State of Oregon Department of Environmental Quality

Attachment E

Lower Columbia-Sandy Subbasin TMDL

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

Redline versions of the following documents are attached:

Attachment E.1 – Total Maximum Daily Load

Attachment E.2 – Water Quality Management Plan

~~Draft~~ Total Maximum Daily Loads for the Lower Columbia-Sandy Subbasin

Temperature

~~January~~August 2024

State of Oregon
DEQ Department of Environmental Quality

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Acknowledgments

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Picture Source: Ryan Michie, Mount Hood from Zigzag Mountain, Sandy River from Oxbow Regional Park

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Lower Columbia-Sandy Subbasin Temperature TMDLs and Water Quality Management Plan would not be possible without the support, contributions, and review of the following:

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Acronyms

7DADM	7-Day Average Daily Maximum
7Q10	7-Day, 10-Year Low 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
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
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
ODFW	Oregon Department of Fish & Wildlife
ORS	Oregon Revised Statutes
POMI	Point of Maximum Impact
RC	Reserve Capacity
STP	Sewage Treatment Plant
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

This Total Maximum Daily Load (TMDL) project is applicable within the Lower Columbia-Sandy Subbasin and ~~will be~~was adopted by reference ~~in~~into Oregon Administrative Rules OAR 340-42-0090.

OAR 340-42-0040(3) requires the Oregon Department of Environmental Quality (DEQ) or ~~the~~ Oregon's Environmental Quality Commission (EQC) to prioritize and schedule TMDLs for completion considering various factors outlined in the rule. Temperature TMDLs for the Lower Columbia-Sandy Subbasin were identified as a high priority due to court order to Oregon and the Environmental Protection Agency (EPA) to establish TMDLs to replace the temperature TMDLs developed as part of the 2005 Sandy River Basin (action ID 11395) (**Table 1-1**).

1.1 Previous TMDLs

DEQ has issued one previous TMDL action in 2005 that addressed listings for temperature and bacteria (DEQ, 2005). Once approved by EPA, the Lower Columbia-Sandy Subbasin TMDLs for temperature will replace the temperature TMDLs approved by EPA in 2005. The bacteria TMDLs approved by the EPA in 2005 are still effective.

Table 1-1: Summary of previous TMDLs developed for the Lower Columbia-Sandy Subbasin.

TMDL action ID	TMDL ~~Name~~name	EPA ~~Approval Date~~approval date	Water ~~Quality Impairments Addressed~~quality impairments addressed
11395	Sandy River Basin Total Maximum Daily Load (TMDL)	4/14/2005	Bacteria (water contact recreation), Temperature

1.2 TMDL administrative process and public participation

Following completion of ~~Oregon Department of Environmental Quality's~~DEQ's drafting process, including engagement of a rule advisory committee on the fiscal impact statement and aspects of the rule, this revised temperature TMDL for the Lower Columbia-Sandy Subbasin ~~will be proposed for adoption by Oregon's Environmental Quality Commission~~was adopted by the EQC, by reference, into rule section OAR 340-042-0090. Any subsequently amended or renumbered rules cited in this document are intended to apply.

DEQ convened a rule advisory committee to provide input on drafts of the TMDL, Water Quality Management Plan~~,~~ (WQMP), Technical Support Document~~,~~ (TSD), fiscal and economic impacts, and Environmental Justice and Racial Equity. The committee met on February 22, 2023, and April 5, 2023. The agency held two informational webinars about this TMDL. ~~DEQ has submitted the drafts for~~A public comment ~~to fulfill the~~period was held from January 10 through February 26, 2024. DEQ held a public ~~participation requirements~~hearing on February 16, 2024. DEQ considered all input received during these public participation opportunities and used input to guide the analyses and preparation of documents. DEQ ~~will provide~~developed a response to comments that ~~will be~~is available online.

2 TMDL name and location

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

Temperature TMDLs for the Lower Columbia-Sandy ~~are~~were developed to address all Category 5 listed assessment units (AUs) impaired for temperature (~~Table 2-2~~**Table 2-2**) and ~~to serve as~~, as applicable, any AUs identified as temperature-impaired in the future. Likewise, this TMDL includes a protection plan for all other assessment categories~~,~~ including ~~unimpaired and~~AUs identified as a potential concern, attaining, or unassessed.

The loading capacity (LC) and allocations, including surrogate measures, and implementation framework apply to all waters determined to be waters of the state as defined under ORS 468B.005(10), including all perennial and intermittent streams that have surface flow or residual pools during the TMDL allocation period, located in the Lower Columbia-Sandy Subbasin (17080001). The temperature TMDLs do not include the section of the Columbia River that flows through the Lower Columbia-Sandy Subbasin (17080001~~), however~~). However, this TMDL implements EPA's Columbia and Lower Snake Rivers temperature TMDL (EPA, 2021) allocation to anthropogenic sources in Columbia River tributaries, including the Sandy River.

The TMDL implementation framework is presented in the Lower Columbia-Sandy Subbasin ~~TMDL Water Quality Management Plan~~WQMP and includes implementation activities and timeframes to improve water quality, as well as measures of success. These and other protection plan elements are further explained in Section ~~12, below.~~12.

The map in ~~Figure 2-1~~**Figure 2-1** provides an overview of where the temperature TMDLs are applicable. Appendix H of the Lower Columbia-Sandy ~~Technical Support Document~~TSD provides a list of all ~~assessment units~~AUs addressed by this TMDL.

In Oregon, the Lower Columbia-Sandy Subbasin is comprised of seven smaller 10-digit hydrologic unit code (HUC) watersheds as listed in ~~Table 2-1~~**Table 2-1**.

Table 2-1: Watersheds within the Lower Columbia-Sandy Subbasin.

~~HU10 code~~HUC	Watershed ~~Name~~name
1708000101	Upper Sandy River
1708000102	Zigzag River
1708000103	Salmon River
1708000104	Middle Sandy River
1708000105	Bull Run River
1708000107	Lower Sandy River
1708000108	City of Washougal-Columbia River

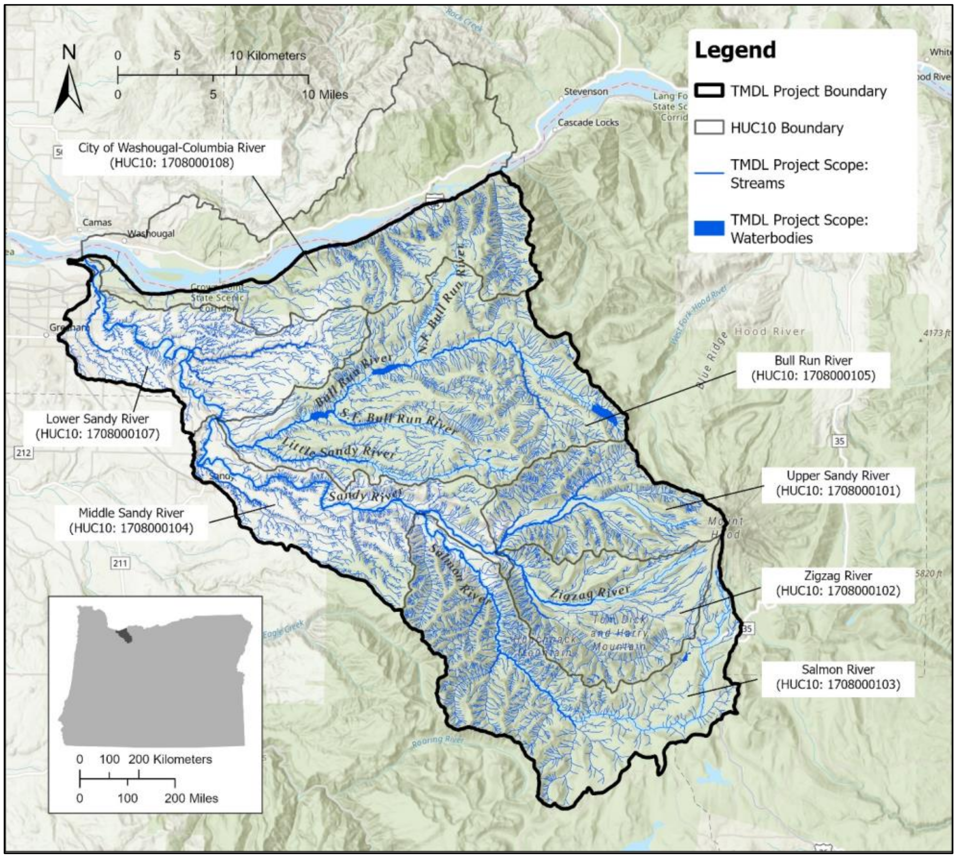


Figure 2-1: Lower Columbia-Sandy Subbasin temperature TMDLs project area overview.

~~Table 2-2~~**Table 2-2** presents stream ~~assessment units~~AUs within the Lower Columbia-Sandy Subbasin that were listed as impaired for temperature on DEQ's 2022 Clean Water Act Section 303(d) List (as part of Oregon's Integrated Report), which was approved by the ~~Environmental Protection Agency~~EPA on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act. ~~Assessment units~~AUs listed in Category 5 (i.e., designated use is not supported or a water quality standard is not attained) require development of a TMDL. Locations of these listed segments are depicted in **Figure 2-2**. ~~Locations of these listed segments are depicted on Figure 2-2.~~

Table 2-2: Lower Columbia-Sandy Subbasin Category 5 temperature impairments on the 2022 Integrated Report.

Assessment ~~Unit Name~~unit name	Assessment ~~Unit~~unit	Use ~~Period~~period
Beaver Creek	OR_SR_1708000107_02_103612	Year round
Beaver Creek	OR_SR_1708000107_02_103612	Spawning
Benson Lake	OR_LK_1708000108_15_100639	Year round
Bull Run River	OR_SR_1708000105_11_103611	Year round
Bull Run River	OR_SR_1708000105_11_103611	Spawning
Cedar Creek	OR_SR_1708000104_02_103607	Year round
Clear Creek	OR_SR_1708000101_02_103597	Year round
Clear Creek	OR_SR_1708000101_02_103597	Spawning
Clear Fork	OR_SR_1708000101_02_103596	Spawning
Gordon Creek	OR_SR_1708000107_02_103615	Spawning
Gordon Creek	OR_SR_1708000107_02_103617	Spawning
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	Spawning
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	Year round
HUC12 Name: Bridal Veil Creek-Columbia River	OR_WS_170800010803_15_103654	Year round
HUC12 Name: Cedar Creek-Sandy River	OR_WS_170800010402_02_103644	Year round
HUC12 Name: Headwaters Sandy River	OR_WS_170800010101_02_103635	Year round
HUC12 Name: Little Sandy River	OR_WS_170800010505_11_103669	Year round
HUC12 Name: Lower Bull Run River	OR_WS_170800010506_11_103650	Year round
HUC12 Name: Lower Salmon River	OR_WS_170800010304_02_103642	Year round
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	Spawning
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	Year round
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	Spawning
Little Sandy River	OR_SR_1708000105_11_103609	Year round
Little Sandy River	OR_SR_1708000105_11_103609	Spawning
Lost Creek	OR_SR_1708000101_02_103598	Spawning
Salmon River	OR_SR_1708000103_02_103606	Year round
Salmon River	OR_SR_1708000103_02_103606	Spawning
Sandy River	OR_SR_1708000101_02_103595	Year round
Sandy River	OR_SR_1708000101_02_103599	Year round
Sandy River	OR_SR_1708000101_02_103599	Spawning
Sandy River	OR_SR_1708000104_02_103608	Year round
Sandy River	OR_SR_1708000104_02_103608	Spawning
Sandy River	OR_SR_1708000107_02_103616	Year round
South Fork Salmon River	OR_SR_1708000103_02_103604	Spawning
Still Creek	OR_SR_1708000102_02_103601	Spawning
Zigzag River	OR_SR_1708000102_02_103600	Spawning

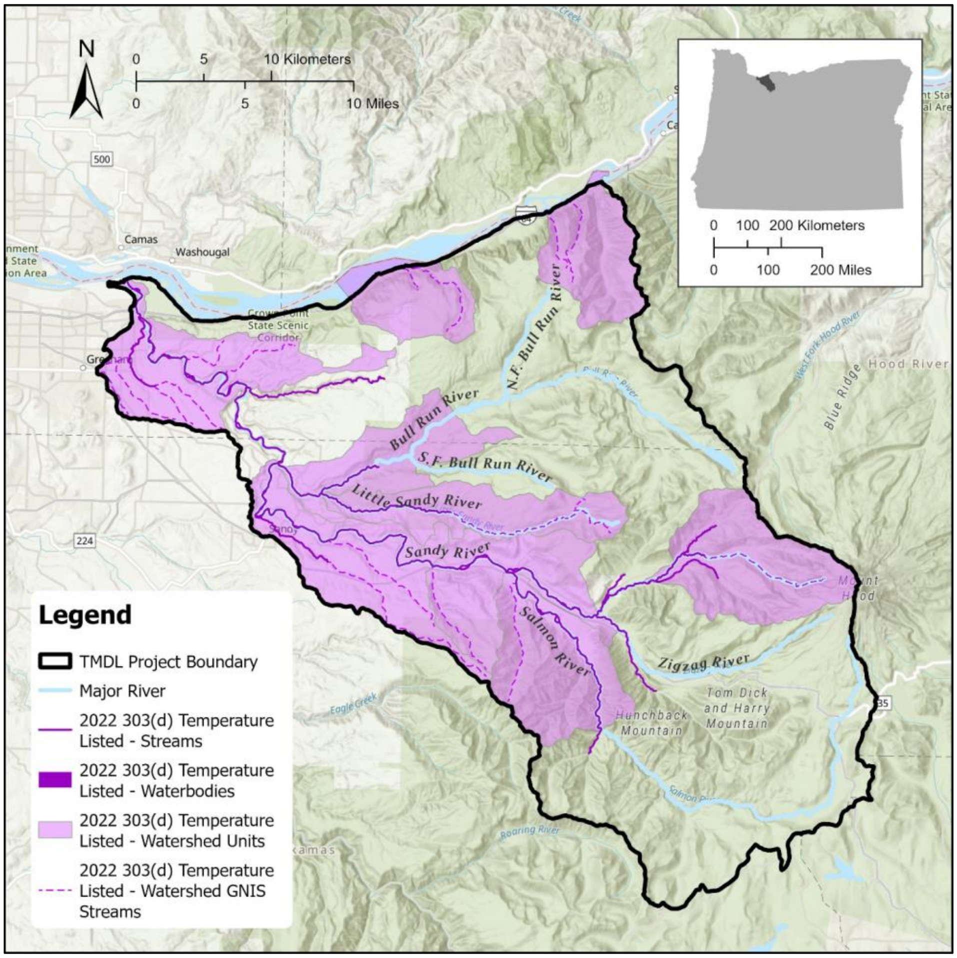


Figure 2-2: Lower Columbia-Sandy Subbasin Category 5 temperature impairments on the 2022 Integrated Report.

3 Pollutant identification

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

Temperature is the water quality parameter of concern, but heat or thermal loading~~,~~ is the pollutant of concern causing impairment. Heat caused by human activities ~~are~~is of particular concern.

EPA regulations (40 CFR 130.2(i)) and OAR 340-042-0040(O)(5)(b) allow for TMDLs to utilize other appropriate measures (or surrogate measures). Surrogate measures are defined in OAR 340-042-0030(14) as "substitute methods or parameters used in a TMDL to represent pollutants." In accordance with OAR 340-042-0040(5)(b), DEQ used effective shade and a percent consumptive use target as ~~a~~ surrogate ~~measure~~measures for thermal loading caused by solar radiation and other fluxes that introduce heat. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint load allocations (LAs) for these temperature TMDLs.

4 Water quality standards and beneficial uses

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

~~Table 4-1 and Table 4-2~~**Table 4-1** and **Table 4-2** specify the designated beneficial uses in the Lower Columbia-Sandy Subbasin surface ~~water~~waters, the applicable numeric and narrative water quality standards and antidegradation rule and policy addressed by these TMDLs, and the most sensitive beneficial uses pertinent to each standard. These TMDLs ~~are~~were designed with the understanding that meeting water quality standards for the most sensitive beneficial uses ~~will be~~is protective of all other uses for that parameter. **Figure 4-1** shows various designated fish uses and applicable criteria, while **Figure 4-2** shows salmon and steelhead spawning use designations.

Table 4-1: Designated beneficial uses in the Lower Columbia-Sandy Subbasin as identified in OAR 340-041-0286 Table 286A.

Beneficial ~~Uses~~uses	**Streams ~~Forming~~forming ~~Waterfalls Near~~ waterfalls near Columbia River ~~Highway~~highway**	**Sandy River**	**Bull Run River and all tributaries~~Tributaries~~**	**All ~~Other~~other tributaries~~Tributaries~~ to Sandy River**
Public Domestic Water Supply		X	X	X
Private Domestic Water Supply		X		X
Industrial Water Supply		X		X
Irrigation		X		X
Livestock Watering		X		X
Fish and Aquatic Life	X	X	X	X
Wildlife and Hunting	X	X		X
Fishing	X	X		X

Beneficial ~~Uses~~uses	Streams ~~Forming~~forming ~~Waterfalls Near~~ waterfalls near Columbia River ~~Highway~~highway	Sandy River	Bull Run River and all tributaries~~Tributaries~~	All ~~Other~~other tributaries~~Tributaries~~ to Sandy River
Boating		X		X
Water Contact Recreation	X	X		X
Aesthetic Quality	X	X	X	X
Hydro Power		X	X	X
Commercial Navigation & Transportation				

Table 4-2: Applicable water quality standards and most sensitive beneficial uses.

Parameter	Rule ~~Citation~~citation	Summary of applicable standards	Waters where standards apply	Most sensitive beneficial use
Statewide Narrative Criteria	OAR 340-041-0007(1)	The highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided ~~so as~~ to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.	All waters of the state	Fish and aquatic life
Temperature	OAR 340-041-0028(4) OAR 340-041-0286 Figures 286A and 286B	(a) The 7-day average maximum temperature may not exceed 13.0°C (55°F) at the times indicated on maps and tables (salmon and steelhead spawning) (b) The 7-day average maximum temperature may not exceed 16.0°C (60.8°F) (core cold water habitat) (c) The 7-day average maximum temperature may not exceed 18.0°C (64.4°F) (salmon and trout rearing and migration)	See OAR Figures 286A and 286B (**Figure 4-1** and **Figure 4-2** in this document)	Salmonid and steelhead spawning
	OAR 340-041-0028(6)	Natural lakes may not be warmed by more than 0.3°C (0.5°F) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life.	Natural Lakes	Fish and aquatic life
	OAR 340-041-0028(11)	(a) Waters that have 7-day average maximum colder than the biologically based criteria may not be warmed by more than 0.3°C (0.5°F) above the colder water ambient temperature, by all sources taken together at the point of maximum impact. (b) A point source that discharges into or above salmon & steelhead spawning waters that are colder than the spawning criterion~~,~~ may not cause the water temperature in the spawning reach to (A) increase 0.5°C above the 60-day average when the 60-day average is 10°~~C~~ -12.8°C; or (B) increase	Cold water	Salmon, steelhead or bull trout presence

Parameter	Rule ~~Citation~~citation	Summary of applicable standards	Waters where standards apply	Most sensitive beneficial use
		1.0°C above the 60-day average when the 60-day average is less than 10°C.		
	OAR 340-041-0028(12)(b)	(B) Human ~~Use Allowance~~use allowance. Following a temperature TMDL or other cumulative effects analysis, wasteload and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3°C (0.5°F) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.	All waters of the state	Salmonid and steelhead spawning
	Antidegradation OAR 340-041-0004 and 40 CFR 131.12(a)(2)	(3)(c) Insignificant temperature increases authorized under OAR 340-041-0028(11) and (12) are not considered a reduction in water quality.		
		(5)(a) Riparian Restoration Activities Exemption: When DEQ determines that activities to restore geomorphology or riparian vegetation have a net ecological benefit, antidegradation review is not needed.		

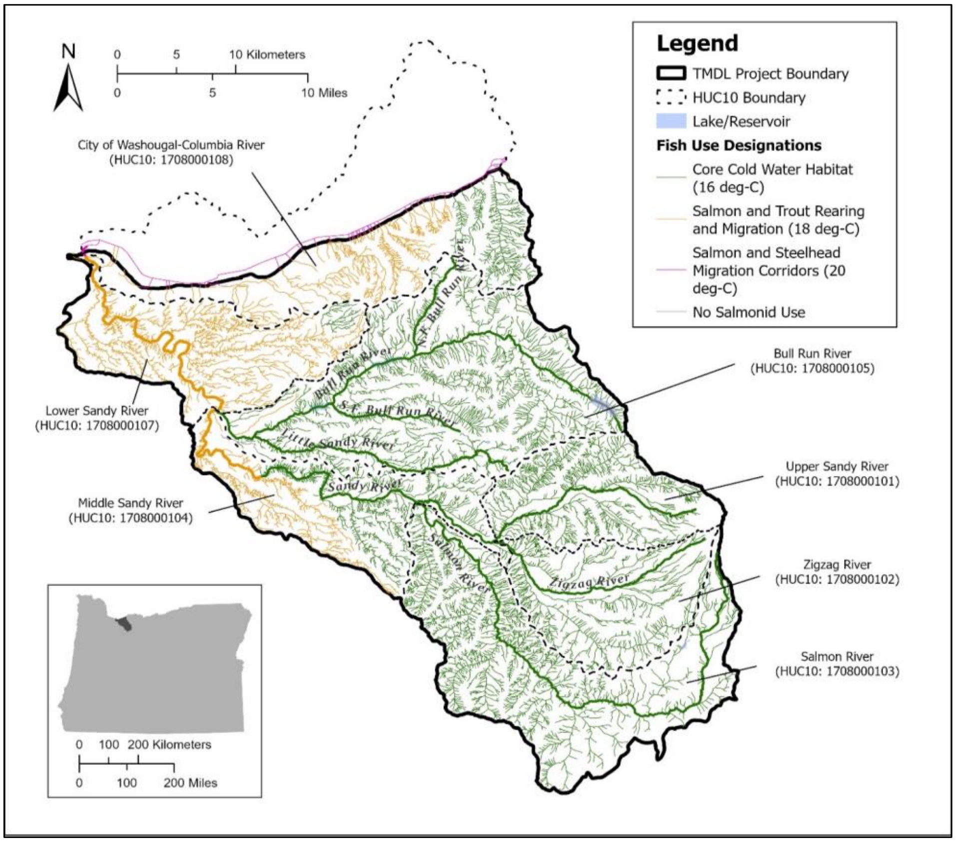


Figure 4-1: Fish use designations in the Lower Columbia-Sandy Subbasin temperature TMDL project area.

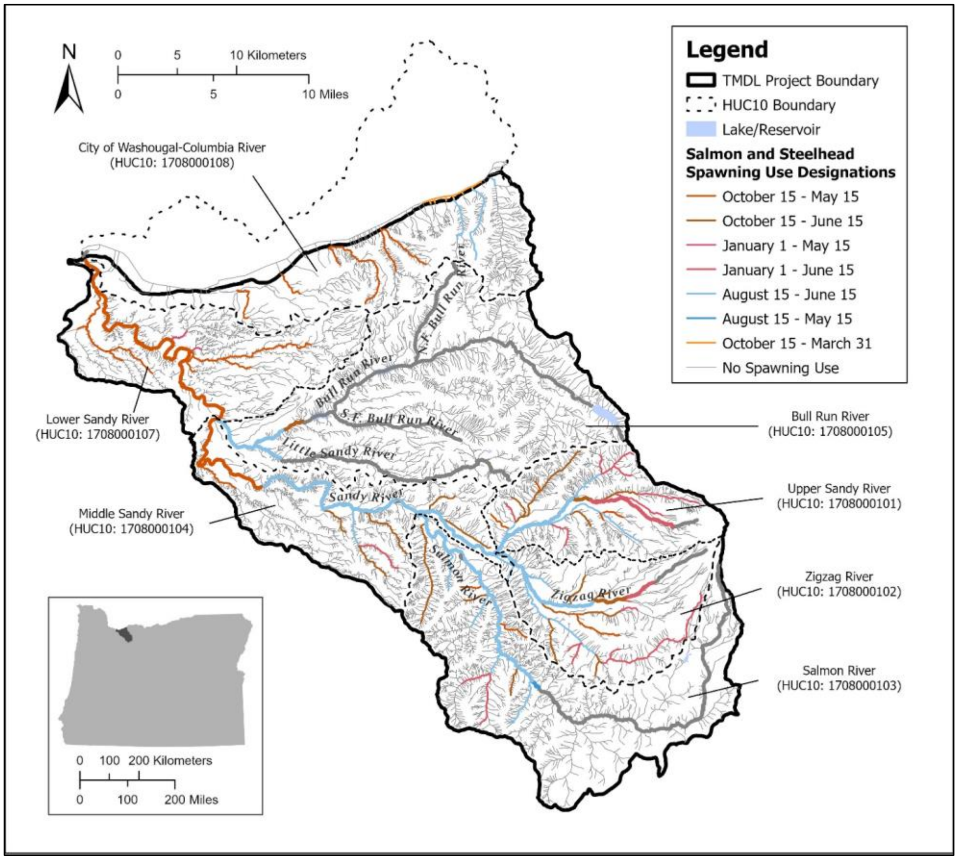


Figure 4-2: Salmon and steelhead spawning use designations in the Lower Columbia-Sandy Subbasin temperature TMDL project area.

5 Seasonal variation and critical period for temperature

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

Maximum stream temperatures typically occur in July or August when stream flows are low, solar radiation fluxes are high, and ambient air temperature conditions are warmest. This TMDL ~~is~~was designed to meet applicable criteria for river flows down to the "7Q10" flow, which is a summary statistic equal to the lowest seven-day average flow that occurs once every ten years (on average) (see Section 8).

The critical period ~~is~~was determined based on when seven-day average daily maximum stream temperatures (7DADM) ~~exceed~~exceeded the applicable temperature criteria. DEQ ~~uses~~used the critical period to determine when allocations apply. In setting this period, DEQ relied upon monitoring sites with the longest period of exceedance. When downstream monitoring sites ~~have~~had longer exceedance periods relative to upstream waters, the longer period ~~is~~was used as the critical period for upstream waterbodies. This is a margin of safety to ensure warming of upstream waters does not contribute to downstream exceedances.

The critical periods for waterbodies in the Lower Columbia-Sandy Subbasin are presented in **Table 5-1**. Based on available temperature data, the critical period is May 1 through October 31 on all waterbodies in the Lower Columbia-Sandy Subbasin except those within the Bull Run River Watershed (HUC 1708000105) and Beaver Creek-Sandy Subwatershed (HUC 170800010703). For waterbodies in the Bull Run River Watershed, the critical period is May 1 through November 15. The critical period is March 15 through November 15 for waterbodies located in the Beaver Creek-Sandy Subwatershed.

Section 5 of the ~~Technical Support Document~~TSD summarizes the critical period approach and presents plots of 7DADM temperature data used to determine seasonal variation and the critical period.

Table 5-1: Designated critical periods for Lower Columbia-Sandy Subbasin waterbodies.

HUC	Watershed name	Critical period
17090001	Lower Columbia-Sandy Subbasin except Bull Run River Watershed and Beaver Creek-Sandy Subwatershed	May 1 – October 31
1708000105	Bull Run River Watershed	May 1 – November 15
170800010703	Beaver Creek-Sandy Subwatershed	March 15 – November 15

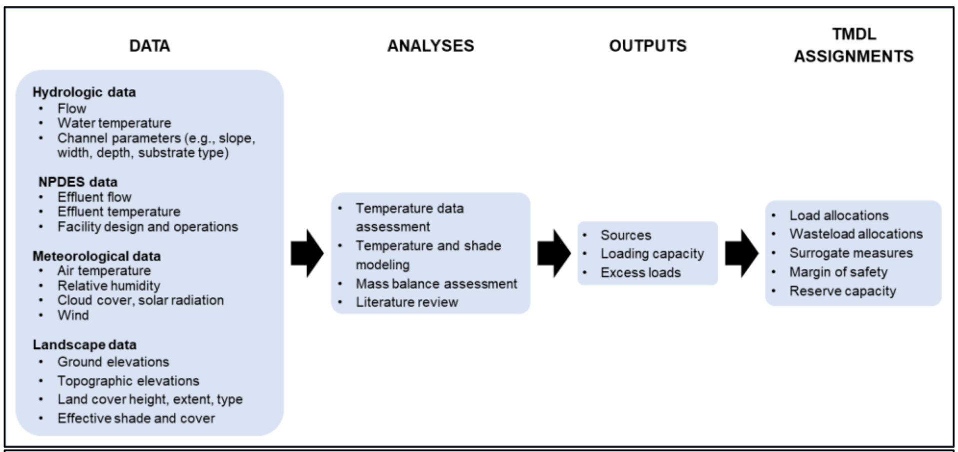
6 Temperature water quality data evaluation overview

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

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

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

~~Figure 6-1~~**Figure 6-1** provides an overview of the types of data and analyses completed for this TMDL.



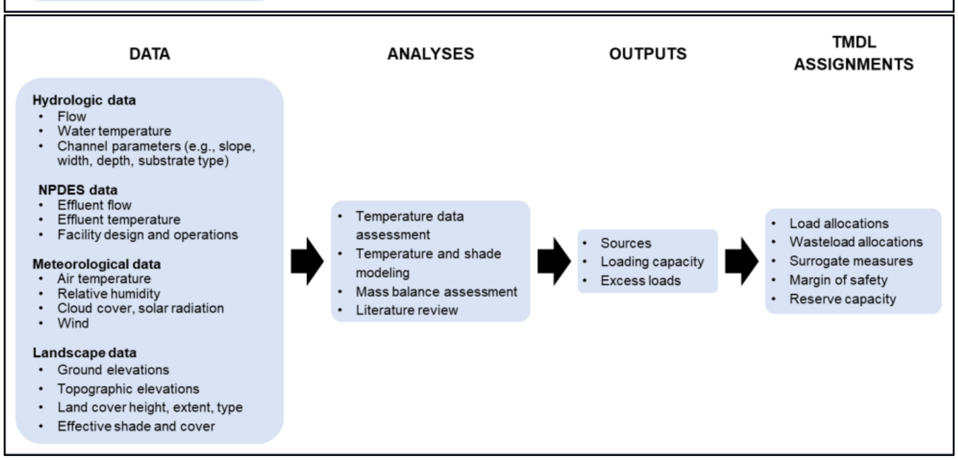


Figure 6-1: Lower Columbia-Sandy River Subbasin temperature analysis overview.

7 Pollutant sources or source categories

As noted in OAR 340-042-0040(4)(f) and OAR 340-042-030(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 contribute thermal pollution to surface waters in the Lower Columbia-Sandy Subbasin. 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 discharge rate and temperature, the prevalence of associated activities, the land area extent on which activities occur, the proximity of activities to surface water, and thermal transport mechanisms.

