Neil Creek	Spawning
OR_WS_171003070405_02_105732	HUC12 Name: North Fork Big Butte Creek	Spawning
OR_WS_171003070405_02_105732	HUC12 Name: North Fork Big Butte Creek	Year-round
OR_WS_171003090201_02_105784	HUC12 Name: Palmer Creek-Applegate River	Year-round
OR_WS_171003100201_02_104865	HUC12 Name: Pickett Creek-Rogue River	Year-round
OR_WS_171003100305_02_104871	HUC12 Name: Poorman Creek-Grave Creek	Year-round
OR_WS_171003090503_02_106358	HUC12 Name: Powell Creek-Williams Creek	Spawning
OR_WS_171003090503_02_106358	HUC12 Name: Powell Creek-Williams Creek	Year-round
OR_WS_171003110604_02_104893	HUC12 Name: Rancherie Creek-Illinois River	Year-round
OR_WS_171003110404_02_104885	HUC12 Name: Rough and Ready Creek	Year-round
OR_WS_171003080401_02_106354	HUC12 Name: Savage Creek-Rogue River	Year-round
OR_WS_171003100601_02_106319	HUC12 Name: Shasta Costa Creek	Year-round
OR_WS_171003110603_02_104892	HUC12 Name: Sixmile Creek-Illinois River	Year-round
OR_WS_171003090604_02_104861	HUC12 Name: Slate Creek	Year-round
OR_WS_171003070503_02_105738	HUC12 Name: Sugarpine Creek	Spawning
OR_WS_171003070503_02_105738	HUC12 Name: Sugarpine Creek	Year-round
OR_WS_171003110601_02_104915	HUC12 Name: Town of Kerby-Illinois River	Year-round
OR_WS_171003070810_02_105756	HUC12 Name: Upper Antelope Creek	Year-round
OR_WS_171003070406_02_105733	HUC12 Name: Upper Big Butte Creek	Spawning
OR_WS_171003070406_02_105733	HUC12 Name: Upper Big Butte Creek	Year-round
OR_WS_171003110701_02_104894	HUC12 Name: Upper Briggs Creek	Year-round
OR_WS_171003080101_02_105759	HUC12 Name: Upper Emigrant Creek	Year-round
OR_WS_171003080301_02_105777	HUC12 Name: Upper Evans Creek	Year-round
OR_WS_171003070803_02_105749	HUC12 Name: Upper South Fork Little Butte Creek	Year-round
OR_WS_171003080302_02_105778	HUC12 Name: Upper West Fork Evans Creek	Year-round
OR_WS_171003110401_02_104911	HUC12 Name: Upper West Fork Illinois River	Spawning
OR_WS_171003110401_02_104911	HUC12 Name: Upper West Fork Illinois River	Year-round
OR_WS_171003080108_02_105766	HUC12 Name: Wagner Creek	Year-round
OR_WS_171003080103_02_105761	HUC12 Name: Walker Creek	Spawning
OR_WS_171003080103_02_105761	HUC12 Name: Walker Creek	Year-round
OR_WS_171003070505_02_105740	HUC12 Name: West Branch Elk Creek-Elk Creek	Year-round

AU ID	AU name	Use period
OR_WS_171003100401_02_104872	HUC12 Name: Whisky Creek-Rogue River	Year-round
OR_WS_171003100304_02_106363	HUC12 Name: Wolf Creek	Year-round
OR_SR_1710030904_02_105616	Humbug Creek	Year-round
OR_SR_1710030904_02_105624	Humbug Creek	Year-round
OR_SR_1710031106_02_104840	Illinois River	Year-round
OR_SR_1710031106_02_104840	Illinois River	Spawning
OR_SR_1710031108_02_106306	Illinois River	Year-round
OR_SR_1710031111_02_104645	Illinois River	Year-round
OR_SR_1710031111_02_104645	Illinois River	Spawning
OR_SR_1710031110_02_106308	Indigo Creek	Year-round
OR_SR_1710030801_02_105533	Jackson Creek	Spawning
OR_SR_1710030801_02_105534	Jackson Creek	Year-round
OR_SR_1710030801_02_105534	Jackson Creek	Spawning
OR_SR_1710031106_02_104838	Josephine Creek	Year-round
OR_SR_1710031001_02_104783	Jumpoff Joe Creek	Year-round
OR_SR_1710031001_02_106344	Jumpoff Joe Creek	Year-round
OR_SR_1710031108_02_104844	Klondike Creek	Year-round
OR_SR_1710030708_02_105510	Lake Creek	Year-round
OR_SR_1710030801_02_105538	Larson Creek	Year-round
OR_SR_1710031111_02_104648	Lawson Creek	Year-round
OR_SR_1710030708_02_105521	Little Butte Creek	Year-round
OR_SR_1710030708_02_105521	Little Butte Creek	Spawning
OR_SR_1710030708_02_105508	Lost Creek	Year-round
OR_SR_1710031001_02_106345	Louse Creek	Year-round
OR_SR_1710031105_02_104836	McMullin Creek	Year-round
OR_SR_1710030708_02_105513	Mud Creek	Year-round
OR_SR_1710030801_02_105537	Myer Creek	Year-round
OR_SR_1710030704_02_105478	North Fork Big Butte Creek	Year-round
OR_SR_1710030704_02_105478	North Fork Big Butte Creek	Spawning
OR_SR_1710030708_02_105511	North Fork Little Butte Creek	Year-round
OR_SR_1710031109_02_104846	North Fork Silver Creek	Year-round
OR_SR_1710031002_02_104785	Pickett Creek	Year-round
OR_SR_1710030803_02_105573	Pleasant Creek	Year-round
OR_SR_1710031001_02_104782	Quartz Creek	Year-round
OR_LK_1710030801_02_100256	Reeder Reservoir	Year-round
OR_SR_1710031003_02_104802	Reuben Creek	Year-round
OR_SR_1710030803_02_105579	Rock Creek	Year-round
OR_SR_1710030803_02_105584	Rock Creek	Year-round
OR_EB_1710031008_01_100280	Rogue River	Year-round
OR_SR_1710030707_04_105507	Rogue River	Year-round
OR_SR_1710030707_04_105507	Rogue River	Spawning
OR_SR_1710030802_04_105816	Rogue River	Year-round
OR_SR_1710030802_04_105816	Rogue River	Spawning
OR_SR_1710030804_04_106341	Rogue River	Year-round
OR_SR_1710030804_04_106341	Rogue River	Spawning
OR_SR_1710031002_04_104794	Rogue River	Year-round
OR_SR_1710031004_04_104821	Rogue River	Year-round
OR_SR_1710031005_04_106305	Rogue River	Year-round
OR_SR_1710031006_04_104637	Rogue River	Year-round
OR_SR_1710031008_04_104646	Rogue River	Year-round
OR_SR_1710030803_02_105578	Salt Creek	Year-round

AU ID	AU name	Use period
OR_SR_1710030803_02_105580	Salt Creek	Year-round
OR_SR_1710030804_02_105594	Savage Creek	Year-round
OR_SR_1710031109_02_104845	Silver Creek	Year-round
OR_SR_1710031109_02_106307	Silver Creek	Year-round
OR_SR_1710030906_02_104779	Slate Creek	Year-round
OR_SR_1710030704_02_105476	South Fork Big Butte Creek	Year-round
OR_SR_1710030704_02_105476	South Fork Big Butte Creek	Spawning
OR_SR_1710031108_02_104647	South Fork Collier Creek	Year-round
OR_SR_1710030708_02_105515	South Fork Little Butte Creek	Year-round
OR_SR_1710030708_02_105522	South Fork Little Butte Creek	Year-round
OR_SR_1710030902_02_105598	Star Gulch	Year-round
OR_SR_1710030903_02_105611	Sterling Creek	Year-round
OR_SR_1710030705_02_105489	Sugarpine Creek	Year-round
OR_SR_1710030705_02_105489	Sugarpine Creek	Spawning
OR_SR_1710030705_02_105490	Sugarpine Creek	Year-round
OR_SR_1710030705_02_105490	Sugarpine Creek	Spawning
OR_SR_1710030801_02_105540	Tyler Creek	Year-round
OR_SR_1710030801_02_105532	Wagner Creek	Year-round
OR_SR_1710030801_02_105532	Wagner Creek	Spawning
OR_SR_1710030801_02_105545	Wagner Creek	Year-round
OR_SR_1710030801_02_105545	Wagner Creek	Spawning
OR_SR_1710030801_02_105539	Walker Creek	Year-round
OR_SR_1710030801_02_105539	Walker Creek	Spawning
OR_SR_1710030801_02_105551	Walker Creek	Year-round
OR_SR_1710030801_02_105551	Walker Creek	Spawning
OR_SR_1710030705_02_105482	West Branch Elk Creek	Year-round
OR_SR_1710030803_02_105574	West Fork Evans Creek	Year-round
OR_SR_1710030803_02_105581	West Fork Evans Creek	Year-round
OR_SR_1710030803_02_105795	West Fork Evans Creek	Year-round
OR_SR_1710031104_02_104831	West Fork Illinois River	Year-round
OR_SR_1710031104_02_104832	West Fork Illinois River	Year-round
OR_SR_1710031104_02_104832	West Fork Illinois River	Spawning
OR_SR_1710030905_02_106342	West Fork Williams Creek	Year-round
OR_SR_1710031004_02_104811	Whisky Creek	Year-round
OR_SR_1710030905_02_105627	Williams Creek	Year-round
OR_SR_1710030704_02_105480	Willow Creek	Year-round
OR_SR_1710031003_02_104801	Wolf Creek	Spawning
OR_SR_1710031003_02_104803	Wolf Creek	Year-round
OR_SR_1710030903_02_105605	Yale Creek	Year-round

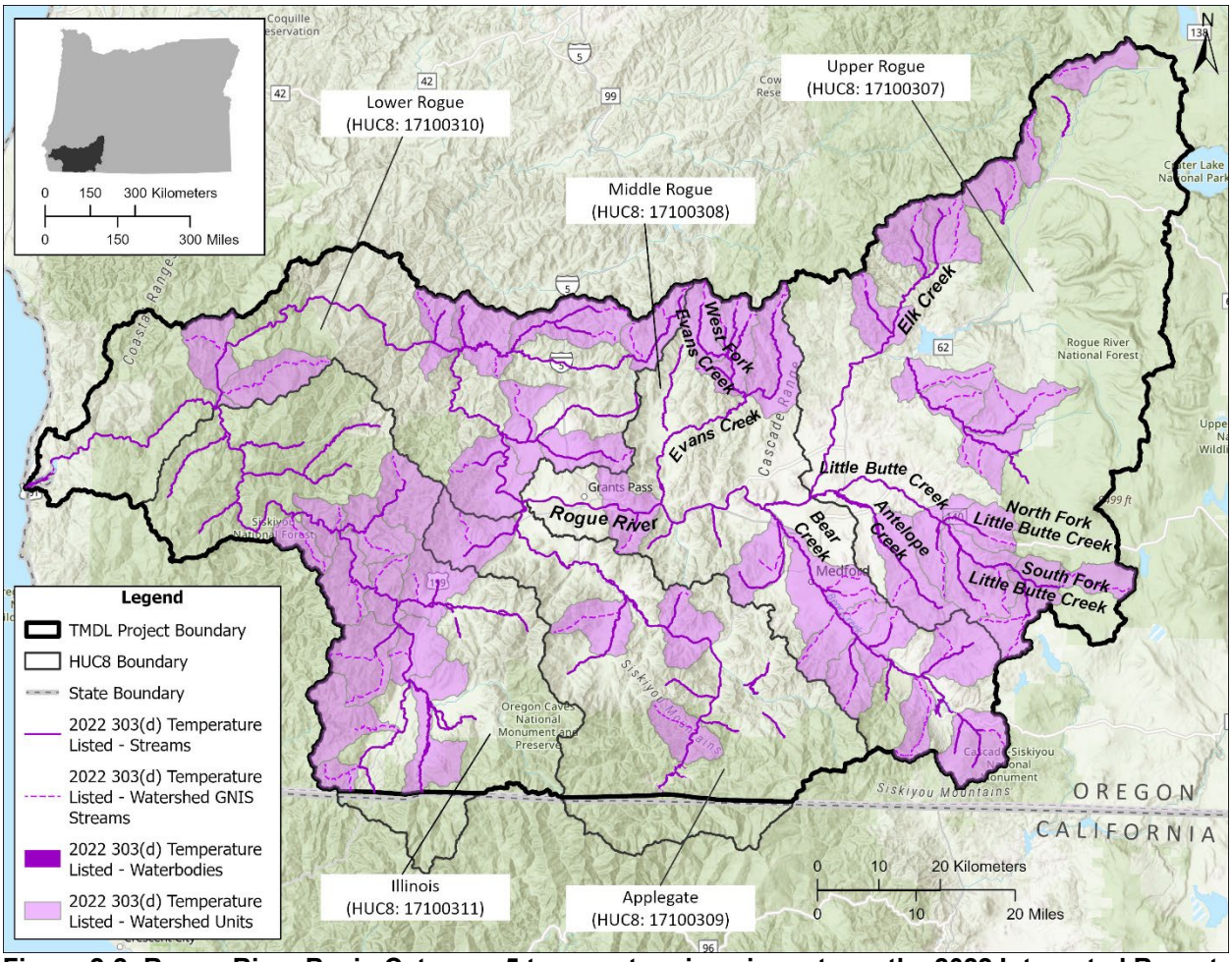

Figure 2-2: Rogue River Basin Category 5 temperature impairments on the 2022 Integrated Report.

2.2 Impaired waters not on the 303(d) list

The following table lists the AUs within the Rogue River Basin with temperature standard exceedances that are not listed on the 2022 Integrated Report but are either listed in the draft 2024 Integrated Report or were found to have excess temperature by data analysis.

Table 2-3: Rogue River Basin (117003) AUs with temperature standard exceedances that are not listed on the 2022 Integrated Report but are either listed in the draft 2024 Integrated Report or were found to have excess temperature by data analysis.

AU ID	AU name	Use period
OR_SR_1710030701_02_105462	Flat Creek	Year-round
OR_SR_1710030702_02_105474	Beaver Dam Creek	Year-round
OR_SR_1710030704_02_105480	Willow Creek	Spawning
OR_SR_1710030705_02_105482	West Branch Elk Creek	Spawning
OR_SR_1710030705_02_105483	Elk Creek	Year-round
OR_SR_1710030705_02_105484	Elk Creek	Spawning
OR_SR_1710030706_02_105492	Trail Creek	Year-round
OR_SR_1710030706_02_105492	Trail Creek	Spawning
OR_SR_1710030706_02_105496	West Fork Trail Creek	Year-round
OR_SR_1710030706_02_105496	West Fork Trail Creek	Spawning
OR_SR_1710030707_02_105498	Reese Creek	Year-round

AU ID	AU name	Use period
OR_SR_1710030707_02_105498	Reese Creek	Spawning
OR_SR_1710030707_02_105503	Indian Creek	Year-round
OR_SR_1710030707_02_105503	Indian Creek	Spawning
OR_SR_1710030707_04_105506	Rogue River	Spawning
OR_SR_1710030708_02_105508	Lost Creek	Spawning
OR_SR_1710030708_02_105509	Antelope Creek	Spawning
OR_SR_1710030708_02_105510	Lake Creek	Spawning
OR_SR_1710030708_02_105511	North Fork Little Butte Creek	Spawning
OR_SR_1710030708_02_105514	Salt Creek	Year-round
OR_SR_1710030708_02_105514	Salt Creek	Spawning
OR_SR_1710030708_02_105522	South Fork Little Butte Creek	Spawning
OR_SR_1710030801_02_105544	*Griffin Creek*	Year-round
OR_SR_1710030802_02_105556	Ward Creek	Year-round
OR_SR_1710030802_02_105557	Sardine Creek	Year-round
OR_SR_1710030802_02_105557	Sardine Creek	Spawning
OR_SR_1710030803_02_105795	West Fork Evans Creek	Spawning
OR_SR_1710030902_02_105599	Applegate River	Year-round
OR_SR_1710030902_02_105600	Beaver Creek	Spawning
OR_SR_1710030902_02_105601	Beaver Creek	Year-round
OR_SR_1710030902_02_105603	Applegate River	Spawning
OR_SR_1710030903_02_105606	Little Applegate River	Year-round
OR_SR_1710030903_02_105608	Little Applegate River	Year-round
OR_SR_1710030903_02_105608	Little Applegate River	Spawning
OR_SR_1710030903_02_105796	Yale Creek	Year-round
OR_SR_1710030903_02_105796	Yale Creek	Spawning
OR_SR_1710030904_02_105620	Thompson Creek	Year-round
OR_SR_1710030904_02_105622	Thompson Creek	Year-round
OR_SR_1710030905_02_106342	West Fork Williams Creek	Spawning
OR_SR_1710030905_02_105626	East Fork Williams Creek	Year-round
OR_SR_1710030906_02_104775	Cheney Creek	Year-round
OR_SR_1710030906_02_104777	Murphy Creek	Year-round
OR_SR_1710031002_02_104787	Galice Creek	Year-round
OR_SR_1710031002_04_104794	Rogue River	Spawning
OR_SR_1710031003_02_104796	Grave Creek	Year-round
OR_SR_1710031003_02_104806	Poorman Creek	Year-round
OR_SR_1710031004_04_104821	Rogue River	Spawning
OR_SR_1710031007_02_104638	Lobster Creek	Year-round
OR_SR_1710031007_02_104640	Lobster Creek	Year-round
OR_SR_1710031008_02_104642	Silver Creek	Year-round
OR_SR_1710031102_02_104824	Sucker Creek	Year-round
OR_SR_1710031102_02_104904	Sucker Creek	Year-round
OR_WS_171003070106_02_105716	HUC12 Name: Bybee Creek-Rogue River	Year-round
OR_WS_171003070206_02_105799	HUC12 Name: Beaver Dam Creek	Year-round
OR_WS_171003070502_02_105737	HUC12 Name: Button Creek-Elk Creek	Year-round
OR_WS_171003090105_02_106356	HUC12 Name: Sturgis Fork	Year-round
OR_WS_171003090201_02_105784	HUC12 Name: Palmer Creek-Applegate River	Spawning
OR_WS_171003090203_02_105786	HUC12 Name: Star Gulch-Applegate River	Year-round
OR_WS_171003090304_02_105789	HUC12 Name: Lower Little Applegate River	Year-round
OR_WS_171003090501_02_106364	HUC12 Name: East Fork Williams Creek	Year-round
OR_WS_171003090605_02_104862	HUC12 Name: Baum Slough-Applegate River	Year-round
OR_WS_171003100202_02_104866	HUC12 Name: Stratton Creek-Rogue River	Year-round

AU ID	AU name	Use period
OR_WS_171003100205_02_104869	HUC12 Name: Bailey Creek-Rogue River	Year-round
OR_WS_171003100402_02_104873	HUC12 Name: Howard Creek-Rogue River	Year-round
OR_WS_171003100402_02_104873	HUC12 Name: Howard Creek-Rogue River	Spawning
OR_WS_171003100701_02_104677	HUC12 Name: North Fork Lobster Creek	Year-round
OR_WS_171003100802_02_104680	HUC12 Name: Quosatana Creek-Rogue River	Year-round
OR_WS_171003100803_02_104698	HUC12 Name: Indian Creek-Rogue River	Year-round
OR_WS_180102060401_05_107143	HUC12 Name: Upper Jenny Creek	Year-round

3. Pollutant identification

As required by OAR 340-042-0040(4)(b), this element identifies the pollutants causing impairment of water quality that are addressed by this TMDL. 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 that causes impairment. Heat caused by human activities is of particular concern.

EPA regulations (40 CFR 130.2(i)) and OAR 340-042-0040(O)(5)(b) allow 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 in this TMDL 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. Also, in accordance with OAR 340-042-0040(5)(b), DEQ used a temperature target as a surrogate measure for thermal loading caused by dam and reservoir operations. Monitoring stream temperature, rather than thermal load, is an easier and more meaningful approach to reservoir management. Temperature is mathematically related to excess thermal load 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. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint source load allocations for this temperature TMDL.

4. Water quality standards and beneficial uses

As required by OAR 340-042-0040(4)(c), this section identifies the applicable water quality standards and beneficial uses in the Rogue River Basin. This section also identifies the beneficial uses that are most sensitive to impairment by the pollutant addressed in this TMDL (temperature).

Table 4-1 specifies the designated beneficial uses in the Rogue River Basin as identified in OAR 340-041-0271 Table 271A. Water quality criteria have been set at a level to protect the most sensitive of these beneficial uses. This TMDL is designed such that meeting water quality criteria for the most sensitive beneficial uses will be protective of all other uses for that pollutant

parameter. Fish and aquatic life use is the most sensitive beneficial use for temperature. Oregon's water temperature criteria use salmonids' life cycles as indicators. If temperatures are protective of these indicator species, other species are also protected. The locations and periods of criteria applicability in the basin are identified from the EPA-approved designated fish use maps in rule at OAR 340-041-0271 Figure 271A and Figure 271B.[1] The applicable Rogue River Basin maps from the rule have been reproduced and shown in Figure 4-1 and Figure 4-2. Figure 4-1 shows various year-round designated fish use designations, while Figure 4-2 shows salmon and steelhead spawning use designations, based on the USGS National Hydrology Dataset (NHD).

Rogue River Basin temperature water quality standards are based on the rolling seven-day average daily maximum (7DADM)[2] temperatures and include the following numeric criteria:

- Salmon and steelhead spawning: 13.0°C (55.4°F) (OAR 340-041-0028(4)(a))
- Core cold water habitat: 16.0°C (60.8°F) (OAR 340-041-0028(4)(b))
- Salmon and trout rearing and migration: 18.0°C (64.4°F) (OAR 340-041-0028(4)(c))

The following narrative temperature water quality standards and other rule provisions also apply in the Rogue River Basin:

- Human use allowance (OAR 340-041-0028(12)(b))
- Minimum duties (OAR 340-041-0028(12)(a))
- Natural lakes (OAR 340-041-0028(6))
- Protecting cold water (OAR 340-041-0028(11))
- Antidegradation (OAR 340-041-0004)

Table 4-1: Designated beneficial uses in the Rogue River Basin (OAR 340-041-0271 Table 271A).

Beneficial Uses	Rogue River Estuary and Adjacent Marine Waters	Rogue River Main Stem from Estuary to Lost Creek Dam	Rogue River Main Stem above Lost Dam and Tributaries	Bear Creek Main Stem	All Other Tributaries to Rogue River and Bear Creek
Public Domestic Water Supply[1]		X	X	*	X
Private Domestic Water Supply		X	X		X
Industrial Water Supply	X	X	X	X	X
Irrigation		X	X	X	X
Livestock Watering		X	X	X	X
Fish and Aquatic Life	X	X	X	X	X
Wildlife and Hunting	X	X	X	X	X
Fishing	X	X	X	X	X

[1] Amended beneficial use designations were adopted by Oregon's Environmental Quality Commission (EQC) on November 16, 2023, but have not yet been approved by EPA for Clean Water Act purposes. The current applicable beneficial uses are those that were in place prior to the EQC amendments and may be referenced online at DEQ's Beneficial Uses of Oregon's Waters web page.

[2] Referred to as the "Seven-Day Average Maximum Temperature" in OAR 340-041 and defined as the average of the daily maximum temperatures from seven consecutive days made on a rolling basis.

Beneficial Uses	Rogue River Estuary and Adjacent Marine Waters	Rogue River Main Stem from Estuary to Lost Creek Dam	Rogue River Main Stem above Lost Dam and Tributaries	Bear Creek Main Stem	All Other Tributaries to Rogue River and Bear Creek
Boating	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X
Aesthetic Quality	X	X	X	X	X
Hydro Power			X		X
Commercial Navigation & Transportation	X	X			

[1] With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards

* Designation for this use is presently under study

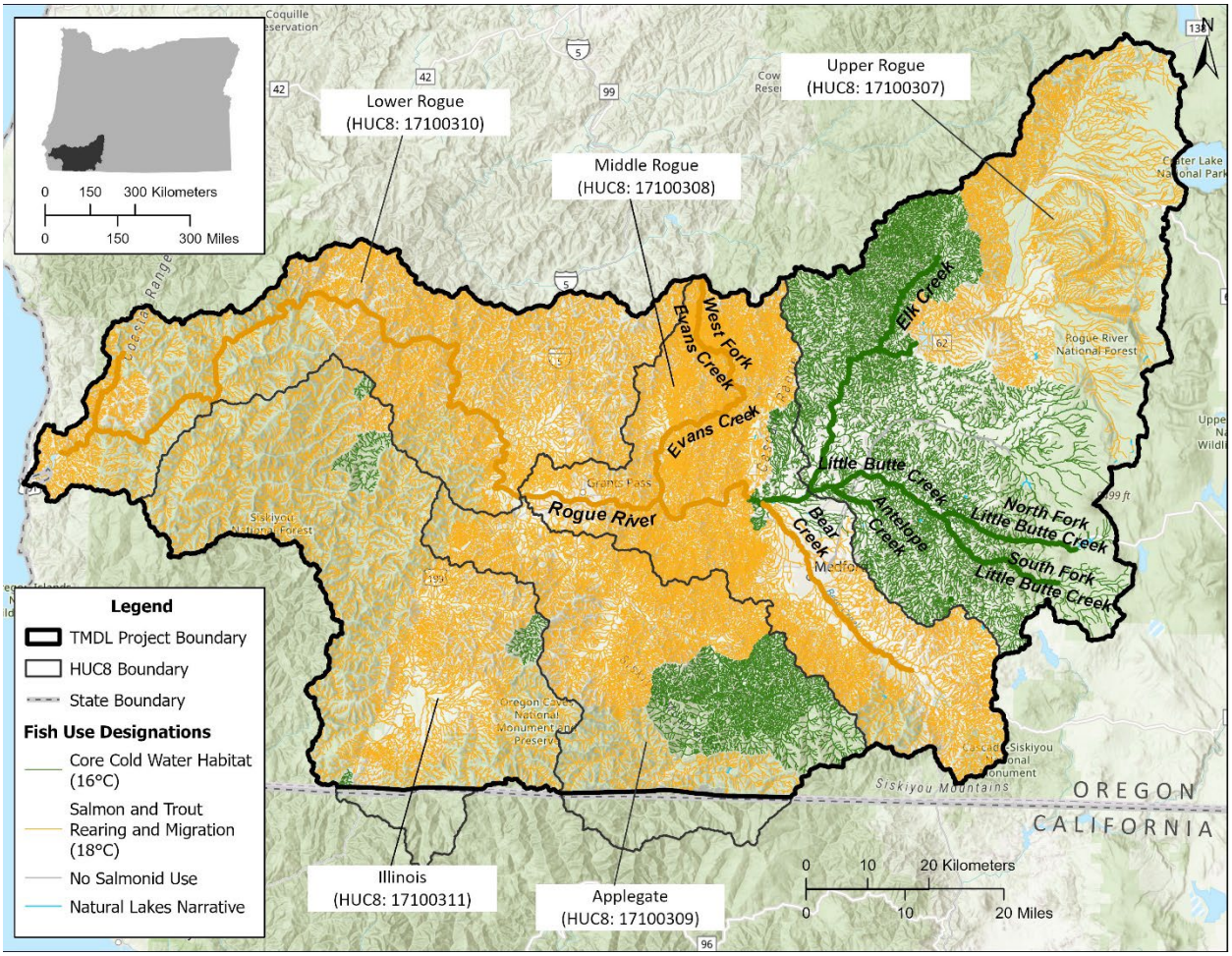

Figure 4-1: Year-round temperature fish use designations in the Rogue River Basin TMDL area (from currently applicable OAR figure).

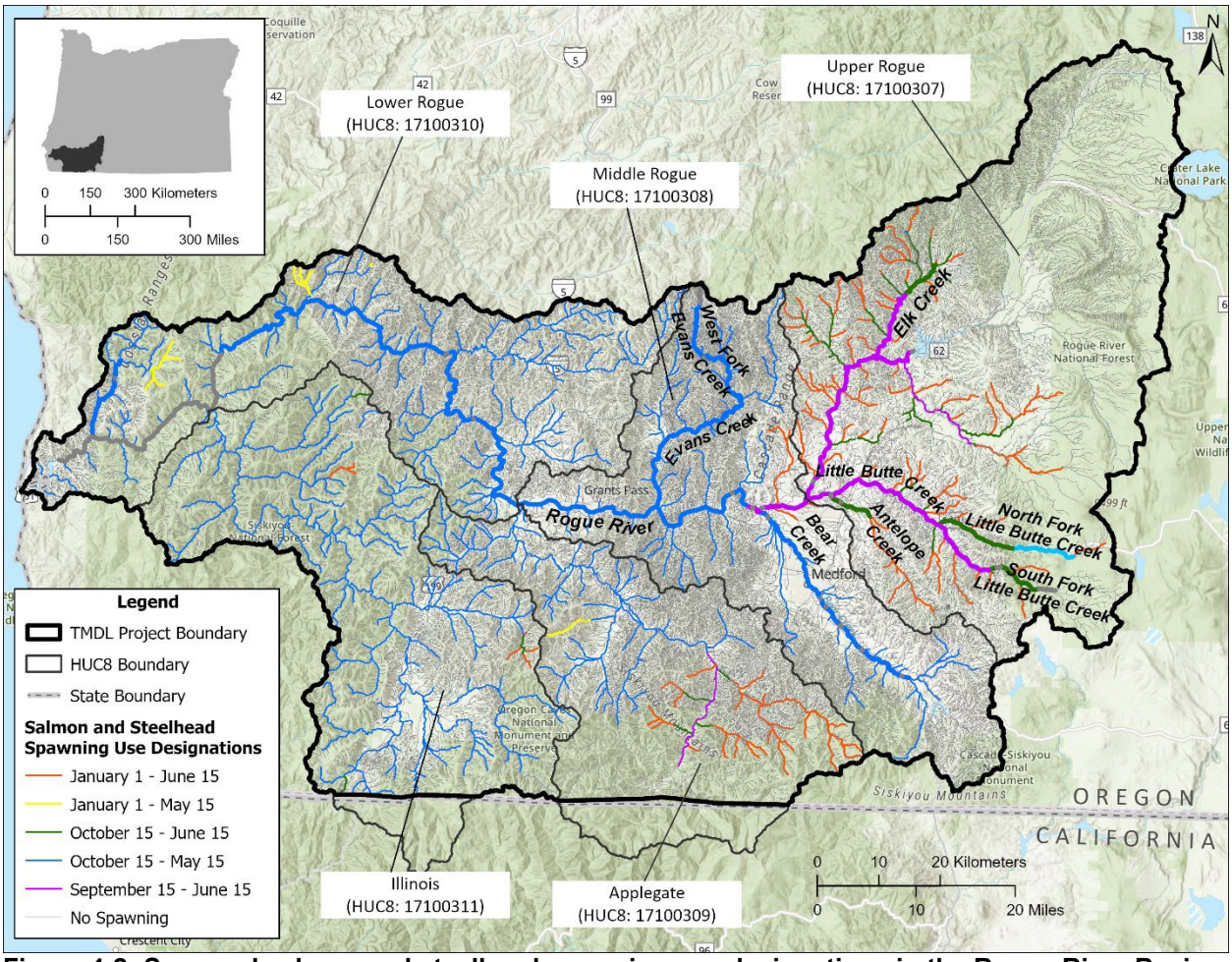

Figure 4-2: Seasonal salmon and steelhead spawning use designations in the Rogue River Basin TMDL area (from currently applicable OAR figure).

4.1 Salmon and steelhead spawning use

OAR 340-041-0028(4)(a) specifies that waters designated as having salmon and steelhead spawning use in the associated spawning use maps may not exceed 13.0°C (55.4°F) expressed as a 7DADM at the times indicated in the maps.

4.2 Core cold water habitat use

OAR 340-041-0028(4)(b) specifies that waters designated as having core cold water habitat use in the associated fish use maps may not exceed 16.0°C (60.8°F) expressed as a 7DADM.

4.3 Salmon and trout rearing and migration

OAR 340-041-0028(4)(b) specifies that waters designated as having salmon and trout rearing and migration use in the associated fish use maps may not exceed 18.0°C (64.4°F) expressed as a 7DADM.

4.4 Human use allowance

Oregon water quality standards 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. 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 biological criterion after complete mixing in the waterbody and at the point of maximum impact (POMI). The rationale behind designation of 0.3°C as the HUA and how DEQ implements this portion of the standard can be found in DEQ (2003) and DEQ's Temperature IMD (DEQ 2008a).

4.5 Antidegradation

Under federal rule (40 CFR 131.12(a)), the EPA directs states and tribes to implement antidegradation policies. Oregon has an antidegradation policy (OAR 340-041-0004) to guide decisions that affect water quality to prevent unnecessary further degradation from new or increased point and nonpoint sources of pollution, and to protect, maintain, and enhance existing surface water quality to ensure the full protection of all existing beneficial uses.

OAR 340-041-0004 (3)(c) specifies that insignificant temperature increases authorized under OAR 340-041-0028(11) and (12) are not considered a reduction in water quality. Furthermore, OAR 340-041-0004 (5)(a) specifies that DEQ-determined activities to restore geomorphology or riparian vegetation that have a net ecological benefit do not need antidegradation review; this is known as the Riparian Restoration Activities Exemption.

4.6 Protecting cold water

The "protecting cold water" (PCW) criterion in OAR 340-041-0028(11) applies to waters of the state that have summer ambient 7DADM temperatures that are colder than the biologically-based criteria. With some exceptions (see Figure 4-3), these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3°C (0.5°F) above the colder ambient water temperature. This criterion applies to all anthropogenic sources taken together (i.e., "cumulatively") at the POMI where salmon, steelhead or bull trout are present. A summary of how DEQ implements this portion of the standard can be found in DEQ's PCW IMD (DEQ, 2011) and Temperature IMD (DEQ, 2008a).

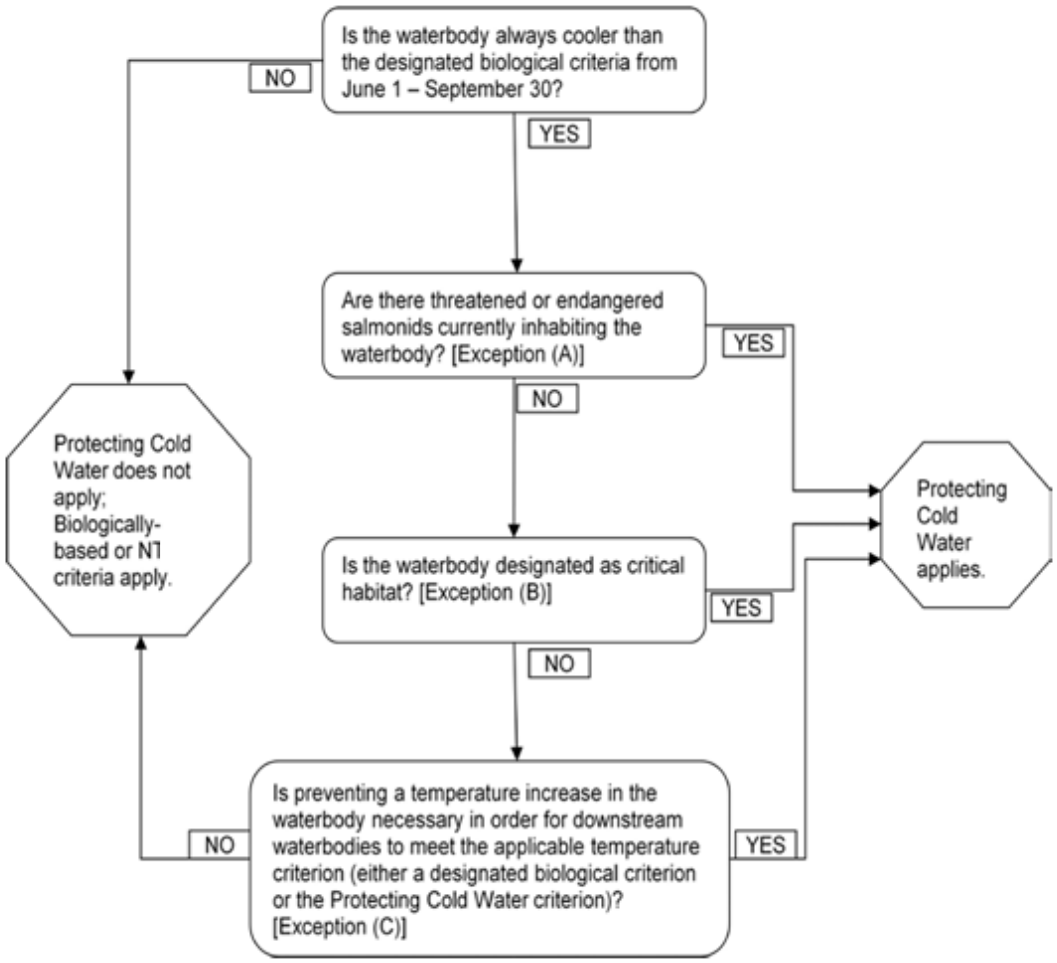

Figure 4-3: Flowchart to determine applicability of the PCW criterion. Extracted from DEQ, 2011.

4.7 Minimum duties

The minimum duties provision at OAR 340-041-0028(12)(a) states that there is no duty for anthropogenic sources to reduce heating of waters of the State below their natural condition. Similarly, each anthropogenic point and nonpoint source is responsible only for controlling the thermal effects of their own discharge or activity in accordance with their overall heat contribution. In no case may a source cause more warming than that allowed by the HUA.

For point sources, DEQ implements 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 but is not processed as part of an industrial or wastewater treatment operation. If a facility mixes intake water with other wastewater or as a method to cool equipment, then DEQ considers the operation’s thermal effects to be part of the facility’s activity and thus 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, then any thermal effects are not due to the receiving stream and are therefore attributed to the facility’s own discharge such that the facility is not considered “flow-through”.

For facilities that operate as a flow-through facility, the minimum duties provision applies when the facility intake temperatures are warmer than the maximum effluent discharge temperatures allowed by the assigned wasteload allocation (WLA). On days when this occurs, the facility cannot add any thermal loading above that contributed by the intake temperatures (i.e. no increase in temperature; HUA = 0.0°C above the intake temperature). In other words, the facility is not required to reduce their effluent temperature below the intake temperature. This is to ensure the facility controls thermal effects that result from water passing through their facility, as required of the facility, and not from upstream sources that are not the facility's responsibility to control. In general, DEQ found this provision applies to most NPDES-permitted fish hatcheries.

The minimum duties provision is also applicable to dam and reservoir operations. On days when temperatures upstream of the reservoir exceed the applicable criteria plus assigned HUA, the dam and reservoir operations must not contribute any additional heat to the waterbody. When this temperature condition occurs, the HUA = 0.0°C relative to the upstream temperatures ensuring dam operators are only responsible for temperature increases caused by the dam and reservoir operations. DEQ developed a surrogate measure temperature target for dam and reservoir operations to be consistent with the minimum duties provision (Section 9.4.1).

4.8 Statewide narrative criteria

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

4.9 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. These temperature targets are summarized in Table 4-2.

Table 4-2: Summary of applicable numeric temperature targets in the Rogue River Basin.

Applicable Criteria	Fish and Aquatic Life Use Protected	7DADM Temperature Target (°C)	Notes
Waters that exceed the biologically based numeric criteria, biologically based numeric criteria with human use allowance apply: OAR 340-041-0028(4) and OAR 340-041-0028(12)(b)	Salmon and steelhead spawning	13.0 + 0.3 HUA	Seasonally applies
Waters that exceed the biologically based numeric criteria, biologically based numeric criteria with human use allowance apply: OAR 340-041-0028(4) and OAR 340-041-0028(12)(b)	Core cold water habitat	16.0 + 0.3 HUA	

Applicable Criteria	Fish and Aquatic Life Use Protected	7DADM Temperature Target (°C)	Notes
Waters that exceed the biologically based numeric criteria, biologically based numeric criteria with human use allowance apply: OAR 340-041-0028(4) and OAR 340-041-0028(12)(b)	Salmon and trout rearing and migration	18.0 + 0.3 HUA	
Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criteria do not apply, Biologically based numeric criteria apply: OAR 340-041-0028(4)	Salmon and steelhead spawning	13.0	Seasonally applies
Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criteria do not apply, Biologically based numeric criteria apply: OAR 340-041-0028(4)	Core cold water habitat	16.0	
Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criteria do not apply, Biologically based numeric criteria apply: OAR 340-041-0028(4)	Salmon and trout rearing and migration	18.0	
Waters that are always colder than the applicable biologically based numeric criteria and the protecting colder water criterion applies, Protecting cold water criteria apply: OAR 340-041-0028(11)	Fish and aquatic life (Summer)	Ambient temperature + 0.3 HUA	
Natural lakes, Natural lakes narrative applies: OAR 340-041-0028(6)	Fish and aquatic life Natural Lakes	Natural thermal condition + 0.3 HUA	Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ presumes 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.

The critical periods for waterbodies in the Rogue River Basin TMDL area 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 in the Rogue River Basin.

Subbasin	Waterbody name	Critical period
Applegate Subbasin 17100309	All waters, except those noted in other rows of this table	Mar. 15 – Nov. 15
	Little Applegate Watershed (1710030903)	April 15 – Oct. 31
Illinois Subbasin 17100311	All waters	May 1 – Oct. 31
Lower Rogue River Subbasin 17100310	All waters, except those noted in other rows of this table	April 1 – Oct. 31
	Lobster Creek Watershed (1710031007)	May 1 – Oct. 31
	Rogue River Watershed (1710031008)	May 1 – Oct. 31
Middle Rogue River Subbasin 17100308	All waters, except those noted in other rows of this table	April 1 – Oct. 31
	Bear Creek Watershed (1710030801)	April 1 – Nov. 15
Upper Rogue River Subbasin 17100307	All waters, except those noted in other rows of this table	April 1 – Oct. 31
	Headwaters Rogue River Watershed (1710030701)	May 1 – Oct. 31
	South Fork Rogue River Watershed (1710030702)	May 1 – Oct. 31

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, assess potential pollutant sources, and evaluate the ability of various management scenarios in achieving the TMDL and applicable temperature water quality standards, the analysis requires a predictive component. DEQ uses models to evaluate potential stream warming sources and, to the extent existing data allow, their current and TMDL allocation pollutant loads. The Heat Source model was used in this effort and is described in the TSD and TSD Appendices.

6.1 Analysis overview

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

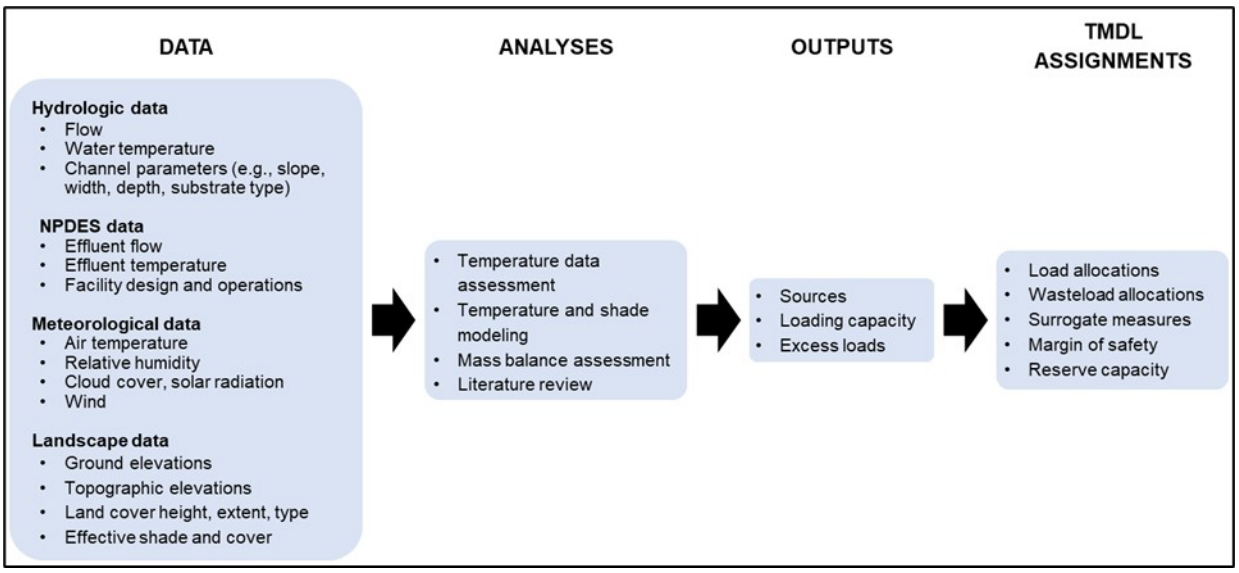

Figure 6-1: Rogue River Basin TMDL temperature analysis overview.

6.2 Model overview

As described in the TSD model report appendices, DEQ set up and calibrated temperature and shade models for streams in the Rogue River Basin (Figure 6-2). Temperature models were developed for:

- Antelope Creek (Upper Rogue Subbasin)
- Elk Creek (Upper Rogue Subbasin)
- Evans Creek and West Fork Evans Creek (Middle Rogue Subbasin)
- Little Butte and North Fork Little Butte Creek (Upper Rogue Subbasin)
- Lobster Creek (Lower Rogue Subbasin)
- Rogue River (Upper Rogue, Middle Rogue, and Lower Rogue Subbasins)
- South Fork Little Butte Creek (Upper Rogue Subbasin)

During development of the 2008 TMDL, the models were adjusted iteratively until acceptable goodness-of-fit was achieved relative to the observed current conditions. For this TMDL effort, DEQ did not adjust the original calibrated temperature models.

DEQ did adjust various model scenarios that were developed for the 2008 TMDL; new scenarios were also developed. These adjustments were principally focused on updating the version of Heat Source model used (Heat Source 8.0.8), accounting for the influences of tributaries on downstream temperatures, updates to Wasteload Allocation model scenario inputs for point sources, and assessing cumulative HUA attainment throughout the modeled river extents.

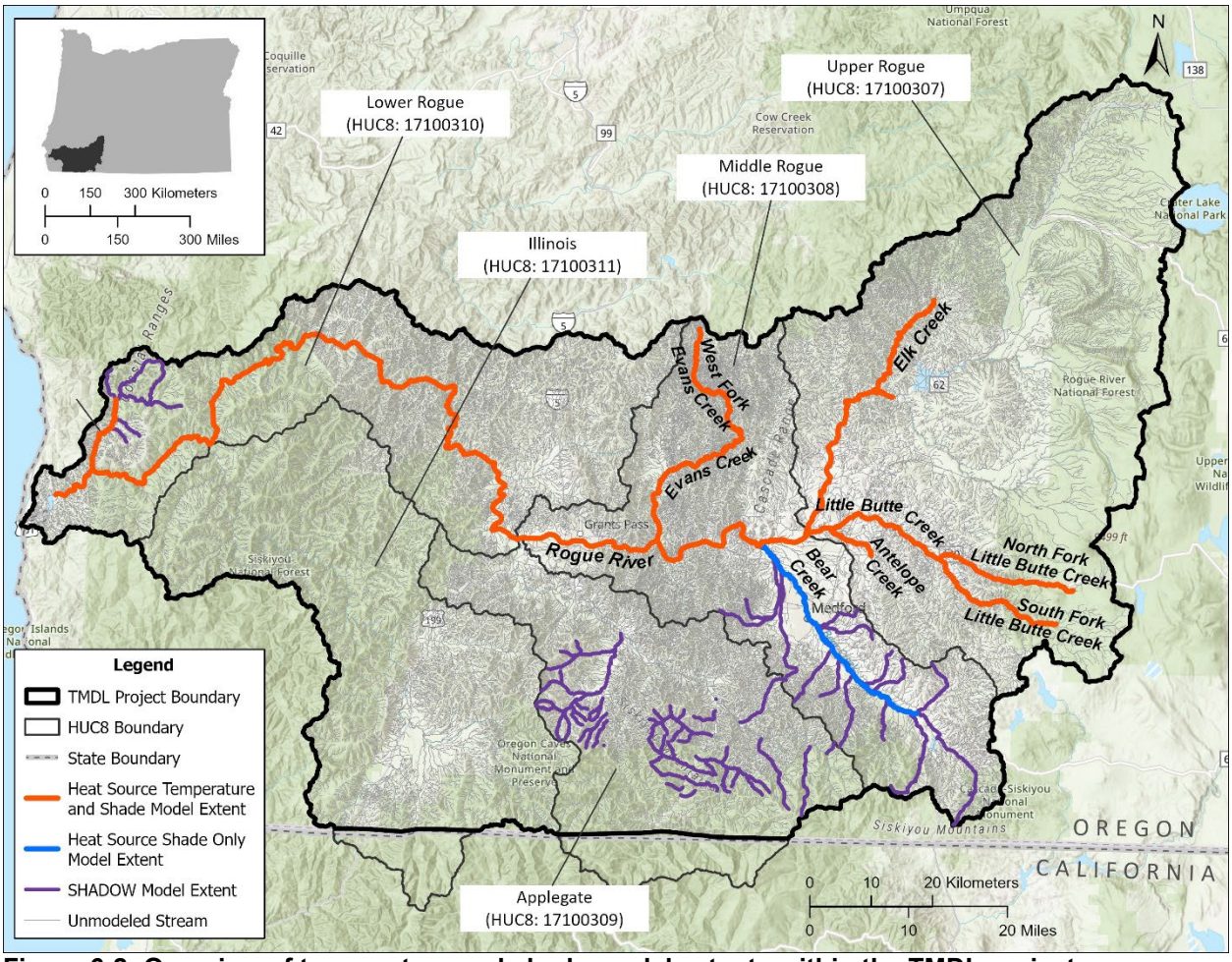

Figure 6-2: Overview of temperature and shade model extents within the TMDL project area.

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

A summary of the source assessment findings is provided in Section 7. Detailed model calibration and scenario results are provided in TSD Appendices.

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 of thermal pollution to surface waters exist in the Rogue River Basin. 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 its areal extent, discharge rate and temperature, activities' prevalence and locations in relation to surface water, and fate and transport mechanisms.

7.1 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."

Most of the sources with individual NPDES permits in the Rogue River Basin were identified as sources of thermal loading to waters and assigned thermal waste load allocations. In addition, some of the point sources with general NPDES permits were also identified as sources of thermal loading to waters in the Rogue River Basin and assigned thermal waste load allocations. These point sources are discussed in more detail below.

7.1.1 Individual NPDES permitted point sources

There are 17 domestic or industrial facilities with individual NPDES permits in the Rogue River Basin. Of these facilities, 15 were identified as potential sources of thermal load at a frequency and magnitude to potentially cause exceedances to the temperature standard. Two permitted facilities covered by individual NPDES permits discharge stormwater and/or landfill leachate only. DEQ determined that discharges from these two facilities do not have potential to discharge thermal loads that contribute to exceedances of applicable temperature criteria (see discussion below). Therefore, no additional TMDL requirements are needed for these two sources to control temperature, other than those included in the current individual NPDES permits. Listings of the facilities noted above, along with a discussion of DEQ's analyses, are included in TSD Chapter 7.

7.1.2 General NPDES permitted point sources

There are multiple categories of general NPDES permits with registrants in the Rogue River Basin. Of these, DEQ determined the following general permit categories may have the potential to discharge thermal loads that contribute to exceedances of the applicable temperature criteria:

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

Listings of the general permit categories, the specific facilities covered by them, and a discussion of DEQ's analyses to determine potential impacts are included in TSD Chapter 7.

Of the three permit types listed above, there are eight registrants to the 100-J, four registrants to the 200-J, and one registrant to the 300-J general permits found to be potential significant sources of thermal load with a temperature impact (Error! Reference source not found.). Wasteload allocations for these registrants are provided in TSD Chapter 7.

There are three additional registrants of these permits, all under the 200-J, that were found to be insignificant sources of thermal load to Rogue River Basin streams at a frequency and magnitude to cause exceedances to the temperature standard. Therefore, no additional TMDL requirements for these registrants are needed to control temperature other than those included in the current NPDES permits. A listing of these registrants and other relevant details is included in TSD Chapter 7.

7.2 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.” Anthropogenic nonpoint sources of heat in Rogue River Basin 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 these sources were identified as significant sources of thermal loading. Reductions from nonpoint sources will be required to attain the applicable temperature criteria.

7.3 Background sources

In many of the modeled streams, thermal loading from background sources also contributed to exceedances of the applicable temperature criteria and therefore were identified as significant source of thermal loading. 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.

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

where,

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

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

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

$Q_R =$ The daily mean river flow rate in cubic feet per second (cfs).

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

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

Equation 8-1 shall be used to calculate the thermal loading capacity for any surface water location in the Rogue River Basin. 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 the 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	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)
Mill Creek	OR_SR_1710030701_02_105459	14	18.3	NA	626.84E+6	N/A
North Fork Diversion Reservoir	OR_LK_1710030701_02_100236	431	18.3	NA	19,297.58E+6	N/A
Rogue River	OR_EB_1710031008_01_100280	2120	18.3	NA	94,920.82E+6	N/A
Rogue River	OR_SR_1710030701_02_105465	759	18.3	NA	*33,983.44E+6*	N/A
Rogue River	OR_SR_1710030703_04_105475	687	16.3	13.3	*27,398.0E+6*	*22,355.42E+6*
Big Butte Creek	OR_SR_1710030704_02_105477	33.1	16.3	13.3	1,320.64E+6	1,077.57E+6
Elk Creek	OR_SR_1710030705_02_105484	4.03	16.3	13.3	160.72E+6	131.14E+6
Elk Creek	OR_SR_1710030705_02_105485	0.32	16.3	13.3	12.67E+6	10.34E+6
Rogue River	OR_SR_1710030707_04_105507	869	16.3	13.3	34,645.62E+6	28,269.12E+6
Antelope Creek	OR_SR_1710030708_02_105509	0.49	16.3	13.3	19.38E+6	15.81E+6
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	5.87	16.3	13.3	234.1E+6	191.01E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105515	17.8	16.3	13.3	709.88E+6	579.22E+6
Antelope Creek	OR_SR_1710030708_02_105519	0.21	16.3	13.3	8.45E+6	6.9E+6
Little Butte Creek	OR_SR_1710030708_02_105521	18.4	16.3	13.3	733.8E+6	598.75E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	29.0	16.3	13.3	1,156.54E+6	943.68E+6
Ashland Creek	OR_SR_1710030801_02_105548	1.94	18.3	13.3	86.86E+6	63.13E+6
Bear Creek	OR_SR_1710030801_05_105552	6.12	18.3	13.3	274.02E+6	199.15E+6
Rogue River	OR_SR_1710030802_04_105816	956	16.3	13.3	38,121.18E+6	31,105.01E+6
West Fork Evans Creek	OR_SR_1710030803_02_105574	0.67	18.3	13.3	29.82E+6	21.67E+6
Evans Creek	OR_SR_1710030803_02_105576	0.40	18.3	13.3	17.78E+6	12.92E+6
West Fork Evans Creek	OR_SR_1710030803_02_105581	0.73	18.3	13.3	32.64E+6	23.72E+6
Evans Creek	OR_SR_1710030803_02_105583	0.79	18.3	13.3	35.24E+6	25.61E+6
West Fork Evans Creek	OR_SR_1710030803_02_105795	5.64	18.3	13.3	252.53E+6	183.53E+6
Rogue River	OR_SR_1710030804_04_106341	955	18.3	13.3	42,745.06E+6	31,066.08E+6
Applegate River	OR_SR_1710030902_02_105599	80.0	16.3	13.3	3,188.52E+6	2,601.67E+6
Applegate River	OR_SR_1710030902_02_105603	32.8	16.3	13.3	1,308.08E+6	1,067.33E+6
Applegate River	OR_SR_1710030904_02_105618	71.4	18.3	13.3	3,197.39E+6	2,323.79E+6
Applegate River	OR_SR_1710030906_02_106343	62.8	18.3	13.3	2,810.81E+6	2,042.83E+6
Rogue River	OR_SR_1710031002_04_104794	533	18.3	13.3	23,864.53E+6	17,344.16E+6
Rogue River	OR_SR_1710031004_04_104821	623	18.3	13.3	27,894.18E+6	20,272.82E+6
Rogue River	OR_SR_1710031005_04_106305	698	18.3	13.3	31,252.23E+6	22,713.37E+6
Rogue River	OR_SR_1710031006_04_104637	1137	18.3	*N/A*	50,923.19E+6	*N/A*
Lobster Creek	OR_SR_1710031007_02_104638	15.0	18.3	13.3	671.61E+6	488.11E+6

AU Name	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)
Lobster Creek	OR_SR_1710031007_02_104640	12.3	18.3	13.3	550.72E+6	400.25E+6
Rogue River	OR_SR_1710031008_04_104646	2080	18.3	*N/A*	93,129.86E+6	*N/A*
Illinois River	OR_SR_1710031106_02_104840	50.2	18.3	13.3	2,247.65E+6	1,633.54E+6
HUC12 Name: Indian Creek-Rogue River	OR_WS_171003070702_02_105745	887	16.3	13.3	*35,374.13E+6*	*28,863.55E+6*
HUC12 Name: Kanutchan Creek-Little Butte Creek	OR_WS_171003070812_02_105758	18.4	16.3	13.3	*733.8E+6*	*598.75E+6*
HUC12 Name: Larson Creek-Bear Creek	OR_WS_171003080110_02_105768	11.4	18.3	13.3	*510.42E+6*	*370.96E+6*
HUC12 Name: Whetstone Creek-Rogue River	OR_WS_171003080202_02_105815	948	18.3 & 16.3	13.3	*37,806.85E+6*	*30,848.53E+6*
HUC12 Name: Louse Creek	OR_WS_171003100103_02_106361	0.171	18.3	13.3	7.66E+6	5.56E+6
HUC12 Name: Lower East Fork Illinois River	OR_WS_171003110303_02_104903	19.3	18.3	13.3	*864.14E+6*	*628.03E+6*
Rogue River	OR_SR_1710030707_04_105506	596	16.3	13.3	23,768.86E+6	19,394.22E+6

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 always possible to calculate 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 Rogue River Basin represents a wide range of waterbodies; however, not all streams in the Rogue River Basin have monitoring data. Equation 8-2 can be used to determine excess temperature and percent reduction for additional streams if data become available.

The excess temperatures are the maximum differences 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 excess temperature. The percent load reduction calculated with Equation 8-2 is mathematically equal to the percent temperature reduction calculated from monitoring data. This is because Equation 8-2 includes the river flow rate term in both its numerator and denominator; this term thus cancels out when calculating the percent reduction.

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

where,

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

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

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

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

Table 8-2: **Excess temperature and percent load reduction for AUs with available temperature data in the Rogue River Basin (171003). "Criterion + HUA (°C)" values of 13.3 apply during the spawning period of a given AU and values of 16.3 or 18.3 apply during the non-spawning period.**

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
Applegate River	OR_SR_1710030902_02_105599	20.20	13.3	6.9	34.2
Applegate River	OR_SR_1710030902_02_105599	21.20	16.3	4.9	23.1
Beaver Creek	OR_SR_1710030902_02_105600	20.86	13.3	7.56	36.2
Beaver Creek	OR_SR_1710030902_02_105600	26.70	16.3	10.4	39.0
Beaver Creek	OR_SR_1710030902_02_105601	16.47	16.3	0.17	1.0
Applegate River	OR_SR_1710030902_02_105603	18.17	13.3	4.87	26.8
Applegate River	OR_SR_1710030902_02_105603	21.04	16.3	4.74	22.5
Little Applegate River	OR_SR_1710030903_02_105606	18.56	16.3	2.26	12.2
Little Applegate River	OR_SR_1710030903_02_105608	14.89	13.3	1.59	10.7
Little Applegate River	OR_SR_1710030903_02_105608	25.50	16.3	9.2	36.1
Sterling Creek	OR_SR_1710030903_02_105611	20.47	16.3	4.17	20.4
Yale Creek	OR_SR_1710030903_02_105796	14.54	13.3	1.24	8.5
Yale Creek	OR_SR_1710030903_02_105796	20.77	16.3	4.47	21.5
Forest Creek	OR_SR_1710030904_02_105617	15.10	18.3	0	0.0
Applegate River	OR_SR_1710030904_02_105618	17.80	13.3	4.5	25.3
Applegate River	OR_SR_1710030904_02_105618	25.30	18.3	7	27.7
Thompson Creek	OR_SR_1710030904_02_105620	20.30	18.3	2	9.9
Thompson Creek	OR_SR_1710030904_02_105622	24.61	18.3	6.31	25.6
East Fork Williams Creek	OR_SR_1710030905_02_105626	20.74	18.3	2.44	11.8
Williams Creek	OR_SR_1710030905_02_105627	21.79	18.3	3.49	16.0
West Fork Williams Creek	OR_SR_1710030905_02_106342	22.73	18.3	4.43	19.5
West Fork Williams Creek	OR_SR_1710030905_02_106342	19.31	13.3	6.01	TBD
Cheney Creek	OR_SR_1710030906_02_104775	21.40	18.3	3.1	14.5
Murphy Creek	OR_SR_1710030906_02_104777	19.13	18.3	0.83	4.3
Slate Creek	OR_SR_1710030906_02_104779	24.36	18.3	6.06	24.9
Applegate River	OR_SR_1710030906_02_106343	19.10	13.3	5.8	30.4
Applegate River	OR_SR_1710030906_02_106343	27.00	18.3	8.7	32.2
HUC12 Name: Sturgis Fork	OR_WS_171003090105_02_106356	19.37	18.3	1.07	5.5
HUC12 Name: Steve Fork	OR_WS_171003090106_02_106370	17.18	18.3	0	0.0
HUC12 Name: Palmer Creek-Applegate River	OR_WS_171003090201_02_105784	15.67	13.3	2.37	15.1
HUC12 Name: Palmer Creek-Applegate River	OR_WS_171003090201_02_105784	19.31	16.3	3.01	15.6

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
HUC12 Name: Star Gulch-Applegate River	OR_WS_171003090203_02_105786	17.55	16.3	1.25	7.1
HUC12 Name: Upper Little Applegate River	OR_WS_171003090301_02_105787	12.80	13.3	0	0.0
HUC12 Name: Upper Little Applegate River	OR_WS_171003090301_02_105787	13.90	16.3	0	0.0
HUC12 Name: Lower Little Applegate River	OR_WS_171003090304_02_105789	21.10	16.3	4.8	22.7
HUC12 Name: Humbug Creek-Applegate River	OR_WS_171003090403_02_105791	19.67	18.3	1.37	7.0
HUC12 Name: Thompson Creek	OR_WS_171003090404_02_105792	16.86	18.3	0	0.0
HUC12 Name: East Fork Williams Creek	OR_WS_171003090501_02_106364	18.93	18.3	0.63	3.3
HUC12 Name: West Fork Williams Creek	OR_WS_171003090502_02_106357	17.26	18.3	0	0.0
HUC12 Name: Powell Creek-Williams Creek	OR_WS_171003090503_02_106358	12.34	13.3	0	0.0
HUC12 Name: Powell Creek-Williams Creek	OR_WS_171003090503_02_106358	31.65	18.3	13.35	42.2
HUC12 Name: Slate Creek	OR_WS_171003090604_02_104861	21.17	18.3	2.87	13.6
HUC12 Name: Baum Slough-Applegate River	OR_WS_171003090605_02_104862	23.98	18.3	5.68	23.7
Althouse Creek	OR_SR_1710031101_02_104822	19.89	18.3	1.59	8.0
Sucker Creek	OR_SR_1710031102_02_104824	9.92	13.3	0	0.0
Sucker Creek	OR_SR_1710031102_02_104824	19.23	18.3	0.93	4.8
Sucker Creek	OR_SR_1710031102_02_104904	22.46	18.3	4.16	18.5
East Fork Illinois River	OR_SR_1710031103_02_104825	23.51	18.3	5.21	22.2
East Fork Illinois River	OR_SR_1710031103_02_104827	26.64	18.3	8.34	31.3
East Fork Illinois River	OR_SR_1710031103_02_104828	19.23	18.3	0.93	4.8
West Fork Illinois River	OR_SR_1710031104_02_104831	25.09	18.3	6.79	27.1
West Fork Illinois River	OR_SR_1710031104_02_104832	29.89	18.3	11.59	38.8
Deer Creek	OR_SR_1710031105_02_104834	12.60	13.3	0	0.0
Deer Creek	OR_SR_1710031105_02_104834	26.59	18.3	8.29	31.2
Deer Creek	OR_SR_1710031105_02_104835	28.23	18.3	9.93	35.2
McMullin Creek	OR_SR_1710031105_02_104836	22.13	18.3	3.83	17.3
Anderson Creek	OR_SR_1710031105_02_104837	18.87	18.3	0.57	3.0
Josephine Creek	*OR_SR_1710031106_02_104838*	27.97	18.3	9.67	34.6
Illinois River	OR_SR_1710031106_02_104840	18.60	13.3	5.3	28.5
Illinois River	OR_SR_1710031106_02_104840	28.04	18.3	9.74	34.7
Briggs Creek	OR_SR_1710031107_02_104843	22.72	18.3	4.42	19.5
Illinois River	OR_SR_1710031111_02_104645	17.00	13.3	3.7	21.8
Illinois River	OR_SR_1710031111_02_104645	23.84	18.3	5.54	23.2
Lawson Creek	OR_SR_1710031111_02_104648	21.81	18.3	3.51	16.1
HUC12 Name: Middle Sucker Creek	OR_WS_171003110202_02_104881	16.81	18.3	0	0.0

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
HUC12 Name: Grayback Creek	OR_WS_171003110203_02_104882	15.99	18.3	0	0.0
HUC12 Name: Lower Sucker Creek	OR_WS_171003110204_02_104883	18.01	18.3	0	0.0
HUC12 Name: Lower East Fork Illinois River	OR_WS_171003110303_02_104903	19.91	18.3	1.61	8.1
HUC12 Name: Upper West Fork Illinois River	OR_WS_171003110401_02_104911	13.11	13.3	0	0.0
HUC12 Name: Upper West Fork Illinois River	OR_WS_171003110401_02_104911	21.66	16.3	5.36	24.7
HUC12 Name: South Fork Deer Creek	OR_WS_171003110501_02_104887	12.06	13.3	0	0.0
HUC12 Name: South Fork Deer Creek	OR_WS_171003110501_02_104887	15.13	16.3	0	0.0
HUC12 Name: South Fork Deer Creek	OR_WS_171003110501_02_104887	15.61	18.3	0	0.0
HUC12 Name: Lower Deer Creek	OR_WS_171003110504_02_104890	11.42	13.3	0	0.0
HUC12 Name: Lower Deer Creek	OR_WS_171003110504_02_104890	21.32	18.3	3.02	14.2
HUC12 Name: Josephine Creek	OR_WS_171003110602_02_104891	21.53	18.3	3.23	15.0
HUC12 Name: Sixmile Creek-Illinois River	OR_WS_171003110603_02_104892	21.50	18.3	3.2	14.9
HUC12 Name: Rancherie Creek-Illinois River	OR_WS_171003110604_02_104893	23.52	18.3	5.22	22.2
Jumpoff Joe Creek	OR_SR_1710031001_02_104783	31.27	18.3	12.97	41.5
Louse Creek	OR_SR_1710031001_02_106345	20.54	18.3	2.24	10.9
Galice Creek	OR_SR_1710031002_02_104787	19.27	18.3	0.97	5.0
Rogue River	OR_SR_1710031002_04_104794	13.67	13.3	0.37	2.7
Rogue River	OR_SR_1710031002_04_104794	23.87	18.3	5.57	23.3
Grave Creek	OR_SR_1710031003_02_104796	12.71	13.3	0	0.0
Grave Creek	OR_SR_1710031003_02_104796	28.85	18.3	10.55	36.6
Coyote Creek	OR_SR_1710031003_02_104797	24.93	18.3	6.63	26.6
Grave Creek	OR_SR_1710031003_02_104800	28.56	18.3	10.26	35.9
Wolf Creek	OR_SR_1710031003_02_104801	29.13	18.3	10.83	37.2
Reuben Creek	OR_SR_1710031003_02_104802	21.07	18.3	2.77	13.1
Wolf Creek	OR_SR_1710031003_02_104803	23.34	18.3	5.04	21.6
Poorman Creek	OR_SR_1710031003_02_104806	19.17	18.3	0.87	4.5
Grave Creek	OR_SR_1710031003_02_106346	26.13	18.3	7.83	30.0
Whisky Creek	OR_SR_1710031004_02_104811	12.13	13.3	0	0.0
Whisky Creek	OR_SR_1710031004_02_104811	18.70	18.3	0.4	2.1
Rogue River	OR_SR_1710031004_04_104821	13.51	13.3	0.21	1.6
Rogue River	OR_SR_1710031004_04_104821	24.40	18.3	6.1	25.0
Rogue River	OR_SR_1710031005_04_106305	24.70	18.3	6.4	25.9
Rogue River	OR_SR_1710031006_04_104637	26.50	18.3	8.2	30.9
Lobster Creek	OR_SR_1710031007_02_104638	21.32	18.3	3.02	14.2