7.1 Point sources

OAR 340-045-001(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." Under the NPDES program, points sources are regulated under either "individual" or "general" permits.

Three individual NPDES permittees (~~Table 7-1~~**Table 7-1,** ~~Table 2-1~~**Table 2-1**) and a 300-J general permit registrant (~~Table 7-2~~**Table 7-2**) were identified as sources of thermal loading to streams in the Lower Columbia-Sandy Subbasin. A fourth individual NPDES permittee, City of Sandy WWTP, was identified as a potential source.

The City of Sandy WWTP currently holds an individual NPDES permit for discharge to Tickle Creek in the Clackamas Subbasin but is under an EPA consent decree to upgrade and add treatment capacity. The city submitted an NPDES permit application to DEQ for the upgrade and construction of a new outfall to the Sandy River. If implemented, this discharge to the Sandy River is estimated to be a source of thermal loading.

Table 7-1: Individual NPDES permit registrants that contribute thermal loads or are proposed to contribute to thermal loads to Lower Columbia-Sandy Subbasin streams at a frequency and magnitude to cause ~~exceedances to the~~ temperature standard exceedances.

Permittee	Permit type	DEQ WQ file number	EPA number	Receiving water name	River mile	River km
Government Camp STP	NPDES-DOM-Da	34136	OR0027791	Camp Creek	6.5	10.2
WES Hoodland STP	NPDES-DOM-Da	39750	OR0031020	Sandy River	41	67.4
City of Troutdale Water Pollution Control Facility	NPDES-DOM-C2a	89941	OR0020524	Sandy River	~~1~~2.3	~~2.15~~3.70

City of Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Sandy River	24[1]	38.50[1]
[1] Potential future discharge location. Current location is outside of TMDL watershed boundary.						

There are multiple types of general NPDES permits with registrants in the Lower Columbia-Sandy, including:

- 300-J Industrial Wastewater, NPDES fish hatcheries
- 1200-A Stormwater: NPDES sand & gravel mining
- 1200-C Stormwater: NPDES construction
- 1200-Z Stormwater: NPDES specific Standard Industrial Classification codes
- MS4 – Phase II: Stormwater, NPDES: Municipal Separate Storm Sewer System

There is one 300-J permit registrant (~~Table 7-2~~**Table 7-2)** found to be a thermal loading source, with a temperature impact on Cedar Creek as high as 0.~~36~~38°C.

Table 7-2: General NPDES permit registrants that contribute thermal loads to Lower Columbia-Sandy Subbasin streams at a frequency and magnitude to cause ~~exceedances to the~~ temperature standard exceedances.

Permittee	Permit type	DEQ WQ file number	EPA number	Receiving water name	River mile	River km
ODFW Sandy River Hatchery	300-J	64550	ORG130009	Cedar Creek	0.7	1.1

Additionally, there is one registrant to the general MS4 Phase II permit (City of Troutdale), and approximately 26 total registrants to the 1200-A, 1200-C, and 1200-Z permits. ~~DEQ found that there is insufficient evidence to demonstrate that stormwater discharges authorized under this latter set of general permits (MS4 Phase II, Construction (1200-C), and Industrial (1200-A and 1200-Z)) contribute to temperature standard exceedances in the Lower Columbia-Sandy. This determination was based on~~DEQ completed a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon and concluded that stormwater discharges authorized under the current municipal (MS4), construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits are unlikely to contribute to exceedances of the temperature standard. Therefore, no additional TMDL requirements are needed for stormwater sources to control temperature, other than those included in the current permits.

7.2 Nonpoint sources

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

- Human-caused increases in solar radiation loading to streams from stream-side vegetation disturbance or removal~~;~~,
- Channel modification and widening~~;~~,
- Dam and reservoir operation~~;~~,
- Activities that modify flow rate or volume~~;~~, and~~,~~

- Background sources, including natural sources and anthropogenic sources of warming through climate change and other factors.

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

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

7.3 Background sources

By definition (OAR 340-042-0030(1)), background sources include all sources of pollution or pollutants not originating from human activities. Background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state.

The background thermal loading a stream receives is influenced by ~~a number of~~ landscape and meteorological characteristics, such as: substrate and channel morphology conditions~~;~~, streambank and channel elevations~~;~~, near-stream vegetation~~;~~, groundwater~~;~~, hyporheic flow~~;~~, tributary inflows~~;~~, precipitation~~;~~, cloudiness~~;~~, air temperature~~;~~, relative humidity, and others. Many of these factors, however, are influenced by anthropogenic ~~impacts related to the surrogate measures~~factors. As such, it was not possible to develop a model in which all human influences were controlled or accounted for. As a best estimate, background thermal sources were quantified for the modeled rivers with delineable anthropogenic influences (i.e., dams and reservoirs, vegetation alterations, point source discharges) accounted for, thus isolating the remaining background sources. In each river modeled, thermal loading from background sources contributed to exceedances of the applicable temperature criteria and therefore ~~were~~was identified as a significant source of thermal loading. 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 using **Equation 8-1**.

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

where,

$LC =$ Loading Capacity (kilocalories/day).
$T_C =$ The applicable river temperature criterion (°C).

$\text{HUA} =$ The 0.~~3~~30°C human use allowance allocated to point sources, nonpoint sources, margin of safety, or reserve capacity.
The daily mean river flow rate (cfs).
$Q_R =$ When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow.
$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

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

~~**Equation 8-1**~~**Equation 8-1** shall be used to calculate the thermal ~~loading capacity~~LC for any surface water location in the Lower Columbia-Sandy Subbasin. ~~Table 8-1~~**Table 8-1** presents the ~~loading capacities~~LCs for select temperature-impaired Category 5 ~~assessment units~~AUs that have a current NPDES discharge within the ~~assessment unit~~AU extent or that were modeled for the TMDL analysis. The ~~loading capacities~~LCs in ~~Table 8-1~~**Table 8-1** were calculated based on the 7Q10 low-flow. ~~**Equation 8-1**~~**Equation 8-1** may be used to calculate ~~loading capacity~~LC when river flow is greater than 7Q10. ~~**Equation 8-1**~~**Equation 8-1** may also be used to calculate the ~~loading capacity~~LC if in the future the applicable temperature criteria are updated and approved by EPA.

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

Assessment ~~Unit Name~~unit name, ID, and ~~Extent~~extent	Annual 7Q10 (cfs)	Year ~~Round Criterion~~-round criterion + HUA (°C)	Spawning ~~Criterion~~criterion + HUA (°C)	7Q10 LC ~~Year Round~~[1], year-round[1] (kilocalories/day)	7Q10 LC ~~Spawning~~[1], spawning[1] (kilocalories/day)
Bull Run River - Bull Run Reservoir Number Two to confluence with Sandy River OR_SR_1708000105_11_103611	20~~.4~~	16.3	13.3	~~813.57E~~797.61E+6	~~663.83E~~650.81E+6
Cedar Creek - Beaver Creek to confluence with Sandy River OR_SR_1708000104_02_103607	4.9	18.3	13.3	219.39E+6	159.45E+6
Little Sandy River - Bow Creek to confluence with Bull Run River OR_SR_1708000105_11_103609	~~10.5~~11	16.3	13.3	~~418.75E~~438.69E+6	~~341.68E~~357.95E+6
Salmon River - South Fork Salmon River to confluence with Sandy River OR_SR_1708000103_02_103606	174	16.3	13.3	6,939.23E+6	5,662.07E+6
Sandy River - Bull Run River to confluence with Columbia River OR_SR_1708000107_02_103616	278~~.4~~	18.3	13.3	12,~~465.07E~~447.16E+6	9,~~059.32E~~046.30E+6
Sandy River - Clear Fork to Zigzag River OR_SR_1708000101_02_103599	50~~.3~~	18.3	13.3	2,~~252.13E~~238.70E+6	1,~~636.79E~~627.03E+6
Sandy River - Zigzag River to Bull Run River	~~215.9~~217	16.3	13.3	8,~~610.23E~~654.10E+6	7,~~025.53E~~061.32E+6

Assessment ~~Unit Name~~unit name, ID, and ~~Extent~~extent	Annual 7Q10 (cfs)	Year ~~Round Criterion~~-round criterion + HUA (°C)	Spawning ~~Criterion~~criterion + HUA (°C)	7Q10 LC ~~Year Round~~[1], year-round[1] (kilocalories/day)	7Q10 LC ~~Spawning~~[1], spawning[1] (kilocalories/day)
OR_SR_1708000104_02_103608					
Zigzag River - Still Creek to confluence with Sandy River OR_SR_1708000102_02_103600	48~~.2~~	16.3	13.3	1,~~922.25E~~914.27E+6	1,~~568.46E~~561.95E+6
[1] Listed LCs were calculated based on the 7Q10 flow.					

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~~LC of that waterbody.

Because flow monitoring data were not available at most temperature monitoring locations, it was not possible to calculate the excess load. Instead, the excess temperature and percent load reduction were calculated for each ~~assessment unit~~AU where temperature data were available (**Table 8-2**). The excess temperature is the maximum positive difference between the monitored 7DADM river temperature and sum of the applicable numeric criterion plus the ~~human use allowance.~~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 required to attain the TMDL loading capacity is calculated from the maximum observed excess temperature. If the maximum calculated observed excess temperature is negative, the excess temperature and required percent load reduction are zero.

Table 8-2: Excess temperature and percent load reduction for various assessment units in the Lower Columbia-Sandy Subbasin.

Assessment ~~Unit Name~~unit name	Assessment ~~Unit~~unit ID	Maximum 7DADM ~~River Temperature~~river temperature (°C)	Applicable ~~Criterion~~criterion + HUA (°C)	Excess ~~Temperature~~temperature (°C)	Percent ~~Load Reduction~~load reduction
Clear Fork	OR_SR_1708000101_02_103596	14.7	13.3	1.4	9.2
Clear Fork	OR_SR_1708000101_02_103596	14.9	16.3	0.0	0.0
Clear Creek	OR_SR_1708000101_02_103597	17.4	13.3	4.1	23.5
Clear Creek	OR_SR_1708000101_02_103597	17.8	16.3	1.5	8.2
Lost Creek	OR_SR_1708000101_02_103598	13.6	13.3	0.3	2.1
Lost Creek	OR_SR_1708000101_02_103598	15.2	16.3	0.0	0.0
Sandy River	OR_SR_1708000101_02_103599	19.4	13.3	6.1	31.5
Sandy River	OR_SR_1708000101_02_103599	20.1	16.3	3.8	19.0
Zigzag River	OR_SR_1708000102_02_103600	13.9	13.3	0.6	4.3
Zigzag River	OR_SR_1708000102_02_103600	15.7	16.3	0.0	0.0
Still Creek	OR_SR_1708000102_02_103601	16.0	13.3	2.7	16.8
Still Creek	OR_SR_1708000102_02_103601	16.3	16.3	0.0	0.2
Zigzag River	OR_SR_1708000102_02_103602	12.1	13.3	0.0	0.0
Zigzag River	OR_SR_1708000102_02_103602	12.5	16.3	0.0	0.0
Salmon River	OR_SR_1708000103_02_103605	11.4	16.3	0.0	0.0

Assessment ~~Unit Name~~unit name	Assessment ~~Unit~~unit ID	Maximum 7DADM ~~River Temperature~~river temperature (°C)	Applicable ~~Criterion~~criterion + HUA (°C)	Excess ~~Temperature~~temperature (°C)	Percent ~~Load Reduction~~load reduction
Salmon River	OR_SR_1708000103_02_103606	19.7	13.3	6.4	32.6
Salmon River	OR_SR_1708000103_02_103606	21.0	16.3	4.7	22.3
Cedar Creek	OR_SR_1708000104_02_103607	19.7	18.3	1.4	6.9
Sandy River	OR_SR_1708000104_02_103608	19.3	13.3	6.0	31.2
Sandy River	OR_SR_1708000104_02_103608	19.5	16.3	3.2	16.3
Little Sandy River	OR_SR_1708000105_11_103609	19.1	13.3	5.8	30.3
Little Sandy River	OR_SR_1708000105_11_103609	22.2	16.3	5.9	26.6
South Fork Bull Run River	OR_SR_1708000105_11_103610	18.3	16.3	2.0	10.9
Bull Run River	OR_SR_1708000105_11_103611	20.6	13.3	7.3	35.4
Bull Run River	OR_SR_1708000105_11_103611	21.1	16.3	4.8	22.6
Bull Run River	OR_SR_1708000105_11_103688	17.8	16.3	1.5	8.4
Beaver Creek	OR_SR_1708000107_02_103612	20.1	13.3	6.8	33.8
Beaver Creek	OR_SR_1708000107_02_103612	27.8	18.3	9.5	34.2
Gordon Creek	OR_SR_1708000107_02_103615	13.3	13.3	0.0	0.0
Gordon Creek	OR_SR_1708000107_02_103615	19.2	18.3	0.9	4.5
Sandy River	OR_SR_1708000107_02_103616	14.5	13.3	1.2	8.2
Sandy River	OR_SR_1708000107_02_103616	23.2	18.3	4.9	21.2
HUC12 Name: Upper Salmon River	OR_WS_170800010302_02_103640	15.7	16.3	0.0	0.0
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	16.5	13.3	3.2	19.3
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	15.5	16.3	0.0	0.0
HUC12 Name: Upper Bull Run River	OR_WS_170800010502_11_103647	7.0	16.3	0.0	0.0
HUC12 Name: Middle Bull Run River	OR_WS_170800010503_11_103648	16.9	16.3	0.6	3.6
HUC12 Name: Little Sandy River	OR_WS_170800010505_11_103669	24.2	16.3	7.9	32.5
HUC12 Name: Lower Bull Run River	OR_WS_170800010506_11_103650	17.6	16.3	1.3	7.5
HUC12 Name: Gordon Creek	OR_WS_170800010701_02_103651	13.0	16.3	0.0	0.0
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	21.4	13.3	8.1	37.8
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	26.2	18.3	7.9	30.0
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	18.1	13.3	4.8	26.3
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	18.9	16.3	2.6	13.9
HUC12 Name: Woodard Creek-Columbia River	OR_WS_170800010802_15_103653	17.5	18.3	0.0	0.0
HUC12 Name: Bridal Veil Creek-Columbia River	OR_WS_170800010803_15_103654	19.9	18.3	1.6	8.1

9 Allocations, reserve capacity, and margin of safety

OAR 340-042-0040(4)(g),(h),(i) and (k) [and 40 CFR 130.2(h) and (g) and 130.7(c) (1) and (2)] respectively define the required TMDL elements of apportionment of the allowable pollutant load: point source wasteload allocations; nonpoint source load allocations (including background); margin of safety; and reserve capacity. Collectively, these elements add up to the maximum pollutant load that still allows a waterbody to meet water quality standards. OAR 304-042-0040(5) and (6) describe potential factors to consider when determining and distributing these allocations of the pollutant loading capacities. Water quality data analysis must be conducted to determine allocations, potentially including statistical analysis and mathematical modeling. Factors to consider in allocation distribution may include: source contributions~~;~~, costs to implement management measures~~;~~, ease of implementation~~;~~, timelines to attain water quality standards~~;~~, environmental impacts of allocations~~;~~, unintended consequences~~;~~, reasonable assurance of implementation~~;~~, and any other relevant factor.

TMDL allocations have been determined in conjunction with requirements established in this TMDL to demonstrate achievement of all Oregon temperature criteria.

9.1 Thermal allocations

Human ~~Use Allowance allocations~~

9.1.1 ~~The human~~ use allowance ~~discussion~~assignments

The HUA at OAR 340-041-0028(12)(b)(B) identifies the allowed temperature increase reserved for human uses. The rule requires that wasteload and load allocations restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.30°C (0.5°F) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact (POMI). ~~Table 9-1~~**Table 9-1** through ~~Table 9-11~~**Table 9-7** present the portions of the HUA assigned ~~portion of the human use allowance~~ to anthropogenic source categories across different ~~streams and stream extents~~AUs in the Lower Columbia-Sandy Subbasin.

The dam and reservoir operations source category accounts for nonpoint source temperature impacts associated with the dam impoundment and release of the impounded water back into the natural channel.

The water management activities and water withdrawals source category accounts for nonpoint source temperature impacts associated with the withdrawal of water that is intended for consumptive uses (e.g., irrigation) and the warming that may occur as withdrawn water moves through a canal or ditch before being returned to the source river (i.e., non-consumptive uses).

The assigned HUA for NPDES point sources is the maximum cumulative warming anywhere in the AU and at the POMI from all NPDES individual permittees and registrants to general NPDES permits.

The assigned portion of the ~~human use allowance~~HUA for nonpoint source categories represents the maximum cumulative warming anywhere in the ~~waterbody~~AU and at the ~~point of maximum impact~~POMI from all nonpoint source activities within each source category. Therefore, DEQ expects the amount of warming for each unique nonpoint source activity to be less than the values shown in ~~Table 9-1~~**Table 9-1** through ~~Table 9-6.~~**Table 9-7**. DEQ will implement the TMDL in a manner consistent with the ~~human use allowance~~HUA rule by requiring all nonpoint sources to implement management strategies and reduce their warming impact such that the assigned ~~human use allowance~~HUA is attained.

Table 9-1: ~~Human use allowance allocations~~HUA assignments on the Sandy River ~~from City of Troutdale WPCF outfall to~~, model km 69.90-29.55 (Assessment Unit OR_SR_1708000104_02_103608) and on the ~~mouth.~~Zigzag River (Assessment Units OR_SR_1708000102_02_103600 and OR_SR_1708000102_02_103602).

Portion of ~~Human Use Allowance~~human use allowance (°C)	Source or source category
0.09~~*~~	NPDES point sources
~~0.09~~	~~Warming from tributaries~~
0.00	~~City of Portland Bull Run dam~~Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.03	Solar loading from existing transportation, buildings, and utility easements and infrastructure
0.00	Solar loading from other NPS sectors
0.13	Reserve capacity
0.30	**Total**

Table 9-2: HUA assignments on the Sandy River, model km 29.50-0.00 (Assessment Unit OR_SR_1708000107_02_103616).

Portion of human use allowance (°C)	Source or source category
0.12*	NPDES point sources
0.02	City of Portland Bull Run dam and reservoir operations
0.05	Water management activities and water withdrawals
0.~~04~~05	Solar loading from existing transportation ~~corridors, existing~~, buildings, and ~~existing~~ utility easements and infrastructure
0.00	Solar loading from other NPS sectors
0.~~03~~06	Reserve capacity
0.30	**Total**

Note: * NPDES permitted point sources are allowed up to 0.~~09~~12°C cumulatively at the ~~point of maximum impact~~POMI on the Sandy River ~~from the City of Troutdale WPCF outfall to the mouth.~~. The portion of the ~~human use allowance~~HUA allocated to each point source at the point of discharge is identified in ~~Table 9-7.~~**Table 9-8**.

Table 9-3~~: Human use allowance allocations~~: HUA assignments on the ~~Sandy River from~~ Bull Run River ~~to upstream of the Troutdale WPCF outfall.~~ (Assessment Unit OR_SR_1708000105_11_103611).

Portion of ~~Human Use Allowance~~human use allowance (°C)	Source or source category
0.~~05*~~00	NPDES point sources
~~0.00~~	~~Warming from tributaries~~
0.~~01~~30	City of Portland Bull Run dam and reservoir operations*
~~0.05~~	~~Water management activities and water withdrawals~~
0.00	Solar loading from ~~existing transportation corridors, existing buildings, and existing utility infrastructure~~other NPS sectors

0.00	Reserve capacity
0.30	**Total**
Note: * The HUA assigned to City of Portland includes discharges of any cooling water or sump pump wastewater associated with the dam or powerhouses.	

Table 9-4: HUA assignments on the Salmon River (Assessment Unit OR_SR_1708000103_02_103606).

Portion of human use allowance (°C)	Source or source category
0.00	NPDES point sources
0.05	Water management activities and water withdrawals
0.06	Solar loading from existing transportation, buildings, and utility easements and infrastructure
0.00	Solar loading from other NPS sectors
0.19	Reserve capacity
0.30	**Total**

Table 9-5: HUA assignments on Cedar Creek (Assessment Unit OR_SR_1708000104_02_103607).

Portion of human use allowance (°C)	Source or source category
0.30	NPDES point sources: ODFW Sandy River Fish Hatchery
0.00	Solar loading from other NPS sectors
0.00	Reserve capacity
0.30	**Total**
~~Note: * NPDES permitted point sources are allowed up to 0.05°C cumulatively at the point of maximum impact on the Sandy River from Bull Run River to just upstream of the City of Troutdale WPCF outfall. The portion of the human use allowance allocated to each point source at the point of discharge is identified in Table 9-7.~~Note: If DEQ approves ODFW's Sandy River Fish Hatchery discharge to the Sandy River (WLA option B), the distribution of the HUA on Cedar Creek will be identical to those in **Table 9-7**.	

Table 9-6~~: Human use allowance allocations~~: HUA assignments on ~~the Sandy River from the headwaters to the Bull Run River.~~Camp Creek (Assessment Unit OR_WS_170800010202_02_103638).

Portion of ~~Human Use Allowance~~human use allowance (°C)	Source or source category
0.~~08*~~20	NPDES point sources: Government Camp STP
~~0.21~~	~~Warming from tributaries~~
0.~~01~~05	Water management activities and water withdrawals
0.~~00~~02	Solar loading from existing transportation~~ corridors, existing~~, buildings, and ~~existing~~ utility easements and infrastructure
0.00	Solar loading from other NPS sectors
0.~~00~~03	Reserve capacity
0.30	**Total**
~~Note: * NPDES permitted point sources are allowed up to 0.08°C cumulatively at the point of maximum impact on the Sandy River from the headwaters to the Bull Run River. The portion of the human use allowance allocated to each point source at the point of discharge is identified in Table 9-7.~~	

Table 9-7~~: Human use allowance allocations on~~: HUA assignments for all other waters in the ~~Bull Run River~~Lower Columbia-Sandy Subbasin.

Portion of ~~Human Use Allowance~~human use allowance (°C)	Source or source category

0.00	NPDES point sources
0.30	City of Portland Bull Run dam and reservoir operations
0.00	Other anthropogenic nonpoint sources
0.00	Reserve capacity
0.30	**Total**

Table 9-5: Human use allowance allocations on Cedar Creek.

Portion of Human Use Allowance (°C)	Source or source category
0.30	ODFW Sandy River Fish Hatchery
0.00	Anthropogenic Nonpoint sources
0.00	Reserve capacity
0.30	**Total**
Note: If DEQ approves ODFW's Sandy River Fish Hatchery discharge to the Sandy River (WLA option B), the distribution of the human use allowance on Cedar Creek will be identical to those in Table 9-6.	

Table 9-6: Human use allowance allocations on Camp Creek.

Portion of Human Use Allowance (°C)	Source or source category
0.20	Government Camp STP
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Other anthropogenic nonpoint source sectors
0.03	Reserve capacity
0.30	**Total**

Table 9-7: Human Use Allowance allocations for all other waters in the Lower Columbia-Sandy Subbasin.

Portion of Human Use Allowance (°C)	Source or source category
0.00	NPDES point sources
0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing, buildings, and existing utility easements and infrastructure
0.00	Solar loading from other nonpointNPS sectors
0.23	Reserve capacity
0.30	**Total**

~~9.1.1~~9.1.2 Thermal wasteload allocations for point sources

~~Wasteload allocations are assigned~~**Equation 9-1** was used to calculate 7Q10-based WLAs for NPDES~~-~~-permitted point sources ~~listed in Table 9-7.~~ (**Table 9-8**). The ~~wasteload allocation~~effluent flows for all permitted point sources (**Table 9-8**) were based on average (mean) dry-weather facility design flow, except for the ODFW Sandy River Fish Hatchery, where the effluent flow value was the maximum effluent discharge characterized from discharge data provided by ODFW. The WLA for registrants under the general stormwater permits (MS4 phase II, 1200-A, 1200-C, and 1200-Z) and general permit registrants not identified in ~~Table 9-7~~**Table 9-8** is equal to any existing thermal load authorized under the current permit. This means that registrants must follow their permit conditions to meet the narrative WLA. Beyond current permit limits, no additional TMDL requirements are needed for stormwater sources to control temperature. For all general wastewater and stormwater NPDES permits, more precise ~~wasteload allocations~~WLAs may be considered if subsequent data analysis indicates a need and capacity is available.

~~Wasteload allocations for the NPDES permitted point sources listed in Table 9-7 were calculated using **Equation 9-1**.~~

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

(1) Incorporate the 7Q10-based ~~wasteload allocation in Table 9-7~~WLA in **Table 9-8** as a static numeric limit. Permit writers may recalculate the static limit using ~~**Equation 9-1** with~~ different values for 7Q10 (Q_R~~),~~) and effluent ~~flow~~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 ~~human use allowance~~HUA (ΔT) is static and based on the value in ~~Table 9-7.~~**Table 9-8**. Permit writers may recalculate the 7Q10 using seasonal or annual values, as appropriate, if better estimates are available.

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

where,

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

$\Delta T =$ The ~~allocated~~assigned portion of the human use allowance from **Table 9-8**. It is the maximum temperature increase (°C) above the applicable river temperature criterion, using 100% of river flow, not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0. See **Table 9-9** for list of NPDES permittees where minimum duties provision may apply.

$Q_E =$ The daily mean effluent flow rate (cfs).
When effluent flow is in million gallons per day (MGD) convert to cfs: 1.5472

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

$Q_R =$ The daily mean river flow rate (cfs), upstream (of the NPDES discharge).
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 cubic feet per second (cfs): 2,446,665

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

NPDES~~-~~-permitted point sources discharging to the Sandy River are allowed up to 0.~~09~~12°C cumulatively at the ~~point of maximum impact.~~POMI. Based on DEQ modeling, the ~~point of maximum impact~~POMI is located at the City of Troutdale WPCF's outfall (river km ~~2.15~~3.70). Modeling described in the ~~Technical Support Document,~~TSD Appendix C, Section 5 shows that these allocations attain the cumulative allocation. Note that the maximum cumulative impact of all point sources at the ~~point of maximum impact~~POMI is less than the sum of individual point source impacts at their respective points of discharge due to heat dissipation between point~~-~~source discharges.

The City of Sandy WWTP currently holds an NPDES permit for discharge to Tickle Creek (Clackamas Subbasin) but is under an EPA consent decree to upgrade and add treatment capacity. At the time of writing, the city has provided DEQ with an NPDES permit application to upgrade and construct a new outfall to the Sandy River. DEQ evaluated this potential discharge and provided a ~~wasteload allocation~~WLA based on the discharge location proposed in the NPDES application. The proposed outfall (outfall 004) is in the Sandy River reach between Cedar Creek and Badger Creek just downstream of Revenue Bridge (Ten Eyck Road). If the outfall is ~~instead relocated to~~constructed in another Sandy River reach, modeling will be required to ensure the ~~wasteload allocation~~WLA in ~~Table 9-7~~**Table 9-8** attains the 0.~~09~~12°C point source cumulative ~~human use allowance~~HUA at the ~~point of maximum impact~~POMI, as presented in ~~Table 9-1 and Table 9-2~~**Table 9-2**.

~~Table 9-7~~**Table 9-8** provides two ~~wasteload allocation~~WLA options to ODFW's Sandy River Fish Hatchery (option A and option B). Option A is for discharge to Cedar Creek, i.e., the current discharge location. Option B is for the potential Sandy River discharge location described in the previous paragraph. Option B was developed in case ODFW relocates the discharge point from Cedar Creek to the Sandy River. ODFW may only select one ~~wasteload allocation~~WLA option.

Table 9-8: Thermal wasteload allocations for point sources.

NPDES ~~Permittee~~permittee WQ ~~File#~~file number : EPA ~~Number~~number	~~Allocated Human Use Allowance~~Assigned human use allowance ΔT (°C)	WLA period start	WLA period end	Annual 7Q10 ~~River~~river flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Government Camp STP 34136 : OR0027791	0.20	5/1	10/31	5.7	0.4	2.98E+6
Hoodland STP (WES) 39750 : OR0031020	0.06	5/1	10/31	158	1.4	23.40E+6
City of Troutdale WPCF 89941 : OR0020524	0.~~06~~09	5/1	10/31	278~~.4~~	4.6	~~41.54E~~62.23E+6
City of Sandy WWTP 78615 : OR0026573	0.05	5/1	10/31	~~215.9~~217	1.9	26.~~64E~~78E+6
ODFW Sandy River Fish Hatchery 64550 : ORG130009 Option A – Discharge to Cedar Creek	0.30*	5/1	10/31	4.9	3.2	5.95E+6*

NPDES ~~Permittee~~permittee WQ ~~File#~~file number : EPA ~~Number~~number	~~Allocated Human Use Allowance~~Assigned human use allowance ΔT (°C)	WLA period start	WLA period end	Annual 7Q10 ~~River~~river flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
ODFW Sandy River Fish Hatchery 64550 : ORG130009 Option B – Discharge to Sandy River	0.08	5/1	10/31	~~215.9~~217	3.2	~~42.89E~~43.10E+6

[1] Listed WLAs were calculated based on the 7Q10 flow.
~~Notes: Applicable criterion = Biologically-based numeric criteria~~ Notes:
WLA = wasteload allocation; kcals/day = kilocalories/day
* When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ODFW Sandy River Fish Hatchery ΔT = 0.0 and the WLA = 0 kilocalories/day. Minimum duties provision does not apply under WLA Option B.

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

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

When the minimum duties provision applies, the facility cannot add any additional thermal loading to the intake temperatures when the intake temperatures are warmer than the maximum effluent discharge temperatures allowed by the WLA. The purpose is to ensure the facility controls for thermal effects resulting from passing the water through and not from upstream sources. The specific equations to implement this approach in NPDES permits are included in the TSD Section 9.1. DEQ determined the minimum duties provision is applicable to the facilities listed in **Table 9-9**.

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

NPDES permittee	WQ file number : EPA number	Intake and receiving stream	Assessment unit
ODFW Sandy River Fish Hatchery	64550 : ORG130009	Cedar Creek	OR_SR_1708000104_02_103607

~~9.1.2~~9.1.3 Thermal load allocations for nonpoint sources

Load allocations are assigned to background sources and anthropogenic nonpoint sources on all waters in the Lower Columbia-Sandy Subbasin. ~~Load allocations apply May 1 through October 31 on all waters except the Bull Run River and in the Beaver Creek-Sandy Sub-watershed (HUC 170800010703). On the Bull Run River, load allocations apply May 1 through~~

~~November 15. Load allocations apply March 15 through November 15 in the Beaver Creek-Sandy Subwatershed.~~LAs apply during the critical periods identified in **Table 4-1**. LAs for background sources are calculated using **Equation 9-2**.