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
Fall Creek	OR_SR_1710031007_02_104639	17.90	18.3	0	0.0
Lobster Creek	OR_SR_1710031007_02_104640	23.01	18.3	4.71	20.5
Silver Creek	OR_SR_1710031008_02_104642	19.95	18.3	1.65	8.3
Saunders Creek	OR_SR_1710031008_02_104643	17.76	18.3	0	0.0
Rogue River	OR_SR_1710031008_04_104646	24.68	18.3	6.38	25.9
HUC12 Name: Louse Creek	OR_WS_171003100103_02_106361	16.46	18.3	0	0.0
HUC12 Name: Lower Jumpoff Joe Creek	OR_WS_171003100104_02_104864	21.84	18.3	3.54	16.2
HUC12 Name: Stratton Creek-Rogue River	OR_WS_171003100202_02_104866	10.73	13.3	0	0.0
HUC12 Name: Stratton Creek-Rogue River	OR_WS_171003100202_02_104866	20.10	18.3	1.8	9.0
HUC12 Name: Bailey Creek-Rogue River	OR_WS_171003100205_02_104869	19.94	18.3	1.64	8.2
HUC12 Name: Wolf Creek	OR_WS_171003100304_02_106363	18.63	18.3	0.33	1.8
HUC12 Name: Whisky Creek-Rogue River	OR_WS_171003100401_02_104872	11.00	13.3	0	0.0
HUC12 Name: Whisky Creek-Rogue River	OR_WS_171003100401_02_104872	18.24	18.3	0	0.0
HUC12 Name: Howard Creek-Rogue River	OR_WS_171003100402_02_104873	15.32	13.3	2.02	13.2
HUC12 Name: Howard Creek-Rogue River	OR_WS_171003100402_02_104873	20.86	18.3	2.56	12.3
HUC12 Name: Jenny Creek-Rogue River	OR_WS_171003100404_02_104875	13.74	18.3	0	0.0
HUC12 Name: Shasta Costa Creek	OR_WS_171003100601_02_106319	22.58	18.3	4.28	19.0
HUC12 Name: Foster Bar-Rogue River	OR_WS_171003100602_02_104676	21.90	18.3	3.6	16.4
HUC12 Name: North Fork Lobster Creek	OR_WS_171003100701_02_104677	18.86	18.3	0.56	3.0
HUC12 Name: Lobster Creek	OR_WS_171003100702_02_104678	18.18	18.3	0	0.0
HUC12 Name: Copper Canyon-Rogue River	OR_WS_171003100801_02_104679	17.51	18.3	0	0.0
HUC12 Name: Quosatana Creek-Rogue River	OR_WS_171003100802_02_104680	22.41	18.3	4.11	18.3
HUC12 Name: Indian Creek-Rogue River	OR_WS_171003100803_02_104698	20.77	18.3	2.47	11.9
Baldy Creek	OR_SR_1710030801_02_105524	16.53	18.3	0	0.0
Wagner Creek	OR_SR_1710030801_02_105532	14.41	13.3	1.11	7.7
Wagner Creek	OR_SR_1710030801_02_105532	21.16	18.3	2.86	13.5
Griffin Creek	OR_SR_1710030801_02_105544	22.84	18.3	4.54	19.9
Wagner Creek	OR_SR_1710030801_02_105545	15.56	13.3	2.26	14.5
Wagner Creek	OR_SR_1710030801_02_105545	33.00	18.3	14.7	44.5
Wagner Creek	OR_SR_1710030801_02_105545	14.95	13.3	1.65	11.0
Wagner Creek	OR_SR_1710030801_02_105545	21.95	18.3	3.65	16.6
Ashland Creek	OR_SR_1710030801_02_105548	22.03	18.3	3.73	16.9
Emigrant Creek	OR_SR_1710030801_02_105823	17.73	13.3	4.43	25.0
Emigrant Creek	OR_SR_1710030801_02_105823	21.63	18.3	3.33	15.4

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
Bear Creek	OR_SR_1710030801_05_105552	19.89	13.3	6.59	33.1
Bear Creek	OR_SR_1710030801_05_105552	27.01	18.3	8.71	32.2
Ward Creek	OR_SR_1710030802_02_105556	13.29	13.3	0	0.0
Ward Creek	OR_SR_1710030802_02_105556	19.14	18.3	0.84	4.4
Sardine Creek	OR_SR_1710030802_02_105557	14.56	13.3	1.26	8.7
Sardine Creek	OR_SR_1710030802_02_105557	23.33	18.3	5.03	21.6
Rogue River	OR_SR_1710030802_04_105816	21.00	13.3	7.7	36.7
Rogue River	OR_SR_1710030802_04_105816	30.40	16.3	14.1	46.4
Rogue River	OR_SR_1710030802_04_105816	20.30	18.3	2	9.9
Rogue River	OR_SR_1710030802_04_105816	18.90	*XX*	*XX*	*XX*
Cold Creek	OR_SR_1710030803_02_105577	17.03	18.3	0	0.0
West Fork Evans Creek	OR_SR_1710030803_02_105581	10.96	13.3	0	0.0
West Fork Evans Creek	OR_SR_1710030803_02_105581	20.89	18.3	2.59	12.4
Evans Creek	OR_SR_1710030803_02_105583	26.04	18.3	7.74	29.7
Rock Creek	OR_SR_1710030803_02_105584	22.31	18.3	4.01	18.0
West Fork Evans Creek	OR_SR_1710030803_02_105795	13.31	13.3	0.01	0.1
West Fork Evans Creek	OR_SR_1710030803_02_105795	25.90	18.3	7.6	29.3
West Fork Evans Creek	OR_SR_1710030803_02_105795	30.46	*XX*	*XX*	*XX*
Rogue River	OR_SR_1710030804_04_106341	17.20	13.3	3.9	22.7
Rogue River	OR_SR_1710030804_04_106341	22.6	18.3	4.3	19.0
HUC12 Name: Griffin Creek	OR_WS_171003080111_02_105769	13.23	18.3	0	0.0
HUC12 Name: Upper West Fork Evans Creek	OR_WS_171003080302_02_105778	15.64	18.3	0	0.0
Mill Creek	OR_SR_1710030701_02_105459	12.94	18.3	0	0.0
Abbott Creek	OR_SR_1710030701_02_105460	23.21	18.3	4.91	21.2
Flat Creek	OR_SR_1710030701_02_105462	22.12	18.3	3.82	17.3
Rogue River	OR_SR_1710030701_02_105465	16.90	18.3	0	0.0
Muir Creek	OR_SR_1710030701_02_105468	15.37	18.3	0	0.0
Middle Fork Rogue River	OR_SR_1710030702_02_105470	14.43	18.3	0	0.0
Red Blanket Creek	OR_SR_1710030702_02_105471	13.74	18.3	0	0.0
Beaver Dam Creek	OR_SR_1710030702_02_105474	19.65	18.3	1.35	6.9
Rogue River	OR_SR_1710030703_04_105475	13.00	13.3	0	0.0
Rogue River	OR_SR_1710030703_04_105475	14.40	16.3	0	0.0
South Fork Big Butte Creek	OR_SR_1710030704_02_105476	15.80	13.3	2.5	15.8
South Fork Big Butte Creek	OR_SR_1710030704_02_105476	16.60	16.3	0.3	1.8

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
Big Butte Creek	OR_SR_1710030704_02_105477	19.10	13.3	5.8	30.4
Big Butte Creek	OR_SR_1710030704_02_105477	22.61	16.3	6.31	27.9
North Fork Big Butte Creek	OR_SR_1710030704_02_105478	15.14	13.3	1.84	12.2
North Fork Big Butte Creek	OR_SR_1710030704_02_105478	23.16	16.3	6.86	29.6
Willow Creek	OR_SR_1710030704_02_105480	14.01	13.3	0.71	5.1
Willow Creek	OR_SR_1710030704_02_105480	26.3	16.3	10	38.0
West Branch Elk Creek	OR_SR_1710030705_02_105482	16.00	13.3	2.7	16.9
West Branch Elk Creek	OR_SR_1710030705_02_105482	21.50	16.3	5.2	24.2
Elk Creek	OR_SR_1710030705_02_105483	20.90	16.3	4.6	22.0
Elk Creek	OR_SR_1710030705_02_105484	14.94	13.3	1.64	11.0
Elk Creek	OR_SR_1710030705_02_105484	20.35	16.3	4.05	19.9
Elk Creek	OR_SR_1710030705_02_105485	27.40	13.3	14.1	51.5
Elk Creek	OR_SR_1710030705_02_105485	31.50	16.3	15.2	48.3
Sugarpine Creek	OR_SR_1710030705_02_105489	19.96	13.3	6.66	33.4
Sugarpine Creek	OR_SR_1710030705_02_105489	24.32	16.3	8.02	33.0
Sugarpine Creek	*OR_SR_1710030705_02_105490*	16.31	13.3	3.01	18.5
Sugarpine Creek	*OR_SR_1710030705_02_105490*	22.65	16.3	6.35	28.0
Trail Creek	OR_SR_1710030706_02_105492	24.83	13.3	11.53	46.4
Trail Creek	OR_SR_1710030706_02_105492	28.13	16.3	11.83	42.1
West Fork Trail Creek	OR_SR_1710030706_02_105496	18.61	13.3	5.31	28.5
West Fork Trail Creek	OR_SR_1710030706_02_105496	29.87	16.3	13.57	45.4
Reese Creek	OR_SR_1710030707_02_105498	24.76	13.3	11.46	46.3
Reese Creek	OR_SR_1710030707_02_105498	25.19	16.3	8.89	35.3
Indian Creek	OR_SR_1710030707_02_105503	19.24	13.3	5.94	30.9
Indian Creek	OR_SR_1710030707_02_105503	21.56	16.3	5.26	24.4
Rogue River	OR_SR_1710030707_04_105506	14.10	13.3	0.8	5.7
Rogue River	OR_SR_1710030707_04_105506	15.80	16.3	0	0.0
Rogue River	OR_SR_1710030707_04_105507	16.30	13.3	3	18.4
Rogue River	OR_SR_1710030707_04_105507	19.50	16.3	3.2	16.4
Lost Creek	OR_SR_1710030708_02_105508	18.10	13.3	4.8	26.5
Lost Creek	OR_SR_1710030708_02_105508	24.94	16.3	8.64	34.6
Antelope Creek	OR_SR_1710030708_02_105509	25.35	13.3	12.05	47.5
Antelope Creek	OR_SR_1710030708_02_105509	27.94	16.3	11.64	41.7
Lake Creek	OR_SR_1710030708_02_105510	18.03	13.3	4.73	26.2

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
Lake Creek	OR_SR_1710030708_02_105510	24.60	16.3	8.3	33.7
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	24.26	13.3	10.96	45.2
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	23.47	16.3	7.17	30.5
Salt Creek	OR_SR_1710030708_02_105514	14.64	13.3	1.34	9.2
Salt Creek	OR_SR_1710030708_02_105514	22.80	16.3	6.5	28.5
South Fork Little Butte Creek	OR_SR_1710030708_02_105515	15.30	16.3	0	0.0
Dead Indian Creek	OR_SR_1710030708_02_105520	18.53	16.3	2.23	12.0
Little Butte Creek	OR_SR_1710030708_02_105521	26.61	13.3	13.31	50.0
Little Butte Creek	OR_SR_1710030708_02_105521	29.54	16.3	13.24	44.8
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	25.65	13.3	12.35	48.1
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	27.40	16.3	11.1	40.5
HUC12 Name: Muir Creek	OR_WS_171003070102_02_105712	17.93	18.3	0	0.0
HUC12 Name: National Creek-Rogue River	OR_WS_171003070103_02_105713	12.34	18.3	0	0.0
HUC12 Name: Crater Creek	OR_WS_171003070104_02_105714	14.01	18.3	0	0.0
HUC12 Name: Foster Creek-Rogue River	OR_WS_171003070105_02_105715	17.55	18.3	0	0.0
HUC12 Name: Bybee Creek-Rogue River	OR_WS_171003070106_02_105716	18.57	18.3	0.27	1.5
HUC12 Name: Union Creek	OR_WS_171003070108_02_105718	12.91	18.3	0	0.0
HUC12 Name: Castle Creek-Rogue River	OR_WS_171003070109_02_105800	14.78	18.3	0	0.0
HUC12 Name: Abbott Creek	OR_WS_171003070110_02_105719	23.83	18.3	5.53	23.2
HUC12 Name: Upper South Fork Rogue River	OR_WS_171003070201_02_105723	11.61	18.3	0	0.0
HUC12 Name: Imnaha Creek	OR_WS_171003070202_02_105724	11.15	18.3	0	0.0
HUC12 Name: Red Blanket Creek	OR_WS_171003070204_02_105825	15.80	18.3	0	0.0
HUC12 Name: Beaver Dam Creek	OR_WS_171003070206_02_105799	26.91	18.3	8.61	32.0
HUC12 Name: Lower South Fork Rogue River	OR_WS_171003070207_02_105726	10.31	18.3	0	0.0
HUC12 Name: Upper South Fork Big Butte Creek	OR_WS_171003070401_02_105728	14.26	16.3	0	0.0
HUC12 Name: Lower South Fork Big Butte Creek	OR_WS_171003070404_02_105731	16.97	16.3	0.67	3.9
HUC12 Name: North Fork Big Butte Creek	OR_WS_171003070405_02_105732	19.58	16.3	3.28	16.8
HUC12 Name: Upper Big Butte Creek	OR_WS_171003070406_02_105733	14.94	13.3	1.64	11.0
HUC12 Name: Upper Big Butte Creek	OR_WS_171003070406_02_105733	20.71	16.3	4.41	21.3
HUC12 Name: Lower Big Butte Creek	OR_WS_171003070408_02_105735	13.16	13.3	0	0.0
HUC12 Name: Lower Big Butte Creek	OR_WS_171003070408_02_105735	17.67	16.3	1.37	7.8
HUC12 Name: Button Creek-Elk Creek	OR_WS_171003070502_02_105737	19.12	16.3	2.82	14.7
HUC12 Name: West Branch Elk Creek-Elk Creek	OR_WS_171003070505_02_105740	12.80	13.3	0	0.0
HUC12 Name: West Branch Elk Creek-Elk Creek	OR_WS_171003070505_02_105740	17.24	16.3	0.94	5.5

AU Name	AU ID	Max. 7DADM River Temp. (°C)	Criterion + HUA (°C)	Excess Temp. (°C)	Percent Load Reduction
HUC12 Name: Middle South Fork Little Butte Creek	OR_WS_171003070805_02_105751	22.21	16.3	5.91	26.6
HUC12 Name: Lower South Fork Little Butte Creek	OR_WS_171003070806_02_105752	20.36	16.3	4.06	19.9
HUC12 Name: Upper Jenny Creek	OR_WS_180102060401_05_107143	23.81	16.3	7.51	31.5

9. Allocations, reserve capacity, and margin of safety

OAR 340-042-0040(6) identifies the factors that DEQ or EQC may consider when distributing wasteload and load allocations.

The factors include:

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

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

9.1 Human use allowance assignments

The HUA rule 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 9-5 present the HUA portion assigned to each relevant anthropogenic source category in each AU in the TMDL project area. Temperature impacts associated with climate change sources are assigned a zero HUA. See TSD Section 9 for the HUA assignment methodology and additional details.

The HUA assigned to NPDES point sources in each AU represents the maximum cumulative warming allowed anywhere in that AU from all NPDES permittees taken together. Similarly, the HUA portions assigned to various nonpoint source categories represent the maximum cumulative warming allowed anywhere in the AU and at the POMI from all nonpoint source activities in that source category. The HUA assignments in Table 9-1 through Table 9-5 for nonpoint source categories are achieved through the implementation of the load allocations described in Section 9.3 and the surrogate measures described in Section 9.4. 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.

It is unlikely that the maximum HUA for each point and nonpoint source category will be consumed simultaneously in an AU; instead, various sources will typically use their entire HUA at different times; thus, DEQ expects the total warming for each unique point or nonpoint source activity add up to less than the sum of each row's values in Table 9-1 through Table 9-5. DEQ will implement the TMDL in a manner consistent with the HUA rule by requiring all nonpoint sources to implement management strategies to 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. Note that HUA assignments to specific NPDES point sources are presented in Section 9.1.2, and assignments to specific non-point sources in Section 9.1.3.

The "Dam and reservoir operations" source category accounts for nonpoint source temperature impacts associated with dam impoundment and release of impounded water back into the natural channel. Dam and reservoir discharges associated with an NPDES permit are included in the NPDES assigned HUAs (Section 9.1.2). The HUAs for dam and reservoir operations not associated with an NPDES permit are achieved through implementation of the load allocations described in Section 9.1.3 and the temperature target surrogate measure described in Section 9.1.4.1.

The HUA category "Anthropogenic warming from tributaries" accounts for temperature increases in a stream that are caused by point or nonpoint source anthropogenic warming in tributaries to that stream. This category also includes inflow from canals and drains. For each row in Table 9-1 through Table 9-5, the HUA assignments were derived based on all tributaries to the listed AU(s) having a maximum anthropogenic warming of 0.3°C at their mouth.

The background load allocation accounts for warming from background sources (Section 9.1.3, Table 9-8). Other nonpoint source categories include temperature warming associated with climate change, solar loading from streamside vegetation disturbance, and water withdrawals for consumptive uses.

Table 9-1: HUA assignments for source or source categories on assessment units in the Applegate Subbasin (17100309).

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Applegate River	OR_SR_1710030906_02_106343	0.01	0	0	0.01	0.04	0	0.24	0.3
Applegate River	OR_SR_1710030902_02_105603, OR_SR_1710030904_02_105618	0.00	0	0	0.01	0.04	0	0.25	0.3
All other AUs	Applicable AUs are listed in TSD Appendix D	0	0	0	0.01	0.04	0	0.25	0.3

Table 9-2: HUA assignments for source or source categories on assessment units in the Illinois Subbasin (17100311).

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Kerby Ditch	OR_WS_171003110303_02_104903	0.075	0	0	0.05	0.05	0	0.125	0.3
Illinois River	OR_SR_1710031106_02_104840, OR_SR_1710031108_02_106306, OR_SR_1710031111_02_104645	0.1	0	0	0.05	0.05	0	0.1	0.3
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0	0	0.05	0.05	0	0.125	0.3

Table 9-3: HUA assignments for source or source categories on assessment units in the Lower Rogue River Subbasin (17100310).

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Rogue River	OR_SR_1710031008_04_104646, OR_EB_1710031008_01_100280	0.12[a]	0	0.08	0.01	0.04	0	0.05	0.3
Rogue River	OR_SR_1710031006_04_104637	0.16[b]	0	0.04	0.01	0.04	0	0.05	0.3
Rogue River	OR_SR_1710031005_04_106305	0.15[a]	0	0.05[a]	0.01[a]	0.04[a]	0	0.05[a]	0.3
		0.16[b]		0.04[b]	0.01[b]	0.04[b]		0.05[b]	
Rogue River	OR_SR_1710031004_04_104821	0.15[a]	0	0.00[a]	0.01[a]	0.04[a]	0	0.10[a]	0.3
		0.16[b]		0.04[b]	0.01[b]	0.04[b]		0.05[b]	
Rogue River	OR_SR_1710031002_04_104794	0.16[a]	0	0.06[a]	0.01[a]	0.03[a]	0	0.04[a]	0.3
		0.18[b]		0.03[b]	0.01[b]	0.03[b]		0.05[b]	
Lobster Creek	OR_SR_1710031007_02_104640, OR_SR_1710031007_02_104638	0.075	0	0.03	0.05	0.05	0	0.095	0.3
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0	0	0.05	0.05	0	0.125	0.3

[a] Spawning period
[b] Non-spawning period

Table 9-4: HUA assignments for source or source categories on assessment units in the Middle Rogue River Subbasin (17100308).

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Rogue River	OR_SR_1710030802_04_105816	0.16[a]	0	0.00[a]	0.01[a]	0.04[a]	0	0.09[a]	0.3
		0.19[b]		0.01[b]	0.01[b]	0.04[b]		0.05[b]	
Rogue River	OR_SR_1710030804_04_106341	0.20[a]	0	0.05[a]	0.01[a]	0.02[a]	0	0.02[a]	0.3
		0.23[b]		0.01[b]	0.01[b]	0.02[b]		0.03[b]	
Bear Creek	OR_SR_1710030801_05_105552	0.20	0	0.06	0	0	0	0.04	0.3

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Ashland Creek	OR_SR_1710030801_02_105548	0.10	0	N/A	0	0	0	0.2	0.3
Evans Creek and West Fork Evans Creek	OR_SR_1710030803_02_105574, OR_SR_1710030803_02_105581, OR_SR_1710030803_02_105795, OR_SR_1710030803_02_105576, OR_SR_1710030803_02_105583	0.0	0	0.03	0.05	0.05	0	0.17	0.3
Larson Creek-Bear Creek	OR_WS_171003080110_02_105768	0.20	0	0	0.01	0.04	0	0.05	0.3
Whetstone Creek-Rogue River	OR_WS_171003080202_02_105815	0.225	0	0	0.01	0.04	0	0.025	0.3
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0	0	0.05	0.05	0	0.125	0.3

[a] Spawning period
[b] Non-spawning period

Table 9-5: HUA assignments for source or source categories on assessment units in the Upper Rogue River Subbasin (17100307).

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Antelope Creek	OR_SR_1710030708_02_105509	0.075	0	0.042	0.05	0	0	0.133	0.3
Elk Creek	OR_SR_1710030705_02_105485, OR_SR_1710030705_02_105484	0.075	0	0.086	0.05	0	0	0.089	0.3
Rogue River	OR_SR_1710030707_02_105499, OR_SR_1710030703_04_105475, OR_SR_1710030701_02_105465, OR_SR_1710030707_04_105506	0	0	0	0.01	0.04	0	0.25	0.3

Assessment Unit	Assessment Unit ID	NPDES point sources	NPS Dam and reservoir operations	Anthropogenic warming from tributaries	Consumptive use water management and withdrawals	Solar loading: existing transportation corridors, buildings, and utility infrastructure	Solar loading: Other nonpoint sectors	Reserve capacity	Total HUA
Rogue River	OR_SR_1710030707_04_105507	0.06[a] 0.11[b]	0	0.01[a] 0.00[b]	0.01[a] 0.01[b]	0.04[a] 0.04[b]	0	0.18[a] 0.14[b]	0.3
Little Butte Cr. and North Fork Little Butte Cr.	OR_SR_1710030708_02_105521, OR_SR_1710030708_02_105511	0	0	0.04	0.05	0.05	0	0.16	0.3
Lost Creek Lake	OR_LK_1710030703_02_100244	0.2	0	0	0.01	0.04	0	0.05	0.3
Lower Middle Fork Rogue River	OR_WS_171003070205_02_105803	0.075	0	0	0.05	0.05	0	0.125	0.3
Kanutchan Creek- Little Butte Creek	OR_WS_171003070812_02_105758	0.075	0	0	0.05	0.05	0	0.125	0.3
South Fork Butte Creek	OR_SR_1710030708_02_105522, OR_SR_1710030708_02_105515	0	0	0.03	0.05	0.05	0	0.17	0.3
All Other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0	0	0.05	0.05	0	0.125	0.3

[a] Spawning period
[b] Non-spawning period

9.2 Wasteload allocations for point sources

Wasteload allocations for point sources were calculated using **Equation 9-1**.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F \qquad \textbf{Equation 9-1}$$

where,

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

$\Delta T =$ The assigned portion of the HUA from Table 9-6. 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. Table 9-6 includes a note indicating the NPDES permittees for which the 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:
$\frac{1{,}000{,}000\ gallons}{1\ day} \cdot \frac{0.13368 ft^3}{1\ gallon} \cdot \frac{1\ day}{86{,}400\ sec} = 1.5472\ ft^3/sec$

$Q_R =$ 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.

$C_F =$ 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 HUAs assigned to specific NPDES point sources are summarized in Table 9-6. The effluent discharges (Q_E) used to calculate the wasteload allocations presented in Table 9-6 are based on actual discharge data; the average dry weather facility design; or the maximum discharge authorized by an NPDES permit, depending on the information available for each facility. More information on the specific sources of the effluent discharge data and the rationale behind the assigned HUA is described in TSD Section 9.2.

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

(1) Incorporate the 7Q10 wasteload allocation in Table 9-6 as a static numeric limit. Permit writers may recalculate the static limit using different values for 7Q10 (Q_R) and effluent discharge (Q_E), if 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 9-6. Permit writers may recalculate the 7Q10 using seasonal or annual values, as appropriate, if 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. Wasteload allocations in Table 9-6 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 9-6: Thermal wasteload allocations (WLA) assigned to point sources.

NPDES Permittee WQ File Number: EPA Number	WLA period	Applicable Temperature Criteria (°C)	Assigned HUA ΔT (°C)	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcal/day)
ASHLAND STP – Outfall 001 (3780: OR0026255)	4/1 – 11/15	13[3]/18	0.025	1.94	3.559	0.34E+6
ASHLAND STP – Outfall 002 (3780: OR0026255)	4/1 – 11/15	13[3]/18	0.20	4.73	3.559	4.06E+6
ASHLAND WTP (3781: ORG383519)	4/1 – 11/15	13[3]/18	0.075	2.74	0	0.50E+6
BOISE - MEDFORD PLYWOOD – Outfall 001 (9539: OR0000850)	4/1 – 11/15	18	0.20	1.09	0.200	0.63E+6
BOISE - MEDFORD PLYWOOD – Outfall 002 (9539: OR0000850)	4/1 – 11/15	18	0.20	0.167	0.419	0.29E+6
BUTTE FALLS STP (12800: OR0029891)	4/1 – 10/31[4]	13	0.04	33.1	0.382	3.28E+6
CASCADE WOOD PRODUCTS - WHITE CITY (101757: OR0032786)	4/1 – 10/31	13[3]/18	0.075	0	0.014	0.0026E+6
CAVE JUNCTION WASTEWATER TREATMENT FACILITY (15243: OR0028339)	5/1 – 6/30[7]	13[3]/18	0.10	148	0.68	8.96E+6
CAVE JUNCTION WASTEWATER TREATMENT FACILITY (15243: OR0028339)	7/1 – 9/30[5]	18	0.00	148	0.000	0.00E+6
CAVE JUNCTION WASTEWATER TREATMENT FACILITY (15243: OR0028339)	10/1 – 10/31[6]	13[3]/18	0.10	148	0.080	8.96E+6
COUNTRY VIEW MOBILE HOME ESTATES (96385: OR0029661)	5/1 – 10/31	13[2]/16	0.075	0	0.014	0.0026E+6
FLEMING MIDDLE SCHOOL STP (29920: OR0028355)	4/1 – 10/31[4]	18	0.075	0.00	0.056	0.01E+6
GOLD BEACH WTP (109728: ORG383553)	5/1 – 10/31	18	0.005	2070	1.290	25.34E+6

NPDES Permittee WQ File Number: EPA Number	WLA period	Applicable Temperature Criteria (°C)	Assigned HUA ΔT (°C)	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcal/day)
GOLD HILL STP (33901: OR0022594)	4/1 – 10/31	13[3]/18	0.0057	968.6	0.542	13.52E+6
GRANTS PASS STP (34630: OR0028843)	4/1 – 10/31	13[3]/18	0.044	962	33.420	107.12E+6
GRANTS PASS WTP (34631: ORG383508)	4/1 – 10/31	18	0.20	0.0	1.782	0.87E+6
HIDDEN VALLEY HIGH SCHOOL STP (38625: OR0030210)	3/15 – 11/15[4]	13[3]/18	0.01	60.5	0.057	1.48E+6
MEDFORD RWRF (55125: OR0026263)	4/1 – 10/31	13[2]/16	0.15	948	67.6	372.63E+6
ODFW - COLE M. RIVERS HATCHERY (64445: ORG133508)	4/1 – 10/31	13[2]/16	0.00	502	225	0.00E+6*
ROBERT A. DUFF WTP (55370: ORG383504)	4/1 – 10/31	13[2]/16	0.03	948	1.84	69.70E+6
RIVIERA MOBILE PARK (75500: OR0030546)	4/1 – 4/30	13	0.000089	962	0.056	0.21E+6
RIVIERA MOBILE PARK (75500: OR0030546)	5/1 – 10/31	13[3]/18	0	962	0.000	0.00E+6
ROGUE RIVER STP (76030: OR0023043)	4/1 – 10/31	13[3]/18	0.0046	969	1.702	10.81E+6
SHADY COVE STP (80535: OR0030660)	4/1 – 10/31	13[2]/16	0.0092	887	2.360	20.02E+6
U.S Army Corp of Engineers - William L. Jess Dam Project (126718: Not Assigned)	4/1 – 10/31	13[2]/16	0.03	502	3.586	37.11E+6

[1] Listed WLAs were calculated based on the 7Q10 flow.
[2] Criterion applies from Sept. 15th to June 15th.
[3] Criterion applies from Oct. 15th to May 15th.
[4] No discharge permitted May 1st through Oct. 31st per NPDES permit.
[5] No discharge permitted during this period per NPDES permit
[6] Discharge is only permitted under specific conditions per NPDES permit.
[7] In June, discharge is only permitted under specific conditions per NPDES permit.

Notes:
WLA = wasteload allocation; kcals/day = kilocalories/day
* When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0 and WLA = 0 kcal/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 their 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 facility's 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 Sections 9.2.2 through 9.2.9. For this TMDL, DEQ determined the minimum duties provision is applicable to the ODFW Cole M. Rivers Hatchery (64445: ORG133508).

9.2.1 Wasteload allocations for 100-J general permit registrants

The TMDL includes WLA requirements for 100-J general permit registrants. TSD Chapter 7 lists current 100-J general permit registrants in the Rogue River Basin. The WLA for current and future 100-J general permit registrants equals the thermal load allowed by the current 100-J general permit and the TMDL requirements identified in Table 9-7 and Table 9-8. See TSD Section 9.2.3 for additional information.

Table 9-7: Assigned HUA and TMDL requirements for 100-J permit registrants in the Rogue River Basin.

AU Name and ID	Assigned HUA (°C)	Maximum number of registrants per AU*
All stream/river (SR) AUs not listed below	0.075	See **Table 9-9**
All watershed (WS) AUs not listed below	0.075	1
Military Slough ; OR_WS_171003080202_02_105815	0.150	2

***Additional 100-J registrants are allowed above the maximum if they do not increase stream temperature above the applicable criteria or reserve capacity is assigned.**

Table 9-8: TMDL requirements for 100-J registrants on stream/river (SR) AUs in the Rogue River Basin not listed in Table 9-7.

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

***Additional 100-J registrants are allowed above the maximum if they do not increase stream temperature above the applicable criteria or reserve capacity is assigned.**

9.3 Load allocations for nonpoint sources

OAR 340-042-0040(4)(h) defines load allocations as the portions of the receiving water's loading capacity that are allocated to existing nonpoint sources, including runoff, deposition, soil contamination and groundwater discharges, or to background sources. Load allocations are best estimates of loading and may range from reasonably accurate estimates to gross allotments depending on the availability of data and appropriate techniques for predicting loading. Whenever reasonably feasible, natural background, long-range transport and anthropogenic nonpoint source loads will be distinguished from each other.

Load allocations assigned to background sources on each AU are calculated with 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).

$T_C =$ 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

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

Table 9-9 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 locations in the Rogue River Basin not identified in Table 9-9 or on any AUs identified in Table 9-9 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

Load allocations assigned to anthropogenic nonpoint sources on each AU are calculated with Equation 9-3. Section 9.1 presents the HUA (ΔT) portions assigned to nonpoint sources or source categories. When all 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).

$\Delta T =$ The portion of the HUA assigned to each nonpoint source or source category representing the maximum cumulative temperature increase (°C) from the

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

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

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

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

Table 9-9: Thermal load allocations (LA) assigned to background sources.

AU Name	AU ID	Annual 7Q10 (cfs)	Year-round criterion	Spawning criterion	7Q10 LC year-round (kcal/day)	7Q10 LC spawning (kcal/day)
Mill Creek	OR_SR_1710030701_02_105459	TBD	18	NA	-	NA
North Fork Diversion Reservoir	OR_LK_1710030701_02_100236	431	18	NA	18,981.23E+6	NA
Rogue River	OR_EB_1710031008_01_100280	2120	18	NA	93,364.74E+6	NA
Rogue River	OR_SR_1710030701_02_105465	759	18	NA	33,426.34E+6	NA
Rogue River	OR_SR_1710030703_04_105475	687	16	13	26,893.74E+6	21,851.17E+6
Big Butte Creek	OR_SR_1710030704_02_105477	33.1	16	13	1,296.33E+6	1,053.27E+6
Elk Creek	OR_SR_1710030705_02_105484	4.03	16	13	157.76E+6	128.18E+6
Elk Creek	OR_SR_1710030705_02_105485	0.32	16	13	12.44E+6	10.11E+6
Rogue River	OR_SR_1710030707_04_105507	869	16	13	34,007.97E+6	27,631.47E+6
Antelope Creek	OR_SR_1710030708_02_105509	0.49	16	13	19.03E+6	15.46E+6
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	5.87	16	13	229.79E+6	186.71E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105515	17.8	16	13	696.81E+6	566.16E+6
Antelope Creek	OR_SR_1710030708_02_105519	0.21	16	13	8.30E+6	6.74E+6
Little Butte Creek	OR_SR_1710030708_02_105521	18.4	16	13	720.30E+6	585.24E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	29.0	16	13	1,135.25E+6	922.39E+6
Ashland Creek	OR_SR_1710030801_02_105548	1.94	18	13	85.44E+6	61.7E+6
Bear Creek	OR_SR_1710030801_05_105552	6.12	18	13	269.52E+6	194.66E+6
Rogue River	OR_SR_1710030802_04_105816	956	16	13	37,419.56E+6	30,403.39E+6
West Fork Evans Creek	OR_SR_1710030803_02_105574	0.67	18	13	29.33E+6	21.18E+6
Evans Creek	OR_SR_1710030803_02_105576	0.40	18	13	17.48E+6	12.63E+6
West Fork Evans Creek	OR_SR_1710030803_02_105581	0.73	18	13	32.11E+6	23.19E+6
Evans Creek	OR_SR_1710030803_02_105583	0.79	18	13	34.66E+6	25.03E+6
West Fork Evans Creek	OR_SR_1710030803_02_105795	5.64	18	13	248.39E+6	179.39E+6
Rogue River	OR_SR_1710030804_04_106341	955	18	13	42,044.32E+6	30,365.34E+6
Applegate River	OR_SR_1710030902_02_105599	80.0	16	13	3,129.83E+6	2,542.99E+6
Applegate River	OR_SR_1710030902_02_105603	32.8	16	13	1,284.01E+6	1,043.26E+6
Applegate River	OR_SR_1710030904_02_105618	71.4	18	13	3,144.97E+6	2,271.37E+6
Applegate River	OR_SR_1710030906_02_106343	62.8	18	13	2,764.73E+6	1,996.75E+6
Rogue River	OR_SR_1710031002_04_104794	533	18	13	23,473.30E+6	16,952.94E+6
Rogue River	OR_SR_1710031004_04_104821	623	18	13	27,436.90E+6	19,815.54E+6
Rogue River	OR_SR_1710031005_04_106305	698	18	13	30,739.90E+6	22,201.04E+6
Rogue River	OR_SR_1710031006_04_104637	1137	18	NA	50,088.38E+6	NA
Lobster Creek	OR_SR_1710031007_02_104638	15.0	18	13	660.60E+6	477.10E+6
Lobster Creek	OR_SR_1710031007_02_104640	12.3	18	13	541.69E+6	391.22E+6

AU Name	AU ID	Annual 7Q10 (cfs)	Year-round criterion	Spawning criterion	7Q10 LC year-round (kcal/day)	7Q10 LC spawning (kcal/day)
Rogue River	OR_SR_1710031008_04_104646	2080	18	NA	91,603.14E+6	NA
Illinois River	OR_SR_1710031106_02_104840	50.2	18	13	2,210.81E+6	1,596.69E+6
HUC12 Name: Indian Creek-Rogue River	OR_WS_171003070702_02_105745	887	16	13	34,723.07E+6	28,212.49E+6
HUC12 Name: Kanutchan Creek-Little Butte Creek	OR_WS_171003070812_02_105758	18.4	16	13	720.30E+6	585.24E+6
HUC12 Name: Larson Creek-Bear Creek	OR_WS_171003080110_02_105768	11.4	18	13	502.06E+6	362.60E+6
HUC12 Name: Whetstone Creek-Rogue River	OR_WS_171003080202_02_105815	948	16	13	37,111.01E+6	30,152.7E+6
HUC12 Name: Louse Creek	OR_WS_171003100103_02_106361	0.171	18	13	7.53E+6	5.44E+6
HUC12 Name: Lower East Fork Illinois River	OR_WS_171003110303_02_104903	19.3	18	13	849.97E+6	613.87E+6
Rogue River	OR_SR_1710030707_04_105506	596	16	13	23,331.40E+6	18,956.76E+6
Illinois River	OR_SR_1710031108_02_106306	73.3	18	13	3,228.13E+6	2,331.43E+6
Illinois River	OR_SR_1710031111_02_104645	121	18	13	5,328.84E+6	3,848.60E+6
Rogue River	OR_SR_1710030707_02_105499	?	?	?		
Lost Creek Lake	OR_LK_1710030703_02_100244	696	18	NA	30,651.82E+6	NA
HUC12 Name: Lower Middle Fork Rogue River	OR_WS_171003070205_02_105803	113	18	NA	4,976.52E+6	NA

Table 9-10: Thermal load allocations (LA) assigned to anthropogenic nonpoint sources. Values reflect LA for entire critical period except where LAs differ between spawning and non-spawning periods (indicated by footnotes).

AU Name	AU ID	7Q10 LA Dam and reservoir operations (kcal/day)	7Q10 LA Anthropogenic warming from tributaries (kcal/day)	7Q10 LA Consumptive use water management and water withdrawals (kcal/day)	7Q10 LA Solar loading from existing transportation corridors, buildings, and utility infrastructure (kcal/day)	7Q10 LA Solar loading from other NPS sectors (kcal/day)
Mill Creek	OR_SR_1710030701_02_105459	*0.00E+6*	0.00E+6	1.71E+6	1.71E+6	0.00E+6
N. Fork Diversion Reservoir	OR_LK_1710030701_02_100236	*0.00E+6*	0.00E+6	52.73E+6	52.73E+6	0.00E+6
Estuary: Mainstem	OR_EB_1710031008_01_100280	*0.00E+6*	414.95E+6	51.87E+6	207.48E+6	0.00E+6
Rogue River	OR_SR_1710030701_02_105465	*0.00E+6*	0.00E+6	18.57E+6	74.28E+6	0.00E+6
Rogue River	OR_SR_1710030703_04_105475	*0.00E+6*	0.00E+6	16.81E+6	67.23E+6	0.00E+6

AU Name	AU ID	7Q10 LA Dam and reservoir operations (kcal/day)	7Q10 LA Anthropogenic warming from tributaries (kcal/day)	7Q10 LA Consumptive use water management and water withdrawals (kcal/day)	7Q10 LA Solar loading from existing transportation corridors, buildings, and utility infrastructure (kcal/day)	7Q10 LA Solar loading from other NPS sectors (kcal/day)
Big Butte Creek	OR_SR_1710030704_02_105477	*0.00E+6*	0.00E+6	4.05E+6	4.05E+6	0.00E+6
Elk Creek	OR_SR_1710030705_02_105484	*0.00E+6*	0.85E+6	0.49E+6	0.00E+6	0.00E+6
Elk Creek	OR_SR_1710030705_02_105485	*0.00E+6*	0.07E+6	0.04E+6	0.00E+6	0.00E+6
Rogue River	OR_SR_1710030707_04_105507 A	*0.00E+6*	21.25E+6	21.25E+6	85.02E+6	0.00E+6
Rogue River	OR_SR_1710030707_04_105507 B	*0.00E+6*	0.00E+6	21.25E+6	85.02E+6	0.00E+6
Antelope Creek	OR_SR_1710030708_02_105509	*0.00E+6*	0.05E+6	0.06E+6	0.00E+6	0.00E+6
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	*0.00E+6*	0.57E+6	0.72E+6	0.72E+6	0.00E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105515	*0.00E+6*	1.31E+6	2.18E+6	2.18E+6	0.00E+6
Antelope Creek	OR_SR_1710030708_02_105519	*0.00E+6*	0.00E+6	0.03E+6	0.03E+6	0.00E+6
Little Butte Creek	OR_SR_1710030708_02_105521	*0.00E+6*	1.8E+6	2.25E+6	2.25E+6	0.00E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	*0.00E+6*	2.13E+6	3.55E+6	3.55E+6	0.00E+6
Ashland Creek	OR_SR_1710030801_02_105548	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
Bear Creek	OR_SR_1710030801_05_105552	*0.00E+6*	0.00E+6	0.9E+6	0.00E+6	0.00E+6
Rogue River	OR_SR_1710030802_04_105816A	*0.00E+6*	0.00E+6	23.39E+6	93.55E+6	0.00E+6
Rogue River	OR_SR_1710030802_04_105816B	*0.00E+6*	23.39E+6	23.39E+6	93.55E+6	0.00E+6
West Fork Evans Creek	OR_SR_1710030803_02_105574	*0.00E+6*	0.05E+6	0.08E+6	0.08E+6	0.00E+6
Evans Creek	OR_SR_1710030803_02_105576	*0.00E+6*	0.03E+6	0.05E+6	0.05E+6	0.00E+6
West Fork Evans Creek	OR_SR_1710030803_02_105581	*0.00E+6*	0.05E+6	0.09E+6	0.09E+6	0.00E+6
Evans Creek	OR_SR_1710030803_02_105583	*0.00E+6*	0.06E+6	0.1E+6	0.1E+6	0.00E+6
West Fork Evans Creek	OR_SR_1710030803_02_105795	*0.00E+6*	0.41E+6	0.69E+6	0.69E+6	0.00E+6
Rogue River	OR_SR_1710030804_04_106341 A	*0.00E+6*	116.79E+6	23.36E+6	46.72E+6	0.00E+6
Rogue River	OR_SR_1710030804_04_106341 B	*0.00E+6*	23.36E+6	23.36E+6	46.72E+6	0.00E+6
Applegate River	OR_SR_1710030902_02_105599	*0.00E+6*	0.00E+6	1.96E+6	7.82E+6	0.00E+6
Applegate River	OR_SR_1710030902_02_105603	*0.00E+6*	0.00E+6	0.8E+6	3.21E+6	0.00E+6
Applegate River	OR_SR_1710030904_02_105618	*0.00E+6*	0.00E+6	1.75E+6	6.99E+6	0.00E+6
Applegate River	OR_SR_1710030906_02_106343	*0.00E+6*	0.00E+6	1.54E+6	6.14E+6	0.00E+6
Rogue River	OR_SR_1710031002_04_104794 A	*0.00E+6*	78.24E+6	13.04E+6	39.12E+6	0.00E+6
Rogue River	OR_SR_1710031002_04_104794 B	*0.00E+6*	39.12E+6	13.04E+6	39.12E+6	0.00E+6
Rogue River	OR_SR_1710031004_04_104821 A	*0.00E+6*	0.00E+6	15.24E+6	60.97E+6	0.00E+6

AU Name	AU ID	7Q10 LA Dam and reservoir operations (kcal/day)	7Q10 LA Anthropogenic warming from tributaries (kcal/day)	7Q10 LA Consumptive use water management and water withdrawals (kcal/day)	7Q10 LA Solar loading from existing transportation corridors, buildings, and utility infrastructure (kcal/day)	7Q10 LA Solar loading from other NPS sectors (kcal/day)
Rogue River	OR_SR_1710031004_04_104821[B]	*0.00E+6*	60.97E+6	15.24E+6	60.97E+6	0.00E+6
Rogue River	OR_SR_1710031005_04_106305[A]	*0.00E+6*	85.39E+6	17.08E+6	68.31E+6	0.00E+6
Rogue River	OR_SR_1710031005_04_106305[B]	*0.00E+6*	68.31E+6	17.08E+6	68.31E+6	0.00E+6
Rogue River	OR_SR_1710031006_04_104637	*0.00E+6*	111.31E+6	27.83E+6	111.31E+6	0.00E+6
Lobster Creek	OR_SR_1710031007_02_104638	*0.00E+6*	1.1E+6	1.83E+6	1.83E+6	0.00E+6
Lobster Creek	OR_SR_1710031007_02_104640	*0.00E+6*	0.9E+6	1.5E+6	1.5E+6	0.00E+6
Rogue River	OR_SR_1710031008_04_104646	*0.00E+6*	407.13E+6	50.89E+6	203.56E+6	0.00E+6
Illinois River	OR_SR_1710031106_02_104840	*0.00E+6*	0.00E+6	6.14E+6	6.14E+6	0.00E+6
HUC12 Name: Indian Creek-Rogue River	OR_WS_171003070702_02_105745	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
HUC12 Name: Kanutchan Creek-Little Butte Creek	OR_WS_171003070812_02_105758	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
HUC12 Name: Larson Creek-Bear Creek	OR_WS_171003080110_02_105768	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
HUC12 Name: Whetstone Creek-Rogue River	OR_WS_171003080202_02_105815	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
HUC12 Name: Louse Creek	OR_WS_171003100103_02_106361	*0.00E+6*	0.00E+6	0.02E+6	0.02E+6	0.00E+6
HUC12 Name: Lower East Fork Illinois River	OR_WS_171003110303_02_104903	*0.00E+6*	0.00E+6	0.00E+6	0.00E+6	0.00E+6
Rogue River	OR_SR_1710030707_04_105506	*0.00E+6*	0.00E+6	14.58E+6	58.33E+6	0.00E+6
Illinois River	OR_SR_1710031108_02_106306	*0.00E+6*	0.00E+6	8.97E+6	8.97E+6	0.00E+6
Illinois River	OR_SR_1710031111_02_104645	*0.00E+6*	0.00E+6	14.8E+6	14.8E+6	0.00E+6
Rogue River	OR_SR_1710030707_02_105499	*0.00E+6*	0.00E+6	?	?	?
Lost Creek Lake	OR_LK_1710030703_02_100244	*0.00E+6*	0.00E+6	17.03E+6	68.12E+6	0.00E+6
HUC12 Name: Lower Middle Fork Rogue River	OR_WS_171003070205_02_105803	*0.00E+6*	0.00E+6	*13.82E+6*	*13.82E+6*	0.00E+6

[A] Spawning period
[B] Non-spawning period

9.4 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 the surrogate measure that implement the load allocations.

9.4.1 Dam and reservoir operations

Dam and reservoir operations have been assigned 0.00°C of the HUA (Section 9.1) and the equivalent load allocation as calculated 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 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 show that 7DADM temperatures do not exceed the applicable temperature criteria 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;
    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.

To implement 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 is not influenced by the dam's operations.

9.4.2 Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in Table 9-11 through Table 9-23 represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for

nonpoint sources that manage 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 correction. 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 to the target effective shade values presented in Table 9-11 through Table 9-23 may result in redistribution of the sector or source responsible for excess load reduction. If the shade target value increases, the equivalent portion of the excess load is reassigned from background sources to nonpoint sources. If the shade target value 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 values do not impact the loading capacity, HUA, or 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 9-11: 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
Antelope Creek	10.2	42	82	40
Bear Creek	44.6	27	74	47
Elk Creek	22.6	46	81	35
Evans Creek and West Fork Evans Creek	59.7	42	82	41
Little Butte Creek and North Fork Little Butte Creek	54.4	57	83	26
Lobster Creek	15.4	42	73	31
Rogue River	240.0	9	24	15
South Fork Little Butte Creek	28.6	46	79	33

Table 9-12: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Antelope Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
Jackson County	1.6	34	79	45
Oregon Department of Agriculture	8.4	43	83	40
Oregon Department of Fish and Wildlife	0.2	47	60	13

Table 9-13: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Bear Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
City of Ashland	2.8	36	86	50
City of Central Point	0.6	6	65	59
City of Medford	9.9	31	77	46
City of Phoenix	1.4	43	82	39
City of Talent	1	16	73	57
Jackson County	15	21	67	46
Oregon Department of Agriculture	5.8	31	81	50
Oregon Department of Fish and Wildlife	1	9	55	46
Oregon Department of Transportation	7	31	78	47

Table 9-14: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Elk Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
Jackson County	2.3	51	82	31
Oregon Department of Agriculture	1.3	34	85	51
Oregon Department of Forestry - Private	5.1	64	89	25
U.S. Army Corps of Engineers	12.2	35	77	42
U.S. Bureau of Land Management	1.7	73	91	18

Table 9-15: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Evans Creek and West Fork Evans Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
City of Rogue River	1.4	20	60	40
Jackson County	9.7	31	73	42
Oregon Department of Agriculture	9.7	29	73	44
Oregon Department of Forestry - Private	22.9	44	86	42
Oregon Department of Transportation	0.2	13	48	35
U.S. Bureau of Land Management	15.9	55	91	36

Table 9-16: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Little Butte Creek and North Fork Little Butte Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
City of Eagle Point	2.6	28	67	39
Jackson County	6.2	37	79	42
Oregon Department of Agriculture	22	55	84	29
Oregon Department of Fish and Wildlife	4.4	29	64	35
Oregon Department of Forestry - Private	4.6	77	95	18
Oregon Department of Transportation	2.4	66	94	28
Oregon Parks and Recreation Department	0.2	3	28	25
U.S. Bureau of Land Management	4.4	92	97	5
U.S. Forest Service	7	72	87	15

Table 9-17: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Lobster Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
Oregon Department of Forestry - Private	14.5	43	74	31
U.S. Forest Service	0.9	23	57	34

Table 9-18: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the Rogue River model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
Central Oregon & Pacific Railroad	1	2	16	14
City of Gold Hill	1	4	33	29
City of Grants Pass	4.5	1	6	5
City of Shady Cove	5	12	29	17
Curry County	13	11	22	11
Jackson County	29	4	27	23
Josephine County	21	4	18	14
Oregon Department of Agriculture	17.5	4	19	15
Oregon Department of Fish and Wildlife	3	1	8	7
Oregon Department of Forestry - Private	15	5	22	17
Oregon Department of Forestry - Public	2	10	21	11
Oregon Department of Geology and Mineral Industries	0.5	1	1	0
Oregon Department of State Lands	0.5	19	35	16
Oregon Department of Transportation	14.5	3	27	24
Oregon Parks and Recreation Department	1.5	1	6	5
U.S. Bureau of Land Management	49	13	28	15
U.S. Forest Service	46.5	17	33	16

Table 9-19: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in the South Fork Little Butte Creek model area.

DMA	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
Jackson County	2.9	50	76	26
Oregon Department of Agriculture	9.5	30	67	37
Oregon Department of Forestry - Private	5.3	48	83	35
U.S. Bureau of Land Management	8.3	53	85	32
U.S. Forest Service	2.6	73	94	21

Table 9-20: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for modeled Evans Creek and West Fork Evans Creek AUs.

AU ID	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
OR_SR_1710030803_02_105574	9.5	55	94	39
OR_SR_1710030803_02_105581	5.5	42	92	50
OR_SR_1710030803_02_105795	42.3	36	78	42
OR_WS_171003080302_02_105778	2.5	82	96	14

Table 9-21: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for modeled Little Butte Creek AUs.

AU ID	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
OR_SR_1710030708_02_105511	8.8	67	94	27
OR_SR_1710030708_02_105521	27.4	41	74	33
OR_SR_1710030708_02_105522	0.6	25	82	57
OR_WS_171003070801_02_105747	12	74	90	16
OR_WS_171003070802_02_105748	5.6	82	96	14

Table 9-22: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for modeled Rogue River AUs.

AU ID	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
OR_SR_1710030707_04_105506	4	3	29	26
OR_SR_1710030707_04_105507	31.5	8	26	18
OR_SR_1710030802_04_105816	35	3	27	24
OR_SR_1710030804_04_106341	25.5	2	15	13
OR_SR_1710031002_04_104794	42.5	7	16	9
OR_SR_1710031004_04_104821	32	16	37	21
OR_SR_1710031005_04_106305	22	25	42	17
OR_SR_1710031006_04_104637	12	13	28	15
OR_SR_1710031008_04_104646	35.5	6	13	7

Table 9-23: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for modeled South Fork Little Butte Creek AUs.

AU ID	Total kilometers assessed	Assessed effective shade (%)	TMDL target effective shade (%)	Shade Gap
OR_SR_1710030708_02_105515	7.4	56	91	35
OR_SR_1710030708_02_105522	21	42	74	32
OR_WS_171003070803_02_105749	0.2	96	98	2

9.4.3 Effective shade curve surrogate measure

(Note: This section will be completed as part of the final draft TMDL.)

Effective shade surrogate measure targets represent a surrogate for the solar loading that will attain the HUA and load allocations for nonpoint sources that manage streamside vegetation. *Effective shade curves* are applicable to any stream without defined site-specific shade targets (Section 9.4.2). Effective shade curves represent the maximum possible effective shade for a given vegetation type over certain geographic conditions. The values presented in the effective shade curves (Figure XX to Figure YY) represent the mean effective shade targets for different mapping units, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer widths associated with each mapping unit are summarized in Table 9-24. See the TSD Appendices X and Y for additional details on the model approach for shade curves and the methodologies used to determine the mapping units and vegetation characteristics. Section 13 of this TMDL document provides tables of the plotted shade curve values. A map of

all mapping units in the Rogue River Basin can be found in the TSD Appendix X. 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 9-24: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets for each mapping unit.

Mapping Unit	Landcover code	Vegetation type	Height (m)	Density (%)	Overhang (m)	Buffer Width (m)
1b - Coastal Uplands	100	Conifer	41.1	80%	0.0	36.8
1b - Coastal Uplands	101	Hardwood	27.4	70%	0.0	36.8
1b - Coastal Uplands	102	Mixed	30.5	75%	0.0	36.8
1h - Southern Oregon Coastal Mountains	200	Mixed	48.8	70%	0.0	36.8
4d - Cascade Subalpine/ Alpine	201	Herbaceous plants	0.2	50%	0.0	36.8
4e - High Southern Cascades Montane Forest	202	Conifer	42.7	70%	0.0	36.8
4e - High Southern Cascades Montane Forest	300	Mixed	14.9	80%	0.0	36.8
4g - Southern Cascades	301	Hardwood	14.9	80%	0.0	36.8
4g - Southern Cascades	302	Conifer	56.4	70%	0.0	36.8
4g - Southern Cascades	303	Mixed	35.7	75%	0.0	36.8
78a - Rogue/Illinois Valleys	400	Hardwood	28.2	70%	0.0	36.8
78a - Rogue/Illinois Valleys	500	Conifer	46.0	80%	0.0	36.8
78a - Rogue/Illinois Valleys	501	Mixed	37.1	75%	0.0	36.8
78b - Siskiyou Foothills	502	Mixed	42.1	70%	0.0	36.8
78b - Siskiyou Foothills	600	Hardwood	29.3	85%	0.0	36.8
78b - Siskiyou Foothills	601	Conifer	51.8	80%	0.0	36.8
78d - Serpentine Siskiyous	602	Mixed	36.0	52%	0.0	36.8
78d - Serpentine Siskiyous	700	Willows	4.6	90%	0.0	36.8
78e - Inland Siskiyous	701	Mixed	42.1	70%	0.0	36.8
78e - Inland Siskiyous	702	Hardwood	29.3	85%	0.0	36.8
78e - Inland Siskiyous	800	Conifer	53.6	80%	0.0	36.8
78e - Inland Siskiyous	801	Willows	4.6	90%	0.0	36.8
78f - Coastal Siskiyous	802	Hardwood	27.4	70%	0.0	36.8
78f - Coastal Siskiyous	900	Conifer	57.0	70%	0.0	36.8
78f - Coastal Siskiyous	901	Mixed	42.2	70%	0.0	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 XX Creek watershed, in the City of XX, along the west bank of a tributary to the XX River. Open the Rogue River Basins Interactive TMDL Map (TSD Appendix X) 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 XX).

Figure XY: Mapping units in the example area of interest from the Rogue River Basin 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 XX). 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%.

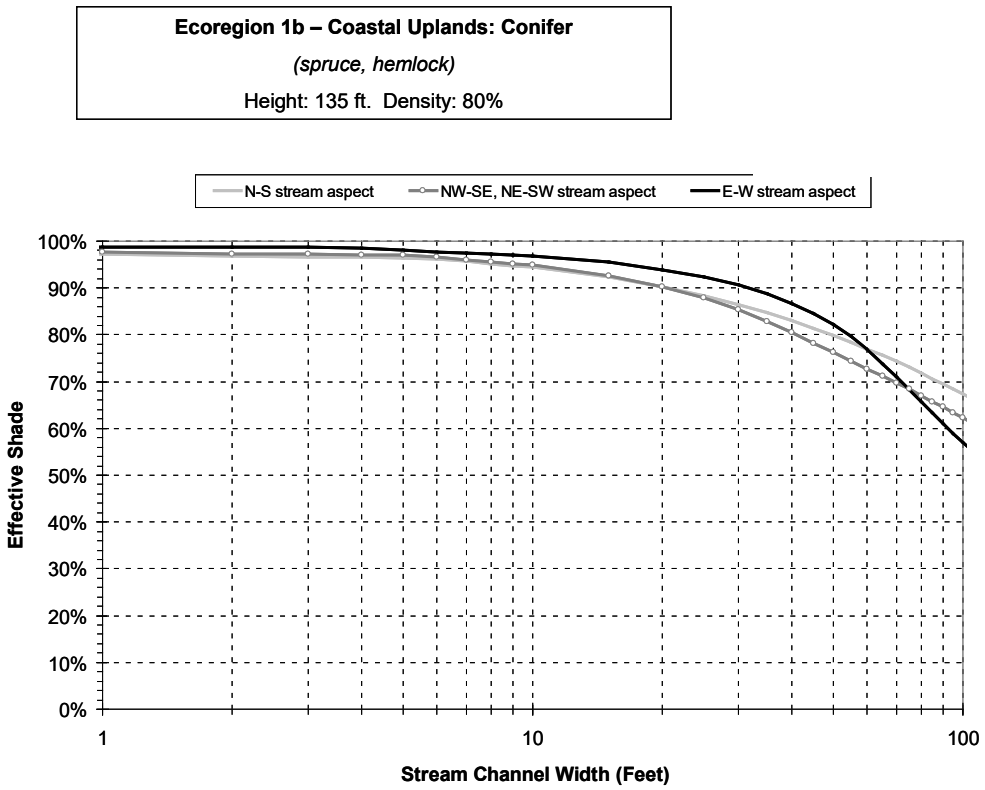

Figure 9-1: Effective shade curve for ecoregion 1b - Coastal uplands conifer.

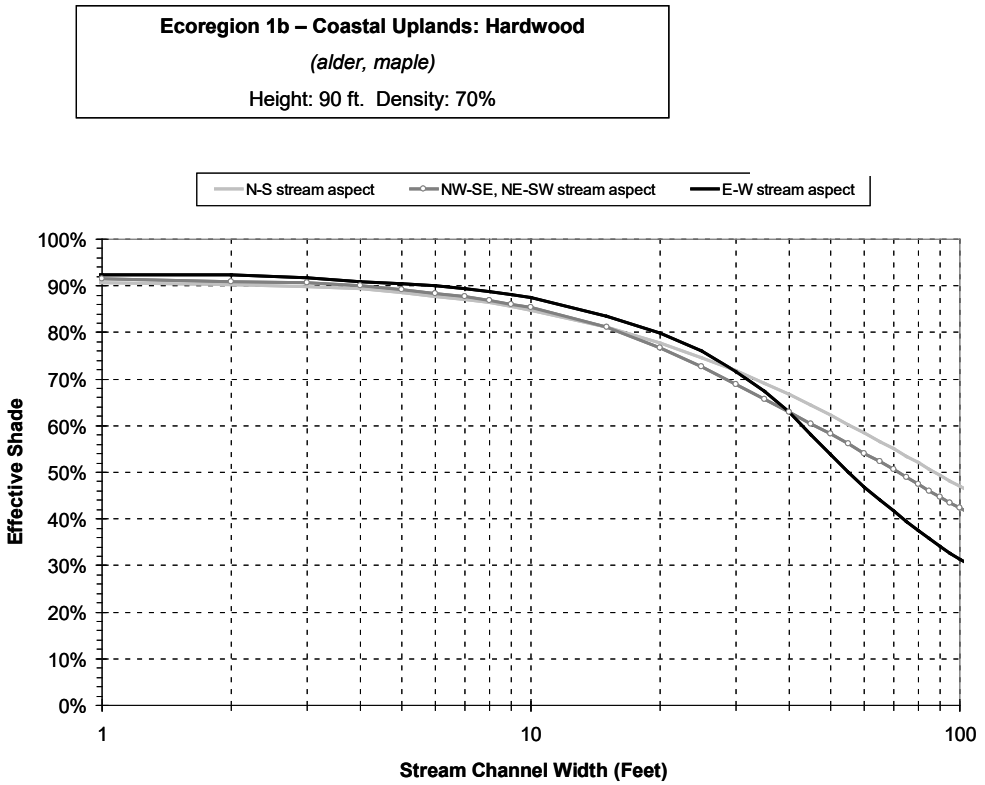

Figure 9-2: Effective shade curve for ecoregion 1b - Coastal uplands hardwood

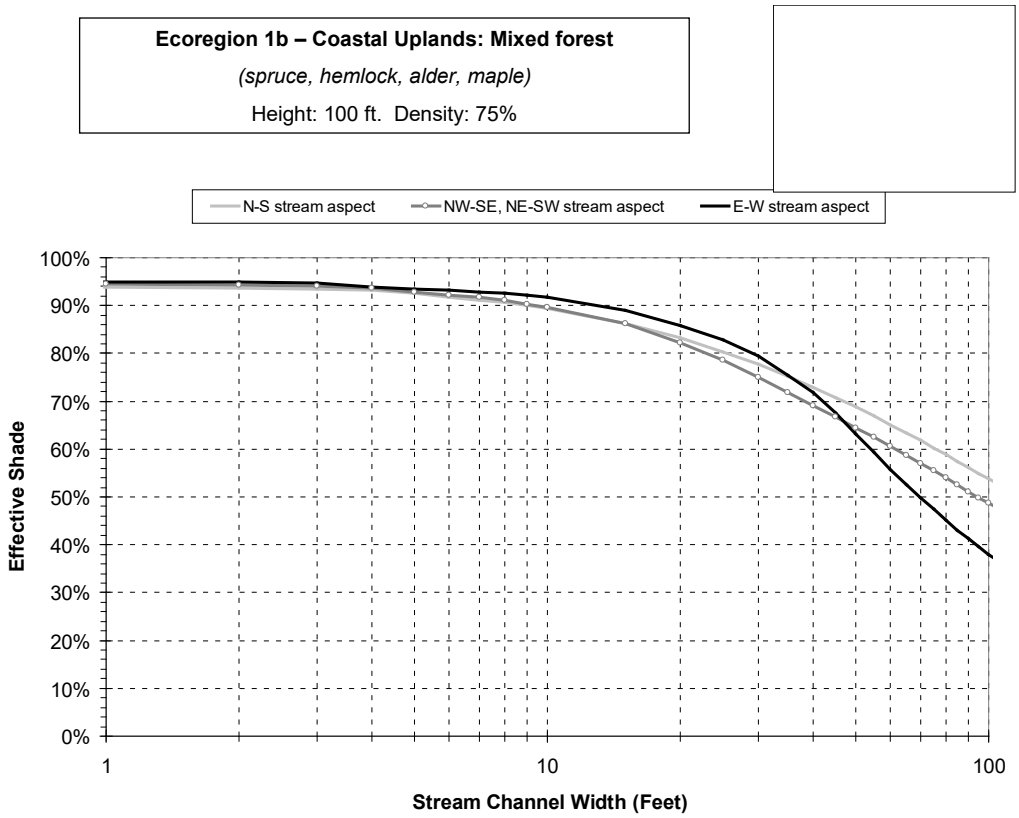

Figure 9-3: Effective shade curve for ecoregion 1b - Coastal uplands mixed forest.

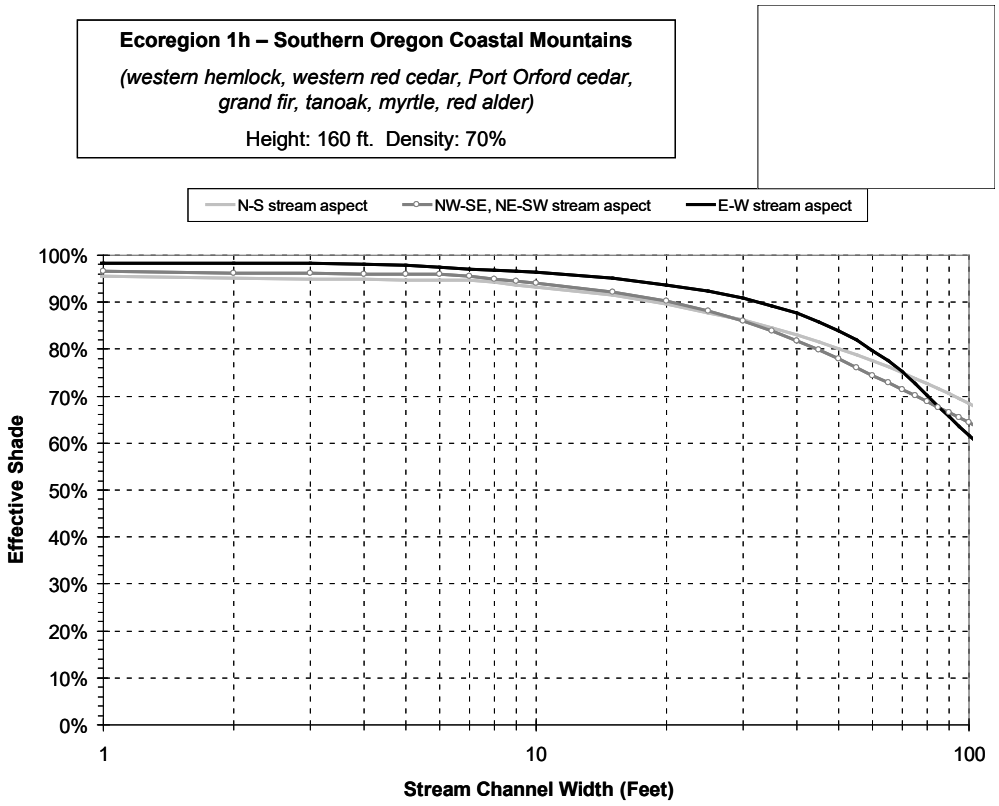

Figure 9-4: Effective shade curve for ecoregion 1h - Southern Oregon coastal mountains.