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

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

where,

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

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

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

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

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

~~Table 9-8~~**Table 9-10** presents the 7Q10-based ~~load allocations~~LAs for background sources on temperature-impaired Category 5 ~~assessment units~~AUs that (a) have current NPDES discharge(s) within the ~~assessment unit~~AU extent, and/or (b) were modeled for the TMDL analysis. ~~The load allocations are~~The LAs were calculated with **Equation 9-2** based on the ~~7Q10 low river flows and the minimum~~ applicable year-round ~~applicable~~ criterion and the spawning criterion in the respective AU, along with the 7Q10 low river flows. In cases when ~~two~~more than one year-round ~~applicable temperature criteria apply to the same assessment unit. Equation 9-2~~criterion applied in the AU, the minimum criterion was used. **Equation 9-2** shall be used to calculate the ~~load allocations~~LAs assigned to background sources on all other ~~assessment units~~AUs or stream ~~location~~locations in the Lower Columbia-Sandy Subbasin not identified in ~~Table 9-8~~**Table 9-10**, or for ~~assessment units~~AUs identified in ~~Table 9-8~~**Table 9-10** when river flows are greater than 7Q10.

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

Table 9-10: Thermal load allocations for background sources.

Assessment ~~Unit~~unit	Annual 7Q10 flow (cfs)	Year ~~Round Criterion~~-round criterion (°C)	Spawning ~~Criterion~~criterion (°C)	LA period start	LA period end	7Q10 LA[1] – ~~Year Round~~year-round (kcal/day)	7Q10 LA[1] – ~~Spawning~~spawning (kcal/day)
Bull Run River - Bull Run Reservoir Number Two to confluence with Sandy River ; OR_SR_1708000105_11_103611	20~~.4~~	16.0	13.0	5/1	11/15	~~798.59E~~782.93E+6	~~648.86E~~636.13E+6
Cedar Creek - Beaver Creek to confluence with Sandy River ; OR_SR_1708000104_02_103607	4.9	18.0	13.0	5/1	10/31	215.80E+6	155.85E+6
Little Sandy River - Bow Creek to confluence with Bull Run River ; OR_SR_1708000105_11_103609	~~10.5~~11	16.0	13.0	5/1	10/31	~~411.04E~~430.61E+6	~~333.97E~~349.87E+6
Salmon River - South Fork Salmon River to confluence with Sandy River ; OR_SR_1708000103_02_103606	174	16.0	13.0	5/1	10/31	6,811.52E+6	5,534.36E+6

Assessment ~~Unit~~unit	Annual 7Q10 flow (cfs)	Year ~~Round Criterion~~-round criterion (°C)	Spawning ~~Criterion~~criterion (°C)	LA period start	LA period end	7Q10 LA[1] – ~~Year Round~~year-round (kcal/day)	7Q10 LA[1] – ~~Spawning~~spawning (kcal/day)
Sandy River - Bull Run River to confluence with Columbia River ; OR_SR_1708000107_02_103616	278~~.4~~	18.0	13.0	5/1	10/31	12,~~260.73E~~243.11E+6	8,~~854.97E~~842.25E+6
Sandy River - Clear Fork to Zigzag River ; OR_SR_1708000101_02_103599	50~~.3~~	18.0	13.0	5/1	10/31	2,~~215.21E~~202.00E+6	1,~~599.87E~~590.33E+6
Sandy River - Zigzag River to Bull Run River ; OR_SR_1708000104_02_103608	~~215.9~~217	16.0	13.0	5/1	10/31	8,~~451.76E~~494.82E+6	6,~~867.05E~~902.04E+6
Zigzag River - Bow Creek to confluence with Bull Run River ; OR_SR_1708000102_02_103600	48~~.2~~	16.0	13.0	5/1	10/31	1,~~886.87E~~879.04E+6	1,~~533.08E~~526.72E+6

[1] Listed LAs were calculated based on the 7Q10 river flow.
Notes: Applicable criterion = Biologically-based numeric criteria (to protect cold water fish); LA = load allocation; kcals/day = kilocalories/day.

~~Load allocations~~LAs assigned to anthropogenic nonpoint sources on any ~~assessment unit~~AU or stream location in the Lower Columbia-Sandy Subbasin are calculated using ~~**Equation 9-3.**~~**Equation 9-3**. The portions of the ~~human use allowance~~HUA (ΔT) assigned to nonpoint source categories are presented in ~~Table 9-1~~**Table 9-1** through ~~Table 9-6.~~ **Table 9-7**.

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

where,

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

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

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

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

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

~~9.1.3~~9.1.4 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 surrogate measures that implement the ~~load allocations~~LAs.

~~9.1.3.1~~9.1.4.1 Dam and reservoir operations

Dam and reservoir operations in the Lower Columbia-Sandy have been allocated a portion of the ~~human use allowance~~HUA as presented in ~~Table 9-1~~**Table 9-1** through ~~Table 9-7~~**Table 9-7** and the equivalent ~~load allocation~~LA as calculated using ~~Equation 9-2~~**Equation 9-2**. Monitoring stream ~~temperature~~temperatures, rather than ~~a~~ thermal ~~load~~loads, is an easier and ~~a~~ more meaningful approach ~~for~~to 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~~LA for dam and reservoir operations. ~~The minimum duties provision in rule at OAR 340-042-0028(12)(a) states~~

~~that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with its overall heat contribution. For dam and reservoir operations, the minimum duties provision is implemented when 7DADM temperatures upstream of the reservoirs exceed the applicable temperature criteria, the dam and reservoir operations must not contribute any additional warming above and beyond those upstream temperatures entering the reservoir.~~

DEQ has developed the following surrogate measure temperature approach to implement the ~~load allocation~~LA. The surrogate measure compliance point is located just downstream of the dam or just downstream of where impounded water is returned to the free-flowing stream. The surrogate measure is:

a) The 7DADM temperatures immediately upstream of the reservoirs. If multiple streams flow into the reservoir, 7DADM temperatures upstream of the reservoirs may be calculated as a flow~~-~~-weighted mean of temperatures from each inflowing tributary. ~~With DEQ approval, the~~The estimated free~~-~~-flowing (no dam) temperatures may ~~also~~ 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 ~~and~~. 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) ~~On days~~Additional adjustments to the surrogate ~~measure~~temperature target calculated or measured under item a) ~~is cooler than~~may be allowed when all the ~~most restrictive~~following are true:

I. Monitoring data show 7DADM temperatures do not exceed the applicable temperature criteria ~~anywhere~~ in the ~~assessment unit immediately~~AU downstream of the dam~~, the surrogate 7DADM temperature may be no warmer than the applicable criteria when all of the following are true:~~;

~~II.~~ The ~~protecting cold water~~ PCW criterion at OAR 340-041-0028(11) does not apply~~;~~

II. . DEQ ~~approves a~~completed an initial screen (summarized in TSD Section 9.3.1.1) and determined the PCW criterion likely does not apply to dams in the Lower Columbia-Sandy;

III. A cumulative effects analysis ~~demonstrating~~ , approved by DEQ, demonstrates that dam release water temperatures warmer than the ~~cooler ambient temperatures~~ surrogate measure calculated or measured under item a) will ~~not increase downstream 7DADM temperatures more than the portion of the HUA allocated to the~~ result in attainment of the dam and reservoir assigned HUA above the applicable criteria in downstream waters.

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

~~9.1.3.2~~9.1.4.2 City of Portland Bull Run drinking water and hydroelectric project

The City of Portland Bull Run drinking water and hydroelectric project has been assigned 0.~~3~~ 30°C of the ~~human use allowance~~HUA (~~Table 9-4)~~**Table 9-3**) and the equivalent ~~load allocation~~LA on the Bull Run River as calculated using ~~Equation 9-2~~**Equation 9-2**. In the Sandy River below the Bull Run River confluence, warming from the dam and reservoirs has been assigned 0.~~01~~02°C of the ~~human use allowance (Table 9-2), and zero downstream of Troutdale WPCF outfall (Table 9-1).~~HUA (**Table 9-2**).

~~A~~For the TMDL analysis, a temperature data analysis and model-~~-~~based cumulative effects analysis were completed ~~for the TMDL analysis. DEQ used the model~~ to estimate the free-~~-~~flow dam temperatures and ~~assess~~evaluate the sufficiency of the surrogate measure temperature target to attain the assigned HUA on the Bull Run River. Based on ~~this analysis~~these analyses, DEQ ~~has~~ determined that dam release temperatures that are below the most restrictive applicable criteria but ~~warmer than~~above ambient temperatures will not increase downstream 7DADM temperatures ~~more than the portion of human use allowance~~above the 0.30°C HUA assigned to the Bull Run project. ~~This assumes~~The model assumed free-~~-~~flowing conditions and ~~attainment of the~~ surrogate measure temperature target attainment.

The transition to the 13.0°C spawning use varies spatially and temporally in the Bull Run River. To be protective of these downstream spawning uses, DEQ used the most restrictive temporal period to determine when to apply the spawning criterion for the surrogate measure target.

Based on these results, the surrogate measure temperature target at the lamprey barrier just downstream of Reservoir #2 is:

a) The estimated free-~~-~~flowing (no dam) 7DADM temperatures at the lamprey barrier as calculated using **Equation 9-4**; or

b) On days the surrogate measure calculated under item a) is cooler than the values in I and II, the surrogate 7DADM temperature may be no warmer than values in I and II.

   I. 16.3°C from June 16 ~~-~~to August 14
   II. 13.3°C from May 1 ~~-~~to June 15 and August 15 ~~-~~to November 15.

If the most restrictive applicable temperature criteria on the Bull Run River between Reservoir #2 and the confluence of the Bull Run River and Sandy River are updated and approved by EPA, the updated criteria and period when they apply shall be used instead.

The low-~~-~~flow conditions provision at OAR 340-041-0028(12)(d) may apply when the daily mean flow at USGS gage 14138850 is less than the 7Q10 of 33 cfs.

DEQ developed a regression equation (~~**Equation 9-3**~~**Equation 9-4**) to predict the free-~~-~~flowing (no dam) daily maximum temperatures at the lamprey barrier. The methodology and data for development of the regression is documented in the Lower Columbia-Sandy ~~Technical Support Document.~~TSD. With DEQ approval, an alternative approach may be used to calculate the free -flowing no dam temperatures.

$$T_{Max} = 0.1405173 + 1.1572642\overline{T_{LS}} + -0.3588068\log\overline{Q_{LS}} + \left(\frac{3.7557135 + 1.1668769T_{dLS} + -0.5969993\log\overline{Q_{LS}}}{2}\right)$$ **Equation 9-4**

Where,

$T_{Max} =$ The no dam daily maximum stream temperature at the lamprey barrier downstream of Reservoir #2.

$\overline{T_{LS}} =$ The daily mean temperature (°C) at USGS Gage 14141500 Little Sandy River Near Bull Run.

$\overline{Q_{LS}} =$ The mean daily discharge (cfs) at USGS Gage 14141500 Little Sandy River Near Bull Run.

$T_{dLS} =$ The daily temperature range (°C) calculated as the daily maximum minus the daily minimum at USGS Gage 14141500 Little Sandy River Near Bull Run.

~~9.1.3.3~~9.1.4.3 Site-specific effective shade surrogate measure

For each ~~designated management agency~~Designated Management Agency (DMA) listed in ~~Table 9-11~~**Table 9-11**, the effective shade surrogate measure values (current and target) are the means across all model nodes assigned to that ~~designated management agency~~DMA (~~**Equation 9-4**).~~**Equation 9-5**). ~~**Equation 9-4**~~**Equation 9-5** may be used to recalculate the mean effective shade values if ~~designated management agency~~DMA boundaries change or need correction. ~~**Equation 9-4**~~**Equation 9-5** 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 ~~Water Quality Management Plan~~WQMP Section 5.3.1.

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

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i} \qquad \textbf{Equation 9-5}$$

Where,

$\overline{ES} =$ The mean effective shade for designated management agency *i.*

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

$n_i =$ Total number of model nodes or measurement points assigned to designated management agency *i.*

Table 9-11: Shade surrogate measure targets to meet nonpoint source load allocations for DMAs on ~~model~~modeled stream extents in the TMDL.

Designated ~~Management Agency~~management agency	Stream ~~Name~~name	Current ~~Shade~~shade (%)	TMDL ~~Target~~target[1] (%)	Shade ~~Gap~~gap
Oregon Department of Forestry - Private	Little Sandy River	74	74	0
U.S. Bureau of Land Management	Little Sandy River	54	66	12
U.S. Forest Service	Little Sandy River	69	71	2
Clackamas County	Zigzag River	32	52	20
Oregon Department of Forestry - Private	Zigzag River	22	37	15

U.S. Forest Service	Zigzag River	50	62	12
Clackamas County	Salmon River	25	37	12
Oregon Department of Forestry - Private	Salmon River	27	~~46~~43	~~19~~16
U.S. Bureau of Land Management	Salmon River	27	36	9
U.S. Forest Service	Salmon River	~~44~~41	~~57~~56	~~13~~15
City of Portland	Sandy River	~~10~~9	13	~~3~~4
City of Sandy	Sandy River	~~24~~21	~~25~~23	~~1~~2
City of Troutdale	Sandy River	15	~~20~~19	~~5~~4
Clackamas County	Sandy River	~~18~~17	~~28~~26	~~10~~9
Multnomah County	Sandy River	16	~~19~~18	~~3~~2
Oregon Department of Agriculture	Sandy River	~~24~~23	~~29~~28	5
Oregon Department of Fish and Wildlife	Sandy River	22	26	4
Oregon Department of Forestry - Private	Sandy River	19	~~24~~23	~~5~~4
Oregon Parks and Recreation Department	Sandy River	6	~~8~~7	~~2~~1
Port of Portland	Sandy River	3	9	6
State of Oregon	Sandy River	13	~~18~~17	~~5~~4
U.S. Bureau of Land Management	Sandy River	~~25~~24	~~29~~27	~~4~~3
U.S. Forest Service	Sandy River	3	~~7~~6	~~4~~3
~~U.S. Government~~	~~Sandy River~~[1] TMDL shade targets for the Sandy River and Salmon River are based on Restored Vegetation "B" shade values.		~~16~~ ~~17~~	~~1~~

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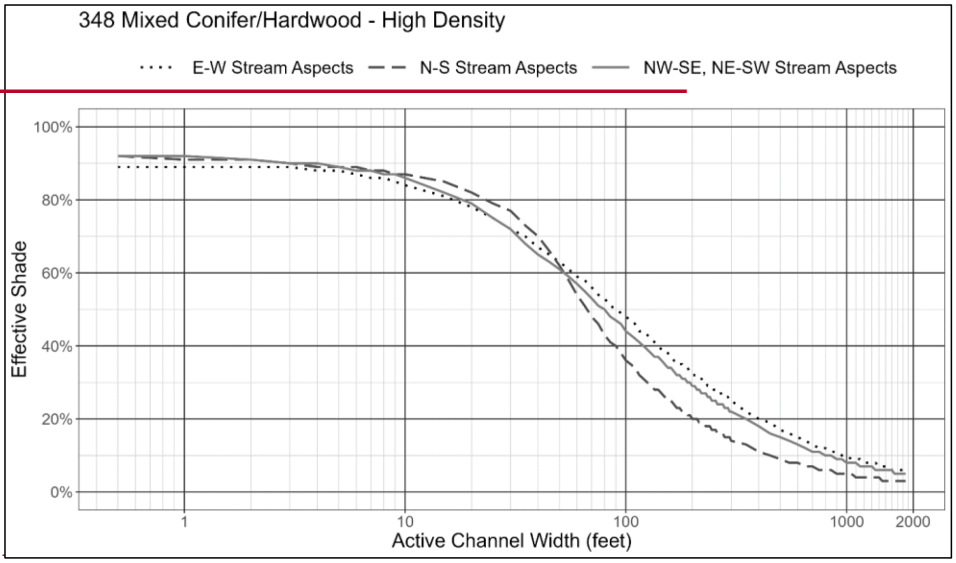
~~9.1.3.4~~9.1.4.4 General effective shade curve surrogate measure

Effective shade curves are applicable to any stream that does not have site-specific shade targets (Section 9.1.4.3). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented in ~~Figure 9-1 to Figure 9-8 and Table 14-1 to Table 14-8~~**Figure 9-1** to **Figure 9-10** and **Table 14-1** to **Table 14-10** represent the mean effective shade target for different composite vegetation types, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer width used for each vegetation type are summarized in ~~Table 9-12. See the Technical Support Document, Appendix B for the methodology used to calculate shade curves~~**Table 9-12**. See the TSD Appendix A for the shade curve calculation methodology. Note that the vegetation type "555 - Mixed Conifer/Hardwood - Low Density" and "650 - Hardwood - Low Density" shade curves are associated with the vegetation assumptions applicable to infrastructure land uses (e.g., existing buildings, transportation, and utility corridors), and are intended for use only in such areas. Likewise, the "975 - Grasses or wetlands" shade curve is intended for use only in naturally open meadows and wetlands.

Effective shade may be prevented from reaching effective shade targets by natural factors including local geology, geography, soils, climate, natural disturbance rates, and other natural phenomena. DEQ will not take enforcement actions for effective shade reductions caused by such natural factors.

Table 9-12: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets.

Landcover CodeCode	Vegetation TypeType	Height (m)	Height (feet)	Density (%)	Overhang (m)	Buffer WidthWidth (m)
348500	Mixed Conifer/Hardwood - High Density	26.7	87.6	60	3.3	36.8
550	Mixed Conifer/Hardwood - Medium Density	26.7	87.6	30	3.3	36.8
555	Mixed Conifer/Hardwood - Low Density	26.7	87.6	10	3.3	36.8
600	Hardwood - High Density	20.1	65.9	75	3.0	36.8
650	Hardwood - Low Density	20.1	65.9	30	3.0	36.8
700	Conifer - High Density	35.1	115.2	60	3.5	36.8
750	Conifer - Low Density	35.1	115.2	30	3.5	36.8
800	ShrubsShrub – High Density	1.8	5.9	75	0.0	36.8
850	ShrubsShrub – Low Density	1.8	5.9	25	0.0	36.8
950975	Grasses/Shrubs - or Wetlands	1.60.9	5.32.0	7590	0.80	36.8



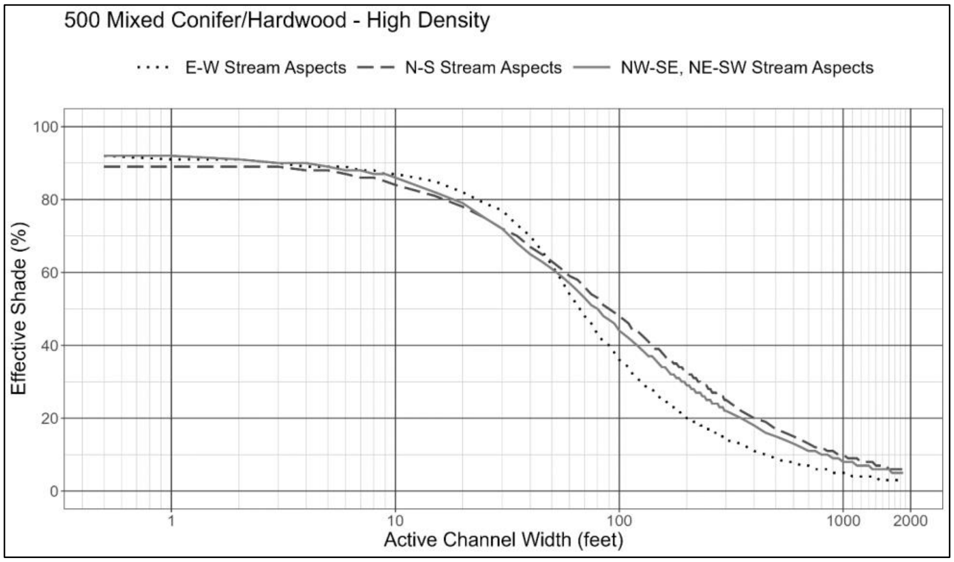
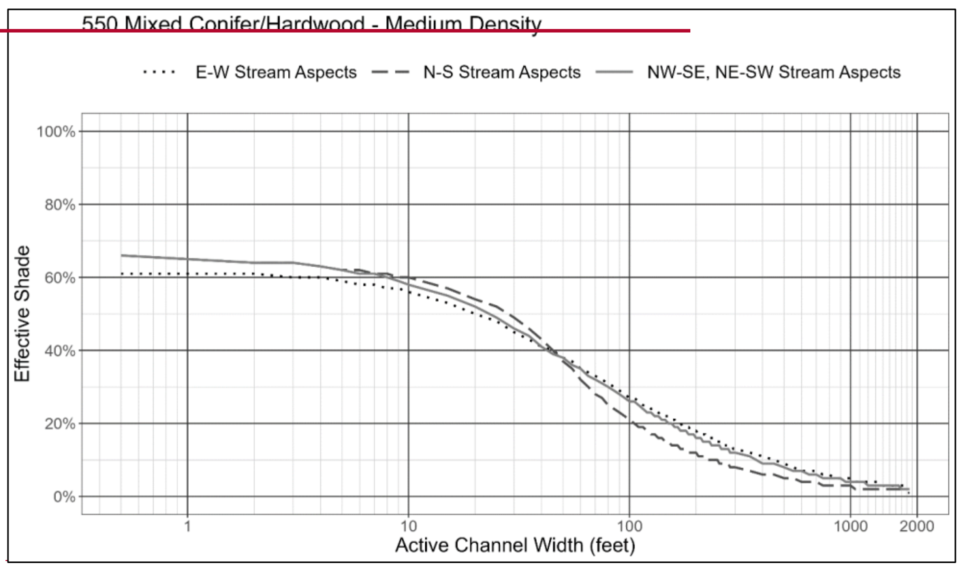


Figure 9-1: Effective shade targets for high density mixed conifer and hardwood stream sites.



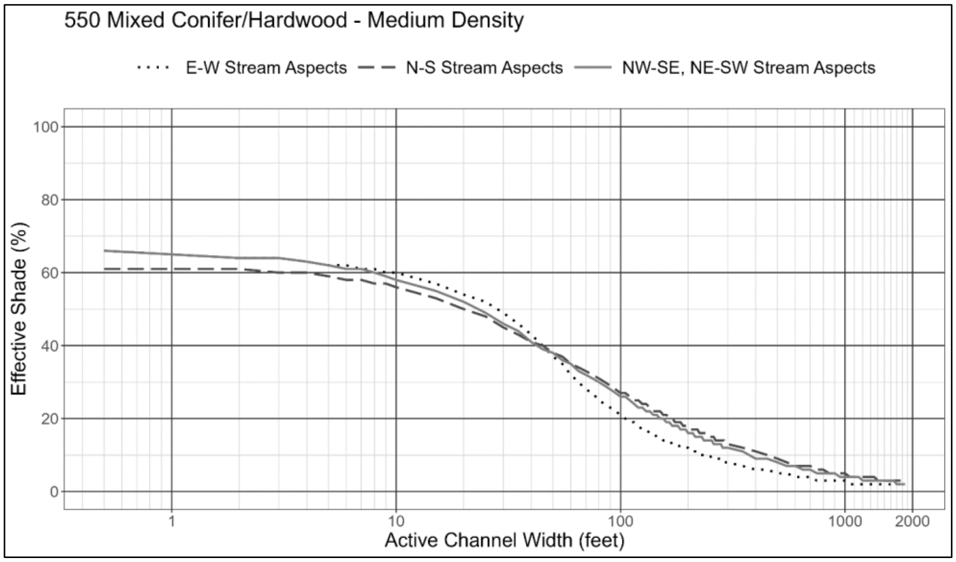
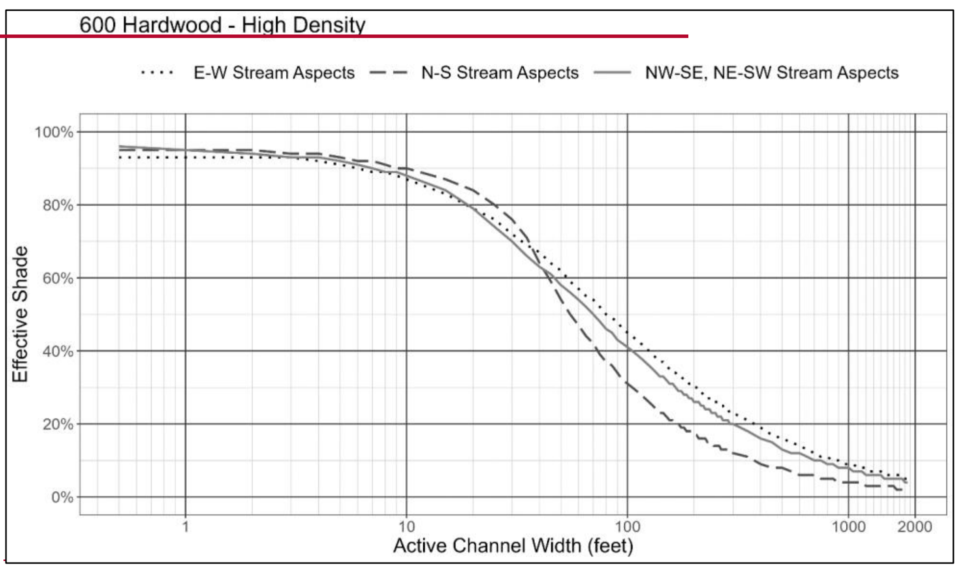


Figure 9-2: Effective shade targets for medium density mixed conifer and hardwood stream sites.



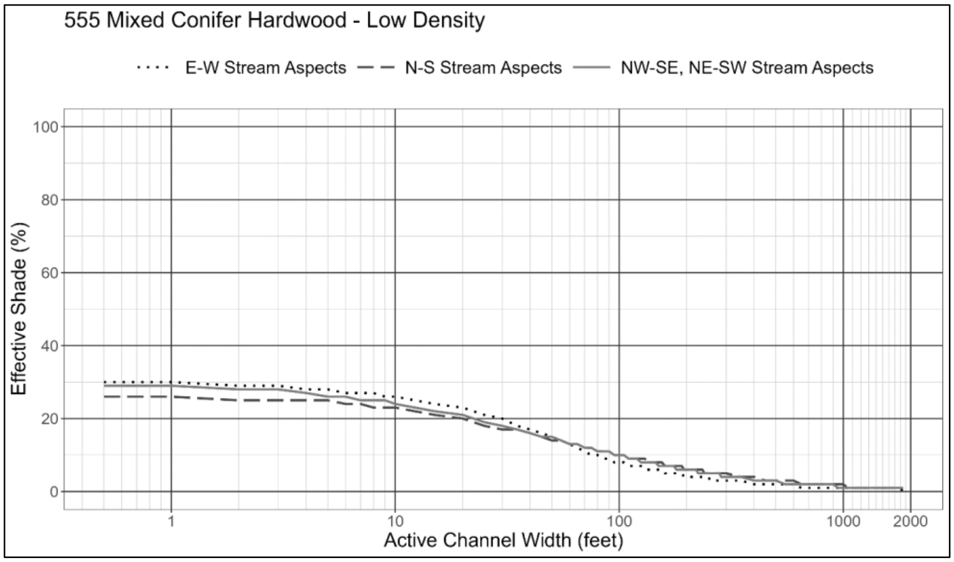
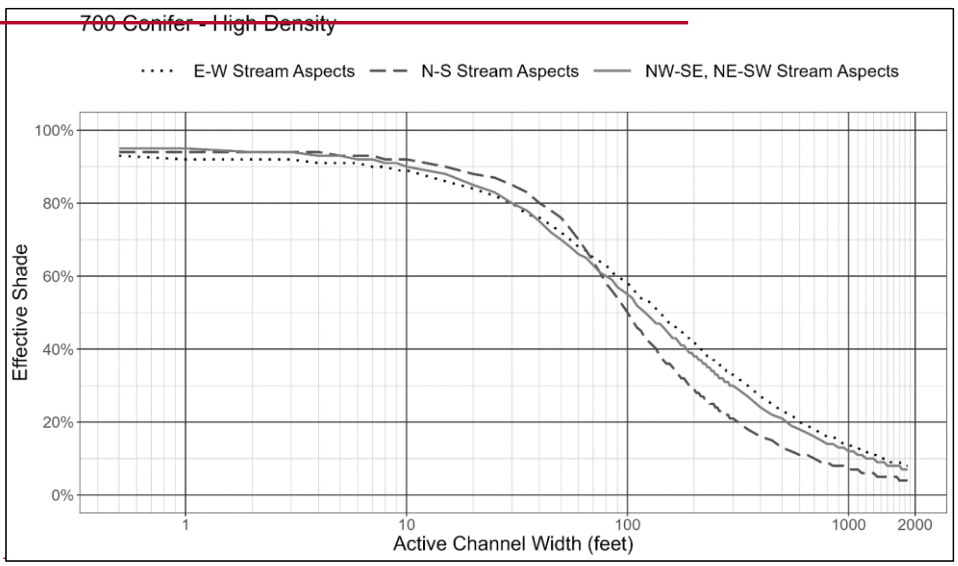


Figure 9-3: Effective shade targets for ~~high~~low density mixed conifer and hardwood ~~dominated~~ stream sites.