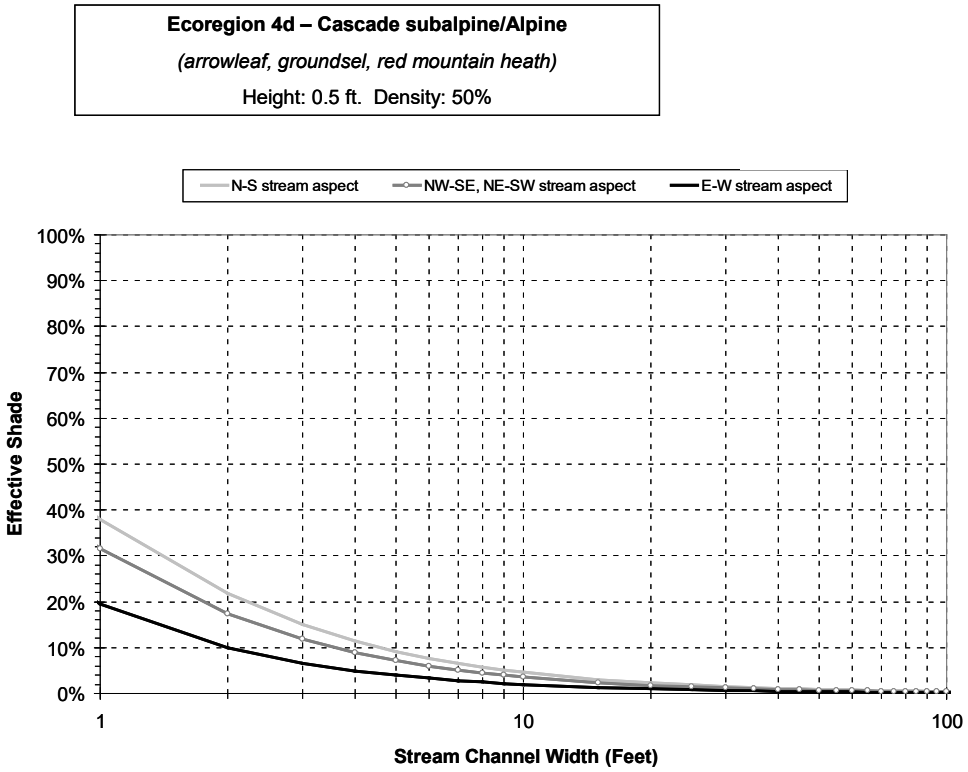

Figure 9-5: Effective shade curve for ecoregion 4d - Cascade subalpine/alpine.

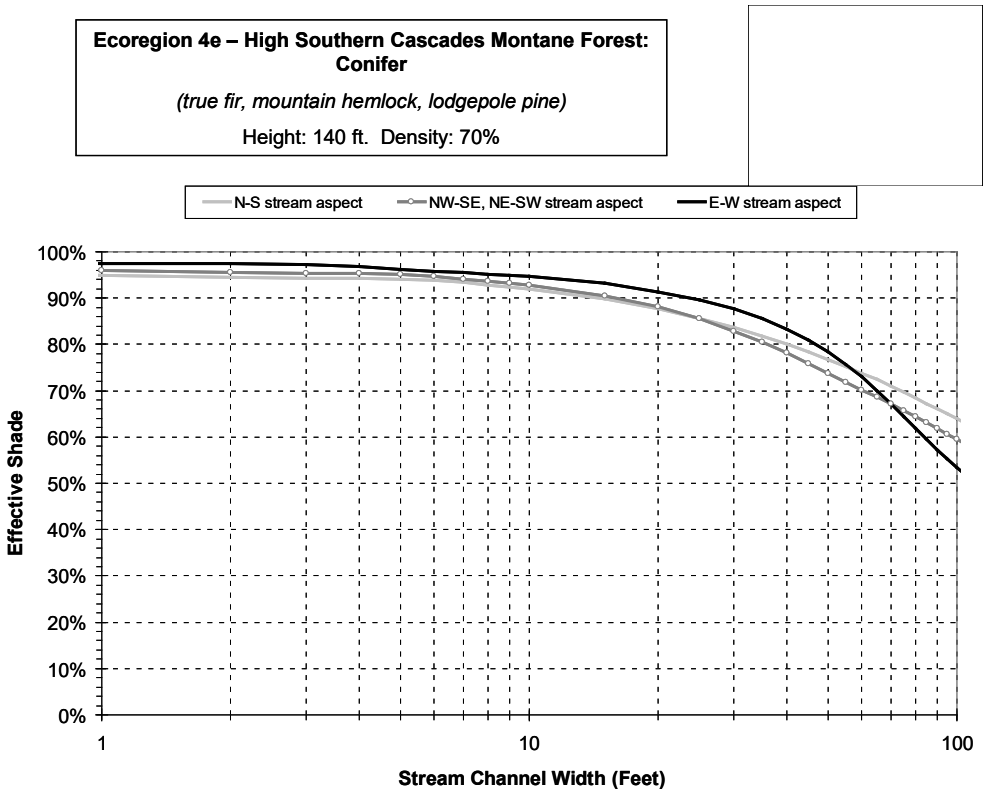

Figure 9-6: Effective shade curve for ecoregion 4e - High southern Cascades montane forest conifer.

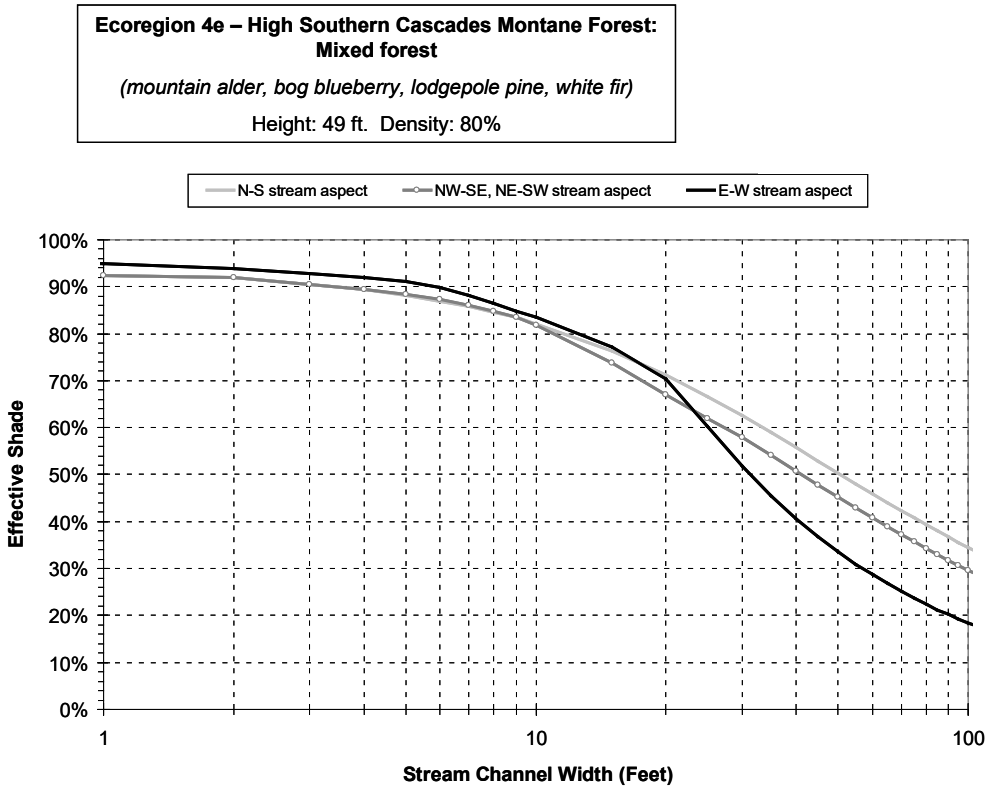

Figure 9-7: Effective shade curve for ecoregion 4e - High southern Cascades montane forest mixed forest.

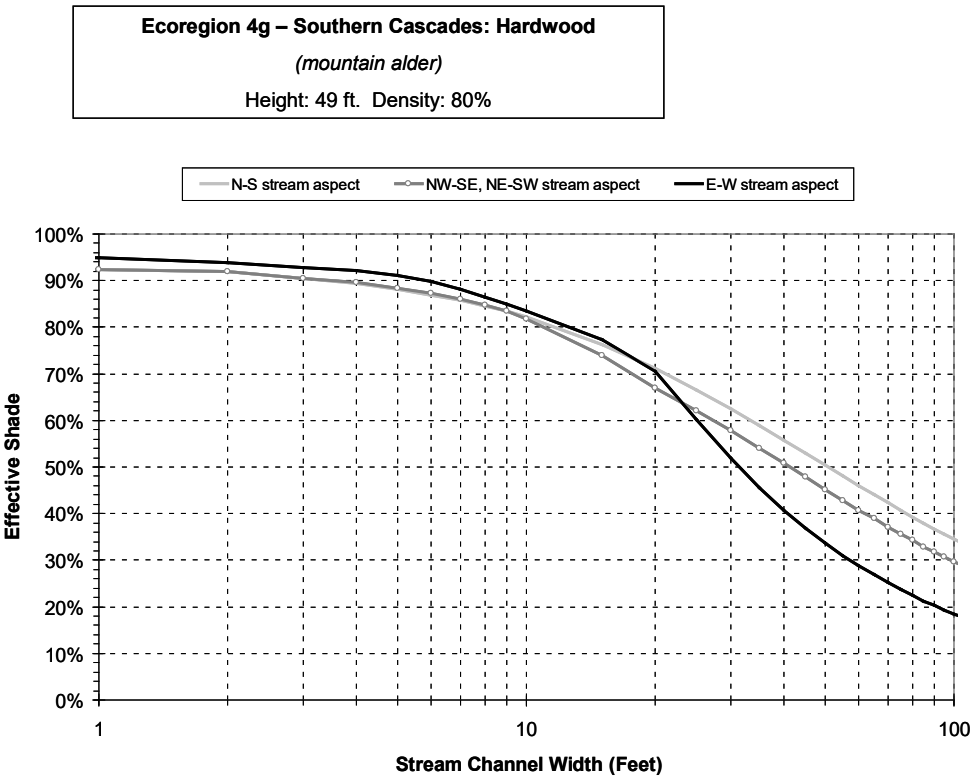

Figure 9-8: Effective shade curve for ecoregion 4g - Southern Cascades hardwood.

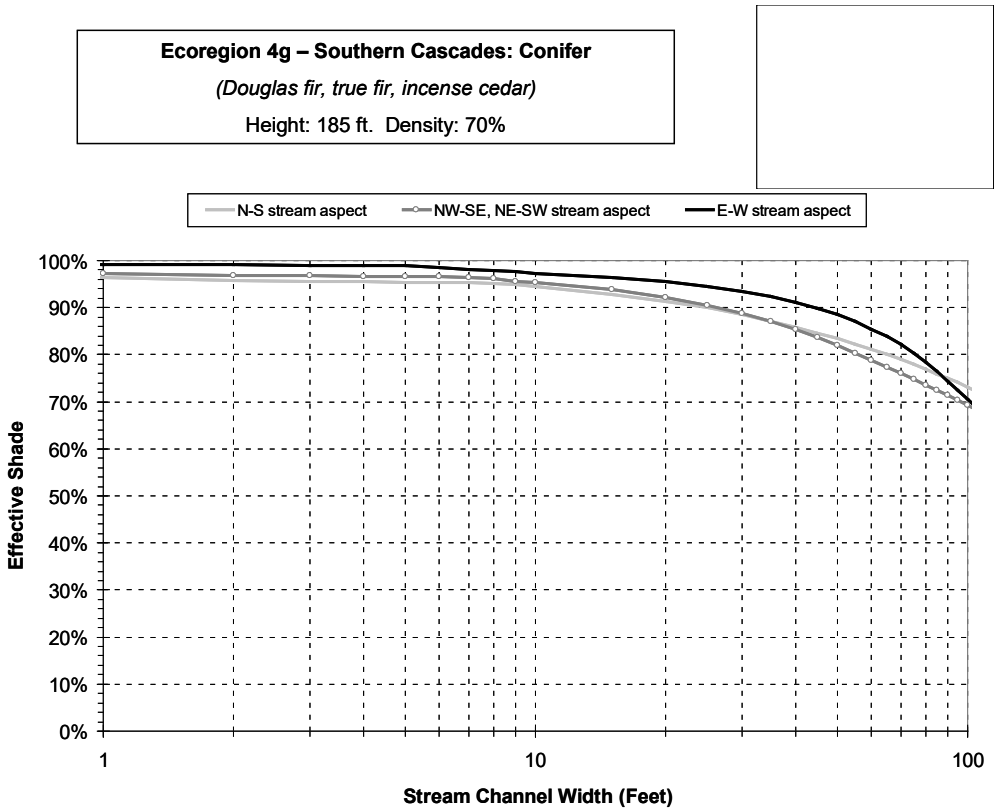

Figure 9-9: Effective shade curve for ecoregion 4g - Southern Cascades conifer.

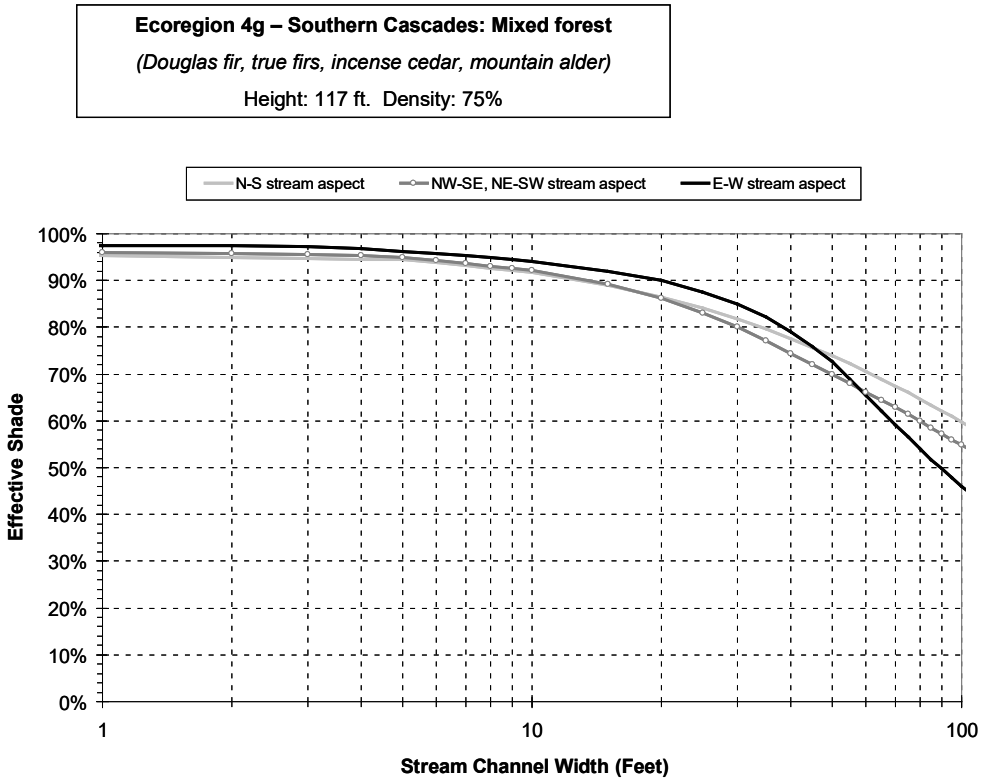

Figure 9-10: Effective shade curve for ecoregion 4g - Southern Cascades mixed forest.

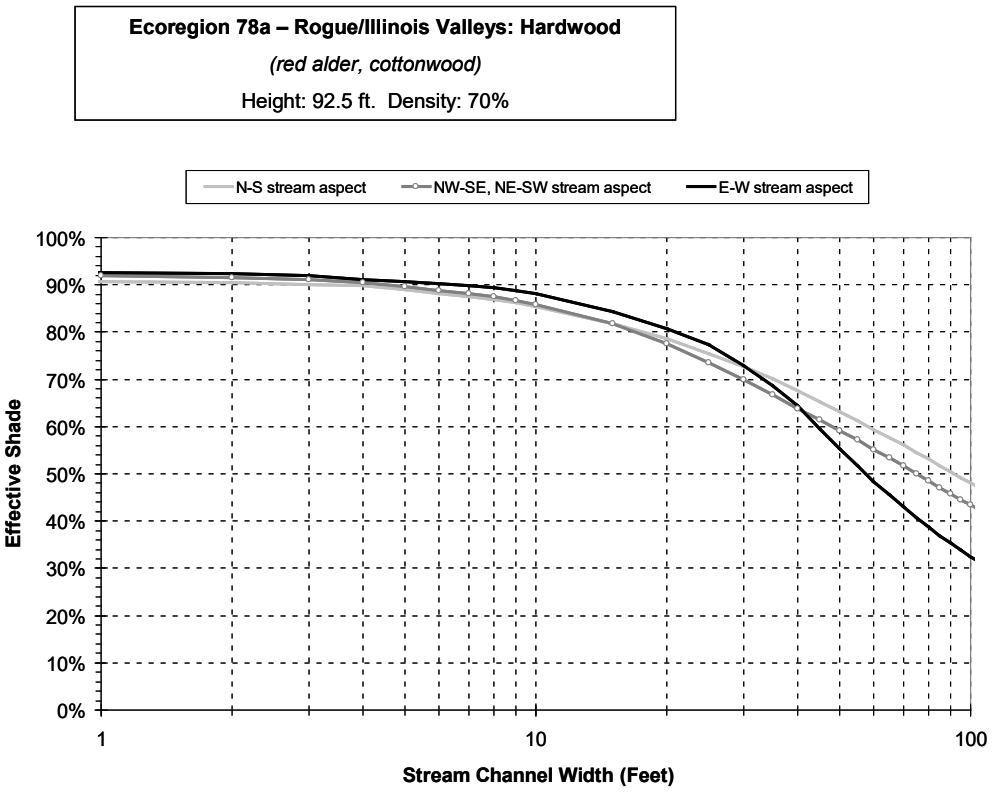

Figure 9-11: Effective shade curve for ecoregion 78a - Rogue/Illinois Valleys hardwood.

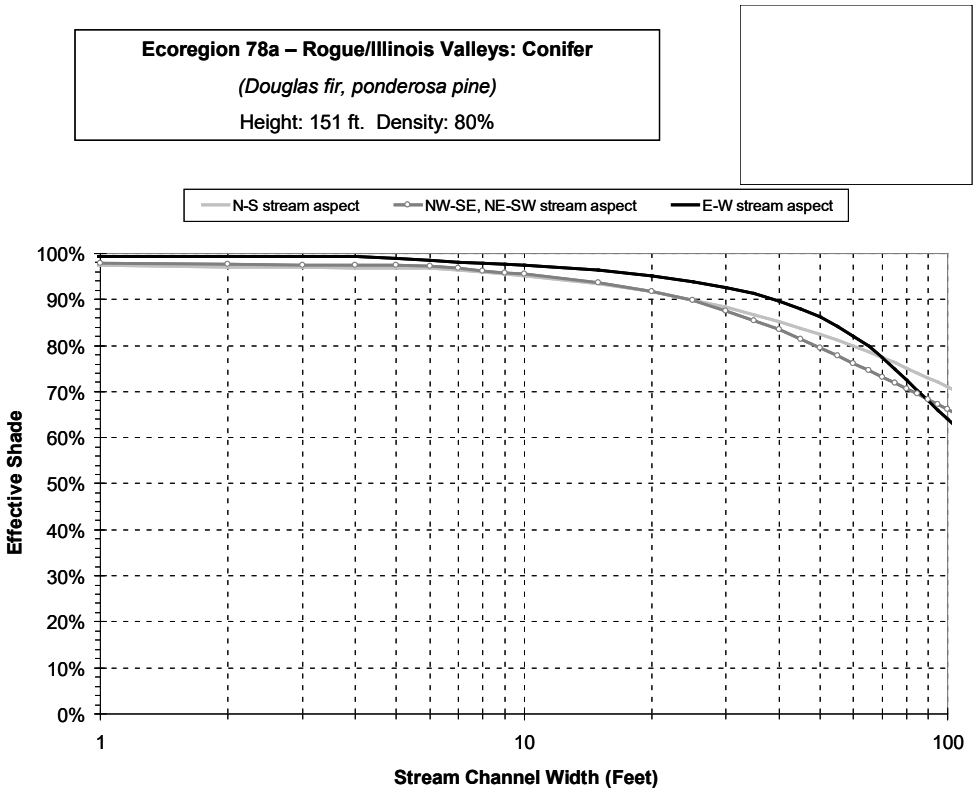

Figure 9-12: Effective shade curve for ecoregion 78a - Rogue/Illinois Valleys conifer.

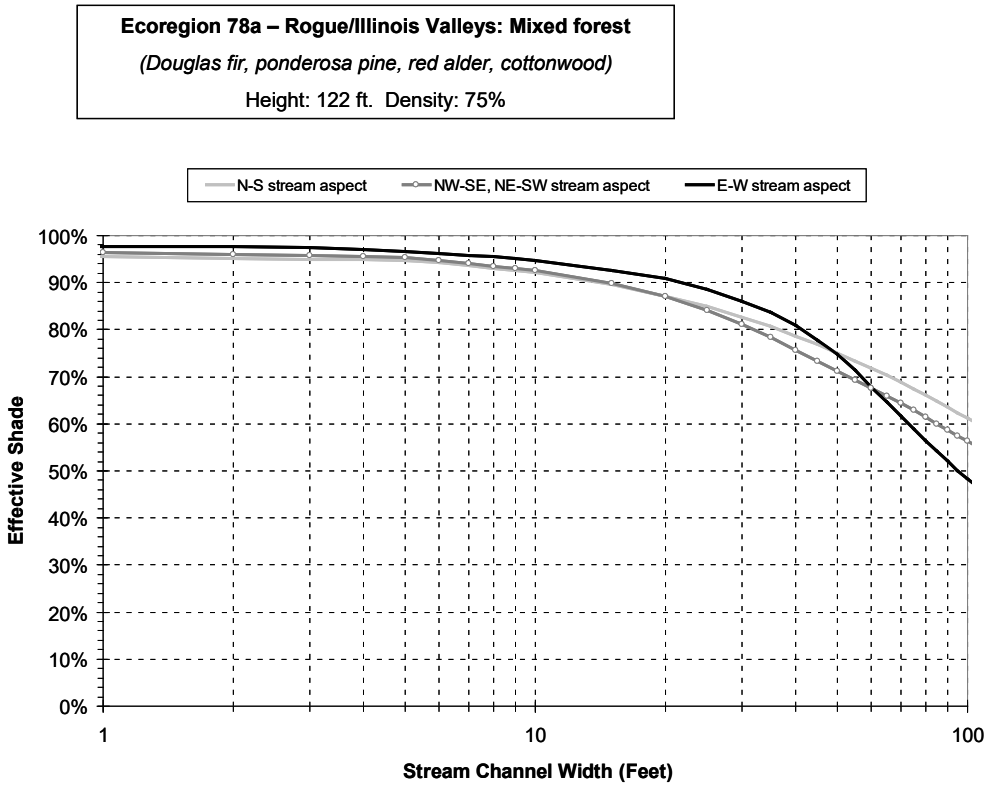

Figure 9-13Effective shade curve for ecoregion 78a - Rogue/Illinois Valleys mixed forest.

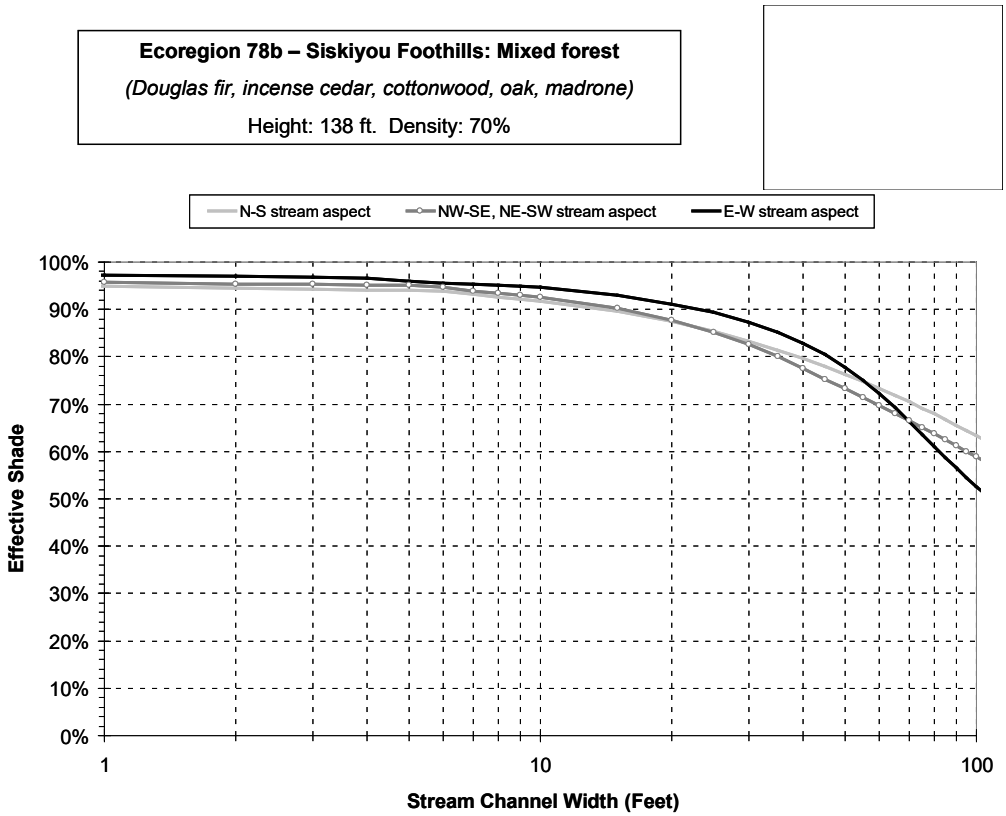

Figure 9-14: Effective shade curve for ecoregion 78b - Siskiyou foothills mixed forest.

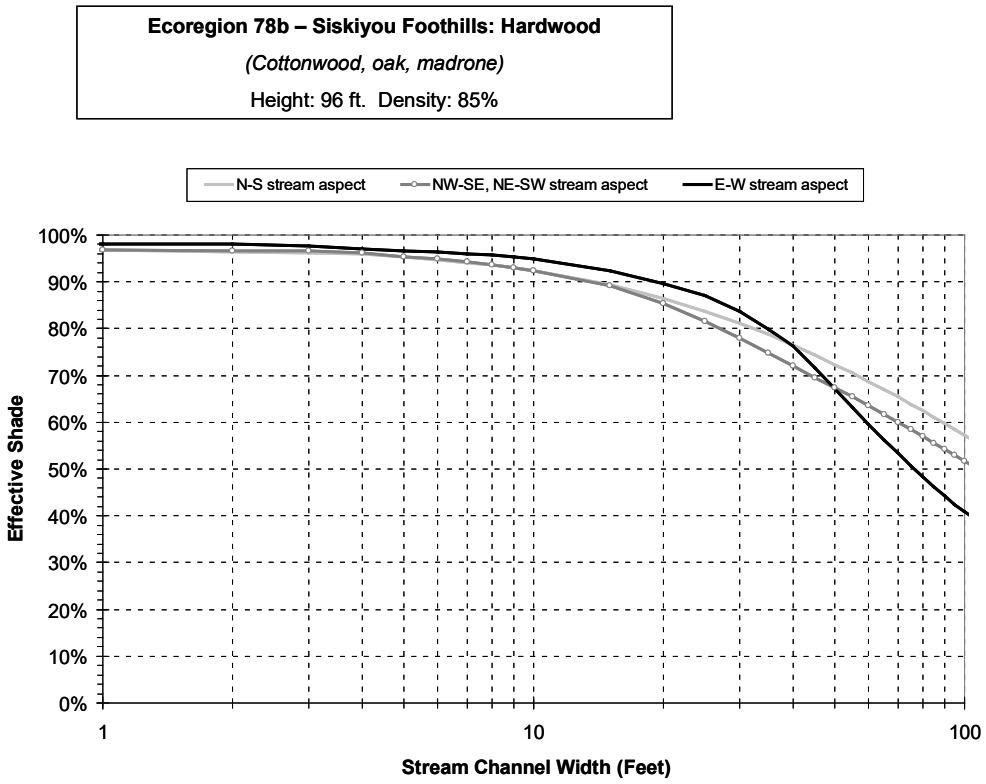

Figure 9-15: Effective shade curve for ecoregion 78b - Siskiyou foothills hardwood.

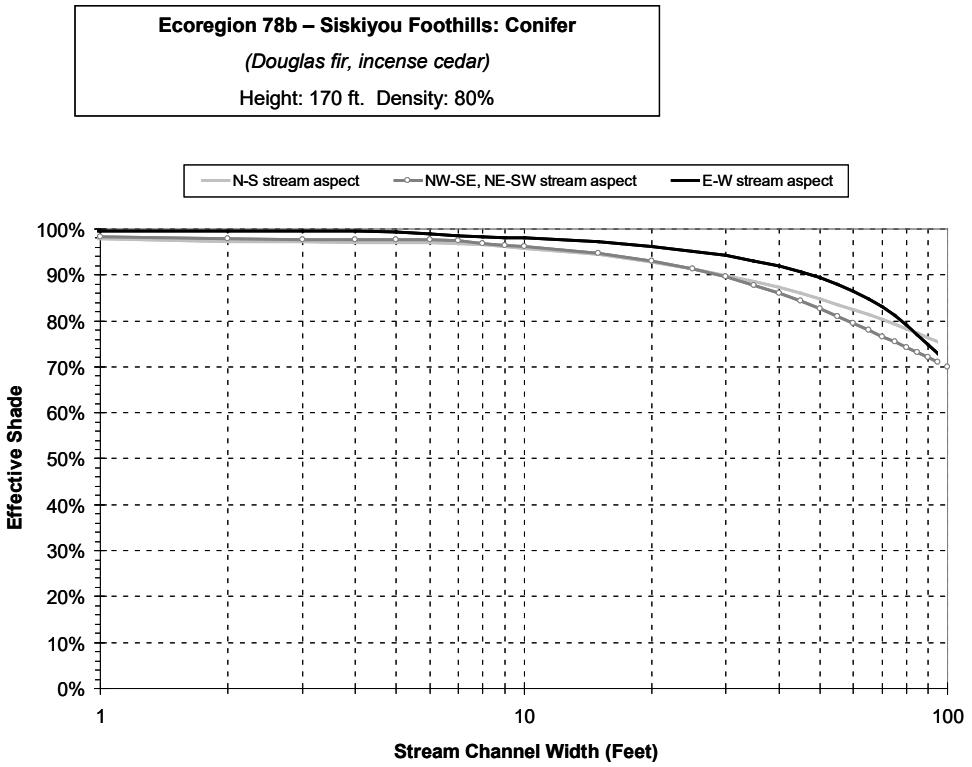

Figure 9-16: Effective shade curve for ecoregion 78b - Siskiyou foothills mixed conifer.

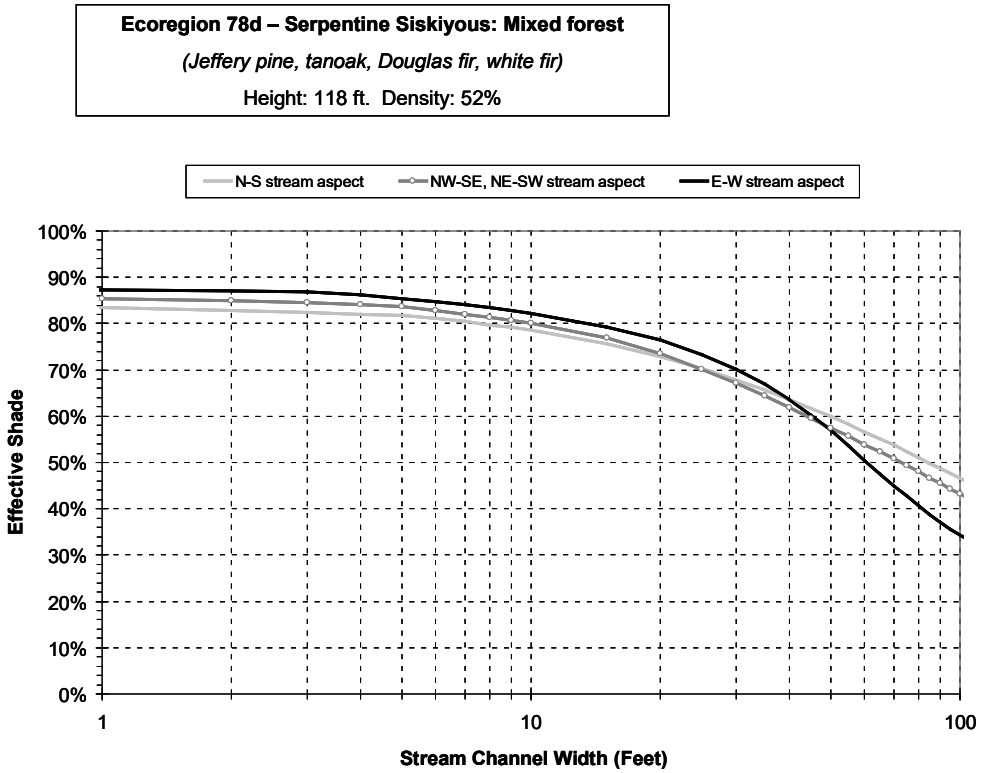

Figure 9-17: Effective shade curve for ecoregion 78d - Serpentine Siskiyous mixed forest.