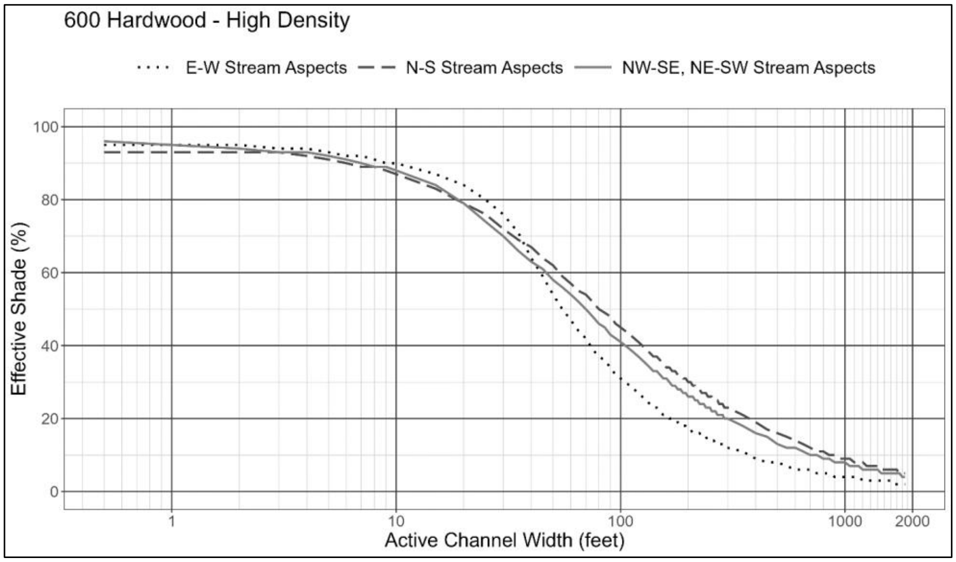
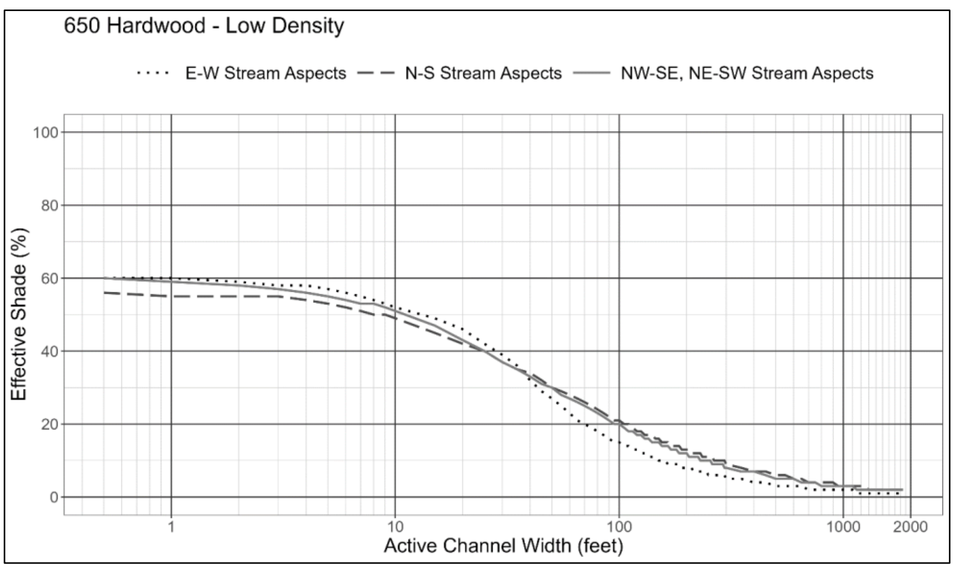


Figure 9-4: Effective shade targets for high density ~~conifer~~hardwood dominated stream sites.



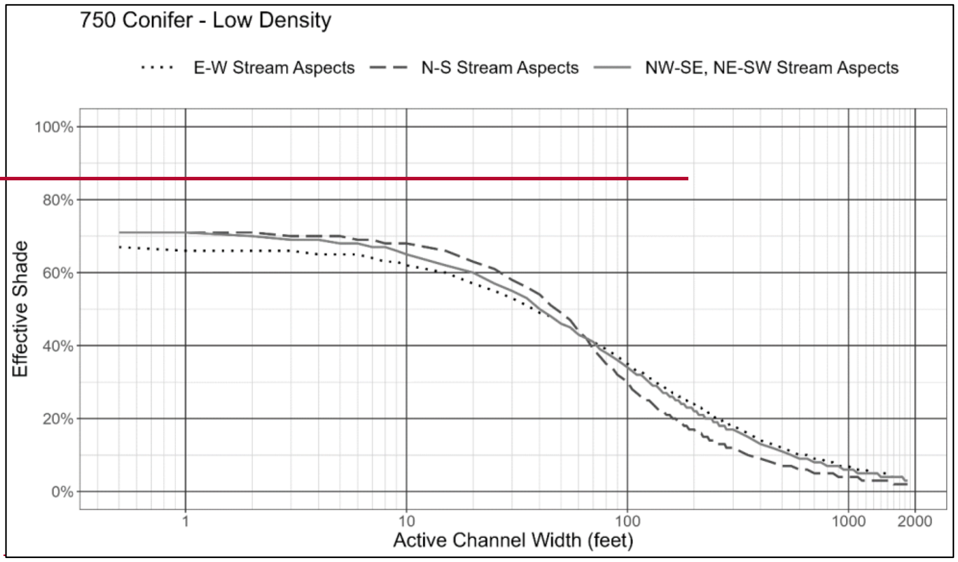
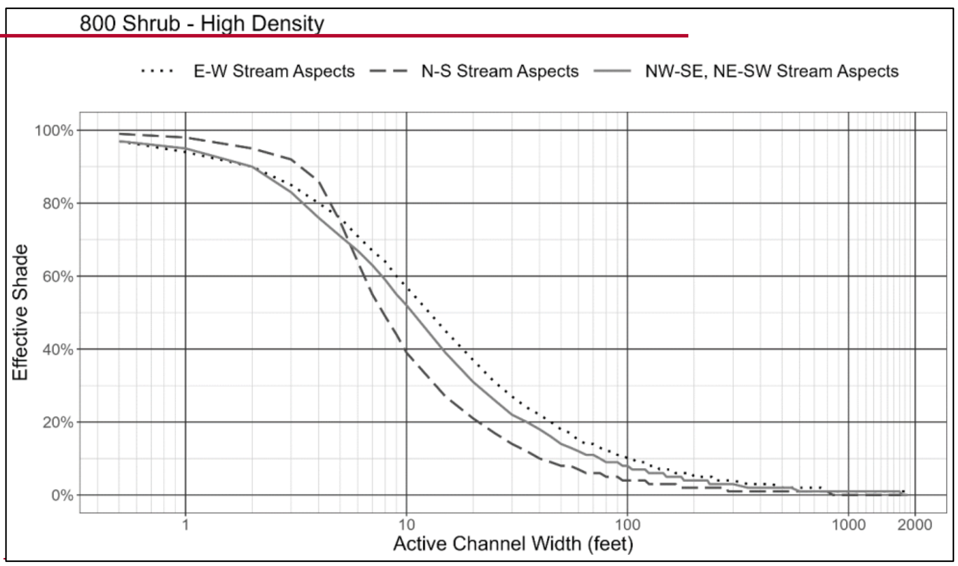


Figure 9-5: Effective shade targets for low density ~~conifer~~hardwood dominated stream sites.



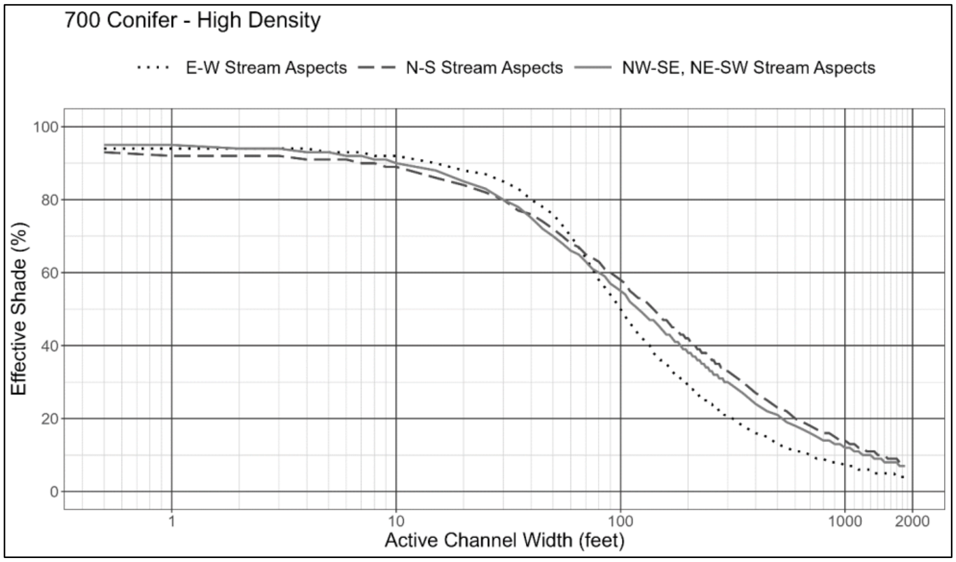
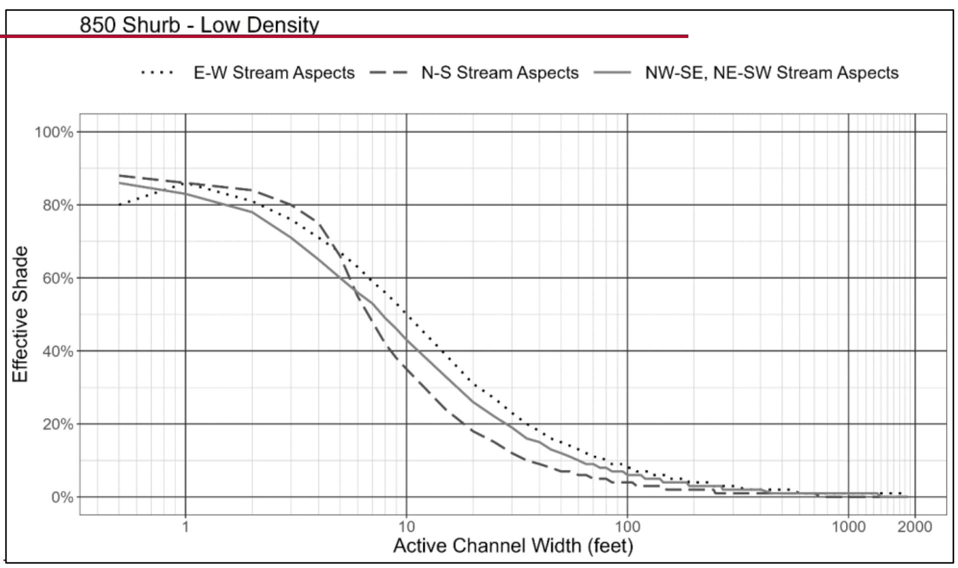


Figure 9-6: Effective shade targets for high density ~~shrub~~conifer dominated stream sites.



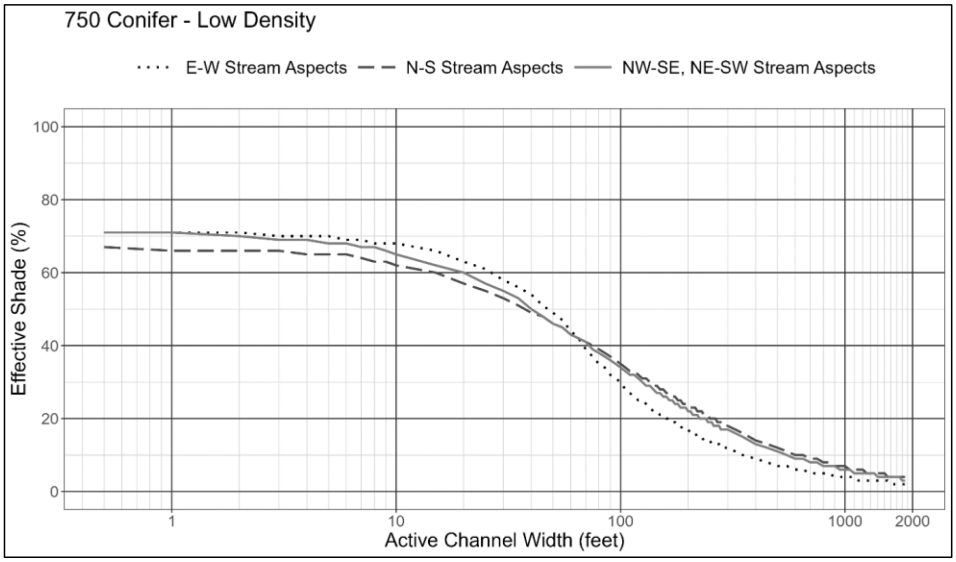
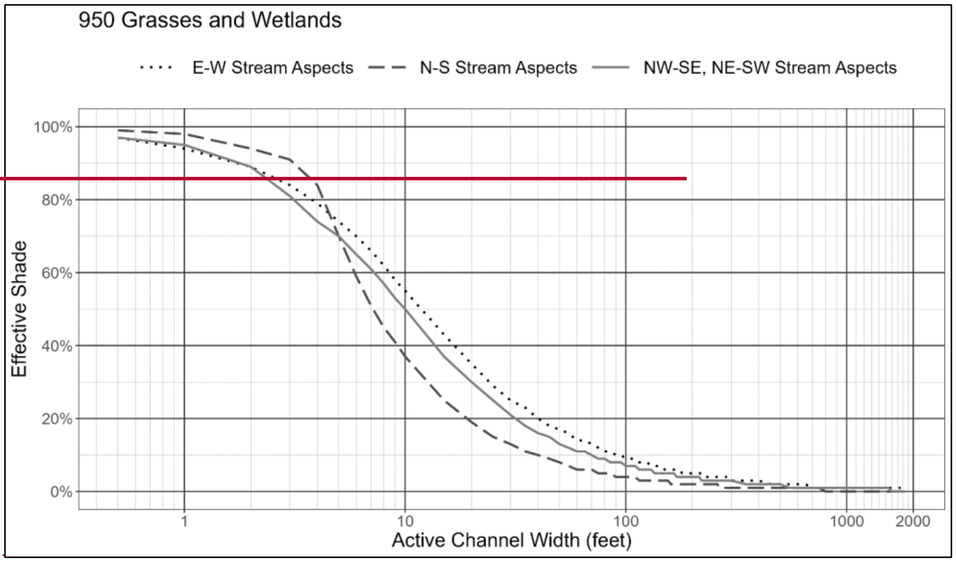


Figure 9-7: Effective shade targets for low density ~~shrub~~conifer dominated stream sites.



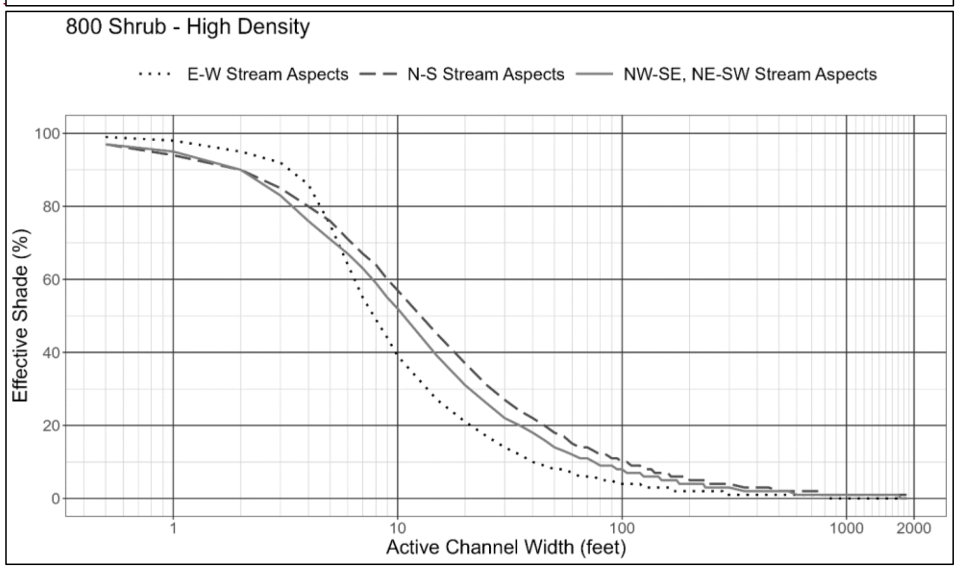


Figure 9-8: Effective shade targets for high density shrub sites.

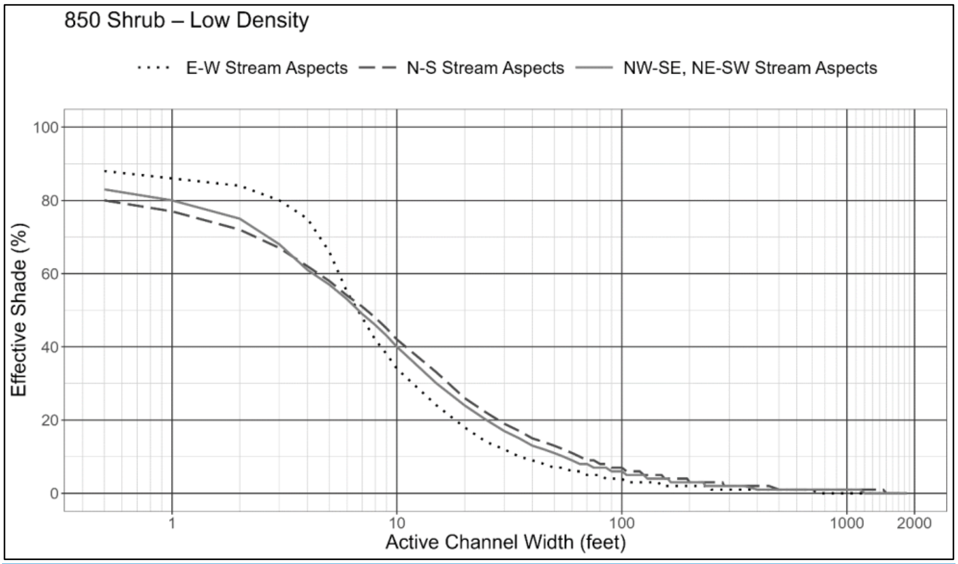


Figure 9-9: Effective shade targets for low density shrub sites.

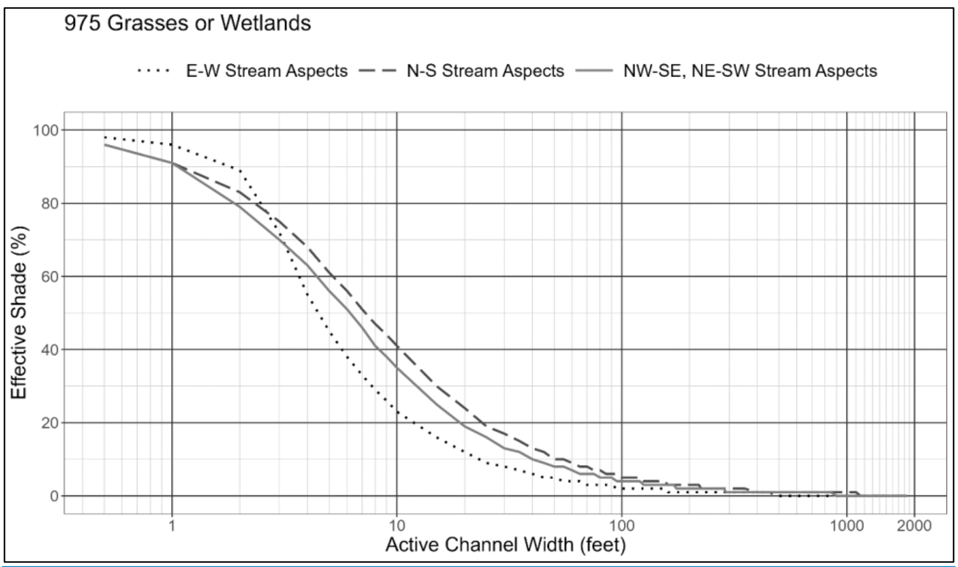


Figure 9-10: Effective shade targets for grass or wetland stream sites.

~~9.1.3.5~~9.1.4.5 Percent consumptive use surrogate measure

Water management activities and water withdrawal activities in the Lower Columbia-Sandy have been assigned a portion of the ~~human use allowance~~HUA as presented in ~~Table 9-1~~**Table 9-1** through ~~Table 9-5~~**Table 9-7** and the equivalent ~~load allocation~~LA as calculated using ~~Equation 9-2.~~**Equation 9-2**. For most streams, the portion of the ~~human use allowance~~HUA allocated is 0.05°C. DEQ completed modeling to estimate the percent consumptive ~~uses~~use that will attain this allocation (see TSD Appendix C, Section 9.0). The percent consumptive use is the percent of the natural surface flow that does not return to surface water after it has been withdrawn for a water use activity. Modeling indicates that a consumptive use flow rate reduction of 1.90 percent at USGS gage 14142500 (Sandy River below Bull Run) will maintain warming from water withdrawal activities at or less than 0.05°C. The natural flow rate ~~was~~is based on the monthly median natural flow.

Table 9-13: Target percent consumptive use flow rate reduction at USGS 14142500 relative to the monthly median natural flow rate at USGS 14142500.

Maximum percent consumptive use	Reference ~~Flow Monitoring Site~~flow monitoring site
1.90	USGS 14142500 – Sandy River below Bull Run

~~9.1.4~~9.1.5 Reserve capacity

DEQ set aside explicit allocations for ~~reserve capacity for providing~~RC to provide either point or nonpoint source allocation(s) to new or increased thermal loads, or to assign corrected allocations to any existing source(s) that were assigned an erroneous allocation or may not have been identified during the development of this TMDL. The portion of the ~~human use allowance~~HUA associated with the ~~reserve capacity~~RC is described in ~~Table 9-1~~**Table 9-1** through ~~Table 9-7.~~**Table 9-7**. The thermal load associated with RC allocations~~ of reserve capacity~~ is calculated using **Equation 9-1** for point sources and ~~Equation 9-2 for nonpoint sources. Allocations from reserve capacity apply May 1 through October 31 on all waterbodies except the Bull Run River and in the Beaver Creek-Sandy Sub-watershed (HUC 170800010703). On the Bull Run River, allocations from reserve capacity apply May 1 through November 15. Allocations from reserve capacity apply March 15 through November 15 in the Beaver Creek-Sandy Subwatershed (HUC 170800010703).~~**Equation 9-2** for nonpoint sources. Allocations from RC apply during the critical period.

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 RC for point sources.

DEQ will consider requests for RC 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 ~~must~~to demonstrate that there are no reasonable alternatives to an increased load and may ~~be required to prepare~~require preparation of a modeling or similar analysis to ensure that ~~loading capacity~~LC is available at the discharge location(s~~).~~) or in downstream waters. The HUA assigned to RC 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~~RC over time and will not approve requests once ~~reserve capacity~~RC is depleted. Allocations of ~~reserve capacity~~RC must be approved by DEQ's ~~Director~~director or designee.

9.2 Margin of safety

CFR 130.7(c)(1) and OAR 340-042-0040(4)(i) require that a TMDL include ~~a margin of safety.~~an MOS. The ~~margin of safety~~MOS 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 incomplete understanding of the actual ~~effect~~effects controls will have on loading reductions and the receiving stream. The ~~margin of safety~~MOS is intended to account for such uncertainties in a manner that is conservative and will result in water quality protection. ~~A margin of safety~~An MOS can be achieved through two approaches: (1) implicitly using conservative analytical assumptions to develop allocations, or (2) explicitly specifying a portion of the TMDL loading capacity as ~~a margin of safety~~an MOS.

In the Lower Columbia-Sandy, an implicit ~~margin of safety~~MOS was used ~~in derivation of~~ to derive the allocations. The primary associated conservative assumptions ~~include~~included:

- ~~Setting effluent~~For model scenarios that assessed point sources' WLAs:
    - Effluent flow rates ~~at~~were set to average dry weather design flow or ~~a~~the maximum flow obtained from ~~discharge monitoring reports for the model scenario assessing the wasteload allocations. It is rare that actual discharges from point sources will reach design flows and sustain that discharge for long periods of time all at the same time~~DMRs.
    - ~~Setting effluent~~Effluent temperatures ~~as high as~~ were set up to 32°C ~~for the model scenario assessing the wasteload allocations.~~. On days when ~~the current~~actual thermal ~~load was less than the wasteload allocation, the~~loads were below the WLA(s), maximum effluent temperatures (model inputs) were ~~increased~~raised above ~~the~~ actual temperatures ~~up~~ to either 32°C or the effluent temperature that would fully utilize the ~~wasteload allocation.~~ WLA.
    - Actual flow and temperature discharges from all point sources rarely reached these maximum ~~effluent temperatures are unlikely to be this warm or be~~ values simultaneously, much less sustained them over ~~multiple days or weeks~~extended periods. Thus, modeled wasteloads were generally greater than actual wasteloads, and resulting instream temperatures would be lower than modeled results.
- Groundwater inflows were assumed to be zero. Because groundwater directly cools stream temperatures via mixing, this means that actual instream temperatures would be lower than modeled temperatures anywhere that groundwater influences exist.
- DEQ used the critical period to determine when allocations apply. In this determination, DEQ relied on monitoring sites with the longest periods of exceedance. When downstream monitoring sites' exceedance periods were longer than in upstream waters, the longer period was used as the critical period for upstream waterbodies. This MOS ensures warming of upstream waters does not contribute to downstream exceedances.
- The sum of individual 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 less than the 0.30°C HUA.
- The cumulative effects analysis ~~used~~applied the maximum ~~increase as~~assigned HUA to each source category to assess cumulative allocation attainment. The modeling shows the ~~basis for assigning and determining attainment of allocations. The~~ maximum allowed temperature increase ~~occurs~~is limited to one or two days and generally less than 5% of the

time~~ and the median increase is less. The~~. Moreover, the maximum increase is geographically limited and focused to distinct locations. ~~ This means that a ~~Thus, the portion of the ~~loading capacity~~LC reserved for human ~~use over the majority~~uses will be unutilized most of the ~~waters of the~~time over most Lower Columbia-Sandy Subbasin ~~will go unutilized most of the time. ~~waters.

- In addition, the cumulative effects for the Sandy River attainment model scenario applied the maximum allowed temperature increase from tributary allocations at the mouth of each tributary, thus maximizing the potential warming downstream from that tributary. The POMI is unlikely to occur at the mouth of every tributary resulting in an overestimate of the cumulative warming contributed from point or nonpoint sources in the tributaries to the Sandy River.

Together, these model assumptions simulated greater thermal loading and transport than would be calculated with measured data. As a result, less solar radiation loading is allowed in the river system, which translates to greater required reductions and an implicit MOS.

10 Water quality management plan

As described in OAR 340-042-0040(4)(l)(A)-(O), an associated WQMP is a required element of a TMDL and must include the following components: (A) Condition assessment and problem description; (B) Goals and objectives; (C) Proposed management strategies design to meet the TMDL allocations; (D) Timeline for implementing management strategies; (E) Explanation of how TMDL implementation will attain water quality standards; (F) Timeline for attaining water quality standards; (G) Identification of persons, including ~~Designated Management Agencies~~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~~Citation of legal authorities relating to TMDL implementation.

DEQ sought and considered input from various persons, including ~~designated management agencies~~DMAs, responsible for TMDL implementation and other interested public and prepared the Lower Columbia-Sandy Subbasin WQMP as a stand-alone document. DEQ ~~intends to propose~~proposed, and the ~~draft~~EQC adopted by rule, this WQMP as an element of ~~Temperature TMDLs for ~~the Lower Columbia-Sandy Subbasin ~~for adoption as rule by the Oregon Environmental Quality Commission~~Temperature TMDLs.

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.” 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 (~~USEPA~~EPA, 1991). Comprehensive explanations of reasonable assurances of implementation are ~~provide~~provided in Section 7 of the Lower Columbia-Sandy Subbasin ~~Water Quality Management Plan.~~ WQMP.

12~~12~~ Protection plan

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

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

Protection plan core elements, as described in materials available on EPA’s webpage (EPA, 2023a~~ and~~, 2023b), are fulfilled by the statements and references to specific sections of the TMDLs, WQMP, and ~~TMDL Technical Support Document~~TSD in the subsections that follow.

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

~~Table 3.1~~**Table 2-2** lists all the ~~assessments units~~AUs within the watershed with 2022 Integrated Report assessment status of Category 5. Those ~~assessment units~~AUs with the status of Category 2~~,~~ or Category 3~~ or unassessed~~ are included in the protection plan, along with other unassessed waters that may be found to be unimpaired for temperature in the future. The map in ~~Figure 2 1~~**Figure 2-1** provides an overview of where the temperature TMDLs and protection plan are applicable. Appendix H of the Lower Columbia-Sandy ~~Technical Support Document~~TSD provides a list of all ~~assessment units~~AUs addressed by this TMDL and the current 2022 Integrated Report assessment status. The same sources and processes described in Section ~~7~~7 that have caused temperature impairments to some reaches in the watershed also pose a risk to unimpaired waters.

12.2~~12.2~~ Quantification of loads and activities expected to resist degradation

Multiple temperature monitoring stations provided data used in the ~~TMDLs~~TMDL analyses. The specific stations and analysis are presented in Appendices A, B and D of the TSD. These data, along with 7Q10 flow estimates, were used to calculate thermal loading capacities presented in Section ~~8~~8, above, and are supported by TSD Section 6.1.

Instructions for calculating loading capacities for any unimpaired or unassessed stream reaches are provided in Section 8, above. Instructions for calculating allocations are provided in Section 9, above.

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

12.3~~12.3~~ Timeframes for protection

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

12.4~~12.4~~ Measures of success

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

13 References

DEQ (Oregon Department of Environmental Quality). 2005. "Sandy River Basin Total Maximum Daily Load (TMDL)."

DEQ (Oregon Department of Environmental Quality). 2023a. "Draft Lower Columbia-Sandy River Subbasin TMDL Technical Support Document."

DEQ (Oregon Department of Environmental Quality). 2023b. "Draft Lower Columbia-Sandy River Subbasin TMDL Water Quality Management Plan."

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

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

EPA (United State Environmental Protection Agency). 2023a. Impaired Waters and TMDLs – Protection Approaches webpage. https://www.epa.gov/tmdl/protection-approaches. Accessed July 20, 2023.