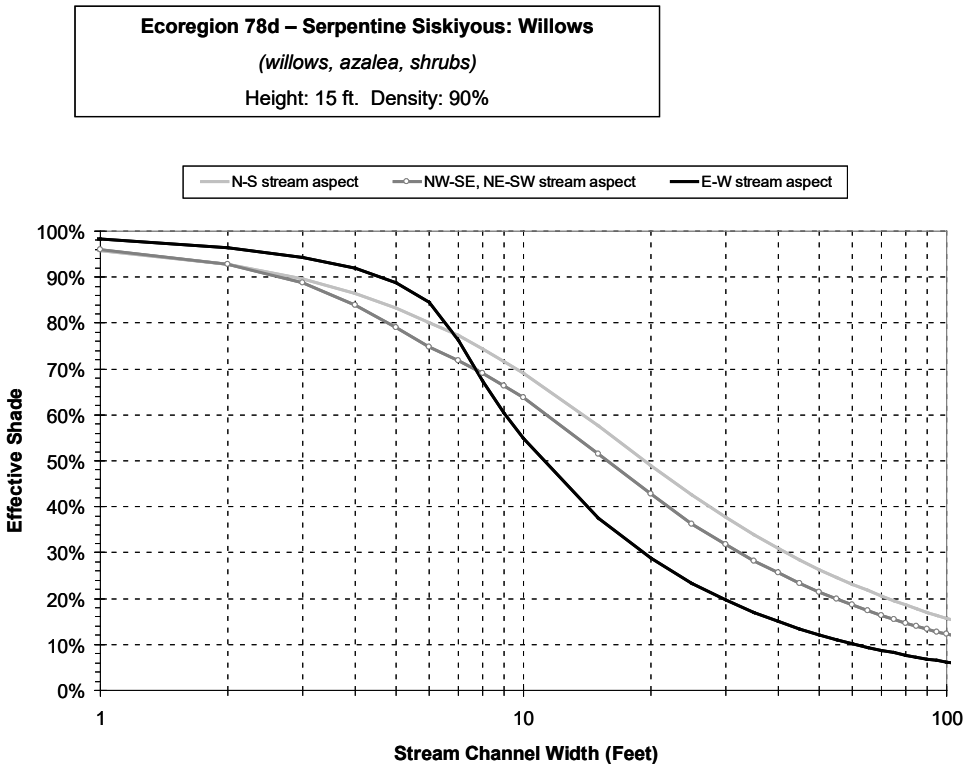

Figure 9-18: Effective shade curve for ecoregion 78d - Serpentine Siskiyous willows.

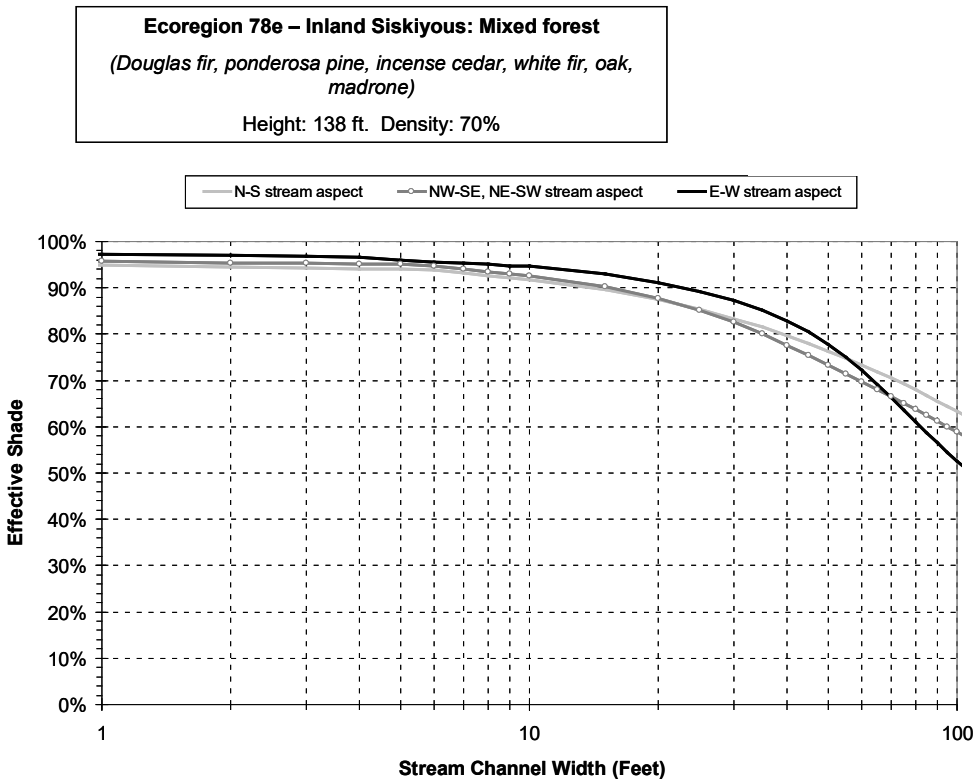

Figure 9-19: Effective shade curve for ecoregion 78e - Inland Siskiyous mixed forest.

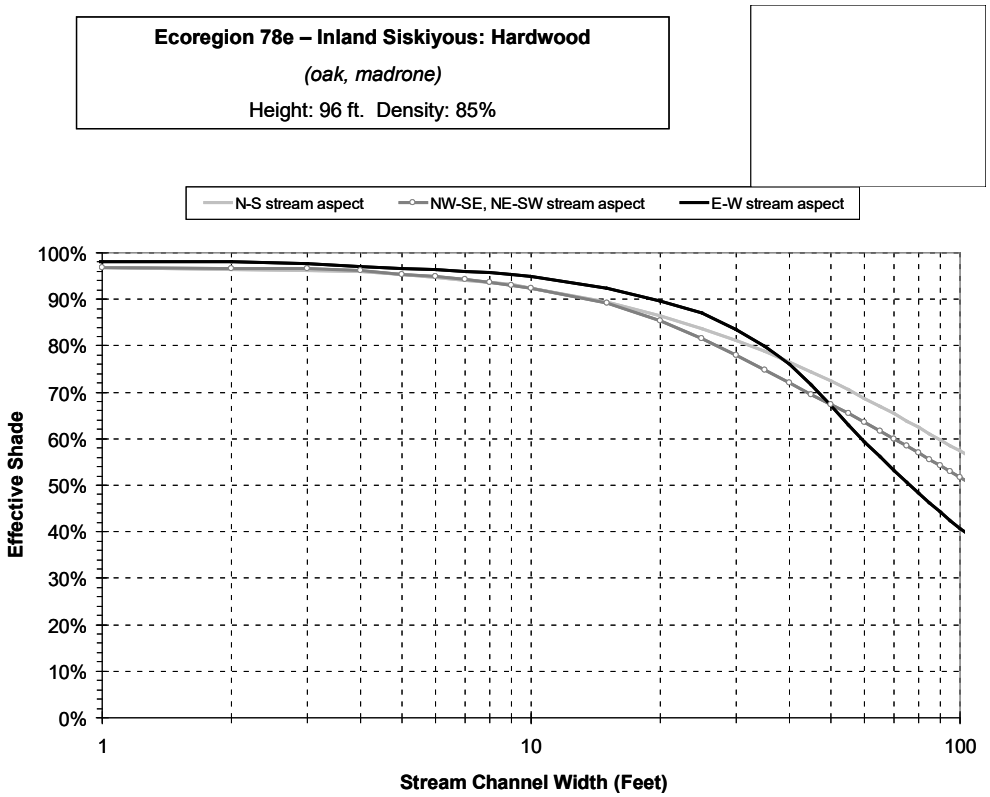

Figure 9-20: Effective shade curve for ecoregion 78e - Inland Siskiyous hardwood.

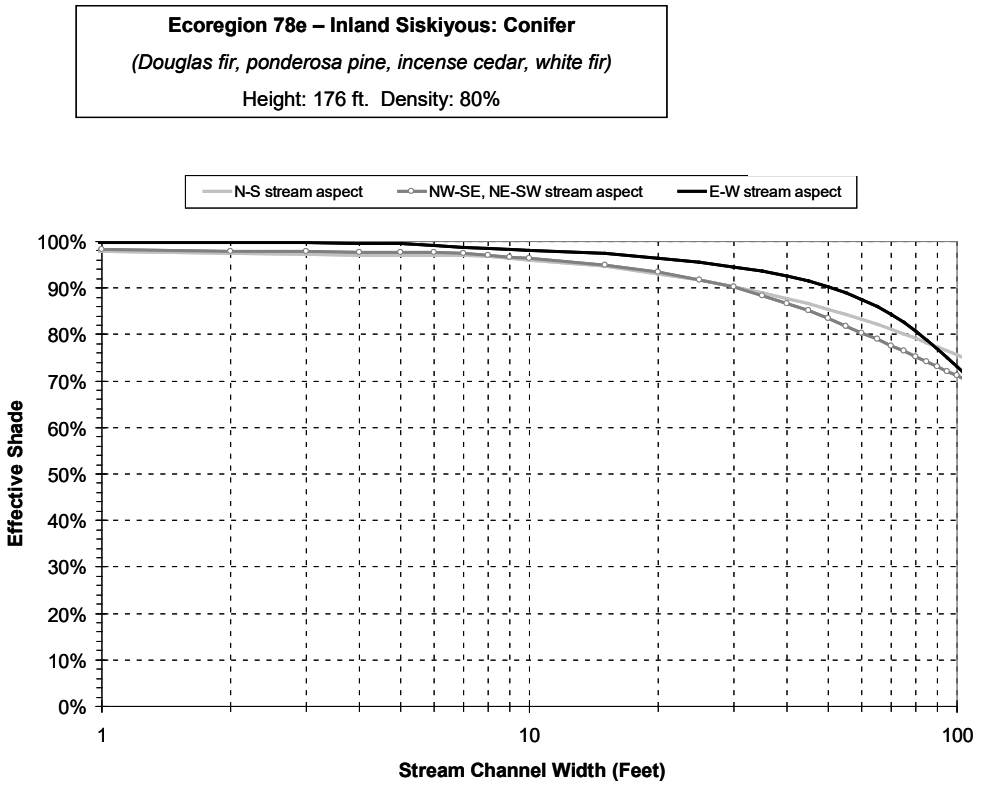

Figure 9-21: Effective shade curve for ecoregion 78e - Inland Siskiyous conifer.

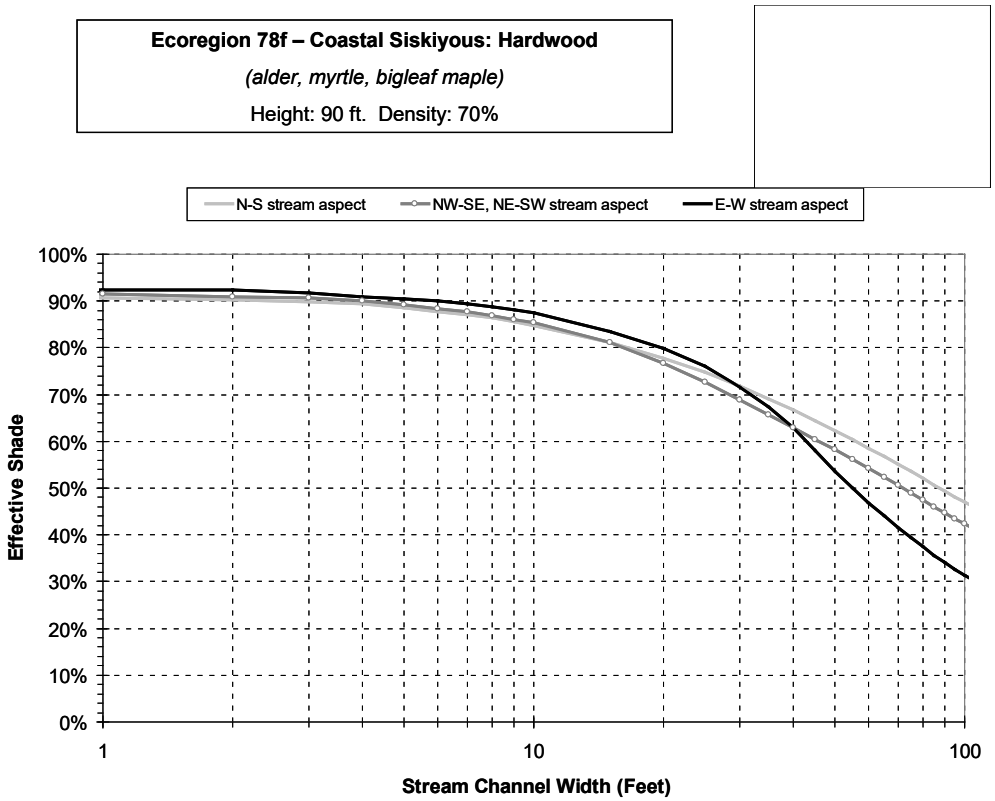

Figure 9-22: Effective shade curve for ecoregion 78f - Coastal Siskiyous hardwood.

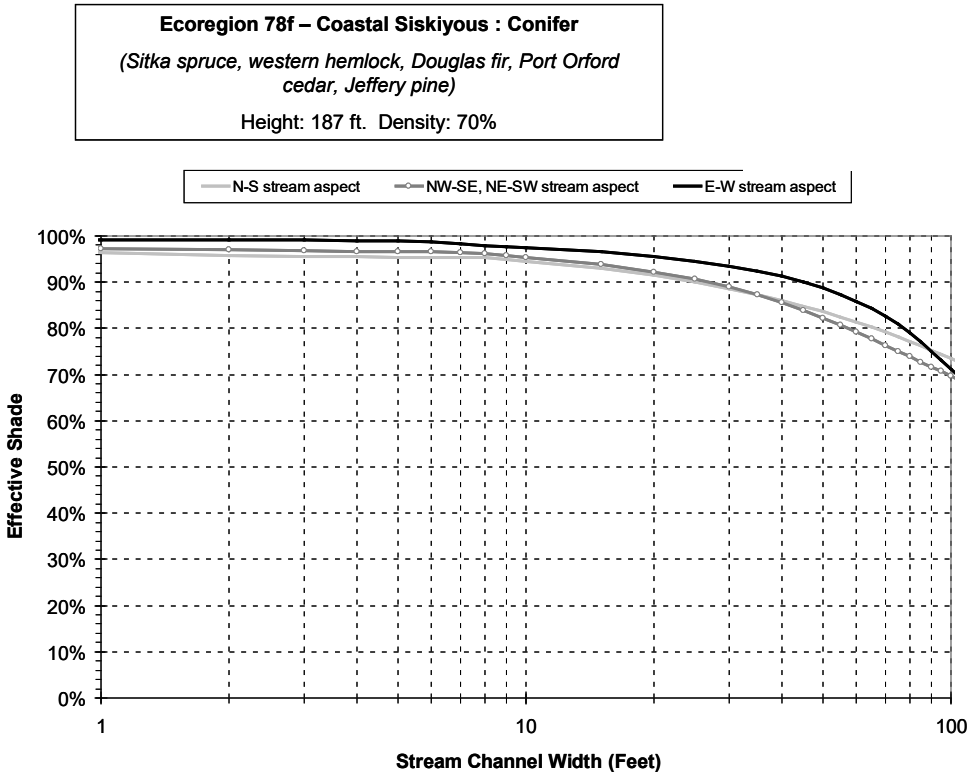

Figure 9-23: Effective shade curve for ecoregion 78f - Coastal Siskiyous conifer.

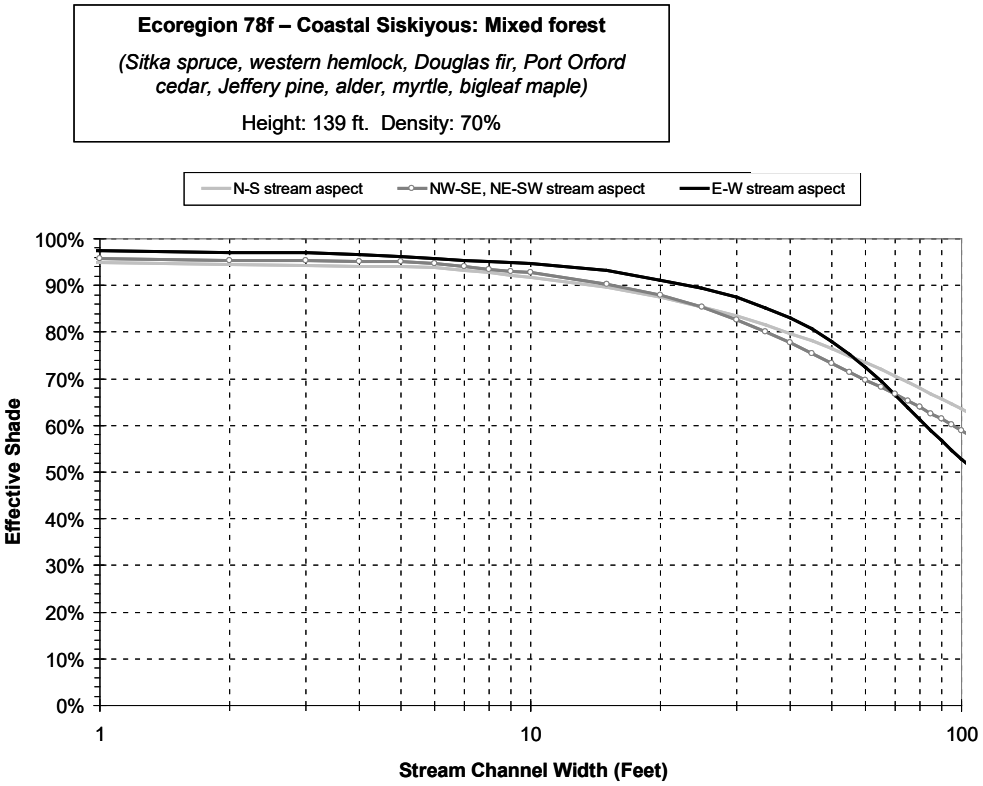

Figure 9-24: Effective shade curve for ecoregion 78f - Coastal Siskiyous mixed forest.

9.5 Reserve capacity

DEQ set aside explicit portions of the HUA as reserve capacity that may be available to provide either point or nonpoint source allocation(s) to new or increased thermal loads, or to assign additional allocation 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 reserve capacity is presented in **Table 9-25** and **Section 9.1**. 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.

Table 9-25: Thermal load set aside as to Reserve Capacity (RC). Values reflect RC for entire critical period except where spawning and non-spawning periods are indicated by footnotes.

AU Name	AU ID	RC HUA ΔT (°C)	7Q10 RC (kcal/d)
Mill Creek	OR_SR_1710030701_02_105459	0.125	4.28E+6
N. Fork Diversion Reservoir	OR_LK_1710030701_02_100236	0.125	131.81E+6
Rogue R., Estuary: Mainstem	OR_EB_1710031008_01_100280	0.05	259.35E+6
Rogue River	OR_SR_1710030701_02_105465	0.25	464.25E+6
Rogue River	OR_SR_1710030703_04_105475	0.25	420.21E+6
Big Butte Creek	OR_SR_1710030704_02_105477	0.125	10.13E+6
Elk Creek	OR_SR_1710030705_02_105484	0.089	0.88E+6
Elk Creek	OR_SR_1710030705_02_105485	0.089	0.07E+6
Rogue River	OR_SR_1710030707_04_105507	0.18[A]	382.59E+6
Rogue River	OR_SR_1710030707_04_105507	0.14[B]	297.57E+6
Antelope Creek	OR_SR_1710030708_02_105509	0.133	0.16E+6
North Fork Little Butte Creek	OR_SR_1710030708_02_105511	0.16	2.3E+6

AU Name	AU ID	RC HUA ΔT (°C)	7Q10 RC (kcal/d)
South Fork Little Butte Creek	OR_SR_1710030708_02_105515	0.17	7.4E+6
Antelope Creek	OR_SR_1710030708_02_105519	0.125	0.06E+6
Little Butte Creek	OR_SR_1710030708_02_105521	0.16	7.2E+6
South Fork Little Butte Creek	OR_SR_1710030708_02_105522	0.17	12.06E+6
Ashland Creek	OR_SR_1710030801_02_105548	0.20	0.95E+6
Bear Creek	OR_SR_1710030801_05_105552	0.04	0.6E+6
Rogue River	OR_SR_1710030802_04_105816	0.09[A]	210.49E+6
Rogue River	OR_SR_1710030802_04_105816	0.05[B]	116.94E+6
West Fork Evans Creek	OR_SR_1710030803_02_105574	0.17	0.28E+6
Evans Creek	OR_SR_1710030803_02_105576	0.17	0.17E+6
West Fork Evans Creek	OR_SR_1710030803_02_105581	0.17	0.3E+6
Evans Creek	OR_SR_1710030803_02_105583	0.17	0.33E+6
West Fork Evans Creek	OR_SR_1710030803_02_105795	0.17	2.35E+6
Rogue River	OR_SR_1710030804_04_106341	0.02[A]	46.72E+6
Rogue River	OR_SR_1710030804_04_106341	0.03[B]	70.07E+6
Applegate River	OR_SR_1710030902_02_105599	0.25	48.9E+6
Applegate River	OR_SR_1710030902_02_105603	0.25	20.06E+6
Applegate River	OR_SR_1710030904_02_105618	0.25	43.68E+6
Applegate River	OR_SR_1710030906_02_106343	0.24	36.86E+6
Rogue River	OR_SR_1710031002_04_104794	0.04[A]	52.16E+6
Rogue River	OR_SR_1710031002_04_104794	0.05[B]	65.2E+6
Rogue River	OR_SR_1710031004_04_104821	0.10[A]	152.43E+6
Rogue River	OR_SR_1710031004_04_104821	0.05[B]	76.21E+6
Rogue River	OR_SR_1710031005_04_106305	0.05	85.39E+6
Rogue River	OR_SR_1710031006_04_104637	0.05	139.13E+6
Lobster Creek	OR_SR_1710031007_02_104638	0.095	3.49E+6
Lobster Creek	OR_SR_1710031007_02_104640	0.095	2.86E+6
Rogue River	OR_SR_1710031008_04_104646	0.05	254.45E+6
Illinois River	OR_SR_1710031106_02_104840	0.10	12.28E+6
HUC12 Name: Indian Creek-Rogue River	OR_WS_171003070702_02_105745	0.125	0.00E+00
HUC12 Name: Kanutchan Creek-Little Butte Creek	OR_WS_171003070812_02_105758	0.125	0.00E+00
HUC12 Name: Larson Creek-Bear Creek	OR_WS_171003080110_02_105768	0.05	0.00E+00
HUC12 Name: Whetstone Creek-Rogue River	OR_WS_171003080202_02_105815	0.025	0.00E+00
HUC12 Name: Louse Creek	OR_WS_171003100103_02_106361	0.125	0.05E+6
HUC12 Name: Lower East Fork Illinois River	OR_WS_171003110303_02_104903	0.125	0.00E+00
Rogue River	OR_SR_1710030707_04_105506	0.25	364.55E+6
Illinois River	OR_SR_1710031108_02_106306	0.10	17.93E+6
Illinois River	OR_SR_1710031111_02_104645	0.10	29.6E+6
Rogue River	OR_SR_1710030707_02_105499	0.25	xx
Lost Creek Lake	OR_LK_1710030703_02_100244	0.05	85.14E+6
HUC12 Name: Lower Middle Fork Rogue River	OR_WS_171003070205_02_105803	0.125	xx

[A] Spawning period dT and RC
[B] Non-spawning period dT and RC

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.

9.6 Margin of safety

CFR 130.7(c)(1) and OAR 340-042-0040(4)(i) require that a TMDL 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 by using conservative analytical assumptions to develop allocations, or (2) explicitly by specifying a portion of the TMDL loading capacity as a margin of safety.

The Rogue River Basin temperature TMDL used an implicit margin of safety in derivation of the allocations. The primary conservative assumptions include:

- Wasteload allocations were calculated based on the paired critical 7Q10 low river flow; maximum effluent temperature; and maximum reported effluent flow, average dry weather design flow (ADWDF), or maximum flow allowed by the NPDES permit. It is rare that actual point sources discharges will reach maximum flows simultaneously with maximum effluent temperature and 7Q10 low river flows.
- Point source effluent temperatures were set up to 32°C for the wasteload allocations model scenario. 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 modeling applied the maximum assigned HUA to each source category to assess cumulative allocation attainment. Analysis of these model results showed that the maximum temperature increases from various source categories is seasonal in nature with maximum increases limited to short periods of time (typically one or two days and less than 5% of the time) and specific geographical areas. In addition, the maximum warming for different source categories typically occurs at different times. However, the HUA and subsequent allocations are assigned based on the conservative assumption that the maximum warming for each category occurs simultaneously with the other categories. 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 Appendices X, Y, and Z).

- 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.
- 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.
- Similarly, the cumulative effects models assumed that the temperature increase (from baseline) for each tributary to the modeled stream was equal to that tributary's temperature increase at its POMI, thus maximizing the potential warming downstream from that tributary. Yet, the POMI is unlikely to occur at the mouth of every tributary, which results in a conservative overestimate of the cumulative warming contributed from point and nonpoint sources in tributaries to the modeled streams in the Rogue River Basin.

9.7 Allocation summary

Allocations for source or source categories may be calculated on each AU in the project area. As an example, Table 9-27 presents TMDL allocations for source or source categories on the segment of the Applegate River from Williams Cr. To confluence with Rogue River (OR_SR_1710030906_02_106343). The allocations to background sources were calculated using Equation 9-2 and were based on the applicable year-round use criterion and the spawning use criterion in the AU. The allocations to NPDES point sources were calculated using Equation 9-1. The allocations to nonpoint sources were calculated using Equation 9-3. All allocations presented in Table 9-27 were calculated using the annual 7Q10 river flow rate (Table 9-26). These calculations assume the 7Q10 flows at these gages include effluent flow from all upstream point sources; plus inflows from upstream tributaries, groundwater, or nonpoint sources; and any outflows. As summarized in the TMDL, allocations may be dynamic and calculated using the relevant equations when river flow rates are greater than 7Q10.

The HUA assignments to all anthropogenic sources or source categories are equal to 0.30°C. Wasteload allocations to point sources and load allocations to nonpoint sources are based on loads equivalent to the allowed 0.30°C increase. For some NPDES permitted point sources and nonpoint sources, the maximum cumulative impact at the POMI in an AU is less than the sum of the individual HUA assignments at their respective points of discharge or activity due to heat dissipation within the AU.

Table 9-26: Example of 7Q10 flow and temperature targets used to calculate allocations for AUs that receive NPDES-permitted discharge or are 303(d) listed and modeled in this TMDL: Applegate River from Williams Cr. To confluence with Rogue River (OR_SR_1710030906_02_106343).

AU Description	AU ID	Annual 7Q10 (cfs)	Year-round Use Period Temperature Target (°C)	Spawning Use Period Temperature Target (°C)
Applegate R. from Williams Cr. to confluence with Rogue R.	**OR_SR_1710030906_02_106343**	**62.8**	**18 + 0.3 HUA (7DADM)**	**13 + 0.3 HUA (7DADM)**

Table 9-27: Example allocation summary: Applegate River from Williams Cr. To confluence with Rogue River (OR_SR_1710030906_02_106343).

Source or Source Category	Assigned HUA (°C)	7Q10 Year Round Use Allocations (kcal/day)	7Q10 Year Spawning Use Allocations (kcal/day)
Background	**0.00**	**2765E+6**	**1997E+6**
NPDES point sources	**0.01**	**1.54E+6**	**1.54E+6**
NPS Dam and reservoir operations	**0.00**	**0.00**	**0.00**
Anthropogenic warming from tributaries	**0.00**	**0.00**	**0.00**
Consumptive use water management and withdrawals	**0.01**	**1.54E+6**	**1.54E+6**
Solar loading: existing transportation corridors, buildings, and utility infrastructure	**0.04**	**6.14E+6**	**6.14E+6**
Solar loading: Other nonpoint sectors	**0.00**	**0.00**	**0.00**
Reserve capacity	**0.24**	**36.90E+6**	**36.90E+6**
Total Allocated Load		**2811.12E+6**	**2043.12E+6**
Loading Capacity		**2811.12E+6**	**2043.12E+6**

10. Water quality management plan

As described in OAR 340-042-0040(4)(I)(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 parties, including DMAs responsible for TMDL implementation and other interested parties, and prepared the Rogue River Basin WQMP as a stand-alone document. DEQ intends to propose the WQMP as an element of the Temperature TMDL for the Rogue River Basin for adoption as rule by the Oregon Environmental Quality Commission.

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).

The Rogue River Basin TMDL was 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 nonpoint source load reductions will be achieved.

12. References

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). 2008a. Temperature Water Quality Standard Implementation – A DEQ Internal Management Directive.

DEQ (Oregon Department of Environmental Quality). 2011. Internal Management Directive Nonpoint Source Compliance With the Protecting Cold Water Criterion of the Temperature Standard.

Appendix X of effective shade curve tables

Table 13-1: Effective shade targets for conifer-dominated stream sites in Coastal Uplands (code 100).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.9%	98.1%	98.8%
0.3	1.0	97.2%	97.6%	98.8%
0.6	2.0	96.8%	97.3%	98.8%
0.9	3.0	96.7%	97.2%	98.8%
1.2	4.0	96.5%	97.1%	98.5%
1.5	5.0	96.4%	97.0%	98.0%
1.8	6.0	96.3%	96.6%	97.7%
2.1	7.0	95.7%	96.0%	97.4%
2.4	8.0	95.2%	95.5%	97.2%
2.7	9.0	94.8%	95.2%	97.0%
3.0	10.0	94.4%	94.8%	96.8%
4.6	15.0	92.4%	92.6%	95.5%
6.1	20.0	90.4%	90.3%	93.8%
7.6	25.0	88.4%	87.9%	92.3%
9.1	30.0	86.5%	85.3%	90.7%
10.7	35.0	84.7%	82.9%	88.7%
12.2	40.0	83.0%	80.5%	86.8%
13.7	45.0	81.4%	78.3%	84.6%
15.2	50.0	79.9%	76.2%	82.1%
16.8	55.0	78.4%	74.4%	79.6%
18.3	60.0	76.9%	72.7%	76.9%
19.8	65.0	75.6%	71.2%	73.8%
21.3	70.0	74.3%	69.7%	70.9%
22.9	75.0	73.0%	68.3%	68.2%
24.4	80.0	71.8%	67.0%	65.7%
25.9	85.0	70.6%	65.7%	63.3%
27.4	90.0	69.5%	64.5%	61.1%
29.0	95.0	68.4%	63.4%	59.0%
30.5	100.0	67.3%	62.2%	57.1%
45.7	150.0	58.5%	53.0%	42.9%
61.0	200.0	51.9%	46.4%	34.5%
76.2	250.0	46.8%	41.4%	29.0%
91.4	300.0	42.6%	37.5%	25.0%
106.7	350.0	39.2%	34.3%	22.1%
121.9	400.0	36.4%	31.7%	19.8%
137.2	450.0	33.9%	29.4%	18.0%
152.4	500.0	31.8%	27.5%	16.5%
167.6	550.0	29.9%	25.8%	15.2%
182.9	600.0	28.3%	24.4%	14.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
198.1	650.0	26.8%	23.1%	13.2%
213.4	700.0	25.5%	21.9%	12.4%
228.6	750.0	24.4%	20.9%	11.7%
243.8	800.0	23.3%	19.9%	11.1%
259.1	850.0	22.3%	19.1%	10.5%
274.3	900.0	21.4%	18.3%	10.0%
289.6	950.0	20.6%	17.6%	9.5%
304.8	1000.0	19.8%	16.9%	9.1%
381.0	1250.0	16.7%	14.2%	7.5%
457.2	1500.0	14.5%	12.3%	6.4%
533.4	1750.0	12.8%	10.8%	5.5%

Table 13-2: Effective shade targets for hardwood-dominated stream sites in Coastal Uplands (code 101).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	91.1%	91.9%	92.4%
0.3	1.0	90.7%	91.5%	92.4%
0.6	2.0	90.2%	90.9%	92.3%
0.9	3.0	89.8%	90.6%	91.7%
1.2	4.0	89.5%	90.0%	90.9%
1.5	5.0	88.5%	89.1%	90.4%
1.8	6.0	87.7%	88.3%	89.9%
2.1	7.0	87.0%	87.7%	89.5%
2.4	8.0	86.5%	86.9%	88.9%
2.7	9.0	85.6%	86.0%	88.2%
3.0	10.0	84.8%	85.3%	87.5%
4.6	15.0	81.2%	81.1%	83.5%
6.1	20.0	77.8%	76.8%	80.0%
7.6	25.0	74.7%	72.7%	76.2%
9.1	30.0	71.8%	68.9%	71.6%
10.7	35.0	69.1%	65.6%	67.3%
12.2	40.0	66.6%	62.8%	63.0%
13.7	45.0	64.4%	60.4%	58.0%
15.2	50.0	62.2%	58.2%	53.7%
16.8	55.0	60.3%	56.1%	50.1%
18.3	60.0	58.4%	54.1%	46.9%
19.8	65.0	56.7%	52.3%	44.1%
21.3	70.0	55.0%	50.6%	41.6%
22.9	75.0	53.5%	49.0%	39.4%
24.4	80.0	52.0%	47.5%	37.5%
25.9	85.0	50.7%	46.1%	35.7%
27.4	90.0	49.4%	44.7%	34.1%
29.0	95.0	48.2%	43.5%	32.7%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
30.5	100.0	47.0%	42.3%	31.4%
45.7	150.0	38.1%	33.6%	22.5%
61.0	200.0	32.3%	28.1%	17.7%
76.2	250.0	28.1%	24.3%	14.7%
91.4	300.0	25.0%	21.5%	12.6%
106.7	350.0	22.5%	19.3%	11.0%
121.9	400.0	20.5%	17.5%	9.8%
137.2	450.0	18.8%	16.0%	8.9%
152.4	500.0	17.4%	14.8%	8.1%
167.6	550.0	16.2%	13.8%	7.4%
182.9	600.0	15.2%	12.8%	6.9%
198.1	650.0	14.3%	12.1%	6.4%
213.4	700.0	13.5%	11.4%	6.0%
228.6	750.0	12.8%	10.7%	5.6%
243.8	800.0	12.1%	10.2%	5.3%
259.1	850.0	11.5%	9.7%	5.0%
274.3	900.0	11.0%	9.2%	4.8%
289.6	950.0	10.5%	8.8%	4.5%
304.8	1000.0	10.1%	8.4%	4.3%
381.0	1250.0	8.3%	7.0%	3.5%
457.2	1500.0	7.1%	5.9%	3.0%
533.4	1750.0	6.2%	5.1%	2.6%

Table 13-3: Effective shade targets for mixed conifer-hardwood dominated stream sites in Coastal Uplands (code 102).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	94.5%	94.9%	95.0%
0.3	1.0	94.0%	94.5%	95.0%
0.6	2.0	93.7%	94.2%	94.9%
0.9	3.0	93.5%	94.1%	94.6%
1.2	4.0	93.2%	93.7%	94.0%
1.5	5.0	92.6%	92.9%	93.5%
1.8	6.0	91.8%	92.2%	93.1%
2.1	7.0	91.2%	91.7%	92.9%
2.4	8.0	90.7%	91.1%	92.5%
2.7	9.0	90.1%	90.3%	92.1%
3.0	10.0	89.4%	89.6%	91.7%
4.6	15.0	86.2%	86.2%	89.1%
6.1	20.0	83.2%	82.3%	85.8%
7.6	25.0	80.3%	78.6%	82.9%
9.1	30.0	77.7%	75.1%	79.5%
10.7	35.0	75.3%	71.9%	75.5%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
12.2	40.0	73.0%	69.1%	71.8%
13.7	45.0	70.8%	66.6%	67.7%
15.2	50.0	68.8%	64.5%	63.2%
16.8	55.0	66.9%	62.4%	59.2%
18.3	60.0	65.1%	60.5%	55.7%
19.8	65.0	63.4%	58.7%	52.6%
21.3	70.0	61.8%	57.1%	49.9%
22.9	75.0	60.3%	55.5%	47.4%
24.4	80.0	58.8%	53.9%	45.1%
25.9	85.0	57.5%	52.5%	43.1%
27.4	90.0	56.2%	51.2%	41.2%
29.0	95.0	54.9%	49.9%	39.5%
30.5	100.0	53.7%	48.7%	38.0%
45.7	150.0	44.5%	39.4%	27.5%
61.0	200.0	38.1%	33.4%	21.7%
76.2	250.0	33.5%	29.1%	18.1%
91.4	300.0	30.0%	25.9%	15.5%
106.7	350.0	27.2%	23.4%	13.6%
121.9	400.0	24.9%	21.3%	12.2%
137.2	450.0	23.0%	19.6%	11.0%
152.4	500.0	21.4%	18.2%	10.0%
167.6	550.0	20.0%	17.0%	9.2%
182.9	600.0	18.8%	15.9%	8.6%
198.1	650.0	17.7%	15.0%	8.0%
213.4	700.0	16.7%	14.1%	7.5%
228.6	750.0	15.9%	13.4%	7.0%
243.8	800.0	15.1%	12.7%	6.6%
259.1	850.0	14.4%	12.1%	6.3%
274.3	900.0	13.8%	11.6%	6.0%
289.6	950.0	13.2%	11.1%	5.7%
304.8	1000.0	12.6%	10.6%	5.4%
381.0	1250.0	10.5%	8.8%	4.4%
457.2	1500.0	9.0%	7.5%	3.7%
533.4	1750.0	7.9%	6.6%	3.2%

Table 13-4: Effective shade targets for mixed conifer-hardwood dominated stream sites in Southern Oregon Coastal Mountains (code 200).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	96.4%	97.3%	98.3%
0.3	1.0	95.6%	96.6%	98.3%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.6	2.0	95.1%	96.3%	98.3%
0.9	3.0	94.9%	96.2%	98.2%
1.2	4.0	94.9%	96.1%	98.2%
1.5	5.0	94.8%	96.0%	97.9%
1.8	6.0	94.8%	95.9%	97.4%
2.1	7.0	94.7%	95.5%	97.1%
2.4	8.0	94.2%	94.9%	96.8%
2.7	9.0	93.6%	94.5%	96.6%
3.0	10.0	93.2%	94.1%	96.3%
4.6	15.0	91.6%	92.2%	95.1%
6.1	20.0	89.6%	90.2%	93.7%
7.6	25.0	87.8%	88.2%	92.4%
9.1	30.0	86.2%	86.1%	90.8%
10.7	35.0	84.6%	83.9%	89.3%
12.2	40.0	83.0%	81.8%	87.7%
13.7	45.0	81.6%	79.8%	85.8%
15.2	50.0	80.1%	77.9%	83.9%
16.8	55.0	78.8%	76.1%	82.0%
18.3	60.0	77.5%	74.4%	79.7%
19.8	65.0	76.2%	72.9%	77.5%
21.3	70.0	75.0%	71.5%	75.2%
22.9	75.0	73.8%	70.2%	72.6%
24.4	80.0	72.7%	68.9%	70.2%
25.9	85.0	71.6%	67.7%	67.9%
27.4	90.0	70.5%	66.5%	65.7%
29.0	95.0	69.5%	65.4%	63.6%
30.5	100.0	68.5%	64.3%	61.7%
45.7	150.0	59.9%	55.2%	47.1%
61.0	200.0	53.4%	48.5%	38.2%
76.2	250.0	48.2%	43.4%	32.2%
91.4	300.0	44.0%	39.3%	27.9%
106.7	350.0	40.5%	36.0%	24.7%
121.9	400.0	37.6%	33.2%	22.2%
137.2	450.0	35.0%	30.9%	20.1%
152.4	500.0	32.8%	28.9%	18.5%
167.6	550.0	30.9%	27.1%	17.1%
182.9	600.0	29.2%	25.6%	15.9%
198.1	650.0	27.7%	24.2%	14.8%
213.4	700.0	26.3%	23.0%	13.9%
228.6	750.0	25.1%	21.9%	13.1%
243.8	800.0	23.9%	20.9%	12.4%
259.1	850.0	22.9%	20.0%	11.8%
274.3	900.0	22.0%	19.1%	11.2%
289.6	950.0	21.1%	18.4%	10.7%
304.8	1000.0	20.3%	17.7%	10.3%
381.0	1250.0	17.1%	14.8%	8.4%
457.2	1500.0	14.8%	12.8%	7.2%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
533.4	1750.0	13.0%	11.2%	6.2%

Table 13-5: Effective shade targets for herbaceous plant-dominated stream sites in Cascade Subalpine/ Alpine (code 201).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	58.8%	52.3%	37.5%
0.3	1.0	38.0%	31.6%	19.6%
0.6	2.0	21.7%	17.4%	9.9%
0.9	3.0	15.1%	11.9%	6.6%
1.2	4.0	11.5%	8.9%	4.9%
1.5	5.0	9.2%	7.2%	4.0%
1.8	6.0	7.7%	6.0%	3.3%
2.1	7.0	6.6%	5.1%	2.8%
2.4	8.0	5.7%	4.5%	2.5%
2.7	9.0	5.1%	4.0%	2.2%
3.0	10.0	4.6%	3.6%	2.0%
4.6	15.0	3.1%	2.4%	1.3%
6.1	20.0	2.3%	1.8%	1.0%
7.6	25.0	1.8%	1.4%	0.8%
9.1	30.0	1.5%	1.2%	0.7%
10.7	35.0	1.3%	1.0%	0.6%
12.2	40.0	1.1%	0.9%	0.5%
13.7	45.0	1.0%	0.8%	0.4%
15.2	50.0	0.9%	0.7%	0.4%
16.8	55.0	0.8%	0.7%	0.4%
18.3	60.0	0.8%	0.6%	0.3%
19.8	65.0	0.7%	0.6%	0.3%
21.3	70.0	0.7%	0.5%	0.3%
22.9	75.0	0.6%	0.5%	0.3%
24.4	80.0	0.6%	0.4%	0.2%
25.9	85.0	0.5%	0.4%	0.2%
27.4	90.0	0.5%	0.4%	0.2%
29.0	95.0	0.5%	0.4%	0.2%
30.5	100.0	0.5%	0.4%	0.2%
45.7	150.0	0.3%	0.2%	0.1%
61.0	200.0	0.2%	0.2%	0.1%
76.2	250.0	0.2%	0.1%	0.1%
91.4	300.0	0.2%	0.1%	0.1%
106.7	350.0	0.1%	0.1%	0.1%
121.9	400.0	0.1%	0.1%	0.0%
137.2	450.0	0.1%	0.1%	0.0%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
152.4	500.0	0.1%	0.1%	0.0%
167.6	550.0	0.1%	0.1%	0.0%
182.9	600.0	0.1%	0.1%	0.0%
198.1	650.0	0.1%	0.1%	0.0%
213.4	700.0	0.1%	0.1%	0.0%
228.6	750.0	0.1%	0.0%	0.0%
243.8	800.0	0.1%	0.0%	0.0%
259.1	850.0	0.1%	0.0%	0.0%
274.3	900.0	0.1%	0.0%	0.0%
289.6	950.0	0.0%	0.0%	0.0%
304.8	1000.0	0.0%	0.0%	0.0%
381.0	1250.0	0.0%	0.0%	0.0%
457.2	1500.0	0.0%	0.0%	0.0%
533.4	1750.0	0.0%	0.0%	0.0%

Table 13-6: Effective shade targets for conifer-dominated stream sites in High Southern Cascades Montane Forest (code 202).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	95.7%	96.6%	97.6%
0.3	1.0	94.9%	95.9%	97.5%
0.6	2.0	94.5%	95.5%	97.4%
0.9	3.0	94.3%	95.4%	97.2%
1.2	4.0	94.2%	95.3%	96.8%
1.5	5.0	94.1%	95.2%	96.3%
1.8	6.0	94.0%	94.8%	95.8%
2.1	7.0	93.4%	94.1%	95.5%
2.4	8.0	92.8%	93.6%	95.2%
2.7	9.0	92.4%	93.2%	95.0%
3.0	10.0	91.9%	92.9%	94.8%
4.6	15.0	89.8%	90.4%	93.3%
6.1	20.0	87.7%	88.0%	91.4%
7.6	25.0	85.6%	85.5%	89.6%
9.1	30.0	83.7%	82.9%	87.7%
10.7	35.0	81.8%	80.4%	85.6%
12.2	40.0	80.1%	78.1%	83.3%
13.7	45.0	78.4%	75.8%	81.0%
15.2	50.0	76.8%	73.7%	78.4%
16.8	55.0	75.2%	71.9%	75.7%
18.3	60.0	73.8%	70.2%	73.0%
19.8	65.0	72.4%	68.6%	70.0%
21.3	70.0	71.0%	67.1%	67.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
22.9	75.0	69.7%	65.7%	64.4%
24.4	80.0	68.5%	64.3%	61.8%
25.9	85.0	67.3%	63.0%	59.5%
27.4	90.0	66.1%	61.8%	57.3%
29.0	95.0	65.0%	60.6%	55.3%
30.5	100.0	63.9%	59.4%	53.4%
45.7	150.0	54.9%	50.1%	39.8%
61.0	200.0	48.3%	43.4%	31.9%
76.2	250.0	43.2%	38.5%	26.8%
91.4	300.0	39.2%	34.6%	23.1%
106.7	350.0	35.8%	31.5%	20.4%
121.9	400.0	33.1%	29.0%	18.2%
137.2	450.0	30.7%	26.8%	16.5%
152.4	500.0	28.7%	25.0%	15.1%
167.6	550.0	26.9%	23.4%	14.0%
182.9	600.0	25.4%	22.0%	13.0%
198.1	650.0	24.0%	20.8%	12.1%
213.4	700.0	22.8%	19.7%	11.4%
228.6	750.0	21.6%	18.7%	10.7%
243.8	800.0	20.6%	17.8%	10.1%
259.1	850.0	19.7%	17.0%	9.6%
274.3	900.0	18.9%	16.3%	9.1%
289.6	950.0	18.1%	15.6%	8.7%
304.8	1000.0	17.4%	15.0%	8.3%
381.0	1250.0	14.6%	12.5%	6.8%
457.2	1500.0	12.6%	10.8%	5.8%
533.4	1750.0	11.0%	9.4%	5.0%

Table 13-7: Effective shade targets for mixed conifer-hardwood dominated stream sites in High Southern Cascades Montane Forest (code 300).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	92.8%	92.8%	95.0%
0.3	1.0	92.5%	92.4%	94.9%
0.6	2.0	91.9%	91.9%	93.8%
0.9	3.0	90.5%	90.5%	92.9%
1.2	4.0	89.4%	89.5%	92.1%
1.5	5.0	88.2%	88.3%	91.0%
1.8	6.0	86.9%	87.2%	89.8%
2.1	7.0	85.8%	86.1%	88.2%
2.4	8.0	84.5%	84.7%	86.5%
2.7	9.0	83.4%	83.4%	84.9%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
3.0	10.0	82.1%	81.9%	83.4%
4.6	15.0	76.4%	73.9%	77.3%
6.1	20.0	71.2%	66.9%	70.5%
7.6	25.0	66.6%	62.0%	60.2%
9.1	30.0	62.5%	57.8%	51.8%
10.7	35.0	58.9%	54.1%	45.5%
12.2	40.0	55.8%	50.8%	40.6%
13.7	45.0	52.9%	47.8%	36.8%
15.2	50.0	50.4%	45.2%	33.6%
16.8	55.0	48.1%	42.9%	31.0%
18.3	60.0	46.0%	40.8%	28.7%
19.8	65.0	44.1%	38.9%	26.8%
21.3	70.0	42.3%	37.2%	25.1%
22.9	75.0	40.8%	35.6%	23.7%
24.4	80.0	39.3%	34.2%	22.4%
25.9	85.0	38.0%	33.0%	21.2%
27.4	90.0	36.7%	31.8%	20.2%
29.0	95.0	35.6%	30.7%	19.3%
30.5	100.0	34.5%	29.7%	18.4%
45.7	150.0	26.7%	22.6%	12.9%
61.0	200.0	22.1%	18.5%	10.0%
76.2	250.0	18.9%	15.7%	8.2%
91.4	300.0	16.6%	13.7%	7.0%
106.7	350.0	14.8%	12.2%	6.0%
121.9	400.0	13.4%	11.0%	5.3%
137.2	450.0	12.3%	10.0%	4.8%
152.4	500.0	11.3%	9.2%	4.3%
167.6	550.0	10.5%	8.5%	4.0%
182.9	600.0	9.8%	7.9%	3.7%
198.1	650.0	9.2%	7.4%	3.4%
213.4	700.0	8.6%	6.9%	3.2%
228.6	750.0	8.1%	6.5%	3.0%
243.8	800.0	7.7%	6.2%	2.8%
259.1	850.0	7.3%	5.8%	2.6%
274.3	900.0	7.0%	5.6%	2.5%
289.6	950.0	6.7%	5.3%	2.4%
304.8	1000.0	6.4%	5.1%	2.3%
381.0	1250.0	5.2%	4.1%	1.8%
457.2	1500.0	4.4%	3.5%	1.5%
533.4	1750.0	3.9%	3.0%	1.3%

Table 13-8: Effective shade targets for hardwood-dominated stream sites in Southern Cascades (code 301).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	92.8%	92.8%	95.0%
0.3	1.0	92.5%	92.4%	94.9%
0.6	2.0	91.9%	91.9%	93.8%
0.9	3.0	90.5%	90.5%	92.9%
1.2	4.0	89.4%	89.5%	92.1%
1.5	5.0	88.2%	88.3%	91.1%
1.8	6.0	86.9%	87.2%	89.8%
2.1	7.0	85.8%	86.1%	88.2%
2.4	8.0	84.5%	84.7%	86.5%
2.7	9.0	83.4%	83.4%	84.9%
3.0	10.0	82.1%	81.9%	83.4%
4.6	15.0	76.4%	73.9%	77.3%
6.1	20.0	71.1%	66.9%	70.5%
7.6	25.0	66.5%	62.0%	60.2%
9.1	30.0	62.5%	57.8%	51.8%
10.7	35.0	58.9%	54.1%	45.5%
12.2	40.0	55.7%	50.8%	40.7%
13.7	45.0	52.9%	47.8%	36.8%
15.2	50.0	50.3%	45.2%	33.6%
16.8	55.0	48.0%	42.9%	31.0%
18.3	60.0	45.9%	40.8%	28.8%
19.8	65.0	44.0%	38.9%	26.8%
21.3	70.0	42.3%	37.2%	25.2%
22.9	75.0	40.7%	35.6%	23.7%
24.4	80.0	39.3%	34.2%	22.4%
25.9	85.0	37.9%	32.9%	21.3%
27.4	90.0	36.7%	31.8%	20.2%
29.0	95.0	35.5%	30.7%	19.3%
30.5	100.0	34.5%	29.7%	18.5%
45.7	150.0	26.7%	22.6%	13.0%
61.0	200.0	22.1%	18.5%	10.0%
76.2	250.0	18.9%	15.7%	8.2%
91.4	300.0	16.6%	13.7%	7.0%
106.7	350.0	14.9%	12.2%	6.1%
121.9	400.0	13.4%	11.0%	5.4%
137.2	450.0	12.3%	10.0%	4.8%
152.4	500.0	11.3%	9.2%	4.4%
167.6	550.0	10.5%	8.5%	4.0%
182.9	600.0	9.8%	7.9%	3.7%
198.1	650.0	9.2%	7.4%	3.4%
213.4	700.0	8.6%	6.9%	3.2%
228.6	750.0	8.1%	6.5%	3.0%
243.8	800.0	7.7%	6.2%	2.8%
259.1	850.0	7.3%	5.9%	2.6%
274.3	900.0	7.0%	5.6%	2.5%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
289.6	950.0	6.7%	5.3%	2.4%
304.8	1000.0	6.4%	5.1%	2.3%
381.0	1250.0	5.2%	4.2%	1.8%
457.2	1500.0	4.5%	3.5%	1.5%
533.4	1750.0	3.9%	3.1%	1.3%

Table 13-9: Effective shade targets for conifer-dominated stream sites in Southern Cascades (code 302).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.4%	98.1%	99.1%
0.3	1.0	96.4%	97.3%	99.1%
0.6	2.0	95.8%	96.9%	99.1%
0.9	3.0	95.6%	96.7%	99.0%
1.2	4.0	95.5%	96.6%	99.0%
1.5	5.0	95.4%	96.6%	98.9%
1.8	6.0	95.3%	96.5%	98.6%
2.1	7.0	95.3%	96.4%	98.2%
2.4	8.0	95.2%	96.1%	97.8%
2.7	9.0	94.9%	95.7%	97.6%
3.0	10.0	94.4%	95.3%	97.3%
4.6	15.0	92.9%	93.8%	96.5%
6.1	20.0	91.3%	92.1%	95.5%
7.6	25.0	90.0%	90.5%	94.4%
9.1	30.0	88.5%	88.8%	93.4%
10.7	35.0	87.2%	87.1%	92.3%
12.2	40.0	85.9%	85.4%	91.0%
13.7	45.0	84.6%	83.6%	89.8%
15.2	50.0	83.4%	82.0%	88.5%
16.8	55.0	82.2%	80.4%	87.0%
18.3	60.0	81.1%	78.8%	85.5%
19.8	65.0	80.0%	77.4%	83.9%
21.3	70.0	78.9%	76.0%	82.1%
22.9	75.0	77.9%	74.8%	80.3%
24.4	80.0	76.9%	73.6%	78.5%
25.9	85.0	75.9%	72.4%	76.4%
27.4	90.0	75.0%	71.4%	74.4%
29.0	95.0	74.1%	70.3%	72.5%
30.5	100.0	73.2%	69.3%	70.6%
45.7	150.0	65.3%	60.8%	55.6%
61.0	200.0	59.0%	54.2%	45.7%
76.2	250.0	53.9%	49.0%	38.9%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
91.4	300.0	49.6%	44.7%	33.9%
106.7	350.0	45.9%	41.2%	30.1%
121.9	400.0	42.8%	38.3%	27.1%
137.2	450.0	40.1%	35.7%	24.7%
152.4	500.0	37.7%	33.5%	22.7%
167.6	550.0	35.6%	31.6%	21.0%
182.9	600.0	33.7%	29.9%	19.6%
198.1	650.0	32.1%	28.3%	18.3%
213.4	700.0	30.5%	26.9%	17.2%
228.6	750.0	29.2%	25.7%	16.2%
243.8	800.0	27.9%	24.6%	15.4%
259.1	850.0	26.8%	23.5%	14.6%
274.3	900.0	25.7%	22.6%	13.9%
289.6	950.0	24.8%	21.7%	13.3%
304.8	1000.0	23.9%	20.9%	12.7%
381.0	1250.0	20.2%	17.7%	10.5%
457.2	1500.0	17.5%	15.3%	8.9%
533.4	1750.0	15.5%	13.5%	7.8%

Table 13-10: Effective shade targets for mixed conifer-hardwood-dominated stream sites in Southern Cascades (code 303).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	96.0%	96.4%	97.5%
0.3	1.0	95.3%	95.9%	97.5%
0.6	2.0	94.9%	95.7%	97.4%
0.9	3.0	94.6%	95.5%	97.3%
1.2	4.0	94.5%	95.3%	96.7%
1.5	5.0	94.4%	94.9%	96.2%
1.8	6.0	93.8%	94.2%	95.7%
2.1	7.0	93.1%	93.6%	95.3%
2.4	8.0	92.6%	93.1%	94.9%
2.7	9.0	92.1%	92.6%	94.5%
3.0	10.0	91.7%	92.1%	94.0%
4.6	15.0	89.1%	89.3%	92.0%
6.1	20.0	86.5%	86.2%	90.0%
7.6	25.0	84.0%	83.0%	87.4%
9.1	30.0	81.8%	80.0%	84.9%
10.7	35.0	79.6%	77.1%	82.2%
12.2	40.0	77.6%	74.4%	79.1%
13.7	45.0	75.7%	72.0%	75.9%
15.2	50.0	73.9%	69.9%	72.7%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
16.8	55.0	72.2%	67.9%	68.9%
18.3	60.0	70.5%	66.2%	65.4%
19.8	65.0	69.0%	64.5%	62.1%
21.3	70.0	67.5%	62.9%	59.2%
22.9	75.0	66.0%	61.4%	56.5%
24.4	80.0	64.7%	59.9%	54.0%
25.9	85.0	63.4%	58.6%	51.8%
27.4	90.0	62.1%	57.2%	49.7%
29.0	95.0	60.9%	56.0%	47.8%
30.5	100.0	59.8%	54.8%	46.0%
45.7	150.0	50.5%	45.3%	33.8%
61.0	200.0	44.0%	38.9%	26.8%
76.2	250.0	39.0%	34.2%	22.4%
91.4	300.0	35.2%	30.6%	19.3%
106.7	350.0	32.1%	27.8%	17.0%
121.9	400.0	29.5%	25.5%	15.2%
137.2	450.0	27.3%	23.5%	13.7%
152.4	500.0	25.5%	21.9%	12.6%
167.6	550.0	23.9%	20.5%	11.6%
182.9	600.0	22.5%	19.2%	10.7%
198.1	650.0	21.2%	18.1%	10.0%
213.4	700.0	20.1%	17.2%	9.4%
228.6	750.0	19.1%	16.3%	8.9%
243.8	800.0	18.2%	15.5%	8.4%
259.1	850.0	17.4%	14.8%	7.9%
274.3	900.0	16.7%	14.1%	7.5%
289.6	950.0	16.0%	13.6%	7.2%
304.8	1000.0	15.3%	13.0%	6.9%
381.0	1250.0	12.8%	10.8%	5.6%
457.2	1500.0	11.0%	9.3%	4.7%
533.4	1750.0	9.7%	8.1%	4.1%

Table 13-11: Effective shade targets for hardwood-dominated stream sites in Rogue/Illinois Valleys (code 400).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	91.3%	92.4%	92.6%
0.3	1.0	90.8%	91.9%	92.5%
0.6	2.0	90.4%	91.4%	92.4%
0.9	3.0	90.1%	91.0%	91.9%
1.2	4.0	89.9%	90.5%	91.2%
1.5	5.0	89.0%	89.6%	90.7%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
1.8	6.0	88.2%	88.8%	90.2%
2.1	7.0	87.5%	88.2%	89.8%
2.4	8.0	86.9%	87.5%	89.3%
2.7	9.0	86.2%	86.6%	88.8%
3.0	10.0	85.4%	85.9%	88.1%
4.6	15.0	81.9%	81.8%	84.3%
6.1	20.0	78.5%	77.6%	80.8%
7.6	25.0	75.5%	73.6%	77.2%
9.1	30.0	72.7%	69.9%	72.8%
10.7	35.0	70.0%	66.6%	68.6%
12.2	40.0	67.6%	63.8%	64.5%
13.7	45.0	65.3%	61.4%	59.6%
15.2	50.0	63.2%	59.2%	55.3%
16.8	55.0	61.3%	57.1%	51.6%
18.3	60.0	59.4%	55.2%	48.4%
19.8	65.0	57.7%	53.3%	45.5%
21.3	70.0	56.1%	51.6%	43.0%
22.9	75.0	54.5%	50.0%	40.7%
24.4	80.0	53.1%	48.5%	38.7%
25.9	85.0	51.7%	47.1%	36.9%
27.4	90.0	50.4%	45.8%	35.3%
29.0	95.0	49.2%	44.5%	33.8%
30.5	100.0	48.1%	43.4%	32.4%
45.7	150.0	39.1%	34.5%	23.3%
61.0	200.0	33.2%	28.9%	18.4%
76.2	250.0	28.9%	25.0%	15.2%
91.4	300.0	25.7%	22.1%	13.0%
106.7	350.0	23.2%	19.9%	11.4%
121.9	400.0	21.1%	18.1%	10.2%
137.2	450.0	19.4%	16.6%	9.2%
152.4	500.0	18.0%	15.3%	8.4%
167.6	550.0	16.8%	14.2%	7.7%
182.9	600.0	15.7%	13.3%	7.2%
198.1	650.0	14.8%	12.5%	6.7%
213.4	700.0	13.9%	11.8%	6.2%
228.6	750.0	13.2%	11.1%	5.9%
243.8	800.0	12.5%	10.6%	5.5%
259.1	850.0	11.9%	10.0%	5.2%
274.3	900.0	11.4%	9.6%	5.0%
289.6	950.0	10.9%	9.1%	4.7%
304.8	1000.0	10.4%	8.8%	4.5%
381.0	1250.0	8.6%	7.2%	3.7%
457.2	1500.0	7.4%	6.1%	3.1%
533.4	1750.0	6.4%	5.3%	2.7%

Table 13-12: Effective shade targets for conifer-dominated stream sites in Rogue/Illinois Valleys (code 500).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	98.3%	98.6%	99.5%
0.3	1.0	97.5%	98.0%	99.4%
0.6	2.0	97.1%	97.7%	99.4%
0.9	3.0	97.0%	97.5%	99.4%
1.2	4.0	96.9%	97.4%	99.3%
1.5	5.0	96.8%	97.4%	98.9%
1.8	6.0	96.7%	97.2%	98.5%
2.1	7.0	96.5%	96.7%	98.2%
2.4	8.0	96.0%	96.3%	97.9%
2.7	9.0	95.5%	95.9%	97.7%
3.0	10.0	95.1%	95.5%	97.5%
4.6	15.0	93.5%	93.7%	96.4%
6.1	20.0	91.7%	91.8%	95.2%
7.6	25.0	89.9%	89.8%	93.9%
9.1	30.0	88.3%	87.6%	92.6%
10.7	35.0	86.8%	85.5%	91.2%
12.2	40.0	85.2%	83.4%	89.7%
13.7	45.0	83.8%	81.4%	88.0%
15.2	50.0	82.4%	79.5%	86.2%
16.8	55.0	81.1%	77.7%	84.2%
18.3	60.0	79.8%	76.1%	82.1%
19.8	65.0	78.6%	74.6%	79.9%
21.3	70.0	77.4%	73.2%	77.4%
22.9	75.0	76.3%	71.9%	74.9%
24.4	80.0	75.1%	70.7%	72.5%
25.9	85.0	74.1%	69.5%	70.2%
27.4	90.0	73.0%	68.3%	68.0%
29.0	95.0	72.0%	67.2%	65.9%
30.5	100.0	71.0%	66.2%	64.0%
45.7	150.0	62.7%	57.3%	49.1%
61.0	200.0	56.2%	50.7%	39.9%
76.2	250.0	51.1%	45.6%	33.7%
91.4	300.0	46.8%	41.5%	29.2%
106.7	350.0	43.3%	38.2%	25.8%
121.9	400.0	40.3%	35.4%	23.2%
137.2	450.0	37.7%	33.0%	21.1%
152.4	500.0	35.5%	30.9%	19.4%
167.6	550.0	33.5%	29.1%	17.9%
182.9	600.0	31.7%	27.5%	16.7%
198.1	650.0	30.1%	26.1%	15.6%
213.4	700.0	28.7%	24.9%	14.6%
228.6	750.0	27.4%	23.7%	13.8%
243.8	800.0	26.3%	22.7%	13.1%
259.1	850.0	25.2%	21.7%	12.4%
274.3	900.0	24.2%	20.8%	11.8%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
289.6	950.0	23.3%	20.0%	11.3%
304.8	1000.0	22.5%	19.3%	10.8%
381.0	1250.0	19.0%	16.3%	8.9%
457.2	1500.0	16.5%	14.1%	7.6%
533.4	1750.0	14.6%	12.5%	6.6%

Table 13-13: Effective shade targets for mixed conifer-hardwood dominated stream sites in Rogue/Illinois Valleys (code 501).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	96.3%	96.9%	97.6%
0.3	1.0	95.6%	96.3%	97.6%
0.6	2.0	95.2%	96.0%	97.6%
0.9	3.0	95.0%	95.8%	97.5%
1.2	4.0	94.8%	95.6%	97.1%
1.5	5.0	94.7%	95.3%	96.5%
1.8	6.0	94.2%	94.6%	96.1%
2.1	7.0	93.6%	94.0%	95.8%
2.4	8.0	93.0%	93.5%	95.5%
2.7	9.0	92.5%	93.1%	95.2%
3.0	10.0	92.2%	92.6%	94.7%
4.6	15.0	89.6%	89.9%	92.7%
6.1	20.0	87.2%	87.0%	90.8%
7.6	25.0	84.9%	84.0%	88.6%
9.1	30.0	82.7%	81.1%	86.1%
10.7	35.0	80.6%	78.3%	83.6%
12.2	40.0	78.7%	75.7%	80.9%
13.7	45.0	76.8%	73.3%	77.8%
15.2	50.0	75.1%	71.2%	74.7%
16.8	55.0	73.4%	69.3%	71.4%
18.3	60.0	71.8%	67.5%	67.9%
19.8	65.0	70.3%	65.9%	64.6%
21.3	70.0	68.8%	64.3%	61.7%
22.9	75.0	67.4%	62.8%	59.0%
24.4	80.0	66.1%	61.4%	56.5%
25.9	85.0	64.8%	60.0%	54.2%
27.4	90.0	63.6%	58.7%	52.0%
29.0	95.0	62.4%	57.5%	50.1%
30.5	100.0	61.3%	56.3%	48.3%
45.7	150.0	52.0%	46.8%	35.6%
61.0	200.0	45.4%	40.3%	28.4%
76.2	250.0	40.5%	35.6%	23.7%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
91.4	300.0	36.5%	31.9%	20.4%
106.7	350.0	33.4%	29.0%	18.0%
121.9	400.0	30.7%	26.6%	16.1%
137.2	450.0	28.5%	24.6%	14.6%
152.4	500.0	26.6%	22.9%	13.3%
167.6	550.0	24.9%	21.5%	12.3%
182.9	600.0	23.5%	20.2%	11.4%
198.1	650.0	22.2%	19.0%	10.7%
213.4	700.0	21.1%	18.0%	10.0%
228.6	750.0	20.0%	17.1%	9.4%
243.8	800.0	19.1%	16.3%	8.9%
259.1	850.0	18.2%	15.6%	8.4%
274.3	900.0	17.5%	14.9%	8.0%
289.6	950.0	16.8%	14.3%	7.7%
304.8	1000.0	16.1%	13.7%	7.3%
381.0	1250.0	13.5%	11.4%	6.0%
457.2	1500.0	11.6%	9.8%	5.1%
533.4	1750.0	10.2%	8.6%	4.4%