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

14 Appendix of effective shade curve tables

Table 14~~14~~-1: Effective shade targets for high density mixed conifer and hardwood dominated stream sites (code ~~348~~500).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	89	92	92
0.3	1	89	92	91
0.6	2	89	91	91
0.9	3	89	90	90
1.2	4	88	90	89
1.5	5	88	89	89
1.8	6	87	88	89
2.1	7	86	88	88
2.4	8	86	87	88
2.7	9	85	87	87
3	10	84	86	87
4.6	15	81	82	85
6.1	20	78	79	82
7.6	25	75	75	79
9.1	30	72	72	77
10.7	35	70	68	73
12.2	40	67	65	70
13.7	45	65	63	66
15.2	50	63	61	62
16.8	55	61	59	58
18.3	60	59	57	54
19.8	65	58	55	51
21.3	70	56	53	48
22.9	75	54	51	46
24.4	80	53	50	43
25.9	85	51	48	41
27.4	90	50	47	40
29	95	49	46	38
30.5	100	48	44	36
32	105	47	43	35
33.5	110	46	42	34
35.1	115	44	41	32

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
36.6	120	44	40	31
38.1	125	43	39	30
39.6	130	42	38	29
41.1	135	41	37	28
42.7	140	40	37	28
44.2	145	39	36	27
45.7	150	39	35	26
47.2	155	38	34	25
48.8	160	37	34	25
50.3	165	36	33	24
51.8	170	36	32	23
53.3	175	35	32	23
54.9	180	35	31	22
56.4	185	34	31	22
57.9	190	34	30	21
59.4	195	33	30	21
61	200	32	29	20
62.5	205	32	29	20
64	210	32	28	20
65.5	215	31	28	19
67.1	220	31	27	19
68.6	225	30	27	19
70.1	230	30	27	18
71.6	235	29	26	18
73.2	240	29	26	18
74.7	245	29	25	17
76.2	250	28	25	17
77.7	255	28	25	17
79.2	260	27	24	16
80.8	265	27	24	16
82.3	270	27	24	16
83.8	275	26	24	16
85.3	280	26	23	15
86.9	285	26	23	15
88.4	290	26	23	15
89.9	295	25	22	15
91.4	300	25	22	14
106.7	350	22	20	13
121.9	400	20	18	11
137.2	450	19	16	10

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
152.4	500	17	15	9
167.6	550	16	14	8
182.9	600	15	13	8
198.1	650	14	12	7
213.4	700	13	11	7
228.6	750	12	11	6
243.8	800	12	10	6
259.1	850	11	10	6
274.3	900	11	9	5
289.6	950	10	9	5
304.8	1000	10	8	5
320	1050	9	8	5
335.3	1100	9	8	4
350.5	1150	9	7	4
365.8	1200	8	7	4
381	1250	8	7	4
396.2	1300	8	7	4
411.5	1350	8	6	4
426.7	1400	7	6	4
442	1450	7	6	3
457.2	1500	7	6	3
472.4	1550	7	6	3
487.7	1600	6	6	3
502.9	1650	6	5	3
518.2	1700	6	5	3
533.4	1750	6	5	3
548.6	1800	6	5	3
563.9	1850	6	5	3

Table 14~~14~~-2: Effective shade targets for medium density mixed conifer and hardwood dominated stream sites (code 550).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	61	66	66
0.3	1	61	65	65
0.6	2	61	64	64
0.9	3	60	64	64

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
1.2	4	60	63	63
1.5	5	59	62	62
1.8	6	58	61	62
2.1	7	58	61	61
2.4	8	57	60	61
2.7	9	57	59	60
3	10	56	58	60
4.6	15	53	55	57
6.1	20	50	52	54
7.6	25	48	49	52
9.1	30	45	46	49
10.7	35	43	44	46
12.2	40	41	41	43
13.7	45	40	39	40
15.2	50	38	38	37
16.8	55	37	36	35
18.3	60	35	35	32
19.8	65	34	33	30
21.3	70	33	32	28
22.9	75	32	31	27
24.4	80	31	30	25
25.9	85	30	29	24
27.4	90	29	28	23
29	95	28	27	22
30.5	100	27	26	21
32	105	27	26	20
33.5	110	26	25	19
35.1	115	25	24	19
36.6	120	25	23	18
38.1	125	24	23	17
39.6	130	24	22	17
41.1	135	23	22	16
42.7	140	22	21	16
44.2	145	22	21	15
45.7	150	22	20	15
47.2	155	21	20	14
48.8	160	21	19	14
50.3	165	20	19	14
51.8	170	20	18	13
53.3	175	19	18	13

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
54.9	180	19	18	13
56.4	185	19	17	12
57.9	190	18	17	12
59.4	195	18	17	12
61	200	18	16	12
62.5	205	17	16	11
64	210	17	16	11
65.5	215	17	15	11
67.1	220	17	15	11
68.6	225	16	15	10
70.1	230	16	15	10
71.6	235	16	14	10
73.2	240	16	14	10
74.7	245	15	14	10
76.2	250	15	14	10
77.7	255	15	14	9
79.2	260	15	13	9
80.8	265	14	13	9
82.3	270	14	13	9
83.8	275	14	13	9
85.3	280	14	13	9
86.9	285	14	12	8
88.4	290	14	12	8
89.9	295	13	12	8
91.4	300	13	12	8
106.7	350	12	11	7
121.9	400	11	9	6
137.2	450	10	9	6
152.4	500	9	8	5
167.6	550	8	7	5
182.9	600	7	7	4
198.1	650	7	6	4
213.4	700	7	6	4
228.6	750	6	5	3
243.8	800	6	5	3
259.1	850	5	5	3
274.3	900	5	5	3
289.6	950	5	4	3
304.8	1000	5	4	3
320	1050	4	4	2

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
335.3	1100	4	4	2
350.5	1150	4	4	2
365.8	1200	4	3	2
381	1250	4	3	2
396.2	1300	4	3	2
411.5	1350	4	3	2
426.7	1400	3	3	2
442	1450	3	3	2
457.2	1500	3	3	2
472.4	1550	3	3	2
487.7	1600	3	3	2
502.9	1650	3	3	2
518.2	1700	3	2	2
533.4	1750	3	2	2
548.6	1800	3	2	1
563.9	1850	3	2	1

Table 14~~14~~-3: Effective shade targets for ~~high~~low density mixed conifer and hardwood dominated stream sites (code ~~600~~555).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	26	29	30
0.3	1	26	29	30
0.6	2	25	28	29
0.9	3	25	28	29
1.2	4	25	27	28
1.5	5	25	26	28
1.8	6	24	26	27
2.1	7	24	25	27
2.4	8	23	25	27
2.7	9	23	25	26
3	10	23	24	26
4.6	15	21	22	24
6.1	20	20	21	23
7.6	25	18	19	21
9.1	30	17	18	20
10.7	35	17	17	18

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
12.2	40	16	16	17
13.7	45	15	15	16
15.2	50	14	15	15
16.8	55	14	14	14
18.3	60	13	13	13
19.8	65	13	13	12
21.3	70	12	12	11
22.9	75	12	12	10
24.4	80	11	11	10
25.9	85	11	11	9
27.4	90	11	11	9
29	95	10	10	8
30.5	100	10	10	8
32	105	10	10	8
33.5	110	9	9	7
35.1	115	9	9	7
36.6	120	9	9	7
38.1	125	9	8	7
39.6	130	9	8	6
41.1	135	8	8	6
42.7	140	8	8	6
44.2	145	8	8	6
45.7	150	8	7	6
47.2	155	8	7	6
48.8	160	7	7	5
50.3	165	7	7	5
51.8	170	7	7	5
53.3	175	7	7	5
54.9	180	7	6	5
56.4	185	7	6	5
57.9	190	7	6	5
59.4	195	6	6	4
61	200	6	6	4
62.5	205	6	6	4
64	210	6	6	4
65.5	215	6	6	4
67.1	220	6	6	4
68.6	225	6	5	4
70.1	230	6	5	4
71.6	235	6	5	4

Active Channel Widthchannel width (m)	Active Channel Widthchannel width (feet)	Effective Shade Targetshade target for E-W Stream AspectsN-S stream aspects (%)	Effective Shade Targetshade target for NW-SE, NE-SW Stream Aspectsstream aspects (%)	Effective Shade Targetshade target for N-S Stream AspectsE-W stream aspects (%)
73.2	240	5	5	4
74.7	245	5	5	4
76.2	250	5	5	4
77.7	255	5	5	3
79.2	260	5	5	3
80.8	265	5	5	3
82.3	270	5	5	3
83.8	275	5	5	3
85.3	280	5	5	3
86.9	285	5	4	3
88.4	290	5	4	3
89.9	295	5	4	3
91.4	300	5	4	3
106.7	350	4	4	3
121.9	400	4	3	2
137.2	450	3	3	2
152.4	500	3	3	2
167.6	550	3	2	2
182.9	600	3	2	2
198.1	650	2	2	1
213.4	700	2	2	1
228.6	750	2	2	1
243.8	800	2	2	1
259.1	850	2	2	1
274.3	900	2	2	1
289.6	950	2	1	1
304.8	1000	2	1	1
320	1050	1	1	1
335.3	1100	1	1	1
350.5	1150	1	1	1
365.8	1200	1	1	1
381	1250	1	1	1
396.2	1300	1	1	1
411.5	1350	1	1	1
426.7	1400	1	1	1
442	1450	1	1	1
457.2	1500	1	1	1
472.4	1550	1	1	1
487.7	1600	1	1	1
502.9	1650	1	1	1

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
518.2	1700	1	1	1
533.4	1750	1	1	1
548.6	1800	1	1	1
563.9	1850	1	1	0

Table 14-4: Effective shade targets for high density hardwood dominated stream sites (code 600).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
0.2	0.5	93	96	95
0.3	1	93	95	95
0.6	2	93	94	95
0.9	3	93	93	94
1.2	4	92	93	94
1.5	5	91	92	93
1.8	6	90	91	92
2.1	7	89	90	92
2.4	8	89	89	91
2.7	9	88	89	90
3	10	87	88	90
4.6	15	83	84	87
6.1	20	79	79	84
7.6	25	76	74	80
9.1	30	72	70	76
10.7	35	69	66	71
12.2	40	67	63	64
13.7	45	64	61	59
15.2	50	62	58	54
16.8	55	59	56	50
18.3	60	57	54	47
19.8	65	55	52	44
21.3	70	54	50	42
22.9	75	52	48	39
24.4	80	50	46	37
25.9	85	49	45	36
27.4	90	48	43	34
29	95	46	42	32
30.5	100	45	41	31
32	105	44	40	30
33.5	110	43	39	29
35.1	115	42	38	28

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
36.6	120	41	37	27
38.1	125	40	36	26
39.6	130	39	35	25
41.1	135	38	34	24
42.7	140	37	33	23
44.2	145	37	33	23
45.7	150	36	32	22
47.2	155	35	31	21
48.8	160	34	31	21
50.3	165	34	30	20
51.8	170	33	29	20
53.3	175	33	29	19
54.9	180	32	28	19
56.4	185	32	28	18
57.9	190	31	27	18
59.4	195	31	27	18
61	200	30	26	17
62.5	205	30	26	17
64	210	29	26	16
65.5	215	29	25	16
67.1	220	28	25	16
68.6	225	28	24	16
70.1	230	27	24	15
71.6	235	27	24	15
73.2	240	27	23	15
74.7	245	26	23	14
76.2	250	26	23	14
77.7	255	26	22	14
79.2	260	25	22	14
80.8	265	25	22	13
82.3	270	25	21	13
83.8	275	24	21	13
85.3	280	24	21	13
86.9	285	24	21	13
88.4	290	23	20	12
89.9	295	23	20	12
91.4	300	23	20	12
106.7	350	21	18	11
121.9	400	19	16	9
137.2	450	17	15	8
152.4	500	16	13	8
167.6	550	15	12	7

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
182.9	600	14	12	6
198.1	650	13	11	6
213.4	700	12	10	6
228.6	750	11	10	5
243.8	800	11	9	5
259.1	850	10	9	5
274.3	900	10	8	4
289.6	950	9	8	4
304.8	1000	9	8	4
320	1050	9	7	4
335.3	1100	8	7	4
350.5	1150	8	7	4
365.8	1200	8	6	3
381	1250	7	6	3
396.2	1300	7	6	3
411.5	1350	7	6	3
426.7	1400	7	6	3
442	1450	6	5	3
457.2	1500	6	5	3
472.4	1550	6	5	3
487.7	1600	6	5	3
502.9	1650	6	5	2
518.2	1700	6	5	2
533.4	1750	5	5	2
548.6	1800	5	4	2
563.9	1850	5	4	2

Table 14~~14~~-5: Effective shade targets for ~~high~~low density ~~conifer~~hardwood dominated stream sites (code ~~700~~650).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	56	60	60
0.3	1	55	59	60
0.6	2	55	58	59
0.9	3	55	57	58
1.2	4	54	56	58
1.5	5	53	55	57
1.8	6	52	54	56
2.1	7	51	53	55

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
2.4	8	50	53	54
2.7	9	50	52	53
3	10	49	51	52
4.6	15	45	47	49
6.1	20	42	43	46
7.6	25	40	40	42
9.1	30	37	37	39
10.7	35	35	35	36
12.2	40	34	33	32
13.7	45	32	31	29
15.2	50	30	30	27
16.8	55	29	28	25
18.3	60	28	27	23
19.8	65	27	26	21
21.3	70	26	25	20
22.9	75	25	24	19
24.4	80	24	23	18
25.9	85	23	22	17
27.4	90	22	21	16
29	95	21	20	15
30.5	100	21	20	15
32	105	20	19	14
33.5	110	20	18	14
35.1	115	19	18	13
36.6	120	18	17	13
38.1	125	18	17	12
39.6	130	17	16	12
41.1	135	17	16	11
42.7	140	17	15	11
44.2	145	16	15	11
45.7	150	16	15	10
47.2	155	15	14	10
48.8	160	15	14	10
50.3	165	15	14	9
51.8	170	14	13	9
53.3	175	14	13	9
54.9	180	14	13	9
56.4	185	14	12	9
57.9	190	13	12	8
59.4	195	13	12	8

Active Channel Widthchannel width (m)	Active Channel Widthchannel width (feet)	Effective Shade Targetshade target for E-W Stream AspectsN-S stream aspects (%)	Effective Shade Targetshade target for NW-SE, NE-SW Stream Aspectsstream aspects (%)	Effective Shade Targetshade target for N-S Stream AspectsE-W stream aspects (%)
61	200	13	12	8
62.5	205	13	11	8
64	210	12	11	8
65.5	215	12	11	7
67.1	220	12	11	7
68.6	225	12	11	7
70.1	230	12	10	7
71.6	235	11	10	7
73.2	240	11	10	7
74.7	245	11	10	7
76.2	250	11	10	6
77.7	255	11	10	6
79.2	260	11	9	6
80.8	265	10	9	6
82.3	270	10	9	6
83.8	275	10	9	6
85.3	280	10	9	6
86.9	285	10	9	6
88.4	290	10	9	6
89.9	295	10	8	6
91.4	300	9	8	5
106.7	350	8	7	5
121.9	400	7	7	4
137.2	450	7	6	4
152.4	500	6	5	3
167.6	550	6	5	3
182.9	600	5	5	3
198.1	650	5	4	3
213.4	700	4	4	2
228.6	750	4	4	2
243.8	800	4	3	2
259.1	850	4	3	2
274.3	900	4	3	2
289.6	950	3	3	2
304.8	1000	3	3	2
320	1050	3	3	2
335.3	1100	3	3	2
350.5	1150	3	2	1
365.8	1200	3	2	1
381	1250	3	2	1

Active Channel Widthchannel width (m)	Active Channel Widthchannel width (feet)	Effective Shade Targetshade target for E-W Stream AspectsN-S stream aspects (%)	Effective Shade Targetshade target for NW-SE, NE-SW Stream Aspectsstream aspects (%)	Effective Shade Targetshade target for N-S Stream AspectsE-W stream aspects (%)
396.2	1300	2	2	1
411.5	1350	2	2	1
426.7	1400	2	2	1
442	1450	2	2	1
457.2	1500	2	2	1
472.4	1550	2	2	1
487.7	1600	2	2	1
502.9	1650	2	2	1
518.2	1700	2	2	1
533.4	1750	2	2	1
548.6	1800	2	2	1
563.9	1850	2	2	1

Table 14-6: Effective shade targets for high density conifer dominated stream sites (code 700).

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
0.2	0.5	93	95	94
0.3	1	92	95	94
0.6	2	92	94	94
0.9	3	92	94	94
1.2	4	91	93	94
1.5	5	91	93	93
1.8	6	91	92	93
2.1	7	90	92	93
2.4	8	90	91	92
2.7	9	89	91	92
3	10	89	90	92
4.6	15	86	88	90
6.1	20	84	85	88
7.6	25	82	83	87
9.1	30	80	80	85
10.7	35	77	78	83
12.2	40	76	75	80
13.7	45	74	72	78
15.2	50	72	70	76
16.8	55	70	68	73
18.3	60	68	66	70
19.8	65	67	65	67
21.3	70	65	63	64
22.9	75	64	61	61

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
24.4	80	63	60	58
25.9	85	61	59	56
27.4	90	60	57	54
29	95	59	56	52
30.5	100	58	55	50
32	105	57	54	48
33.5	110	55	52	46
35.1	115	54	51	45
36.6	120	53	50	43
38.1	125	53	49	42
39.6	130	52	48	41
41.1	135	51	47	40
42.7	140	50	47	38
44.2	145	49	46	37
45.7	150	48	45	36
47.2	155	47	44	36
48.8	160	47	43	35
50.3	165	46	43	34
51.8	170	45	42	33
53.3	175	45	41	32
54.9	180	44	41	32
56.4	185	43	40	31
57.9	190	43	39	30
59.4	195	42	39	30
61	200	42	38	29
62.5	205	41	38	28
64	210	41	37	28
65.5	215	40	37	27
67.1	220	39	36	27
68.6	225	39	36	26
70.1	230	38	35	26
71.6	235	38	35	25
73.2	240	38	34	25
74.7	245	37	34	25
76.2	250	37	33	24
77.7	255	36	33	24
79.2	260	36	32	23
80.8	265	35	32	23
82.3	270	35	32	23
83.8	275	35	31	22
85.3	280	34	31	22
86.9	285	34	31	22

Active channel width (m)	Active channel width (feet)	Effective shade target for N-S stream aspects (%)	Effective shade target for NW-SE, NE-SW stream aspects (%)	Effective shade target for E-W stream aspects (%)
88.4	290	34	30	21
89.9	295	33	30	21
91.4	300	33	30	21
106.7	350	30	27	18
121.9	400	27	24	16
137.2	450	25	22	15
152.4	500	23	21	13
167.6	550	22	19	12
182.9	600	20	18	11
198.1	650	19	17	11
213.4	700	18	16	10
228.6	750	17	15	9
243.8	800	16	14	9
259.1	850	16	14	8
274.3	900	15	13	8
289.6	950	14	13	8
304.8	1000	14	12	7
320	1050	13	12	7
335.3	1100	13	11	7
350.5	1150	12	11	6
365.8	1200	12	10	6
381	1250	11	10	6
396.2	1300	11	10	6
411.5	1350	11	9	5
426.7	1400	10	9	5
442	1450	10	9	5
457.2	1500	10	8	5
472.4	1550	9	8	5
487.7	1600	9	8	5
502.9	1650	9	8	5
518.2	1700	9	8	4
533.4	1750	8	7	4
548.6	1800	8	7	4
563.9	1850	8	7	4

Table 14-7: Effective shade targets for low density conifer dominated stream sites (code 750).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	67	71	71
0.3	1	66	71	71
0.6	2	66	70	71
0.9	3	66	69	70
1.2	4	65	69	70
1.5	5	65	68	70
1.8	6	65	68	69
2.1	7	64	67	69
2.4	8	63	67	68
2.7	9	63	66	68
3	10	62	65	68
4.6	15	60	62	66
6.1	20	57	60	63
7.6	25	55	57	61
9.1	30	53	55	58
10.7	35	51	53	56
12.2	40	49	50	54
13.7	45	48	48	51
15.2	50	46	46	49
16.8	55	45	45	47
18.3	60	43	43	44
19.8	65	42	42	42
21.3	70	41	41	39
22.9	75	40	39	37
24.4	80	39	38	35
25.9	85	38	37	34
27.4	90	37	36	32
29	95	36	35	31
30.5	100	35	34	30
32	105	34	33	28
33.5	110	33	32	27
35.1	115	33	32	26
36.6	120	32	31	25
38.1	125	31	30	25
39.6	130	31	29	24
41.1	135	30	29	23
42.7	140	29	28	22
44.2	145	29	27	22

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
45.7	150	28	27	21
47.2	155	28	26	21
48.8	160	27	26	20
50.3	165	27	25	20
51.8	170	26	25	19
53.3	175	26	24	19
54.9	180	25	24	18
56.4	185	25	23	18
57.9	190	24	23	17
59.4	195	24	23	17
61	200	24	22	17
62.5	205	23	22	16
64	210	23	21	16
65.5	215	23	21	16
67.1	220	22	21	15
68.6	225	22	20	15
70.1	230	22	20	15
71.6	235	21	20	14
73.2	240	21	20	14
74.7	245	21	19	14
76.2	250	20	19	14
77.7	255	20	19	13
79.2	260	20	18	13
80.8	265	20	18	13
82.3	270	19	18	13
83.8	275	19	18	13
85.3	280	19	17	12
86.9	285	19	17	12
88.4	290	18	17	12
89.9	295	18	17	12
91.4	300	18	17	12
106.7	350	16	15	10
121.9	400	14	13	9
137.2	450	13	12	8
152.4	500	12	11	7
167.6	550	11	10	7
182.9	600	10	9	6
198.1	650	10	9	6
213.4	700	9	8	5
228.6	750	9	8	5

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
243.8	800	8	7	5
259.1	850	8	7	5
274.3	900	7	7	4
289.6	950	7	6	4
304.8	1000	7	6	4
320	1050	6	6	4
335.3	1100	6	5	4
350.5	1150	6	5	3
365.8	1200	6	5	3
381	1250	5	5	3
396.2	1300	5	5	3
411.5	1350	5	5	3
426.7	1400	5	4	3
442	1450	5	4	3
457.2	1500	5	4	3
472.4	1550	4	4	3
487.7	1600	4	4	2
502.9	1650	4	4	2
518.2	1700	4	4	2
533.4	1750	4	4	2
548.6	1800	4	3	2
563.9	1850	4	3	2

Table 14~~14~~-8: Effective shade targets for high density shrub dominated stream sites (code 800).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	97	97	99
0.3	1	94	95	98
0.6	2	90	90	95
0.9	3	85	83	92
1.2	4	80	76	86
1.5	5	76	71	75
1.8	6	71	67	64
2.1	7	67	63	55
2.4	8	64	59	49
2.7	9	60	55	44
3	10	57	52	39
4.6	15	45	39	27

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
6.1	20	37	31	21
7.6	25	31	26	17
9.1	30	27	22	14
10.7	35	24	20	12
12.2	40	22	18	10
13.7	45	20	16	9
15.2	50	18	14	8
16.8	55	17	13	8
18.3	60	15	12	7
19.8	65	14	11	6
21.3	70	14	11	6
22.9	75	13	10	6
24.4	80	12	9	5
25.9	85	12	9	5
27.4	90	11	9	5
29	95	11	8	4
30.5	100	10	8	4
32	105	10	7	4
33.5	110	9	7	4
35.1	115	9	7	4
36.6	120	9	7	4
38.1	125	8	6	3
39.6	130	8	6	3
41.1	135	8	6	3
42.7	140	7	6	3
44.2	145	7	6	3
45.7	150	7	5	3
47.2	155	7	5	3
48.8	160	7	5	3
50.3	165	6	5	3
51.8	170	6	5	2
53.3	175	6	5	2
54.9	180	6	4	2
56.4	185	6	4	2
57.9	190	6	4	2
59.4	195	6	4	2
61	200	5	4	2
62.5	205	5	4	2
64	210	5	4	2
65.5	215	5	4	2

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
67.1	220	5	4	2
68.6	225	5	4	2
70.1	230	5	4	2
71.6	235	5	3	2
73.2	240	5	3	2
74.7	245	4	3	2
76.2	250	4	3	2
77.7	255	4	3	2
79.2	260	4	3	2
80.8	265	4	3	2
82.3	270	4	3	2
83.8	275	4	3	2
85.3	280	4	3	2
86.9	285	4	3	1
88.4	290	4	3	1
89.9	295	4	3	1
91.4	300	4	3	1
106.7	350	3	2	1
121.9	400	3	2	1
137.2	450	3	2	1
152.4	500	2	2	1
167.6	550	2	2	1
182.9	600	2	1	1
198.1	650	2	1	1
213.4	700	2	1	1
228.6	750	2	1	1
243.8	800	1	1	1
259.1	850	1	1	0
274.3	900	1	1	0
289.6	950	1	1	0
304.8	1000	1	1	0
320	1050	1	1	0
335.3	1100	1	1	0
350.5	1150	1	1	0
365.8	1200	1	1	0
381	1250	1	1	0
396.2	1300	1	1	0
411.5	1350	1	1	0
426.7	1400	1	1	0
442	1450	1	1	0

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
457.2	1500	1	1	0
472.4	1550	1	1	0
487.7	1600	1	1	0
502.9	1650	1	1	0
518.2	1700	1	1	0
533.4	1750	1	0	0
548.6	1800	1	0	0
563.9	1850	1	0	0

Table 14~~14~~-9: Effective shade targets for low density shrub dominated stream sites (code 850).

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	80	~~86~~83	88
0.3	1	~~86~~77	~~83~~80	86
0.6	2	~~81~~72	~~78~~75	84
0.9	3	~~76~~67	~~71~~68	80
1.2	4	~~71~~62	~~65~~61	75
1.5	5	~~67~~58	~~60~~57	66
1.8	6	~~63~~54	~~56~~53	55
2.1	7	~~59~~51	~~53~~49	48
2.4	8	~~56~~48	~~49~~46	42
2.7	9	~~53~~45	~~46~~43	38
3	10	~~50~~42	~~43~~40	~~35~~34
4.6	15	~~39~~33	~~33~~30	24
6.1	20	~~31~~26	~~26~~24	18
7.6	25	~~27~~22	~~22~~20	~~15~~14
9.1	30	~~23~~19	~~19~~17	12
10.7	35	~~20~~17	~~16~~15	10
12.2	40	~~18~~15	~~15~~13	9
13.7	45	~~16~~14	~~13~~12	8
15.2	50	~~15~~13	~~12~~11	7
16.8	55	~~14~~12	~~11~~10	7
18.3	60	~~13~~11	~~10~~9	6
19.8	65	~~12~~10	~~9~~8	6
21.3	70	~~11~~9	~~9~~8	5
22.9	75	~~11~~9	~~8~~7	5
24.4	80	~~10~~8	~~8~~7	5
25.9	85	~~9~~8	7	4

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
27.4	90	~~9~~7	~~7~~6	4
29	95	~~9~~7	~~7~~6	4
30.5	100	~~8~~7	6	4
32	105	~~8~~6	~~6~~5	~~4~~3
33.5	110	~~7~~6	~~6~~5	3
35.1	115	~~7~~6	~~6~~5	3
36.6	120	~~7~~6	5	3
38.1	125	~~7~~5	5	3
39.6	130	~~6~~5	~~5~~4	3
41.1	135	~~6~~5	~~5~~4	3
42.7	140	~~6~~5	~~5~~4	3
44.2	145	~~6~~5	4	3
45.7	150	~~6~~5	4	2
47.2	155	~~5~~4	4	2
48.8	160	~~5~~4	4	2
50.3	165	~~5~~4	~~4~~3	2
51.8	170	~~5~~4	~~4~~3	2
53.3	175	~~5~~4	~~4~~3	2
54.9	180	~~5~~4	~~4~~3	2
56.4	185	~~5~~4	~~4~~3	2
57.9	190	4	3	2
59.4	195	4	3	2
61	200	~~4~~3	3	2
62.5	205	~~4~~3	3	2
64	210	~~4~~3	3	2
65.5	215	~~4~~3	3	2
67.1	220	~~4~~3	3	2
68.6	225	~~4~~3	3	2
70.1	230	~~4~~3	3	2
71.6	235	~~4~~3	~~3~~2	2
73.2	240	~~4~~3	~~3~~2	2
74.7	245	3	~~3~~2	2
76.2	250	3	~~3~~2	1
77.7	255	3	~~3~~2	1
79.2	260	3	~~3~~2	1
80.8	265	3	~~3~~2	1
82.3	270	3	2	1
83.8	275	3	2	1
85.3	280	3	2	1
86.9	285	~~3~~2	2	1

Active ~~Channel Width~~channel width (m)	**Active ~~Channel Width~~channel width (feet)**	**Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)**	**Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)**	**Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)**
88.4	290	~~3~~2	2	1
89.9	295	~~3~~2	2	1
91.4	300	~~3~~2	2	1
106.7	350	2	2	1
121.9	400	2	~~2~~1	1
137.2	450	2	1	1
152.4	500	~~2~~1	1	1
167.6	550	~~2~~1	1	1
182.9	600	1	1	1
198.1	650	1	1	1
213.4	700	1	1	1
228.6	750	1	1	0
243.8	800	1	1	0
259.1	850	1	1	0
274.3	900	1	1	0
289.6	950	1	1	0
304.8	1000	1	1	0
320	1050	1	1	0
335.3	1100	1	1	0
350.5	1150	1	1	0
365.8	1200	1	~~1~~0	0
381	1250	1	~~1~~0	0
396.2	1300	1	~~1~~0	0
411.5	1350	1	~~1~~0	0
426.7	1400	1	0	0
442	1450	1	0	0
457.2	1500	~~1~~0	0	0
472.4	1550	~~1~~0	0	0
487.7	1600	~~1~~0	0	0
502.9	1650	~~1~~0	0	0
518.2	1700	~~1~~0	0	0
533.4	1750	~~1~~0	0	0
548.6	1800	0	0	0
563.9	1850	0	0	0

Table 14~~14~~-10: Effective shade targets for grass ~~and~~or wetland dominated stream sites (code ~~950~~975).