Table 13-14: Effective shade targets for mixed conifer-hardwood dominated stream sites in Siskiyou Foothills (code 502).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	95.6%	96.4%	97.4%
0.3	1.0	94.8%	95.8%	97.3%
0.6	2.0	94.4%	95.4%	97.0%
0.9	3.0	94.2%	95.3%	96.9%
1.2	4.0	94.1%	95.2%	96.6%
1.5	5.0	94.0%	95.1%	96.1%
1.8	6.0	93.8%	94.6%	95.6%
2.1	7.0	93.3%	94.0%	95.3%
2.4	8.0	92.7%	93.5%	95.0%
2.7	9.0	92.2%	93.1%	94.8%
3.0	10.0	91.8%	92.7%	94.6%
4.6	15.0	89.6%	90.2%	93.1%
6.1	20.0	87.4%	87.8%	91.1%
7.6	25.0	85.3%	85.2%	89.3%
9.1	30.0	83.3%	82.5%	87.4%
10.7	35.0	81.5%	80.0%	85.1%
12.2	40.0	79.7%	77.6%	82.9%
13.7	45.0	78.0%	75.3%	80.5%
15.2	50.0	76.3%	73.2%	77.8%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
16.8	55.0	74.8%	71.4%	75.1%
18.3	60.0	73.3%	69.6%	72.3%
19.8	65.0	71.9%	68.0%	69.2%
21.3	70.0	70.5%	66.5%	66.3%
22.9	75.0	69.2%	65.1%	63.5%
24.4	80.0	67.9%	63.8%	61.0%
25.9	85.0	66.7%	62.5%	58.7%
27.4	90.0	65.5%	61.2%	56.5%
29.0	95.0	64.4%	60.0%	54.5%
30.5	100.0	63.3%	58.9%	52.6%
45.7	150.0	54.3%	49.5%	39.2%
61.0	200.0	47.7%	42.8%	31.4%
76.2	250.0	42.6%	37.9%	26.3%
91.4	300.0	38.6%	34.1%	22.7%
106.7	350.0	35.3%	31.1%	20.0%
121.9	400.0	32.6%	28.5%	17.9%
137.2	450.0	30.2%	26.4%	16.3%
152.4	500.0	28.2%	24.6%	14.9%
167.6	550.0	26.5%	23.0%	13.8%
182.9	600.0	25.0%	21.7%	12.8%
198.1	650.0	23.6%	20.5%	11.9%
213.4	700.0	22.4%	19.4%	11.2%
228.6	750.0	21.3%	18.4%	10.6%
243.8	800.0	20.3%	17.6%	10.0%
259.1	850.0	19.4%	16.8%	9.5%
274.3	900.0	18.6%	16.0%	9.0%
289.6	950.0	17.9%	15.4%	8.6%
304.8	1000.0	17.2%	14.8%	8.2%
381.0	1250.0	14.4%	12.3%	6.7%
457.2	1500.0	12.4%	10.6%	5.7%
533.4	1750.0	10.9%	9.3%	4.9%

Table 13-15: Effective shade targets for hardwood-dominated stream sites in Siskiyou Foothills (code 600).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.3%	97.3%	98.0%
0.3	1.0	96.7%	96.9%	98.0%
0.6	2.0	96.4%	96.7%	98.0%
0.9	3.0	96.2%	96.6%	97.7%
1.2	4.0	96.0%	96.2%	97.0%
1.5	5.0	95.4%	95.4%	96.6%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
1.8	6.0	94.7%	94.8%	96.3%
2.1	7.0	94.1%	94.3%	96.1%
2.4	8.0	93.6%	93.7%	95.7%
2.7	9.0	93.1%	93.1%	95.3%
3.0	10.0	92.4%	92.4%	94.9%
4.6	15.0	89.4%	89.1%	92.4%
6.1	20.0	86.5%	85.3%	89.7%
7.6	25.0	83.7%	81.6%	87.0%
9.1	30.0	81.2%	78.0%	83.6%
10.7	35.0	78.7%	74.7%	79.9%
12.2	40.0	76.5%	72.0%	76.2%
13.7	45.0	74.3%	69.6%	71.6%
15.2	50.0	72.3%	67.4%	67.1%
16.8	55.0	70.4%	65.4%	63.1%
18.3	60.0	68.7%	63.5%	59.4%
19.8	65.0	67.0%	61.7%	56.2%
21.3	70.0	65.4%	60.0%	53.3%
22.9	75.0	63.8%	58.4%	50.7%
24.4	80.0	62.4%	56.9%	48.3%
25.9	85.0	61.0%	55.5%	46.2%
27.4	90.0	59.7%	54.1%	44.2%
29.0	95.0	58.5%	52.9%	42.4%
30.5	100.0	57.3%	51.7%	40.8%
45.7	150.0	47.9%	42.2%	29.6%
61.0	200.0	41.4%	36.0%	23.4%
76.2	250.0	36.7%	31.6%	19.4%
91.4	300.0	33.0%	28.3%	16.7%
106.7	350.0	30.1%	25.6%	14.7%
121.9	400.0	27.7%	23.5%	13.1%
137.2	450.0	25.6%	21.7%	11.8%
152.4	500.0	23.9%	20.1%	10.8%
167.6	550.0	22.4%	18.8%	10.0%
182.9	600.0	21.1%	17.7%	9.2%
198.1	650.0	19.9%	16.7%	8.6%
213.4	700.0	18.9%	15.8%	8.1%
228.6	750.0	18.0%	15.0%	7.6%
243.8	800.0	17.1%	14.3%	7.2%
259.1	850.0	16.4%	13.6%	6.8%
274.3	900.0	15.7%	13.0%	6.5%
289.6	950.0	15.0%	12.5%	6.2%
304.8	1000.0	14.4%	12.0%	5.9%
381.0	1250.0	12.1%	10.0%	4.8%
457.2	1500.0	10.4%	8.6%	4.1%
533.4	1750.0	9.1%	7.5%	3.5%

Table 13-16: Effective shade targets for conifer-dominated stream sites in Siskiyou Foothills (code 601).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	98.7%	98.9%	99.6%
0.3	1.0	97.8%	98.2%	99.6%
0.6	2.0	97.3%	97.9%	99.6%
0.9	3.0	97.1%	97.7%	99.6%
1.2	4.0	97.1%	97.7%	99.5%
1.5	5.0	97.0%	97.6%	99.3%
1.8	6.0	97.0%	97.6%	99.0%
2.1	7.0	96.9%	97.4%	98.6%
2.4	8.0	96.7%	96.9%	98.4%
2.7	9.0	96.2%	96.5%	98.2%
3.0	10.0	95.8%	96.2%	98.0%
4.6	15.0	94.5%	94.7%	97.2%
6.1	20.0	92.7%	93.0%	96.2%
7.6	25.0	91.3%	91.4%	95.2%
9.1	30.0	89.9%	89.7%	94.2%
10.7	35.0	88.5%	87.8%	93.1%
12.2	40.0	87.2%	86.0%	92.0%
13.7	45.0	86.0%	84.3%	90.8%
15.2	50.0	84.8%	82.6%	89.4%
16.8	55.0	83.6%	80.9%	88.0%
18.3	60.0	82.5%	79.4%	86.5%
19.8	65.0	81.4%	78.0%	84.8%
21.3	70.0	80.3%	76.6%	83.0%
22.9	75.0	79.3%	75.4%	81.1%
24.4	80.0	78.3%	74.2%	79.0%
25.9	85.0	77.3%	73.1%	76.9%
27.4	90.0	76.4%	72.0%	74.9%
29.0	95.0	75.5%	71.0%	73.0%
30.5	100.0	74.6%	70.0%	71.1%
45.7	150.0	66.8%	61.6%	56.1%
61.0	200.0	60.7%	55.2%	46.1%
76.2	250.0	55.6%	50.1%	39.2%
91.4	300.0	51.4%	45.9%	34.2%
106.7	350.0	47.8%	42.5%	30.4%
121.9	400.0	44.7%	39.5%	27.3%
137.2	450.0	42.0%	37.0%	24.9%
152.4	500.0	39.6%	34.8%	22.9%
167.6	550.0	37.5%	32.9%	21.2%
182.9	600.0	35.6%	31.1%	19.7%
198.1	650.0	33.9%	29.6%	18.5%
213.4	700.0	32.3%	28.2%	17.4%
228.6	750.0	31.0%	27.0%	16.4%
243.8	800.0	29.7%	25.8%	15.5%
259.1	850.0	28.5%	24.8%	14.8%
274.3	900.0	27.4%	23.8%	14.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
289.6	950.0	26.4%	22.9%	13.4%
304.8	1000.0	25.5%	22.1%	12.9%
381.0	1250.0	21.7%	18.8%	10.6%
457.2	1500.0	18.9%	16.3%	9.0%
533.4	1750.0	16.8%	14.4%	7.9%

Table 13-17: Effective shade targets for mixed conifer-hardwood dominated stream sites in Serpentine Siskiyous (code 602).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	84.1%	86.0%	87.3%
0.3	1.0	83.4%	85.3%	87.2%
0.6	2.0	82.7%	85.0%	87.1%
0.9	3.0	82.3%	84.6%	86.9%
1.2	4.0	82.0%	84.2%	86.2%
1.5	5.0	81.8%	83.6%	85.4%
1.8	6.0	81.2%	82.8%	84.8%
2.1	7.0	80.4%	82.1%	84.2%
2.4	8.0	79.7%	81.4%	83.5%
2.7	9.0	79.1%	80.8%	82.8%
3.0	10.0	78.6%	80.1%	82.2%
4.6	15.0	75.6%	76.8%	79.3%
6.1	20.0	72.8%	73.5%	76.5%
7.6	25.0	70.3%	70.2%	73.2%
9.1	30.0	67.9%	67.2%	70.1%
10.7	35.0	65.7%	64.4%	67.0%
12.2	40.0	63.7%	61.8%	63.6%
13.7	45.0	61.7%	59.5%	60.3%
15.2	50.0	59.9%	57.5%	57.1%
16.8	55.0	58.2%	55.6%	53.6%
18.3	60.0	56.7%	53.9%	50.4%
19.8	65.0	55.1%	52.3%	47.6%
21.3	70.0	53.7%	50.8%	45.0%
22.9	75.0	52.4%	49.4%	42.7%
24.4	80.0	51.1%	48.0%	40.7%
25.9	85.0	49.9%	46.7%	38.9%
27.4	90.0	48.7%	45.5%	37.2%
29.0	95.0	47.6%	44.3%	35.6%
30.5	100.0	46.5%	43.2%	34.2%
45.7	150.0	38.2%	34.7%	24.8%
61.0	200.0	32.5%	29.1%	19.6%
76.2	250.0	28.3%	25.2%	16.3%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
91.4	300.0	25.2%	22.3%	14.0%
106.7	350.0	22.7%	20.0%	12.3%
121.9	400.0	20.6%	18.1%	10.9%
137.2	450.0	19.0%	16.6%	9.9%
152.4	500.0	17.5%	15.3%	9.0%
167.6	550.0	16.3%	14.2%	8.3%
182.9	600.0	15.3%	13.3%	7.7%
198.1	650.0	14.3%	12.4%	7.1%
213.4	700.0	13.5%	11.7%	6.7%
228.6	750.0	12.8%	11.1%	6.3%
243.8	800.0	12.1%	10.5%	5.9%
259.1	850.0	11.5%	10.0%	5.6%
274.3	900.0	11.0%	9.5%	5.3%
289.6	950.0	10.5%	9.0%	5.1%
304.8	1000.0	10.0%	8.7%	4.8%
381.0	1250.0	8.3%	7.1%	3.9%
457.2	1500.0	7.0%	6.0%	3.3%
533.4	1750.0	6.1%	5.2%	2.9%

Table 13-18: Effective shade targets for willow-dominated stream sites in Serpentine Siskiyous (code 700).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.4%	97.6%	99.4%
0.3	1.0	95.9%	96.0%	98.2%
0.6	2.0	92.9%	92.8%	96.3%
0.9	3.0	89.5%	88.7%	94.3%
1.2	4.0	86.4%	83.9%	91.9%
1.5	5.0	83.3%	79.0%	88.8%
1.8	6.0	80.2%	74.9%	84.5%
2.1	7.0	77.3%	71.7%	76.4%
2.4	8.0	74.4%	69.1%	67.4%
2.7	9.0	71.7%	66.4%	60.4%
3.0	10.0	69.0%	63.7%	54.8%
4.6	15.0	57.7%	51.6%	37.6%
6.1	20.0	49.0%	42.7%	28.7%
7.6	25.0	42.6%	36.3%	23.3%
9.1	30.0	37.8%	31.7%	19.7%
10.7	35.0	34.0%	28.3%	17.0%
12.2	40.0	30.9%	25.5%	15.0%
13.7	45.0	28.5%	23.3%	13.4%
15.2	50.0	26.4%	21.5%	12.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
16.8	55.0	24.6%	19.9%	11.0%
18.3	60.0	23.1%	18.6%	10.1%
19.8	65.0	21.7%	17.4%	9.4%
21.3	70.0	20.6%	16.4%	8.7%
22.9	75.0	19.5%	15.5%	8.2%
24.4	80.0	18.6%	14.7%	7.7%
25.9	85.0	17.8%	14.0%	7.2%
27.4	90.0	17.0%	13.3%	6.8%
29.0	95.0	16.3%	12.8%	6.5%
30.5	100.0	15.7%	12.2%	6.2%
45.7	150.0	11.4%	8.6%	4.1%
61.0	200.0	9.0%	6.7%	3.1%
76.2	250.0	7.5%	5.5%	2.5%
91.4	300.0	6.4%	4.7%	2.1%
106.7	350.0	5.6%	4.0%	1.8%
121.9	400.0	5.0%	3.6%	1.6%
137.2	450.0	4.5%	3.2%	1.4%
152.4	500.0	4.1%	2.9%	1.3%
167.6	550.0	3.7%	2.6%	1.1%
182.9	600.0	3.4%	2.4%	1.0%
198.1	650.0	3.2%	2.3%	1.0%
213.4	700.0	3.0%	2.1%	0.9%
228.6	750.0	2.8%	2.0%	0.8%
243.8	800.0	2.6%	1.8%	0.8%
259.1	850.0	2.5%	1.7%	0.7%
274.3	900.0	2.4%	1.6%	0.7%
289.6	950.0	2.2%	1.6%	0.7%
304.8	1000.0	2.1%	1.5%	0.6%
381.0	1250.0	1.7%	1.2%	0.5%
457.2	1500.0	1.4%	1.0%	0.4%
533.4	1750.0	1.2%	0.9%	0.4%

Table 13-19: Effective shade targets for mixed conifer-hardwood dominated stream sites in Inland Siskiyous (code 701).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	95.6%	96.4%	97.4%
0.3	1.0	94.8%	95.8%	97.3%
0.6	2.0	94.4%	95.4%	97.0%
0.9	3.0	94.2%	95.3%	96.9%
1.2	4.0	94.1%	95.2%	96.6%
1.5	5.0	94.0%	95.1%	96.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
1.8	6.0	93.8%	94.6%	95.6%
2.1	7.0	93.3%	94.0%	95.3%
2.4	8.0	92.7%	93.5%	95.0%
2.7	9.0	92.2%	93.1%	94.8%
3.0	10.0	91.8%	92.7%	94.6%
4.6	15.0	89.6%	90.2%	93.1%
6.1	20.0	87.4%	87.8%	91.1%
7.6	25.0	85.4%	85.2%	89.3%
9.1	30.0	83.4%	82.6%	87.4%
10.7	35.0	81.5%	80.0%	85.1%
12.2	40.0	79.7%	77.6%	82.8%
13.7	45.0	78.0%	75.3%	80.5%
15.2	50.0	76.4%	73.2%	77.7%
16.8	55.0	74.8%	71.4%	75.0%
18.3	60.0	73.3%	69.6%	72.3%
19.8	65.0	71.9%	68.0%	69.2%
21.3	70.0	70.5%	66.6%	66.2%
22.9	75.0	69.2%	65.1%	63.5%
24.4	80.0	67.9%	63.8%	61.0%
25.9	85.0	66.7%	62.5%	58.6%
27.4	90.0	65.5%	61.2%	56.5%
29.0	95.0	64.4%	60.0%	54.4%
30.5	100.0	63.3%	58.9%	52.6%
45.7	150.0	54.3%	49.5%	39.2%
61.0	200.0	47.7%	42.8%	31.4%
76.2	250.0	42.7%	37.9%	26.3%
91.4	300.0	38.6%	34.1%	22.7%
106.7	350.0	35.3%	31.1%	20.0%
121.9	400.0	32.6%	28.5%	17.9%
137.2	450.0	30.2%	26.4%	16.2%
152.4	500.0	28.2%	24.6%	14.9%
167.6	550.0	26.5%	23.0%	13.7%
182.9	600.0	25.0%	21.7%	12.8%
198.1	650.0	23.6%	20.5%	11.9%
213.4	700.0	22.4%	19.4%	11.2%
228.6	750.0	21.3%	18.4%	10.5%
243.8	800.0	20.3%	17.5%	10.0%
259.1	850.0	19.4%	16.7%	9.4%
274.3	900.0	18.6%	16.0%	9.0%
289.6	950.0	17.8%	15.4%	8.6%
304.8	1000.0	17.2%	14.8%	8.2%
381.0	1250.0	14.4%	12.3%	6.7%
457.2	1500.0	12.4%	10.6%	5.7%
533.4	1750.0	10.8%	9.3%	4.9%

Table 13-20: Effective shade targets for hardwood-dominated stream sites in Inland Siskiyous (code 702).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.3%	97.3%	98.0%
0.3	1.0	96.7%	96.9%	98.0%
0.6	2.0	96.4%	96.7%	98.0%
0.9	3.0	96.2%	96.6%	97.7%
1.2	4.0	96.0%	96.2%	97.0%
1.5	5.0	95.4%	95.4%	96.6%
1.8	6.0	94.7%	94.8%	96.3%
2.1	7.0	94.1%	94.3%	96.1%
2.4	8.0	93.6%	93.7%	95.7%
2.7	9.0	93.1%	93.1%	95.3%
3.0	10.0	92.4%	92.4%	94.9%
4.6	15.0	89.4%	89.1%	92.4%
6.1	20.0	86.5%	85.3%	89.7%
7.6	25.0	83.7%	81.6%	87.0%
9.1	30.0	81.2%	78.0%	83.6%
10.7	35.0	78.8%	74.8%	79.9%
12.2	40.0	76.5%	72.0%	76.1%
13.7	45.0	74.4%	69.6%	71.6%
15.2	50.0	72.4%	67.4%	67.1%
16.8	55.0	70.5%	65.4%	63.0%
18.3	60.0	68.7%	63.5%	59.4%
19.8	65.0	67.0%	61.7%	56.2%
21.3	70.0	65.4%	60.1%	53.3%
22.9	75.0	63.9%	58.5%	50.7%
24.4	80.0	62.4%	57.0%	48.3%
25.9	85.0	61.1%	55.5%	46.2%
27.4	90.0	59.7%	54.2%	44.2%
29.0	95.0	58.5%	52.9%	42.4%
30.5	100.0	57.3%	51.7%	40.8%
45.7	150.0	47.9%	42.2%	29.5%
61.0	200.0	41.5%	36.0%	23.3%
76.2	250.0	36.7%	31.6%	19.4%
91.4	300.0	33.0%	28.3%	16.7%
106.7	350.0	30.1%	25.6%	14.6%
121.9	400.0	27.7%	23.5%	13.1%
137.2	450.0	25.6%	21.7%	11.8%
152.4	500.0	23.9%	20.1%	10.8%
167.6	550.0	22.4%	18.8%	9.9%
182.9	600.0	21.1%	17.7%	9.2%
198.1	650.0	19.9%	16.7%	8.6%
213.4	700.0	18.9%	15.8%	8.1%
228.6	750.0	18.0%	15.0%	7.6%
243.8	800.0	17.1%	14.3%	7.2%
259.1	850.0	16.3%	13.6%	6.8%
274.3	900.0	15.7%	13.0%	6.4%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
289.6	950.0	15.0%	12.5%	6.1%
304.8	1000.0	14.4%	12.0%	5.9%
381.0	1250.0	12.1%	10.0%	4.8%
457.2	1500.0	10.4%	8.6%	4.0%
533.4	1750.0	9.1%	7.5%	3.5%

Table 13-21: Effective shade targets for conifer-dominated stream sites in Inland Siskiyous (code 800).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	98.8%	99.0%	99.7%
0.3	1.0	97.9%	98.3%	99.7%
0.6	2.0	97.4%	97.9%	99.7%
0.9	3.0	97.2%	97.8%	99.7%
1.2	4.0	97.1%	97.7%	99.7%
1.5	5.0	97.1%	97.7%	99.5%
1.8	6.0	97.0%	97.6%	99.1%
2.1	7.0	97.0%	97.5%	98.8%
2.4	8.0	96.8%	97.1%	98.5%
2.7	9.0	96.4%	96.7%	98.3%
3.0	10.0	96.0%	96.3%	98.1%
4.6	15.0	94.6%	95.0%	97.4%
6.1	20.0	93.0%	93.3%	96.4%
7.6	25.0	91.7%	91.8%	95.5%
9.1	30.0	90.3%	90.2%	94.6%
10.7	35.0	89.0%	88.4%	93.6%
12.2	40.0	87.8%	86.8%	92.5%
13.7	45.0	86.6%	85.1%	91.4%
15.2	50.0	85.4%	83.4%	90.2%
16.8	55.0	84.3%	81.8%	88.9%
18.3	60.0	83.2%	80.3%	87.5%
19.8	65.0	82.2%	78.9%	86.0%
21.3	70.0	81.2%	77.6%	84.3%
22.9	75.0	80.2%	76.4%	82.6%
24.4	80.0	79.2%	75.2%	80.7%
25.9	85.0	78.3%	74.1%	78.8%
27.4	90.0	77.4%	73.1%	76.8%
29.0	95.0	76.5%	72.1%	74.9%
30.5	100.0	75.6%	71.1%	73.1%
45.7	150.0	68.0%	62.9%	58.1%
61.0	200.0	62.0%	56.5%	48.1%
76.2	250.0	56.9%	51.4%	41.0%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
91.4	300.0	52.7%	47.3%	35.8%
106.7	350.0	49.1%	43.8%	31.8%
121.9	400.0	46.0%	40.8%	28.7%
137.2	450.0	43.2%	38.2%	26.1%
152.4	500.0	40.8%	36.0%	24.0%
167.6	550.0	38.7%	34.0%	22.2%
182.9	600.0	36.8%	32.2%	20.7%
198.1	650.0	35.0%	30.7%	19.4%
213.4	700.0	33.5%	29.2%	18.2%
228.6	750.0	32.0%	28.0%	17.2%
243.8	800.0	30.7%	26.8%	16.3%
259.1	850.0	29.5%	25.7%	15.5%
274.3	900.0	28.4%	24.7%	14.8%
289.6	950.0	27.4%	23.8%	14.1%
304.8	1000.0	26.5%	23.0%	13.5%
381.0	1250.0	22.6%	19.5%	11.2%
457.2	1500.0	19.7%	17.0%	9.5%
533.4	1750.0	17.5%	15.0%	8.3%

Table 13-22: Effective shade targets for willow-dominated stream sites in Inland Siskiyous (code 801).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.4%	97.6%	99.4%
0.3	1.0	95.9%	96.0%	98.2%
0.6	2.0	92.9%	92.8%	96.3%
0.9	3.0	89.5%	88.7%	94.3%
1.2	4.0	86.4%	83.9%	91.9%
1.5	5.0	83.3%	79.0%	88.8%
1.8	6.0	80.2%	74.9%	84.5%
2.1	7.0	77.3%	71.7%	76.4%
2.4	8.0	74.4%	69.1%	67.4%
2.7	9.0	71.7%	66.4%	60.4%
3.0	10.0	69.0%	63.7%	54.8%
4.6	15.0	57.7%	51.6%	37.6%
6.1	20.0	49.0%	42.7%	28.7%
7.6	25.0	42.6%	36.3%	23.3%
9.1	30.0	37.8%	31.7%	19.7%
10.7	35.0	34.0%	28.3%	17.0%
12.2	40.0	30.9%	25.5%	15.0%
13.7	45.0	28.5%	23.3%	13.4%
15.2	50.0	26.4%	21.5%	12.1%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
16.8	55.0	24.6%	19.9%	11.0%
18.3	60.0	23.1%	18.6%	10.1%
19.8	65.0	21.7%	17.4%	9.4%
21.3	70.0	20.6%	16.4%	8.7%
22.9	75.0	19.5%	15.5%	8.2%
24.4	80.0	18.6%	14.7%	7.7%
25.9	85.0	17.8%	14.0%	7.2%
27.4	90.0	17.0%	13.3%	6.8%
29.0	95.0	16.3%	12.8%	6.5%
30.5	100.0	15.7%	12.2%	6.2%
45.7	150.0	11.4%	8.6%	4.1%
61.0	200.0	9.0%	6.7%	3.1%
76.2	250.0	7.5%	5.5%	2.5%
91.4	300.0	6.4%	4.7%	2.1%
106.7	350.0	5.6%	4.0%	1.8%
121.9	400.0	5.0%	3.6%	1.6%
137.2	450.0	4.5%	3.2%	1.4%
152.4	500.0	4.1%	2.9%	1.3%
167.6	550.0	3.7%	2.6%	1.1%
182.9	600.0	3.4%	2.4%	1.0%
198.1	650.0	3.2%	2.3%	1.0%
213.4	700.0	3.0%	2.1%	0.9%
228.6	750.0	2.8%	2.0%	0.8%
243.8	800.0	2.6%	1.8%	0.8%
259.1	850.0	2.5%	1.7%	0.7%
274.3	900.0	2.4%	1.6%	0.7%
289.6	950.0	2.2%	1.6%	0.7%
304.8	1000.0	2.1%	1.5%	0.6%
381.0	1250.0	1.7%	1.2%	0.5%
457.2	1500.0	1.4%	1.0%	0.4%
533.4	1750.0	1.2%	0.9%	0.4%

Table 13-23: Effective shade targets for hardwood-dominated stream sites in Coastal Siskiyous (code 802).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	91.2%	91.9%	92.4%
0.3	1.0	90.7%	91.5%	92.4%
0.6	2.0	90.2%	90.9%	92.3%
0.9	3.0	89.8%	90.6%	91.7%
1.2	4.0	89.5%	90.0%	90.9%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
1.5	5.0	88.5%	89.1%	90.4%
1.8	6.0	87.7%	88.3%	89.9%
2.1	7.0	87.0%	87.7%	89.5%
2.4	8.0	86.5%	86.9%	88.9%
2.7	9.0	85.6%	86.0%	88.2%
3.0	10.0	84.8%	85.3%	87.5%
4.6	15.0	81.2%	81.1%	83.5%
6.1	20.0	77.8%	76.8%	79.9%
7.6	25.0	74.7%	72.7%	76.1%
9.1	30.0	71.8%	68.9%	71.5%
10.7	35.0	69.1%	65.7%	67.3%
12.2	40.0	66.7%	62.9%	62.9%
13.7	45.0	64.4%	60.4%	57.9%
15.2	50.0	62.3%	58.2%	53.7%
16.8	55.0	60.3%	56.1%	50.0%
18.3	60.0	58.4%	54.1%	46.8%
19.8	65.0	56.7%	52.3%	44.1%
21.3	70.0	55.0%	50.6%	41.6%
22.9	75.0	53.5%	49.0%	39.4%
24.4	80.0	52.1%	47.5%	37.4%
25.9	85.0	50.7%	46.1%	35.7%
27.4	90.0	49.4%	44.7%	34.1%
29.0	95.0	48.2%	43.5%	32.6%
30.5	100.0	47.0%	42.3%	31.3%
45.7	150.0	38.1%	33.6%	22.5%
61.0	200.0	32.3%	28.1%	17.7%
76.2	250.0	28.1%	24.3%	14.6%
91.4	300.0	25.0%	21.4%	12.5%
106.7	350.0	22.5%	19.2%	11.0%
121.9	400.0	20.5%	17.5%	9.8%
137.2	450.0	18.8%	16.0%	8.8%
152.4	500.0	17.4%	14.8%	8.1%
167.6	550.0	16.2%	13.7%	7.4%
182.9	600.0	15.2%	12.8%	6.9%
198.1	650.0	14.3%	12.0%	6.4%
213.4	700.0	13.5%	11.3%	6.0%
228.6	750.0	12.7%	10.7%	5.6%
243.8	800.0	12.1%	10.2%	5.3%
259.1	850.0	11.5%	9.7%	5.0%
274.3	900.0	11.0%	9.2%	4.7%
289.6	950.0	10.5%	8.8%	4.5%
304.8	1000.0	10.0%	8.4%	4.3%
381.0	1250.0	8.3%	6.9%	3.5%
457.2	1500.0	7.1%	5.9%	3.0%
533.4	1750.0	6.2%	5.1%	2.5%

Table 13-24: Effective shade targets for conifer-dominated stream sites in Coastal Siskiyous (code 900).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	97.4%	98.1%	99.1%
0.3	1.0	96.4%	97.3%	99.1%
0.6	2.0	95.9%	96.9%	99.1%
0.9	3.0	95.7%	96.8%	99.1%
1.2	4.0	95.5%	96.7%	99.0%
1.5	5.0	95.4%	96.6%	99.0%
1.8	6.0	95.4%	96.5%	98.6%
2.1	7.0	95.3%	96.5%	98.3%
2.4	8.0	95.3%	96.2%	97.9%
2.7	9.0	95.0%	95.7%	97.7%
3.0	10.0	94.5%	95.3%	97.4%
4.6	15.0	92.9%	93.9%	96.6%
6.1	20.0	91.5%	92.2%	95.6%
7.6	25.0	90.1%	90.6%	94.5%
9.1	30.0	88.6%	89.0%	93.5%
10.7	35.0	87.3%	87.3%	92.5%
12.2	40.0	86.0%	85.6%	91.3%
13.7	45.0	84.8%	83.9%	90.0%
15.2	50.0	83.6%	82.3%	88.8%
16.8	55.0	82.5%	80.7%	87.4%
18.3	60.0	81.3%	79.1%	85.9%
19.8	65.0	80.3%	77.7%	84.3%
21.3	70.0	79.2%	76.4%	82.6%
22.9	75.0	78.2%	75.1%	80.8%
24.4	80.0	77.2%	73.9%	79.0%
25.9	85.0	76.2%	72.8%	77.0%
27.4	90.0	75.3%	71.7%	75.0%
29.0	95.0	74.4%	70.7%	73.1%
30.5	100.0	73.5%	69.7%	71.2%
45.7	150.0	65.7%	61.2%	56.3%
61.0	200.0	59.4%	54.6%	46.4%
76.2	250.0	54.3%	49.4%	39.5%
91.4	300.0	50.0%	45.2%	34.4%
106.7	350.0	46.3%	41.6%	30.6%
121.9	400.0	43.2%	38.6%	27.5%
137.2	450.0	40.5%	36.1%	25.1%
152.4	500.0	38.1%	33.9%	23.1%
167.6	550.0	36.0%	31.9%	21.3%
182.9	600.0	34.1%	30.2%	19.9%
198.1	650.0	32.4%	28.6%	18.6%
213.4	700.0	30.9%	27.3%	17.5%
228.6	750.0	29.5%	26.0%	16.5%
243.8	800.0	28.2%	24.9%	15.7%
259.1	850.0	27.1%	23.8%	14.9%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
274.3	900.0	26.0%	22.9%	14.2%
289.6	950.0	25.0%	22.0%	13.5%
304.8	1000.0	24.1%	21.2%	12.9%
381.0	1250.0	20.5%	17.9%	10.7%
457.2	1500.0	17.8%	15.5%	9.1%
533.4	1750.0	15.7%	13.7%	7.9%

Table 13-25: Effective shade targets for mixed conifer-hardwood dominated stream sites in Coastal Siskiyous (code 901).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
0.2	0.5	95.6%	96.5%	97.5%
0.3	1.0	94.9%	95.8%	97.4%
0.6	2.0	94.4%	95.4%	97.1%
0.9	3.0	94.3%	95.3%	96.9%
1.2	4.0	94.1%	95.2%	96.7%
1.5	5.0	94.0%	95.1%	96.1%
1.8	6.0	93.9%	94.7%	95.7%
2.1	7.0	93.3%	94.0%	95.3%
2.4	8.0	92.7%	93.5%	95.1%
2.7	9.0	92.2%	93.1%	94.8%
3.0	10.0	91.8%	92.7%	94.7%
4.6	15.0	89.6%	90.3%	93.1%
6.1	20.0	87.5%	87.8%	91.2%
7.6	25.0	85.4%	85.3%	89.4%
9.1	30.0	83.4%	82.7%	87.5%
10.7	35.0	81.6%	80.1%	85.2%
12.2	40.0	79.8%	77.7%	83.0%
13.7	45.0	78.1%	75.4%	80.6%
15.2	50.0	76.5%	73.4%	77.9%
16.8	55.0	74.9%	71.5%	75.2%
18.3	60.0	73.4%	69.8%	72.5%
19.8	65.0	72.0%	68.2%	69.4%
21.3	70.0	70.6%	66.7%	66.5%
22.9	75.0	69.3%	65.3%	63.7%
24.4	80.0	68.1%	63.9%	61.2%
25.9	85.0	66.8%	62.6%	58.9%
27.4	90.0	65.7%	61.4%	56.7%
29.0	95.0	64.6%	60.2%	54.7%
30.5	100.0	63.5%	59.0%	52.8%
45.7	150.0	54.5%	49.6%	39.3%

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%) (0 deg)	Effective shade target for NW-SE, NE-SW stream aspects (%) (45 deg)	Effective shade target for E-W stream aspects (%) (90 deg)
61.0	200.0	47.9%	43.0%	31.5%
76.2	250.0	42.8%	38.1%	26.4%
91.4	300.0	38.7%	34.2%	22.8%
106.7	350.0	35.4%	31.2%	20.1%
121.9	400.0	32.7%	28.6%	18.0%
137.2	450.0	30.3%	26.5%	16.3%
152.4	500.0	28.3%	24.7%	15.0%
167.6	550.0	26.6%	23.1%	13.8%
182.9	600.0	25.1%	21.8%	12.8%
198.1	650.0	23.7%	20.5%	12.0%
213.4	700.0	22.5%	19.5%	11.2%
228.6	750.0	21.4%	18.5%	10.6%
243.8	800.0	20.4%	17.6%	10.0%
259.1	850.0	19.5%	16.8%	9.5%
274.3	900.0	18.7%	16.1%	9.0%
289.6	950.0	17.9%	15.4%	8.6%
304.8	1000.0	17.2%	14.8%	8.2%
381.0	1250.0	14.4%	12.4%	6.7%
457.2	1500.0	12.4%	10.6%	5.7%
533.4	1750.0	10.9%	9.3%	5.0%