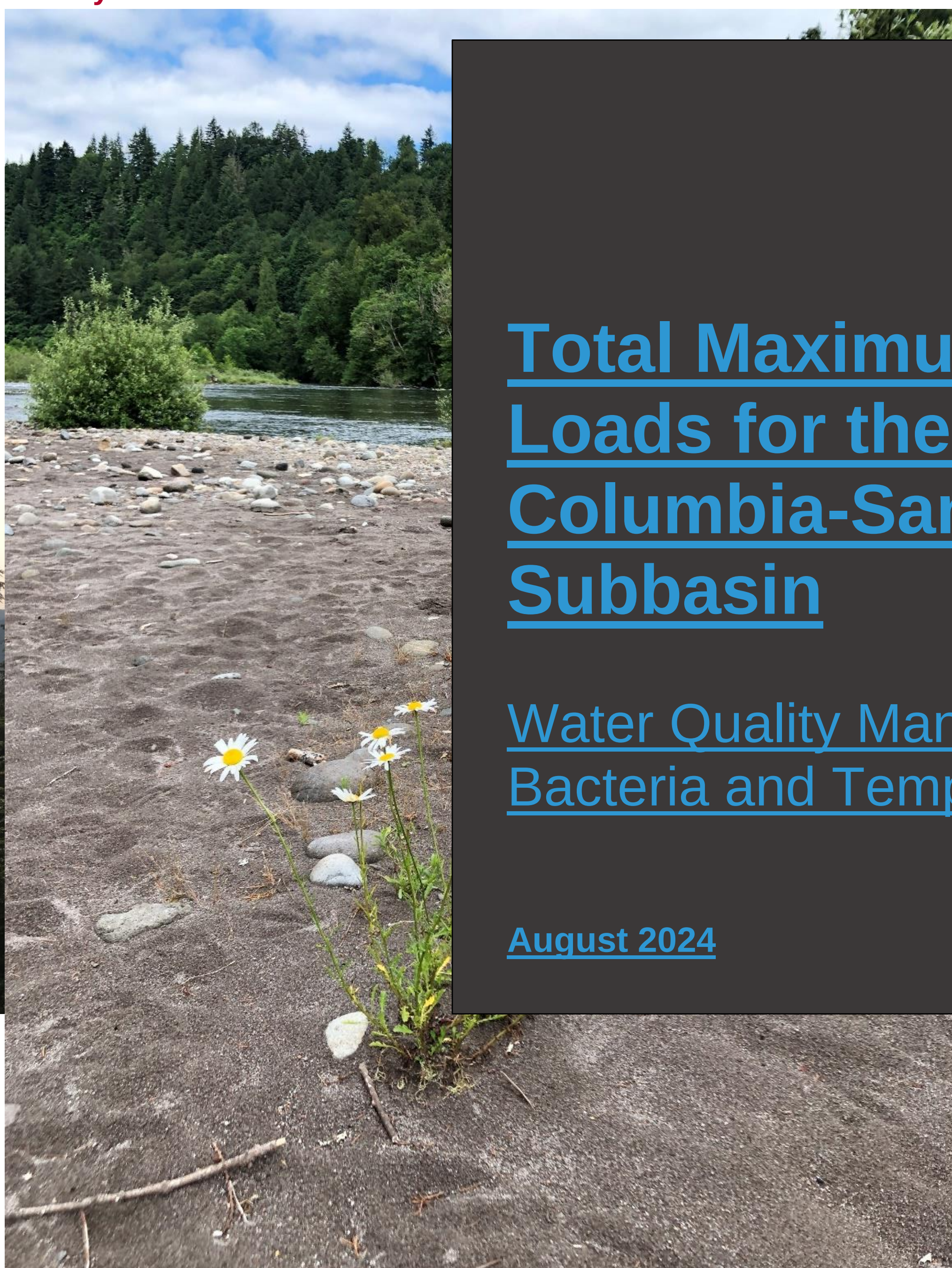
Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
0.2	0.5	~~97~~96	~~97~~96	~~99~~98
0.3	1	~~94~~91	~~95~~91	~~98~~96
0.6	2	~~89~~83	~~89~~79	~~94~~89
0.9	3	~~84~~75	~~81~~70	~~91~~72
1.2	4	~~79~~68	~~74~~63	~~84~~55
1.5	5	~~74~~61	~~70~~56	~~70~~45
1.8	6	~~70~~56	~~65~~51	~~59~~38
2.1	7	~~66~~51	~~61~~46	~~51~~33
2.4	8	~~62~~47	~~57~~41	~~45~~29
2.7	9	~~58~~44	~~53~~38	~~41~~26
3	10	~~55~~41	~~50~~35	~~37~~23
4.6	15	~~43~~30	~~37~~25	~~25~~16
6.1	20	~~35~~24	~~30~~19	~~19~~12
7.6	25	~~29~~19	~~25~~16	~~15~~9
9.1	30	~~25~~17	~~21~~13	~~13~~8
10.7	35	~~23~~15	~~18~~12	~~11~~7
12.2	40	~~20~~13	~~16~~10	~~10~~6
13.7	45	~~18~~12	~~15~~9	~~9~~5
15.2	50	~~17~~10	~~13~~8	~~8~~5
16.8	55	~~16~~10	~~12~~8	~~7~~4
18.3	60	~~14~~9	~~11~~7	~~6~~4
19.8	65	~~14~~8	~~11~~6	~~6~~4
21.3	70	~~13~~8	~~10~~6	~~6~~3
22.9	75	~~12~~7	~~9~~6	~~5~~3
24.4	80	~~11~~7	~~9~~5	~~5~~3
25.9	85	~~11~~6	~~8~~5	~~5~~3
27.4	90	~~10~~6	~~8~~5	~~4~~3
29	95	~~10~~6	~~8~~4	~~4~~2
30.5	100	~~9~~5	~~7~~4	~~4~~2
32	105	~~9~~5	~~7~~4	~~4~~2
33.5	110	~~9~~5	~~7~~4	~~4~~2
35.1	115	~~8~~5	~~6~~4	~~3~~2
36.6	120	~~8~~5	~~6~~4	~~3~~2
38.1	125	~~8~~4	~~6~~3	~~3~~2
39.6	130	~~7~~4	~~6~~3	~~3~~2
41.1	135	~~7~~4	~~5~~3	~~3~~2
42.7	140	~~7~~4	~~5~~3	~~3~~2
44.2	145	~~7~~4	~~5~~3	~~3~~2

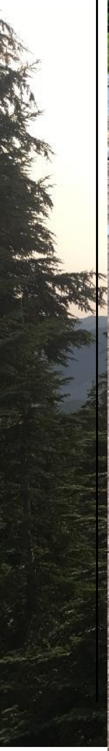
Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
45.7	150	~~6~~4	~~5~~3	~~3~~2
47.2	155	~~6~~4	~~5~~3	~~3~~2
48.8	160	~~6~~3	~~5~~3	~~2~~1
50.3	165	~~6~~3	~~5~~3	~~2~~1
51.8	170	~~6~~3	~~4~~3	~~2~~1
53.3	175	~~6~~3	~~4~~2	~~2~~1
54.9	180	~~5~~3	~~4~~2	~~2~~1
56.4	185	~~5~~3	~~4~~2	~~2~~1
57.9	190	~~5~~3	~~4~~2	~~2~~1
59.4	195	~~5~~3	~~4~~2	~~2~~1
61	200	~~5~~3	~~4~~2	~~2~~1
62.5	205	~~5~~3	~~4~~2	~~2~~1
64	210	~~5~~3	~~4~~2	~~2~~1
65.5	215	~~5~~3	~~4~~2	~~2~~1
67.1	220	~~5~~3	~~3~~2	~~2~~1
68.6	225	~~4~~2	~~3~~2	~~2~~1
70.1	230	~~4~~2	~~3~~2	~~2~~1
71.6	235	~~4~~2	~~3~~2	~~2~~1
73.2	240	~~4~~2	~~3~~2	~~2~~1
74.7	245	~~4~~2	~~3~~2	~~2~~1
76.2	250	~~4~~2	~~3~~2	~~2~~1
77.7	255	~~4~~2	~~3~~2	~~2~~1
79.2	260	~~4~~2	~~3~~2	~~2~~1
80.8	265	~~4~~2	~~3~~2	1
82.3	270	~~4~~2	~~3~~2	1
83.8	275	~~4~~2	~~3~~2	1
85.3	280	~~4~~2	~~3~~2	1
86.9	285	~~4~~2	~~3~~2	1
88.4	290	~~4~~2	~~3~~1	1
89.9	295	~~3~~2	~~3~~1	1
91.4	300	~~3~~2	~~3~~1	1
106.7	350	~~3~~2	~~2~~1	1
121.9	400	~~3~~1	~~2~~1	1
137.2	450	~~2~~1	~~2~~1	1
152.4	500	~~2~~1	~~2~~1	~~1~~0
167.6	550	~~2~~1	1	~~1~~0
182.9	600	~~2~~1	1	~~1~~0
198.1	650	~~2~~1	1	~~1~~0
213.4	700	1	1	~~1~~0
228.6	750	1	1	~~1~~0

Active ~~Channel Width~~channel width (m)	Active ~~Channel Width~~channel width (feet)	Effective ~~Shade Target~~shade target for ~~E-W Stream Aspects~~N-S stream aspects (%)	Effective ~~Shade Target~~shade target for NW-SE, NE-SW ~~Stream Aspects~~stream aspects (%)	Effective ~~Shade Target~~shade target for ~~N-S Stream Aspects~~E-W stream aspects (%)
243.8	800	1	1	0
259.1	850	1	1	0
274.3	900	1	~~1~~0	0
289.6	950	1	~~1~~0	0
304.8	1000	1	~~1~~0	0
320	1050	1	~~1~~0	0
335.3	1100	1	~~1~~0	0
350.5	1150	~~1~~0	~~1~~0	0
365.8	1200	~~1~~0	~~1~~0	0
381	1250	~~1~~0	~~1~~0	0
396.2	1300	~~1~~0	~~1~~0	0
411.5	1350	~~1~~0	~~1~~0	0
426.7	1400	~~1~~0	~~1~~0	0
442	1450	~~1~~0	~~1~~0	0
457.2	1500	~~1~~0	~~1~~0	0
472.4	1550	~~1~~0	~~1~~0	0
487.7	1600	~~1~~0	0	0
502.9	1650	~~1~~0	0	0
518.2	1700	~~1~~0	0	0
533.4	1750	~~1~~0	0	0
548.6	1800	~~1~~0	0	0
563.9	1850	~~1~~0	0	0

~~Draft Water Quality Management Plan – Lower Columbia-Sandy Subbasin Total Maximum Daily Loads – Temperature and Bacteria~~

~~January 2024~~





Total Maximum Daily Loads for the Lower Columbia-Sandy Subbasin

Water Quality Management Plan: Bacteria and Temperature

August 2024

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DEQ

~~State of Oregon Department of Environmental Quality~~

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Photo Source: Ryan Michie, Oregon Department of Environmental Quality

Alternative formats: DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.oregon.gov.

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1. Introduction

The Oregon Department of Environmental Quality developed this~~ draft~~ Water Quality Management Plan to guide implementation of the Lower Columbia-Sandy River Subbasin temperature and bacteria Total Maximum Daily Loads. A WQMP is an element of a TMDL, as described by OAR 340-042-0040(4)(l), which provides the framework for management strategies to attain and maintain water quality standards and is designed to work in conjunction with detailed implementation plans prepared by persons responsible for TMDL implementation.

In March 2005, DEQ issued a TMDL and associated WQMP for temperature in the Sandy River Basin and bacteria in three creeks within the watershed~~; the US~~ (DEQ, 2005). The U.S. Environmental Protection Agency approved the TMDL and WQMP in April 2005. In 2013, EPA disapproved the Natural Conditions Criterion contained in Oregon's water quality standard for temperature due to the 2012 U.S. District Court decision for Northwest Environmental Advocates v. EPA. On October 4, 2019, the U.S. District Court issued a judgment in the lawsuit requiring EPA and DEQ to reissue 15 Oregon temperature TMDLs that were based on the Natural Conditions Criterion, including the Lower Columbia-Sandy Subbasin.

~~This Lower Columbia-Sandy Subbasin WQMP will be proposed for adoption by ~~Oregon's Environmental Quality Commission adopted this Lower Columbia-Sandy Subbasin WQMP, by reference, into rule as OAR 340-042-0090(~~2)(b~~4). This WQMP is intended to provide ~~comprehensive~~consolidated information for implementation of both the temperature and bacteria TMDLs. ~~This~~The WQMP replaces the temperature elements and carries forward the same bacteria ~~elements~~management strategies from the 2005 WQMP for the Designated Management Agencies identified in the 2005 WQMP as responsible for implementing bacteria management strategies. This WQMP replaces the 2005 WQMP and will be amended, as needed, upon issuance of any future new or revised TMDLs within the Lower Columbia-Sandy Subbasin.

1.1 Condition assessment and problem description

The first element of the WQMP, per OAR 340-042-0040(4)(l)(A), is an assessment of water quality conditions in the Lower Columbia-Sandy Subbasin and a problem description. There are assessment units in the Lower Columbia-Sandy WQMP listed as impaired (category 5 or 4A) for temperature in Oregon's 2022 Integrated Report, which was approved by ~~US Environmental Protection Agency~~the EPA on September 1, 2022. There were portions of Beaver Creek, Kelly Creek and Cedar Creek listed as impaired for bacteria on Oregon's 2002 Section 303(d) list of impaired waterbodies. As required by Section 303(d) of the federal Clean Water Act, DEQ developed ~~Total Maximum Daily Loads~~TMDLs for pollutants causing temperature (~~2023~~2024) and bacteria (DEQ, 2005) water quality impairments of waters within the Lower Columbia-Sandy Subbasin. These pollutants are ~~solar radiation and ~~heat or thermal loading from various sources and conditions, which contribute to impairments of the temperature criteria established to support aquatic life beneficial uses; and fecal bacteria, including E. coli bacteria, which contribute to impairments of the bacteria criteria established to support water contact recreation.

1.2 Goals and objectives

OAR 340-042-0040(4)(l)(B) requires identification of the goals and objectives of the WQMP.

The goal of this WQMP is to provide the framework for TMDL implementation to achieve and maintain the temperature and bacteria water quality standards within the Lower Columbia-Sandy Subbasin.

The primary objectives of this WQMP are to describe: ~~responsibilities~~

- Responsibilities for implementing the TMDLs; ~~management~~
- Management strategies and actions necessary to reduce excess pollutant loads ~~in order~~ to meet the TMDL allocations; and, ~~a~~
- A strategy to evaluate progress towards attaining relevant water quality standards throughout the Lower Columbia-Sandy Subbasin.

2. Proposed ~~management strategies~~Management Strategies

As required by OAR 340-042-0040(4)(l)(C), the following section presents proposed management strategies, by pollutant source or category, that are designed to meet the load and wasteload allocations required by the Lower Columbia-Sandy Subbasin temperature and bacteria TMDLs.

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

~~Table 1~~Table 1 includes proven strategies (and practices within the strategies) summarized by pollutant source. These strategies and practices are adapted from published sources. ~~The bacteria sources and strategies are carried forward from the 2005 Sandy Basin bacteria TMDL and WQMP, without change.~~ DEQ used the categories and terminology from Oregon Watershed Enhancement Board's Oregon Aquatic Habitat Restoration and Enhancement Guide and Oregon Watershed Restoration Inventory Online List of Treatments. Additional strategies included in ~~Table 1~~Table 1 are supported by Oregon Department of Agriculture, U.S. Department of Agriculture Natural Resources Conservation Service, Oregon State University Extension Service, and other publicly available published sources. DEQ identified the strategies in ~~Table 1~~Table 1 as appropriate for the conditions and sources within the subbasin. Therefore, these are considered priority strategies and practices that should receive special focus during implementation plan development. The bacteria sources and strategies are carried forward from the 2005 Sandy Basin bacteria TMDL and WQMP without change.

DEQ expects that entities identified in Section 5.1 will develop implementation plans that incorporate strategies and practices ~~in Table 1~~from Table 1 that are applicable to their jurisdiction. Implementation plans must include specifics on where and when priority and other strategies and practices will be applied, along with measurable objectives and milestones for documenting their implementation and ~~gaging~~gauging their effectiveness.

Table 1: Management strategies by sources

Pollutant	Source or activity	Management strategies
~~Solar Radiation~~ Heat (thermal loading)	Insufficient height, density, or width of riparian vegetation	The primary goal is to increase site effective shade (combination of vegetation height, buffer width and canopy density) through streamside vegetation management strategies using regulatory programs and voluntary activities, including incentive-based projects. Streamside tree planting (conifer and hardwood); streamside vegetation planting (shrub or herbaceous cover); streamside vegetation management (invasive thinning, removal or other treatment); voluntary streamside tree retention; streamside invasive plant control; streamside fencing (or other livestock streamside exclusion or management methods); identify and protect cold water refuges Increase site effective shade (combination of vegetation height, buffer width and canopy density) through streamside vegetation management strategies using regulatory programs and voluntary activities, including incentive-based projects; maintain plants until free to grow; monitor survival rates Develop, update and/or enforce streamside code/ordinance to ensure streamside native vegetation and intact bank conditions are protected or restored following site development; purchase, acquire, or designate conservation easements along streamside areas
	Water withdrawals and flow alteration	Pursue new instream water rights, as well as transfers and leases of existing water rights; water right application reviews; irrigation conservation and management; repair or replace leaking pipes and infrastructure; provide incentives for water conservation; implement water consumption restrictions during the summer months, such as lawn watering
~~Heat~~	~~Water withdrawals and flow alteration~~Channel modification and hydromodification	~~Pursue instream water right transfers and leases; water right application reviews; irrigation conservation and management; repair or replace leaking pipes and infrastructure; provide incentives for water conservation; implement water consumption restrictions during the summer months, such as lawn watering~~Conduct whole channel restorations (e.g., enhance channel, wetlands, and floodplain interactions, reduce width to depth channel ratios, bank stabilization, large wood placement, create/connect side channels, etc.); streamside road re-construction/obliteration activities; streamside fencing or other livestock exclusion or management methods; protect and enhance cold water refuges; remove in-channel ponds or modify pond structures to reduce temperature increases downstream; protect areas that do not require restoration actions

Pollutant	Source or activity	Management strategies
	Channel modification and hydromodificationDam and reservoir management	Conduct whole channel restorations (e.g. enhance channel, wetlands, and floodplain interactions, reduce width to depth channel ratios, bank stabilization, large wood placement, create/connect side channels, etc.); streamside road re-construction/obliteration activities; streamside fencing or water gap development (or other livestock exclusion or management methods); protect and enhance cold water refuges; develop dam management strategies for temperature; remove in-channel ponds or modify pond structures to reduce temperature increases downstream; protect areas that do not require restoration actions Modifications to the quantity and nature of water releases to meet water quality standards for temperature
Bacteria	Urban stormwater	Implement stormwater management practices, including managing construction site runoff, implementing public education and outreach activities, and managing stormwater at new development and redevelopment projects Managing pet waste Implement additional best management practices for livestock manure and pasture management and reduce livestock access to streams to reduce organic matter mobilization in runoff and direct deposition into surface waters Implement bacteria source tracking to identify the source of bacteria in surface waters Improve pastures and streamside zones to reduce surface erosion and provide adequate filtration capacity for organic matter and nutrients Assess onsite septic systems to identify those at the highest risk of malfunction or failure and connect to public sanitary sewer systems where possible
	Nonpoint sources and background	Managing pet waste Implement additional best management practices for livestock manure and pasture management and reduce livestock access to streams to reduce organic matter mobilization in runoff and direct deposition into surface waters Implement bacteria source tracking to identify the source of bacteria in surface waters Improve pastures and streamside zones to reduce surface erosion and provide adequate filtration capacity for organic matter and nutrients Assess onsite septic systems to identify those at the highest risk of malfunction or failure and connect to public sanitary sewer systems where possible

2.1 Streamside vegetation management strategies

DEQ's water quality analysis and modeling concluded that streamside vegetation planting and management are the strategies necessary to meet water quality standards in the temperature impaired sections of streams in the Lower Columbia-Sandy Subbasin. This is because streamside overstory vegetation reduces solar radiation loads to streams by providing shade. Protecting and restoring streamside overstory vegetation is essential to achieving the TMDL surrogate measure of effective shade.

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

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

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

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

2.2 Flow management strategies

DEQ's modeling, evaluation of water quality data, and research found that water withdrawals decrease the capacity of streams to assimilate pollutant loads (DEQ 2023a, 2024a). Because temperature is a flow-related parameter, water withdrawals can result in increased pollutant concentrations and warmer stream temperatures. In waterbodies where temperatures are already known to exceed standards, further withdrawals from the stream will reduce the stream's heat capacity and cause greater fluctuation in daytime and nighttime stream temperatures.

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

2.3 Hydromodification strategies

Hydromodification refers to alterations of natural hydrological processes which affect characteristics of a waterbody and impact water quality. Examples of hydromodification include the construction of dams and levees and modifying stream channel morphology. Hydromodification can affect the loading, timing, and delivery of nonpoint source pollutants, including temperature (EPA, 2007).

Altering channel morphology can impact stream temperature (Galli and Dubose, 1990). For example, streams with high width to depth ratios (i.e~~.~~., wide, shallow streams) can allow solar radiation to increase stream temperature compared to channels that are narrow and deep (Larson and Larson, 1996). Activities that make streams more prone to bank erosion, such as uncontrolled livestock access, can also result in shallower streams and increased stream temperatures. Channelization can impact stream morphology by disconnecting streams from their floodplains due to activities such as urban development or road construction. Streams that have been disconnected from floodplains are not able to slow and store floodwaters during the rainy season or recharge groundwater to support summer flows (EPA, 2017).

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

2.3.1 Large ~~Dam Owners~~dam owners and ~~Reservoir Management~~reservoir management

There are approximately ~~12~~11 reservoirs located in the Lower Columbia-Sandy project area that are large enough to require evaluation for dam safety. DEQ compiled this list of dams ~~(Appendix A)~~(Appendix A) from the U.S. Army Corps of Engineers National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department (OWRD), dam safety program. The OWRD prescribes dam safety rules that apply to large dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000). "Dam" means a hydraulic structure built above the natural ground line that is used to impound water. Dams include all appurtenant structures, and together are sometimes referred to as "the works". Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals.

Dams of all sizes can increase stream temperatures, depending on factors such as specific dam and stream characteristics, and the location and number of dams in a watershed. For these reasons, DEQ expects all dam owners to manage their reservoirs to meet water quality standards, including standards for temperature. For details on reservoir operator implementation requirements, see Section 5.3.7.

2.4 Cold water refuges

Cold water refuges are areas within a water body with temperatures colder than the remainder of the water body and are used by migratory fish to escape warmer water temperatures. According to OAR 340-041-0002(10) "Cold Water Refugia" means those portions of a water body where, or times during the day when, the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body.

Due to their importance, these areas should be identified and protected when possible. EPA's Columbia River Cold Water Refuges Plan identifies the importance of the Sandy River as it relates to the Columbia River and includes a list of possible actions to protect cold water refuges in the Sandy River (EPA, 2021).

2.5 Point source priority management strategies

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

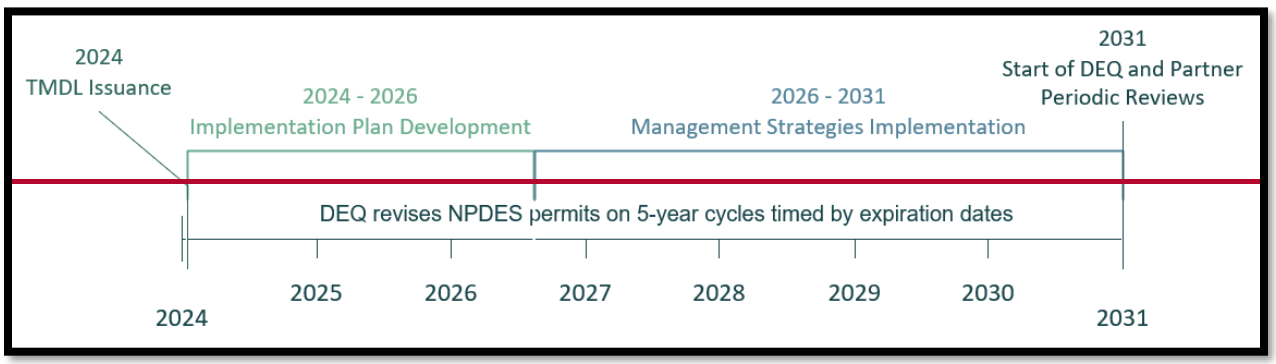
The primary way DEQ addresses numeric wasteload allocations is by including effluent limits in permits (though different mechanisms may be used if they are consistent with the TMDL). There are ~~a number of~~several available pathways that may be used to achieve compliance with these limits and requirements~~.~~,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

Water Quality Trading Opportunities

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

3. Timelines for ~~implementing strategies~~Implementing Strategies

OAR 340-042-0040(4)(l)(D) requires~~ a WQMP address~~ schedules for implementing management strategies including permit revisions, achieving appropriate incremental and measurable water quality targets, implementing control actions, and completing measurable milestones. DEQ's water quality permitting program has responsibility for revising permits to comply with TMDLs. Timelines for implementation of management strategies by responsible persons~~ are discussed separately. Figure 1 presents a typified timeline for TMDL implementation in a five-year increment, adjusted for the longer time allowed for development or revision of implementation plans for the Lower Columbia-Sandy Subbasin TMDL.~~, including DMAs is discussed separately.



~~**Figure 1: Lower Columbia-Sandy Subbasin TMDL implementation timeline**~~

3.1 DEQ ~~Permit~~permit revisions

NPDES permits have five--year terms. ~~Table 2~~

Table 2 includes a list of NPDES permittees in the Sandy Basin and their next expected permit renewal date. DEQ will include any updates to TMDL wasteload allocations in the permittee's next NPDES renewal permit after the TMDL has been approved.

The ~~City~~city of Sandy ~~WWTP~~Wastewater Treatment Plant currently holds an NPDES permit for discharge to Tickle Creek (Clackamas Subbasin) but is under an EPA consent decree to upgrade and add treatment capacity. ~~At this time, the City~~The city of Sandy has provided DEQ with an NPDES permit application for the upgrade and construction of a new outfall to the

Sandy River. The discharge to the Sandy River is estimated to be a significant source of thermal load~~,~~ and has been allocated a portion of the cumulative human use allowance. Additional information regarding the new outfall is in the TMDL ~~Rule,~~rule (DEQ, 2024), Sections 7.1 and 9.1.

Table 2: Sandy Subbasin permits and timelines

Permittee	Permit Type	DEQ file number	EPA permit number	Planned Issuance Date
Government Camp STP	NPDES-Dom-Da	34136	OR0027791	2025
Water Environment Services Hoodland STP	NPDES-Dom-Da	89941	OR0031020	2027
City of Troutdale WPCF	NPDES-Dom-C2a	39750	OR0020524	2023
OR Dept of Fish and Wildlife Sandy River Fish Hatchery	300-J	64550	ORG130009	TBD

3.2 Management strategies implemented by responsible persons

DEQ uses multiple sources to establish current conditions and track implementation progress in the Lower Columbia-Sandy Subbasin project area. One of these sources is the Oregon Watershed Enhancement Board's Oregon Watershed Restoration Inventory, which is a repository for storing watershed restoration activities. OWRI contains project level information from watershed councils, landowners and other groups who have implemented restoration projects to improve aquatic habitat and water quality conditions. Data available from OWRI indicate approximately 39 stream miles have been planted since 2005 in the project area~~.~~ (OWRI, 2023a).

For this TMDL, DEQ also conducted modelling across specific areas within the project area to assess current streamside shade. Where DEQ completed modeling, effective shade targets were calculated for specific water bodies. An effective mean shade was then calculated for DMAs where this modeling occurred, and a shade gap assessment was completed. A shade gap assessment was not completed for all DMAs. For the areas where a shade gap assessment was not completed, effective shade targets are determined through shade curves based on stream site characteristics. The shade gap results for the modeled areas include shade conditions that may have been impacted by streamside planting projects that were completed following the approval of the 2005 Sandy River Basin TMDL.

While DEQ was not able to directly quantify the impact that ~~these~~ planting projects had on modeled streamside shade gaps, available data demonstrate that the pace and scale of streamside planting will need to increase to meet shade targets for this TMDL (~~See~~see section 3.3).

3.3 Timeline for implementation of management strategies

This section of the WQMP includes an estimate of the timeline for implementation of management strategies that will be sufficient to support attainment of water quality standards. Estimating timeframes for meeting shade targets across the project area is influenced by several factors, including:

- The project area is large and the percent effective shade targets to be met are developed at a small scale or through shade curves.
- A shade gap analysis is unavailable for all streams in the Lower Columbia-Sandy Subbasin to ~~gage~~gauge what percent of streamside areas across the project area are not currently meeting effective shade targets.
- DEQ is unable to determine whether the rate of previous streamside plantings will be similar to planting efforts following the adoption of this TMDL.
- DMAs that have a large percentage of private property within their jurisdiction will have challenges in meeting effective shade targets. It will likely take additional time to develop more protective streamside ordinances or regulations, work with landowners, or partner with other organizations to conduct streamside planting and restoration projects in these areas.
- It is unclear how much future planting will be targeted in priority shade gap areas, as opposed to implementing ~~more~~ opportunistic planting projects.
- The scale of implementation, location, and water quality benefits from future in-stream restoration and flow augmentation projects are unknown.
- It is unclear what impacts climate change and forest pests, such as the emerald ash borer, will have on tree species.
- Frequency and magnitude of natural disturbances, such as wildfires.

DEQ expects responsible persons, including DMAs to consider the timeline projections and interim targets presented below in ~~Table 3~~

Table 3 in establishing commitments for streamside planting and protection in TMDL implementation plans. Based on DEQ analysis of the number of stream miles that will need restoration, and the pace of restoration logged in the Oregon Watershed Restoration Inventory database over the previous years of implementation, restoration will need to occur at an accelerated pace to meet the targets below. Timelines for attainment of percent cumulative effective shade ~~are generally~~were estimated based on time for trees to grow to heights sufficient to provide effective shade, and in considerations of the factors described above. ~~Table 3~~

Table 3 gives projections for meeting 10 percent of shade targets across the basin every 10 years beginning in 2030, which will result in meeting all shade targets in 90 years. It is important to note that meeting shade targets on all waterbodies may not be possible due to various factors, such as natural disturbances, the built environment, and private streamside ownership.

Table 3: ~~Projected timelines~~Timelines to meet percent shade targets in the Lower Columbia-Sandy Subbasin TMDL in 10-year increments

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

4. Attaining ~~water quality standards~~Water Quality Standards

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

4.1 How management strategies support attainment of water quality standards

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

4.1.1 Implementation of vegetation management, flow management and hydromodification strategies for temperature reduction

DEQ identified priority implementation management strategies and specific practices in ~~Table 1~~Table 1 and Section 2. DEQ expects these strategies and practices to increase site effective shade and address the excess solar radiation and shade deficits calculated along streams within the Lower Columbia-Sandy Subbasin. DEQ focused on the vegetation strategies described in Section 2.1 to estimate ~~reasonable~~ timelines for achieving surrogate effective shade targets ~~(Table 3),~~(

Table 3), and by extension solar radiation load reductions to meet temperature water quality standards. Some of these vegetation management strategies have been implemented at various locations over the past 18 years by responsible persons, including Designated Management Agencies~~,~~ that were identified in the 2005 TMDL.

DEQ developed site-specific effective shade targets and effective shade curves to meet temperature load allocations in the TMDL ~~Rule~~rule (Section 9 in the TMDL ~~Rule~~rule). Shade curves identify the relationship between stream width, orientation, and effective shade for specific streamside vegetation types. Effective shade curves are applicable to any stream that does not have site specific shade targets. Effective shade curves represent the maximum possible effective shade for a given vegetation type.

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

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

4.1.2 Continued implementation of bacteria management strategies

DEQ's 2005 TMDL and WQMP required strategies for managing bacteria from urban stormwater, pet waste, livestock and pastures, septic areas and sanitary sewer discharges in areas that discharge to Beaver, Kelly and Cedar Creeks. DEQ did not revise the 2005 bacteria TMDL and requires ~~the~~ relevant responsible persons, including DMAs, to include these strategies in updated implementation plans, as appropriate to their jurisdictions, and continue to implement ~~them~~ and report on their effectiveness.

4.2 Timelines for attaining water quality standards

OAR 340-042-0040(4)(l)(F) requires an estimated timeline for attaining water quality standards through implementation of the TMDL, WQMP and associated TMDL implementation plans.

Based on DEQ's source assessment and TMDL analyses (DEQ, ~~2023a~~2024a), point sources and nonpoint sources contribute pollutant thermal loads in the Sandy River, Camp Creek, and Cedar Creek. Nonpoint sources contribute nearly all ~~of~~ the excess thermal pollutant loading associated with temperature water quality impairments to most other impaired waterbodies in the Lower Columbia-Sandy Subbasin. Therefore, it is critical for nonpoint sources to make timely progress toward meeting the TMDL load allocations.

Because the Temperature TMDL calculated NPS load allocations using a percent effective shade surrogate measure, the estimated timelines to meet water quality standards are primarily based on streamside planting activities. However, other management strategies, including stream channel restoration and increasing instream flows will also help improve stream temperature conditions. Based on the

Table 3 timeline to meet effective shade targets ~~(Table 3),~~, temperature water quality standards for the Lower Columbia-Sandy subbasin will be met by 2120. This is a target date~~,~~ and is uncertain due to unknowns related to current conditions and the pace of future restoration activities. Achieving the identified timelines for cumulative effective shade and resulting water quality benefits will require active participation from all responsible persons, including DMAs, within the basin.

DEQ expects Designated Management Agencies responsible for implementing bacteria management strategies for Beaver, Kelly and Cedar Creeks to summarize evaluation of bacteria strategy performance since 2005 when identifying and prioritizing actions in implementation plans.

5. Implementation ~~responsibilities~~Responsibilities and ~~schedule~~Schedule

5.1 Identification of implementation responsibilities

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

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

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

Unless otherwise specified, all responsible persons, including DMAs, are required to develop, submit, ~~implement~~ and revise, as needed, an implementation plan specific to the Lower Columbia-Sandy Subbasin TMDL~~ that includes: management strategies; timelines for~~. As required in OAR 340-042-0080(4)(a), implementation~~; a schedule for achieving milestones; and a performance monitoring component with a plan for periodic review and plan revision. Table 4 contains the list of these responsible persons, along with summaries, where available, of their approximate jurisdictional land area percentages within the subbasin. Entities in Table 4 noted with a # were identified in the 2005 WQMP as being a DMA for bacteria.~~ plans must include:

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

Table 4 contains the list of DMAs that were named in the 2005 Sandy River Basin TMDL for bacteria for specific streams. These DMAs continue to be responsible for implementing an approved TMDL plan for bacteria.

Table 4: ~~Persons responsible for developing implementation plans~~List of designated management agencies in the 2005 Sandy River Basin TMDL for bacteria

~~Entity~~DMA	~~Type~~Geographic Coverage		
~~US Forest Service~~	~~Federal~~	~~70.38%~~	~~70.11%~~
~~Oregon Department of Forestry~~	~~State~~	~~12.88%~~	~~13.62%~~
~~US Bureau of Land Management~~	~~Federal~~	~~4.16%~~	~~5.11%~~
~~Oregon Department of Agriculture~~	~~State~~	~~3.81%~~	~~2.79%~~
Clackamas County ~~#~~	~~County~~Cedar Creek		
City of Sandy	Cedar Creek		
Multnomah County ~~#~~	~~County~~Beaver Creek, Kelly Creek		
~~City of Portland~~	~~City~~	~~0.82%~~	~~1.04%~~
~~Oregon Parks and Recreation Department~~	~~State~~	~~0.77%~~	~~0.65%~~
~~Oregon Department of Transportation~~	~~State~~	~~0.74%~~	~~0.40%~~
City of Gresham ~~#~~	~~City~~Beaver Creek, Kelly Creek		
City of Troutdale ~~#~~	~~City~~Beaver Creek		
~~City of Sandy #~~	~~City~~	~~0.17%~~	~~0.18%~~
~~Union Pacific Railroad *~~	~~Railroad~~	~~0.12%~~	~~0.07%~~
~~Oregon Department of Fish and Wildlife~~	~~State~~	~~0.06%~~	~~0.11%~~
~~Port of Portland *~~	~~Special District~~	~~0.04%~~	~~0.03%~~
~~Clackamas Water Environment Services~~	~~Special District~~	~~-~~	~~-~~

Oregon Department of State Lands *	State	-	-
Department of Geology and Mineral Industries *	State	-	-
Oregon Department of Environmental Quality	State	-	-
Metro *	Special District	-	-
Notes: * Indicates entity is not required to develop a TMDL implementation plan at this time # Indicates entity was previously identified as a DMA for bacteria in the 2005 Sandy WQMP			

The Oregon Department of Environmental Quality is the DMA for implementing point source wasteload allocations. DEQ is not included in Table 4 because DEQ implements waste load allocations through issuance of NPDES permits, which does not require preparation of an implementation plan. In addition, entities noted with an * in Table 4 are not required to develop an implementation plan

Table 5 contains the complete list of responsible persons, including designated management agencies, and approximate jurisdictional land area percentages within the subbasin, where available. Some responsible persons, including DMAs are not required to submit implementation plans for temperature at this time. DEQ made this determination through a review of currently available information, including land ownership and jurisdiction within the for one or more of the following reasons:

1) Water protection actions implemented through permits (e.g., DOGAMI)
2) Limited ability or opportunity to conduct stream restoration activities (e.g., railroads)
3) DMA has limited streamside area, as well as how lands are currently managed. However, if new under its jurisdiction

DEQ may require temperature implementation plans from these entities in the future if ownership or jurisdiction of streamside areas increases, or other data or information indicates these entities should develop ana TMDL implementation plan, is needed to achieve temperature allocations and shade targets identified in this TMDL. DEQ may revise the WQMP or issue individual orders to notifythe DMA notifying them of the required schedule for submitting an implementation plan.

Table 4

Table 5: List of responsible persons including designated management agencies

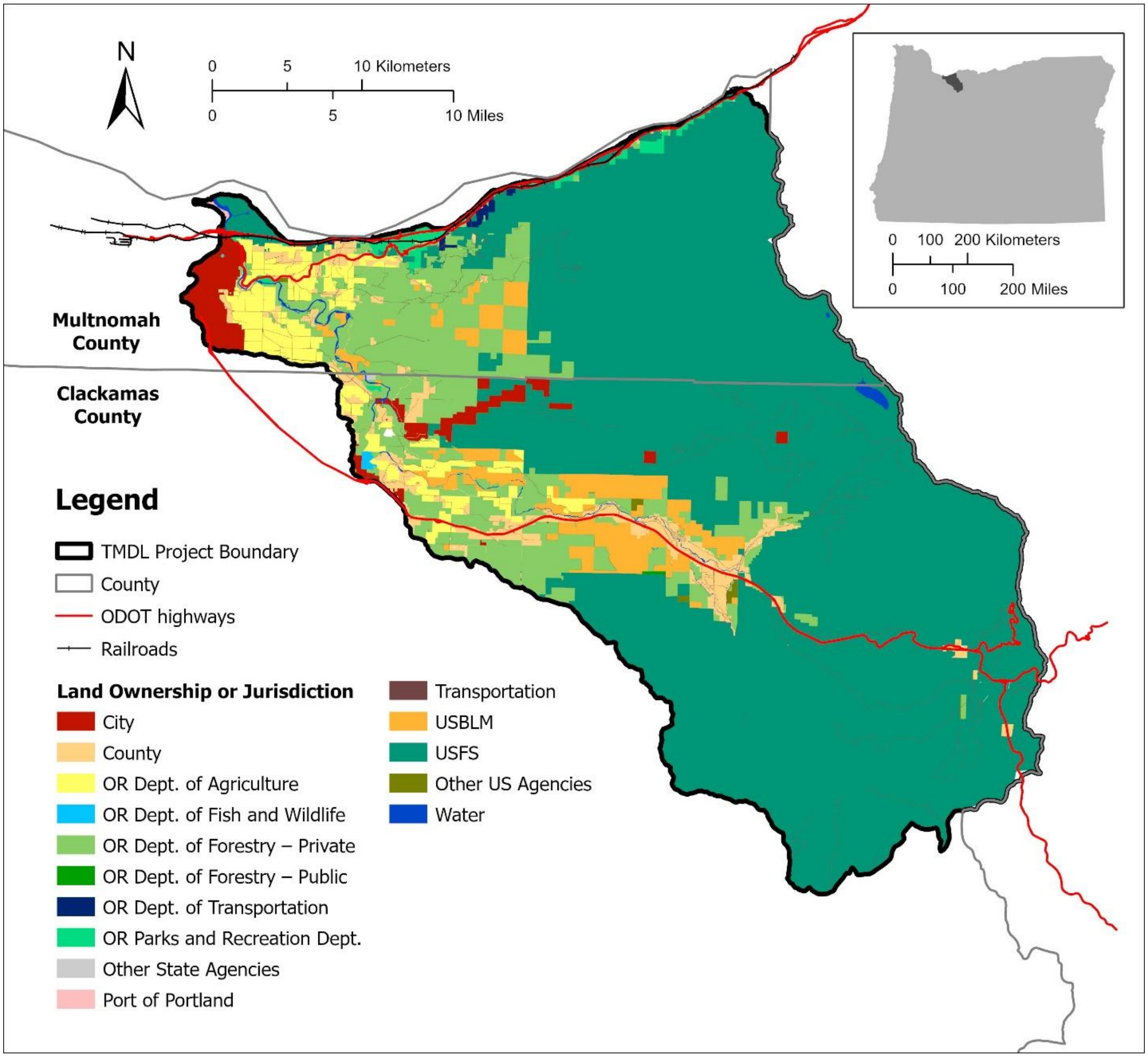
No.	Entity	Type	Approximate percentage of total subbasin area	Approximate percentage of acreage within 150' of streams	TMDL Plan Needed (X)	
					Temperature	Bacteria
1	U.S. Forest Service	Federal	70.38%	70.11%	X	
2	Oregon Department of Forestry	State	12.88%	13.62%	X	
3	U.S. Bureau of Land Management	Federal	4.16%	5.11%	X	
4	Oregon Department of Agriculture	State	3.81%	2.79%	X	
5	Clackamas County	County	2.93%	2.57%	X	X
6	Multnomah County	County	1.11%	0.88%	X	X
7	City of Portland	City	0.82%	1.04%	X	

No.	Entity	Type	Approximate percentage of total subbasin area	Approximate percentage of acreage within 150' of streams	TMDL Plan Needed (X)	
					Temperature	Bacteria
8	Oregon Parks and Recreation Department	State	0.77%	0.65%	X	
9	Oregon Department of Transportation	State	0.74%	0.40%	X	
10	City of Gresham	City	0.78%	0.54%	X	X
11	City of Troutdale	City	0.50%	0.33%	X	X
12	City of Sandy	City	0.17%	0.18%	X	X
13	Union Pacific Railroad	Railroad	0.12%	0.07%		
14	Oregon Department of Fish and Wildlife	State	0.06%	0.11%	X	
15	Port of Portland	Special District	0.04%	0.03%		
16	Clackamas Water Environment Services	Special District	not assessed	not assessed	X	
17	Oregon Department of State Lands	State	not assessed	not assessed		
18	Department of Geology and Mineral Industries	State	not assessed	not assessed		
19	Oregon Department of Environmental Quality	State	not assessed	not assessed		
20	Metro	Special District	not assessed	not assessed		

DEQ is the DMA for implementing point source wasteload allocations. DEQ implements wasteload allocations through issuance of NPDES permits, which does not require preparation of an implementation plan.

Table 5 is not an exhaustive list of every individual that ~~bears responsibility~~is responsible for improving water quality in the Lower Columbia-Sandy River Subbasin. It may be necessary for all people that live, work and recreate in the watershed to take steps to reduce pollution and protect or restore water quality to attain standards and designated beneficial uses. Active participation may be needed to achieve long-term water quality improvements throughout the watershed.

~~Figure 2~~**Error! Reference source not found.** is a map of the watershed showing areas by land use, ownership, or jurisdiction with responsibility for implementation of management strategies by the entities indicated.


N
0 5 10 Kilometers
0 5 10 Miles
0 100 200 Kilometers
0 100 200 Miles
Multnomah County
Clackamas County
Legend
TMDL Project Boundary
County
ODOT highways
Railroads
Land Ownership or Jurisdiction
City
County
OR Dept. of Agriculture
OR Dept. of Fish and Wildlife
OR Dept. of Forestry – Private
OR Dept. of Forestry – Public
OR Dept. of Transportation
OR Parks and Recreation Dept.
Other State Agencies
Port of Portland
Transportation
USBLM
USFS
Other US Agencies
Water

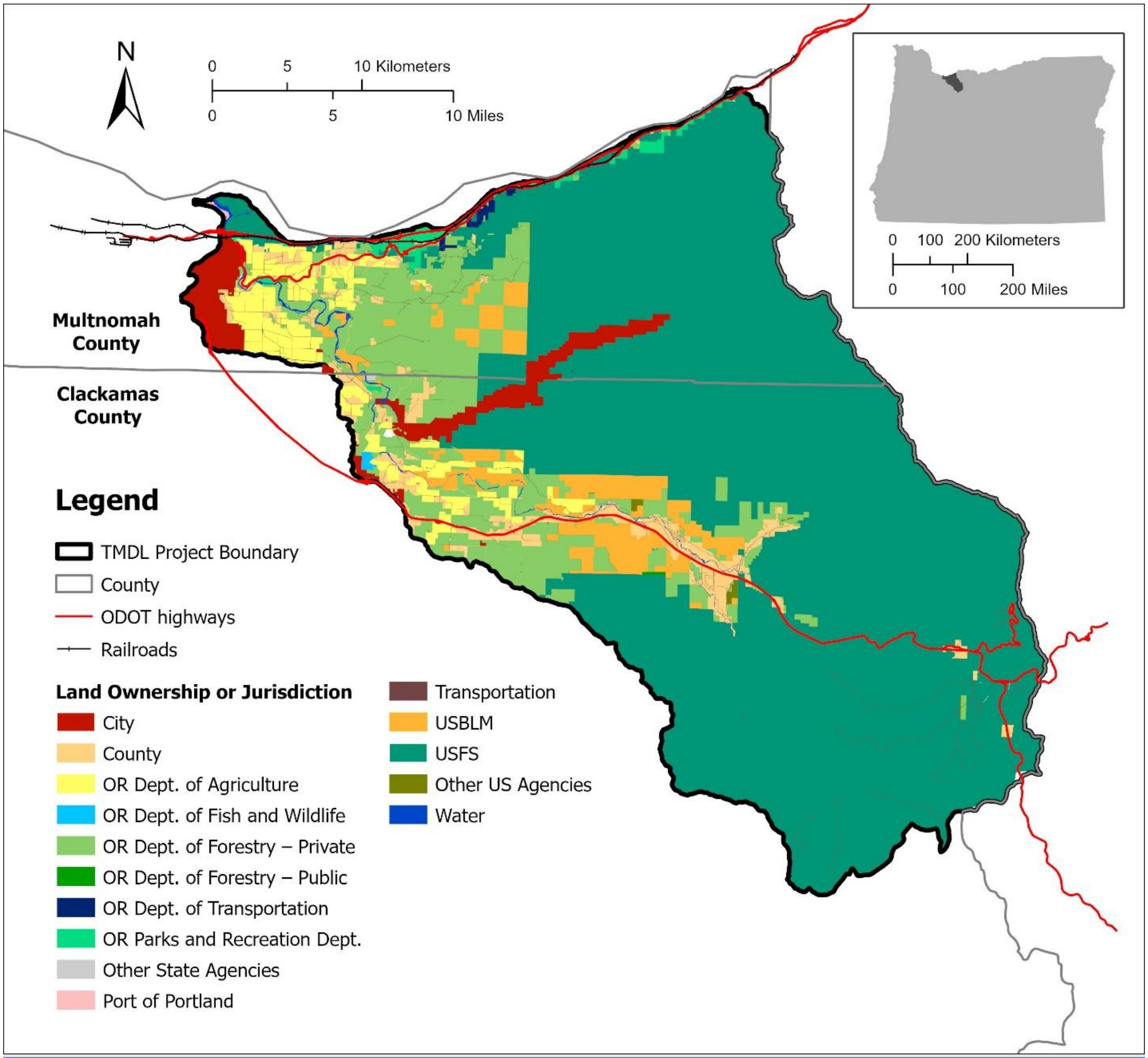


Figure 1: Lower Columbia-Sandy Subbasin land ownership or jurisdiction map

5.2 Existing implementation plans

OAR 340-042-0040(4)(l)(H) requires identification of any source or sector-specific implementation plans available at the time of TMDL issuance. Following issuance of the 2005 Sandy Basin TMDL and Water Quality Management Plan, responsible persons, including DMAs, developed implementation plans that included specific management strategies and reporting requirements. ~~Table 5~~Table 6 identifies those entities with existing TMDL implementation plans. Existing DMAs that already have an implementation plan will need to update their current plan for temperature to ensure any new requirements in this WQMP are met.

Table 6~~: Entities~~: Responsible persons, including DMAs with existing implementation plans

No.	Responsible Person/DMA
1	Multnomah County
2	Clackamas County
3	Clackamas Water Environment Services
4	City of Portland
5	City of Troutdale
6	City of Gresham
7	City of Sandy

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

5.2.1 Oregon Department of Forestry: ~~Adequacy~~adequacy of Forest Practices Act to meet TMDL load allocations and effective shade surrogate measures

Waterway protection measures were established in 1994 for state and private forest practices in Oregon, as codified in Oregon Revised Statutes 527.610 through 527.992, Oregon's Forest Practices Act (OAR 629-600 through 629-665) and Oregon's Plan for Salmon and Watersheds (Executive Order 99-01). As provided in ORS 527.770, forest operations conducted in accordance with the Forest Practices Act and other voluntary measures are generally considered to be in compliance with water quality standards. However, as provided in OAR 340-042-0080(2), revisions to the Forest Practices Act rules may be required when DEQ determines that these rules are not adequate to implement load allocations in an approved TMDL. ~~Periodic revisions to these rules occurred between the 1990s through 2022, with studies by ODF and DEQ showing that the rules adopted prior to 2022 were not adequate to meet the Oregon temperature criterion for protecting cold water. DEQ determined in this TMDL that the generally applicable Forest Practices Act rules in effect prior to 2022 were not adequate to implement the TMDL load allocations for excess solar radiation loading on small and medium fish-bearing streams to meet the temperature criteria.~~

Periodic revisions to the Forest Practices Act rules occurred between the 1990s through 2022. With the publication of the Private Forest Accord Report and subsequent passage of Senate Bill 1501, 1502 and HB 4055, Forest Practices Act rule revisions were adopted by the Board of Forestry in October 2022 and additional amendments are anticipated through 2025. Implementation of these rules, ~~which include~~including increased riparian widths and additional tree retention, may be effective at meeting shade allocations. ~~In addition, as revised rules become effective, implementation of more stringent measures to protect water quality on private forestlands are anticipated to be applied, including in the Sandy River Subbasin. These rules are not expected to result in after-the-fact restoration of riparian areas harvested under previous rules. Therefore, effective shade is likely to be deficient for those riparian areas adjacent to small and medium salmon, steelhead and bull trout streams that were harvested prior to implementation of the new rules. The trajectory for providing future riparian shade on these streams is highly variable because it is based on the rules in effect at the time of harvest and the date of replanting. Multiple years will be needed for potential water quality improvements to be realized so that DEQ can evaluate adequacy of the revised rules in meeting the load allocations and surrogate measures required by the Sandy River Subbasin Temperature~~

~~TMDL.~~The streamside vegetation retention and riparian management area distances in the current Forest Practices Act are summarized in

Table 7. There are multiple other requirements or exceptions found in the forest practice rules not included in the table.

Table 7: Summary of streamside vegetation retention riparian management area distances in Forest Practices Act rules OAR 629-643

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

***ODF Stream Type Definitions:**

SSBT—salmon, steelhead, or bull trout
F—fish-bearing (non-SSBT)
N—non-fish-bearing, non-domestic
Np—perennial, Type-N
Ns—seasonal, Type-N

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

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

For these reasons, ODF is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See
Table 10 for the schedule.

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

5.2.2 Oregon Department of Agriculture: ~~Adequacy~~adequacy of ~~Agricultural Water Quality Management~~agricultural water quality management programs in attaining TMDL load allocations and effective shade surrogate measures

The Agricultural Water Quality Management Program was established in 1993 under ORS 568.900 to 568.933, ORS 561.191 and OAR chapter 603, divisions 90 and 95. Subsequently, the Oregon Department of Agriculture led the development of 38 watershed-based Agricultural Water Quality Area ~~Rules~~rules and Area Plans intended to implement the rules, with the Sandy Subbasin rules and plan established in 2001. Despite implementation of the area rules and plans, including required biennial review and revision of the Area Plan and implementation of other voluntary agricultural initiatives, water quality impairments continue in the Sandy River Subbasin. DEQ's 2020 Water Quality Status and Trends Report shows a degrading trend for temperature in the Sandy Subbasin (more than half the monitoring locations where data were assessed).

Since 2001 and through the present, the Sandy Subbasin Agricultural Water Quality Area ~~Rules~~rules and Plan do not identify quantitative targets for effective shade in riparian areas based on site specific factors, including stream width or orientation (nor for bacteria reduction). DEQ letters during biennial reviews of the Area Plan in 2012, 2015, 2017, 2019 and 2021 identified protecting, maintaining and establishing riparian vegetation to provide water quality functions as the highest priority for the Sandy Subbasin. Although ODA was not identified in the

2005 TMDL as an entity responsible for implementing bacteria reductions, DEQ's letters recommended actions that ODA could take to assist landowners in achieving the TMDL bacteria reduction targets. DEQ's letters each recommended establishment of measurable objectives, milestones and timelines to achieve TMDL load allocations for effective shade and bacteria reduction.

DEQ concluded that current ~~Ag~~ODA WQ program Area Rules, combined with implementation of Area Plan voluntary measures, are not adequate in all locations to ~~provide~~meet the riparian vegetation requirements ~~and targets that are~~ necessary to ~~meet~~achieve TMDL effective shade targets, load allocations and temperature water quality criteria.

Therefore, ODA is required to develop a TMDL implementation plan for temperature to be submitted to DEQ for review and approval. DEQ encourages ODA to include management strategies with measurable objectives and timelines for bacteria reductions in the implementation plan. See

Table 10 for schedule.

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

~~Table 6 provides a summary of~~

Streamside vegetation on BLM managed lands in the Lower Columbia-Sandy Subbasin are currently managed based on BLM's Northwestern and Coastal Oregon Resources Management Plan (BLM, 2016).

BLM defines riparian ~~buffer~~management areas called 'riparian reserves' using-slope distance ~~for~~from the ordinary high-water line on each side of a stream. Slope distance is specific to different types of waterbodies~~. BLM calls these areas riparian reserves.~~ as summarized in Table 8. The slope distance or *riparian reserve distance* is defined based on ~~the~~ site-potential tree height. ~~The site~~Site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given ~~site~~site's class. BLM states that site-potential tree heights generally range from 140 feet to 240 feet, depending on site productivity. ~~Within the~~

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

Table 8. Summary of BLM riparian reserve buffer distance for different waterbody features

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

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

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

Table 10 for schedule.

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

Streamside vegetation on USFS lands in the ~~Lower Columbia-Sandy Subbasin are~~Willamette Subbasins currently managed based on Northwest Forest Plan (USFS and BLM, 1994). As part of the plan, the Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems, including salmon and steelhead habitat on federal lands managed by USFS. Maintaining and restoring water quality is one of the stated objectives of the Aquatic Conservation Strategy. These aquatic ecosystems and the streamside adjacent areas are called *riparian reserves.* ~~Many~~Like BLM, USFS defines many of the reserve distances ~~are defined based on the~~using site-potential tree height. The Northwest Forest Plan states a site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class~~.~~ and is consistent with the BLM definition. The following text is a description of the riparian buffer distance for different types of waterbodies. The text was extracted from USFS and BLM (1994), Attachment A, Standards and Guidelines, Section C, pages C-3- through C-31.

Fish-bearing streams *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.*

Permanently flowing nonfish-bearing streams *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.*

Constructed ponds and reservoirs, and wetlands greater than 1 acre *- Riparian Reserves consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.*

Lakes and natural ponds *- Riparian Reserves consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.*

Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas *- This category applies to features with high variability in size and site-specific characteristics. At a minimum, the Riparian Reserves must include:*

- *The extent of unstable and potentially unstable areas (including earthflows),*
- *The stream channel and extent to the top of the inner gorge,*

- *The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and*
- *Extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.*

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

For these reasons, USFS is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See
Table 10 for schedule.

5.3 Implementation plan requirements

As required in OAR 340-042-0080(4)(a~~)(A)-(E~~), implementation plans must include:

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

The following subsections provide detail on each component required by this WQMP that must be included in implementation plans. Some implementation requirements vary depending on the responsible person or DMA. DEQ will work with each entity required to develop a TMDL implementation plan to ensure that all required elements are included with sufficient detail for ~~the~~their plan to be approved on the schedule required in ~~Section 5.4. 5.3.1 Management strategies~~

Table 10.

TMDL implementation plans and annual reports must be posted to each DMA's website for public transparency. If a DMA does not have a website, these documents must be made available to the public in another manner.

is provided to help responsible persons, including DMAs determine the information and analyses they are responsible for submitting to DEQ.

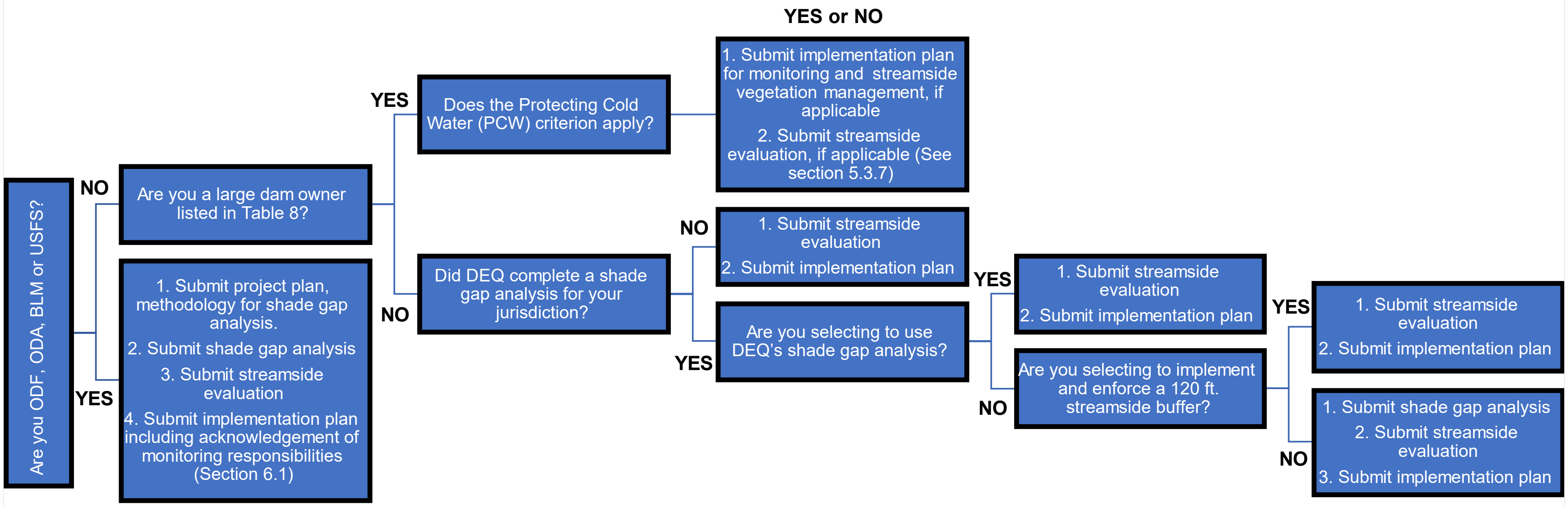


Figure 2: Decision support tree to help identify information and analyses requirements for different responsible persons and DMAs.

5.3.1 Management strategies

Each entity required to develop a TMDL implementation plan must include applicable priority management strategies from ~~Table 1~~Table 1 and/or other practices and actions appropriate for activities and landscape conditions specific to the entities' pollutant sources or source sectors. Implementation plans must identify all streamside areas or streamside activities within an entity's jurisdiction or responsibility.

5.3.2 Streamside ~~Evaluation~~evaluation

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

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

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

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

The streamside evaluation must be completed according to the timeline assigned in ~~Table 8.~~ Table 10. The streamside evaluation will be utilized during the five-year review (see Section 5.3.9.2) to help assess progress in meeting implementation timelines, milestones, and measurable goals in subsequent five-year implementation cycles.

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

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

5.3.4 Streamside ~~Shade Gap Analysis Requirements~~shade gap analysis

DEQ conducted a vegetation height and shade gap analysis within approximately 150-ft of specific modeled waterbodies in the Lower Columbia-Sandy Subbasin, as detailed in Section 9.1.4.3 of the TMDL ~~Rule. This~~rule. DEQ did not complete a shade gap analysis for the entire project area.

The shade gap analysis calculates the ~~shade gap~~difference between current (i.e. assessed) effective shade versus the target effective shade. Where DEQ calculated a shade gap analysis, DEQ averaged the percent shade gap across all waterbodies within a DMA's jurisdiction. DEQ will provide the site-specific shade ~~results upon request. Where DEQ was unable to conduct a shade gap analysis, DEQ developed general shade curves for specific vegetation types (Section 9.1.4.4 of the TMDL Rule); shade curves allow users to find target percent effective shade values for streams based on several stream characteristics. Unlike the shade gap analysis, shade curves do not calculate current effective shade.~~ gap results upon request.

5.3.4.1 Streamside ~~Shade Gap Analysis Methods~~shade gap analysis methods for ~~Responsible Persons~~responsible persons and DMAs

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

1. Measure current effective shade at the stream surface using monitoring equipment, such as the Solar Pathfinder™, or using a hemispherical camera system and imagery analysis software.
    a. Determine general vegetation type, canopy density, stream width and stream orientation.
    b. Compare current effective shade results to either target effective shade from DEQ's shade gap analysis, or to the target percent effective shade values derived from the shade curves in the TMDL to assess the percent effective shade gap.
    c. Entities choosing to use this methodology must submit their assessment strategy to DEQ for approval. Assessments should conform to guidelines outlined in OWEB's Addendum to Water Quality Monitoring Technical GuidebookGuide Book, Ch. 14: https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf (OWEB, 20001999)
2. Conduct modeling using the Heat Source model (as used in this TMDL).
3. Another method approved by DEQ through the TMDL implementation plan approval process.

A project plan which includes a description of the assessment methodology must be submitted to DEQ for review and approval according to the timeline assigned in Table 8.
Table 10. Method documentation for Solar Pathfinder™ can be accessed at https://www.solarpathfinder.com/pdf/pathfinder-manual.pdf and in OWEB's Addendum to Water Quality Monitoring Technical Guide Book, Ch. 14: https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf ..

5.3.4.2 Shade Gap Analysis Requirementsgap analysis requirements for ODF, ODA, BLM, and USFS

Together, the ODF, ODA, BLM, and USFS collectively have jurisdiction of more than 90 percent % of the land area within 150 feet of streams within the Lower Columbia-Sandy Subbasin project area. Increasing shade on streams within the extensive areas within their jurisdictions is important to achieving the surrogate shade measures of this TMDL. Therefore, ODF, ODA, BLM and USFS must complete a streamside evaluation (Section 5.3.2), as well as a shade assessment for streamside areas within their jurisdiction. The assessment must use location-specific methods as givendescribed in Section 5.3.4.1 for determining whether effective shade allocations along the temperature impaired Lower Columbia-Sandy/Subbasin assessment units are met. A shade assessment is not needed for those areas where DEQ has completed a shade gap analysis, or for those areas where DEQ has determined the management strategiesstreamside buffers are sufficient (SectionsSection 5.2.3). The shade gap analysis requirement includes intermittent streams as defined in the TMDL. For more information on intermittent streams and 5.which are included in temperature TMDLs see TSD Section 2.4).. A project plan which includes a description of the shade gap assessment methodology, including any methodology that proposes target effective shade values different from the shade curves developed by DEQ, must be submitted to DEQ for review and approval according to the timeline assigned in Table 8.
Table 10.

5.3.5 Target effective shade values and shade curves

Shade curves, which are charts that represent the mean effective shade target for different mapping units, stream aspects, and active channel widths (TMDL Section 9.1.4.4), were developed (Figures 9-2 – 9-9 in the TMDL rule) to allow users to find target percent effective shade values for streams based on several stream characteristics. Unlike the site-specific shade targets and shade gap analysis (TMDL Section 9.1.4.3), shade curves do not calculate current effective shade. Any responsible person including DMAs can use DEQ shade curves, site-specific shade targets, or other DEQ- approved method to assess and recommend an effective shade target for their jurisdiction.

TMDL implementation plans must include the mean effective shade targets calculated by DEQ, if available, (Table 9-10 in the TMDL rule document), or any updated effective shade target assessment approved or performed in the future.

5.3.6 Percent consumptive use

The TMDL ~~Rule~~rule includes a percent consumptive use surrogate measure, which can be used to ensure that water management and water withdrawal activities meet the portion of the human use allowance assigned to such uses in the TMDL. The percent consumptive use is the percent of natural surface flow that does not return to surface water after it has been withdrawn for a water use activity. The natural flow rate is based on the monthly median natural flow. As modeled for the Sandy River at the location of USGS gage 14142500~~,~~ (Sandy River below Bull Run), the TMDL indicates that a consumptive use flow rate reduction of 1.90% will maintain the human use allowance associated with water withdrawal activities. DEQ anticipates using the consumptive use surrogate measure when reviewing new applications for water rights in the Lower Columbia-Sandy Subbasin. Additional detail regarding this surrogate measure is included in Section 9.1.4.5 of the TMDL ~~Rule.~~ rule.

5.3.~~6~~7 TMDL implementation plan requirements for dam owners

DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations. This means that reservoir operations must not contribute any additional warming above the upstream temperatures entering the reservoir. Section 9.1.4.1 of the TMDL rule contains more information regarding dam and reservoir operations.

All dam and reservoir operators named in Table 9 must submit an implementation plan that addresses the monitoring and assessment requirements described in Section 5.3.7.1. If monitoring and assessment show that dam operations contribute additional warming above upstream temperatures entering the reservoir, then the operator can choose to either:

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

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

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

DEQ is not focusing implementation requirements on dams owned and operated by individuals or businesses~~, or those~~ (See Appendix A for the entire list of dams in the Lower Columbia-Sandy Subbasin project area). Additionally, DEQ is not requiring reservoir management plans for dams that are operated to manage seasonal flow to sustain ecological benefits associated with wetlands ~~or manage stormwater~~and marshes. DEQ encourages partnerships between DMAs and individual dam operators within their jurisdictions to evaluate ways in which these dams could be managed to reduce temperature impacts.

~~In most cases, large dam owners that are a public utility or a government agency are required to monitor and potentially develop TMDL implementation plans that include reservoir-specific management strategies to mitigate temperature increases that happen between the inflow and outlet of the dam. DMAs must identify specific measurable objectives with milestones and associated implementation timelines for implementing these strategies. The requirements in sections 5.3.2 and 5.3.4 also apply to those areas where dam owners have jurisdiction over the management of streamside vegetation. Table 7 includes a list of dams and dam owners that are responsible for developing a monitoring plan and may be required to develop a TMDL implementation plan. Appendix A includes the entire list of large dams in the Lower Columbia-Sandy Subbasin project area.~~

~~Table 7:~~

Table 9: Large dam owners responsible for monitoring and that may be required to submit an implementation plan that includes reservoir management strategies.

No.	Dam Name	Owner	Reservoir Storage (acre-ft)
1	Bull Run Lake Dam	City of Portland	~~14500~~14,500
2	Trillium Lake	Oregon Dept. of Fish and Wildlife	380
3	Wahkeena Rearing Reservoir	Oregon Dept. of Fish and Wildlife	180
4	Development No. 1 Dam	City of Portland	~~33760~~33,760
	~~Spillway Dam~~	~~City of Portland~~	~~25000~~
5	Development No. 2 Dam	City of Portland	~~25000~~25,000

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

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

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

Dam owners in ~~Table 7~~Table 9 will collect temperature data and potentially assess temperature dynamics associated with their dam and reservoir operations using a mechanistic model, empirical model, and/or analysis of continuous temperature data collected upstream, downstream, and in the reservoir. The assessment shall include:

1. ~~(1)~~ Collection of continuous temperature data to characterize reservoir inflow and outflow temperatures~~;~~. If multiple streams flow into the reservoir, 7DADM temperatures upstream of the reservoirs may be calculated as a flow weighted mean of temperatures from each inflowing tributary. The estimated free flowing (no dam) temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations.
    a. ~~(2)~~ Continuous temperature data must be collected for four consecutive years and must be collected during the critical period. Previously collected data can be used as long as it meets DEQ QA/QC protocols and collected within the last five years.

2. Reservoir temperature profiles to sufficiently characterize timing and extent of thermal stratification, and
~~(3) Collection~~
3. Measurement of reservoir water level fluctuations and outflow rates~~.~~

~~All~~Temperature data ~~collected from items 1-3 will~~must be submitted to DEQ ~~or available in an~~and uploaded to the Ambient Water Quality Monitoring System, or through another online publicly accessible database~~.~~ approved by DEQ. These data will ~~establish~~be used for the following purposes:

1. establishing baseline conditions ~~for use in~~ ,
2. adaptive management, and ~~will inform evaluations~~
3. evaluation of site-specific approaches to reduce temperature impacts.

DEQ recommends dam owners develop a mechanistic or empirical model ~~allowing prediction or comparison of~~to predict and compare inflow ~~temperature to~~ and outflow temperatures. This model will ~~provide invaluable information on~~be used to develop effective management strategies to reduce temperature.

For reservoirs on reaches where DEQ has determined ~~Responsible persons, including DMAs may also be required to submit a TMDL implementation plan that includes specific measurable objectives with milestones and an associated implementation timeline for implementing best management practices~~ that ~~address any altered~~the protecting cold water criterion does not apply, operators are required to select one of the two following options. The first option is to ensure that discharges meet the temperature ~~regimes observed~~target surrogate measure (TMDL rule Section 9.1.4.1). The second option is to prepare a cumulative effects analysis to demonstrate that water releases that periodically exceed the ambient temperature criteria would not contribute to cumulative warming above water quality standards at downstream from reservoirs. locations. Reservoir operators who choose this second option will be required to submit a QAPP to DEQ for review and approval. Required elements of the QAPP include descriptions of the dataset and cumulative effects approach that will be used to assess downstream temperature impacts.

5.3.7.2 Protecting cold water criterion

The "protecting cold water" criterion in OAR 340-041-0028(11) applies to waters of the state that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based criteria. With some exceptions, these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the colder water ambient temperature. Reservoir operators on reaches where protecting cold water apply must meet the cold--water criterion and do not have. DEQ's current assessment shows that the option to conduct modelling; see the TMDL Rule Section 9.1.4.1 for additional information.protecting cold water criterion does not likely apply at this time to any dams and reservoirs in the Lower Columbia-Sandy project area. Application of this criterion could change due to updated assessments in the future. Additional information on protecting cold water iscan be found in the TSDTMDL rule Section 9.1.4.1.

For reservoirs on reaches where DEQ has determined protecting cold water does not apply, operators are required either to ensure that discharges meet the temperature target surrogate measure (TMDL Rule Section 9.1.4.1) or complete a DEQ approved cumulative effects analysis to demonstrate that releases of temperatures that exceed the biologically based numeric criteria during some periods would not contribute to cumulative warming above water quality standards at downstream locations. Reservoir operators who choose to complete a cumulative effects analysis to demonstrate that their releases would not contribute to cumulative warming above water quality standards will be required to submit a QAPP to DEQ for review and approval that outlines which dataset and cumulative effects approach will be used to assess impacts of their releases.

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

5.3.67.2 City of Portland

The TMDL Rulerule includes a stream temperature surrogate measure for use by the Citycity of Portland to implement the load allocation for dam and reservoir operations for the Bull Run project. Additional detail regarding this surrogate measure is included in Section 9.1.4.2 of the TMDL Rulerule.

5.3.78 Timeline and schedule

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

Timelines and milestone schedules should be informed by the streamside evaluation, as described in Section 5.3.2 above, and should consider all relevant factors of an entity's specific situation. ~~Identification of management strategy~~The due dates and timelines for specific information and analyses discussed in Sections 5.3.2 and 5.3.4 are shown in
Table 10 below. DMA timelines in TMDL implementation ~~timelines~~plans that differ from ~~those estimated by DEQ to be effective in achieving load allocations must include an explanation of why the revised timelines are reasonable and how the~~ timelines ~~will be met.~~stated below must be approved by DEQ.

Table ~~8:~~10: Due dates for implementation plans and analyses. See sections 5.3.1 through 5.3.7 for more details.

Requirement	Due Date / Timeframe
TMDL implementation plan	18 months after EQC adoption of Willamette Mainstem TMDL*
Streamside Evaluation (Section 5.3.2)	~~18 months~~Three years after EQC adoption of Willamette Mainstem TMDL
Project plan and description of the assessment methodology to be used to complete a shade gap analysis (Section 5.3.4)	18 months after EQC adoption of Willamette Mainstem TMDL
Streamside shade gap analysis (Section 5.3.4) and updated streamside evaluation OR 120 ft. streamside buffer that establishes and protects overstory, woody vegetation (Section 5.3.3)	Four years after implementation plan submission deadline
Reservoir operators named in Table ~~7~~8 (Sec. 5.3.~~6)~~7): Quality Assurance Project Plan for temperature monitoring for each reservoir	~~Submit a Quality Assurance Project Plan for temperature monitoring for each reservoir~~ 18 months after EQC adoption of Willamette Mainstem TMDL. Following the temperature assessment, the DMA will consult with DEQ on a timeframe for submitting a cumulative effects analysis, or TMDL implementation plan as needed. Some reservoir operators must also submit a streamside evaluation and implementation plan for streamside management. See section 5.3.2 for details.
ODA, ODF, USFS, BLM: Quality Assurance Project Plans or project-specific Sampling and Analysis Plans for temperature (Sec. 6.1)	As directed by DEQ following development of a Willamette Basin wide monitoring strategy

Requirement	Due Date / Timeframe
* The Willamette Mainstem TMDL is a separate temperature TMDL to be developed and approved following the Lower Columbia-Sandy Subbasin TMDL.	

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

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

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

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

Oregon Watershed Restoration Inventory Reporting Requirement

Projects that implement temperature related practices listed in OWEB's OWRI Online List of Treatments must be reported once by DMAs to the OWRI database (OWEB, 2023~~, OWEB~~ and 2023a) upon project completion. DEQ utilizes OWRI's database to track implementation activities for various reporting requirements. Responsible persons, including DMAs, must also include implementation activities in annual reports to DEQ to document progress and track implementation actions over time.

~~DEQ will also consider reporting on~~Documenting restoration activities ~~to~~in other publicly accessible databases is allowable when approved by DEQ~~ during the TMDL implementation phase~~.

Adaptive Management

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

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

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

5.3.~~9 Implementation public~~10 Public involvement

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

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

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

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

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

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

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

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

There are multiple sources of local, state and federal funds available for implementation of pollutant management strategies and control practices. ~~Table 9~~Table 11 provides a partial list of financial incentives, technical assistance programs, grant funding, and low interest loans for public entities available in Oregon that may be used to support implementation of assessment, pollution controls, and watershed restoration actions or land condition improvements that improve water quality in the Lower Columbia-Sandy Subbasin. Soil and water conservation districts and watershed councils are additional resources that may support responsible persons and DMAs in implementation of pollutant management strategies and control practices through the programs listed in ~~Table 9.~~Table 11.

Table ~~9:~~11: Partial list of funding programs available in the Lower Columbia-Sandy Subbasin

Program	General Description	Contact
Clean Water State Revolving Fund	Loan program for below-market rate loans for planning, design, and construction of various water pollution control activities.	DEQ
Conservation Reserve Enhancement Program (CREP)	Provides annual rent to landowners who enroll agricultural lands along streams. Also cost-shares conservation practices such as riparian tree planting, livestock watering facilities, and riparian fencing.	NRCS
Conservation Reserve Program (CRP)	Competitive CRP provides annual rent to landowners who enroll highly erodible lands. Continuous CRP provides annual rent to landowners who enroll agricultural lands along seasonal or perennial streams. Also cost-shares conservation practices such as riparian plantings.	NRCS
Conservation Stewardship Program (CSP)	Provides cost-share and incentive payments to landowners who have attained a certain level of stewardship and are willing to implement additional conservation practices.	NRCS
Drinking Water Source Protection Fund	These funds allow states to provide loans for certain source water assessment implementation activities, including source water protection land acquisition and other types of incentive-based source water quality protection measures.	Oregon Health Authority
Emergency Watershed Protection Program (EWP)	Available through the USDA-Natural Resources Conservation Service. Provides federal funds for emergency protection measures to safeguard lives and property from floods and the products of erosion created by natural disasters that cause a sudden impairment to a watershed.	NRCS
Emergency Forest Restoration Program (EFRP)	Available through the USDA-Natural Resources Conservation Service. Helps owners of non-industrial private forests restore forest health damaged by natural disasters.	USDA
Oregon 319 Nonpoint Source Implementation Grants	Fund projects that reduce nonpoint source pollution, improve watershed functions and protect the quality of surface and groundwater, including restoration and education projects.	DEQ
Environmental Quality Incentives Program (EQIP).	Cost-shares water quality and wildlife habitat improvement activities, including conservation tillage, nutrient and manure management, fish habitat improvements, and riparian plantings.	NRCS
Agriculture Water Quality Support Grant	Provides capacity to support voluntary agricultural water quality work in small watersheds and to meet the goals of the Agricultural Water Quality Management Area Plans and the SIA initiative.	ODA

Program	General Description	Contact
Agricultural Conservation Easement Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.	NRCS
Farm and Ranchland Protection Program (FRPP)	Cost-shares purchases of agricultural conservation easements to protect agricultural land from development.	NRCS, SWCDs, ODF
Federal Reforestation Tax Credit	Provides federal tax credit as incentive to plant trees.	Internal Revenue Service
Grassland Reserve Program (GRP)	Provides incentives to landowners to protect and restore pastureland, rangeland, and certain other grasslands.	NRCS
Landowner Incentive Program (LIP)	Provides funds to enhance existing incentive programs for fish and wildlife habitat improvements.	U.S. Fish and Wildlife Service
Oregon Watershed Enhancement Board (OWEB)	Provides grants for a variety of restoration, assessment, monitoring, and education projects, as well as watershed council staff support. 25 percent local match requirement on all grants.	OWEB
Oregon Watershed Enhancement Board Small Grant Program	Provides grants up to $10,000 for priority watershed enhancement projects identified by local focus group.	OWEB
Partners for Wildlife Program	Provides financial and technical assistance to private and non-federal landowners to restore and improve wetlands, riparian areas, and upland habitats in partnership with the U.S. Fish and Wildlife Service and other cooperating groups.	U.S. Fish and Wildlife Service
Public Law 566 Watershed Program	Program available to state agencies and other eligible organizations for planning and implementing watershed improvement and management projects. Projects should reduce erosion, siltation, and flooding; provide for agricultural water management; or improve fish and wildlife resources.	NRCS, SWCDs
Resource Conservation & Development (RC & D) Grants	Provides assistance to organizations within RC & D areas in accessing and managing grants.	Resource Conservation and Development
ODF Small Forestland Investment in Stream Habitat (SFISH) Grants	Provides funding for Small Forestland Owners (SFO's) to improve road conditions and stream crossings as part of forest operations.	ODF
State Forestation Tax Credit	Provides for reforestation of under-productive forestland not covered under the Oregon Forest Practices Act. Situations include brush and pasture conversions, fire damage areas, and insect and disease areas.	ODF
Forest Stewardship Program	Provides cost share dollars through USFS funds to family forest landowners to have management plans developed.	ODF
Western Bark Beetle Mitigation	ODF administers a cost share program for forest management practices pertaining to bark beetle mitigation for forest health and is funded through the USFS.	ODF
State Tax Credit for Fish Habitat Improvements	Provides tax credit for part of the costs of voluntary fish habitat improvements and required fish screening devices.	ODFW

Program	General Description	Contact
Wetlands Reserve Program (WRP)	Provides cost-sharing to landowners who restore wetlands on agricultural lands.	NRCS
Wildlife Habitat Tax Deferral Program	Maintains farm or forestry deferral for landowners who develop a wildlife management plan with the approval of the Oregon Department of Fish and Wildlife.	ODFW
Funding Resources for Watershed Protection and Restoration	EPA's Funding Resources for Watershed Protection and Restoration (EPA, 2023) contains links to multiple funding sources	Various

5.4 Schedule for implementation plan submittal

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

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

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

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

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

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

6. Monitoring and ~~evaluation~~Evaluation of ~~progress~~Progress

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

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

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

All responsible persons, including DMAs, are responsible for tracking the implementation and effectiveness of their actions and meeting milestones where established. ~~Progress in implementing~~The streamside ~~actions prioritized~~evaluation (section 5.3.2) will provide a baseline for DMA implementation plans against which DMA progress will be assessed. DEQ acknowledges that it will take decades for restored streamside areas to provide mature, overstory woody vegetation that shades streams, so DEQ will rely on tracking implementation compliance through DEQ approved implementation plans, annual reports, and comprehensive year five reviews (section 5.3.9) in the ~~prioritization framework,~~coming years.

DEQ effective shade targets are regulatory and can be used to assess implementation progress in the future. In areas where stream temperature criteria are not met, DEQ will assess the status of current conditions and effective shade targets as ~~well as~~ part of the adaptive management process. DEQ will also evaluate other restoration efforts that have been implemented to improve stream temperature~~ (e.g.~~, for example channel morphology and stream flow restoration, protection and enhancement of cold~~-~~-water refuges, etc~~.) will form the basis against which implementation progress will be assessed. Although DEQ encourages responsible persons, including DMAs, to conduct physical, chemical or biological monitoring to better evaluate how implementation actions may impact water quality conditions, DEQ is only requiring the DMAs listed under section 6.1~~. In cases where DEQ determines implementation actions are not making sufficient progress, DEQ will rely on the adaptive management process and our enforcement authority to ~~conduct water column monitoring associated~~assess compliance with ~~this TMDL.~~the load allocations.

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

6.1 Persons responsible for monitoring

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

DEQ is requiring USFS, BLM, ODF, and ODA to undertake monitoring actions in areas within their jurisdiction or ownership to help determine the status of instream water quality and landscape conditions associated with water quality. Combined, the USFS, BLM, ODF, and ODA have jurisdiction over more than 90% of the streamside areas within the Lower Columbia-Sandy Subbasin. For this reason, DEQ considers it appropriate for these agencies to collaborate with DEQ on the Monitoring Strategy. The city of Portland (Portland Water Bureau) has specific monitoring requirements related to reservoir management of the Bull Run project (see below). DEQ encourages and invites other DMAs~~, including those~~ to collaborate with DEQ on collecting water quality data, especially DMAs that ~~collect~~have been collecting temperature data as part of TMDL implementation or other related programs~~, to collaborate with DEQ on collecting water quality data~~.

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

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

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

Environmental media and water column monitoring activities conducted by ODA, ODF, BLM, USFS, or other DMAs to meet TMDL objectives, data collection and management must be performed in adherence to Quality Control procedures and Quality Assurance protocols established by DEQ, U.S. EPA, or other appropriate organizations. This requirement will be met through developing or adapting Quality Assurance Project Plans and/or project-specific

Sampling and Analysis Plans~~,~~ and submitting the plans to DEQ for review and approval based on a schedule determined by DEQ once development of the Monitoring Strategy has been initiated. USFS, BLM, ODF, ODA, or other DMAs can also agree to participate in a collaborative monitoring plan under an umbrella QAPP. DEQ staff will coordinate QAPP development with USFS, BLM, ODF, and ODA upon request in advance of submission. Resources for developing QAPPs and sampling and analysis plans are available on DEQ's water quality monitoring website (DEQ, 2023).

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

~~The~~Specific City of Portland (Portland Water Bureau) Monitoring Requirements

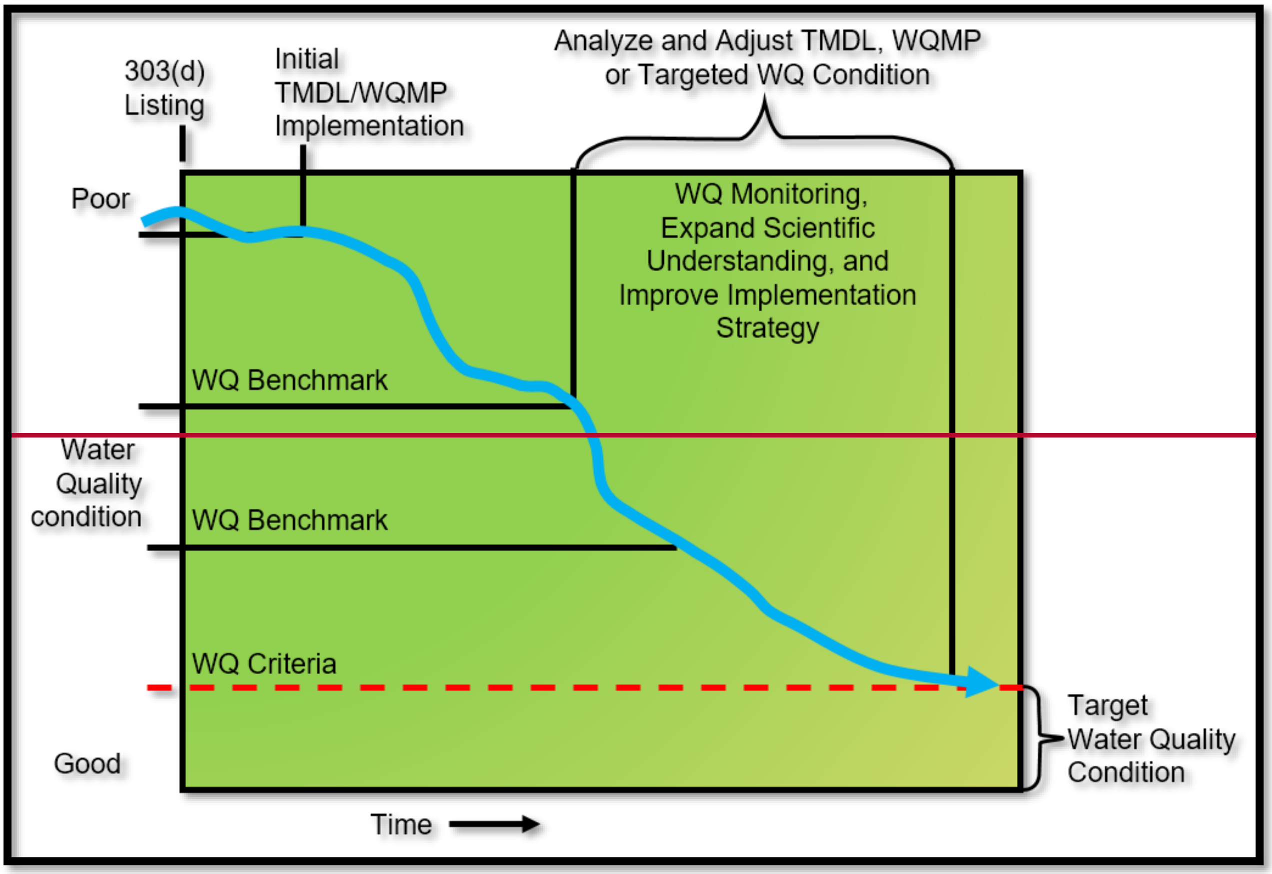
The city of Portland is responsible for reservoir management of the Bull Run project~~,~~ and manages flow releases to meet temperature standards. ~~Implementation~~To implement and ~~assessment of~~assess the temperature surrogate measure in TMDL Section 9.1.4.2, DEQ requires ~~collection of~~the city to collect stream temperature and discharge data~~. DEQ requires the City of Portland to establish~~ to:

1. Establish a continuous temperature monitoring site at the lamprey barrier downstream of Bull Run reservoir #2~~, maintain~~.
2. Maintain a continuous discharge and temperature monitoring site at the location of USGS gage 14141500 if that gage is discontinued or until DEQ approves an alternative approach to calculate the free flowing no dam temperatures~~,~~.
3. Use the USGS defined QA/QC protocol for their gages or develop a monitoring QAPP for DEQ's approval~~, and make the~~ .
4. Submit data to DEQ through the Ambient Water Quality Monitoring System, or to another publicly ~~available or be submitted annually to DEQ.~~accessible database approved by DEQ.

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

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

Adaptive management is a process that acknowledges and incorporates improved technologies and practices over to refine implementation. A conceptual representation of the TMDL adaptive management process is presented in ~~Figure 3.~~Figure 3.



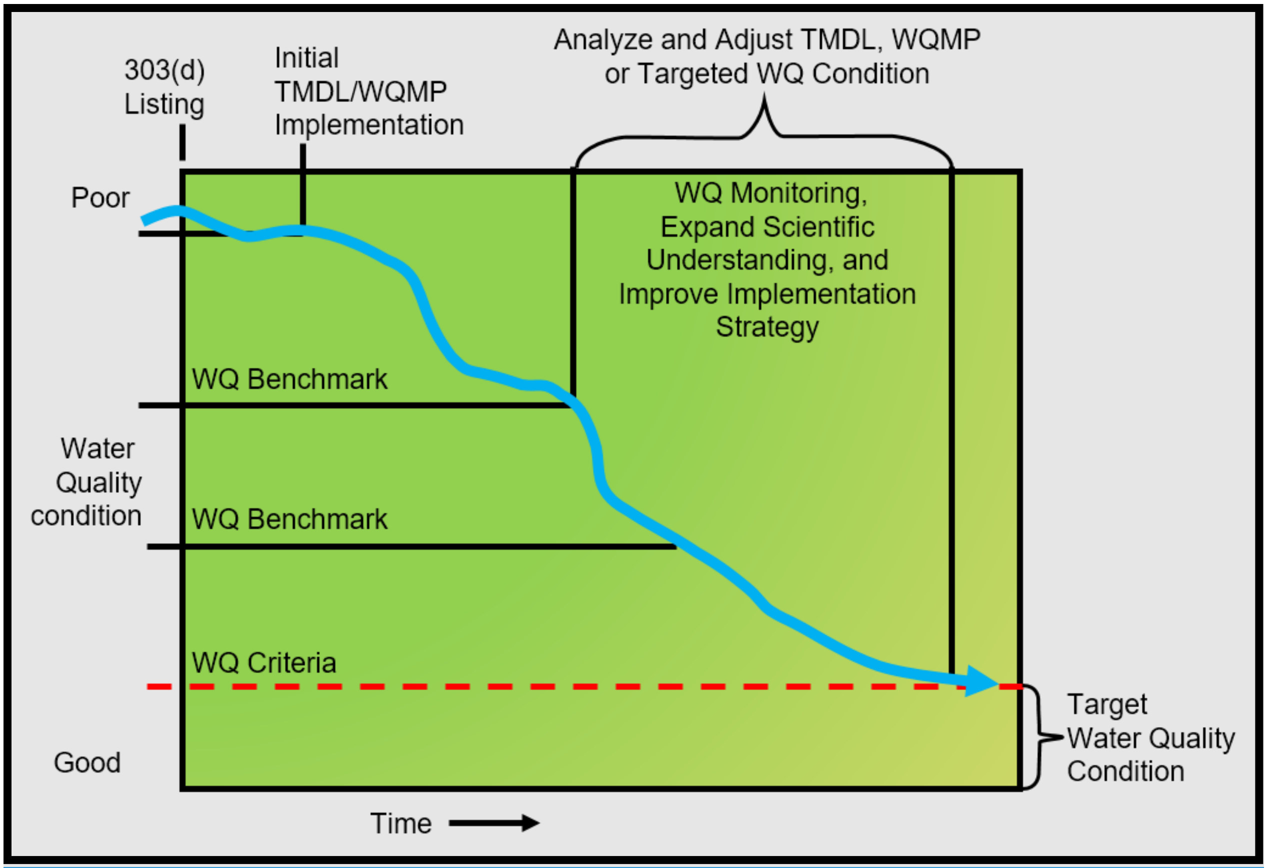


Figure 3: Conceptual representation of adaptive management

DEQ considers entities complying with DEQ-approved TMDL implementation plans to be in compliance with the requirements in the TMDLs. The ~~information generated by each of the entities compiling~~ annual reports and ~~gathering data~~Year Five Reviews submitted to DEQ by each of the responsible persons, including DMAs, in the Lower Columbia-Sandy Subbasin will be evaluated individually and collectively. DEQ will use this information to determine whether management actions are supporting progress towards TMDL objectives, or if changes in management actions and/or TMDLs are needed.

DEQ will review annual reports, participate with ~~DMAs and other~~ responsible persons, including DMAs, in review of monitoring information, and participate in implementing the Lower Columbia-Sandy Subbasin Monitoring Strategy.

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

- ~~Where~~DEQ will require responsible persons including DMAs to revise their implementation plans to address deficiencies where DEQ determines that implementation plans, or effectiveness of management strategies are inadequate~~, DEQ will require DMAs and responsible persons to revise the components of their implementation plans to address these deficiencies~~.
- ~~Where progress toward meeting Monitoring Strategy objectives is not being made,~~ DEQ and partners will revise sampling and analysis plans or other aspects of the Monitoring Strategy where progress toward meeting Monitoring Strategy objectives is not being made.

- ~~If~~DEQ will consider TMDL revisions if DEQ's evaluation of water monitoring data and supporting information indicate that the TMDL load allocations for a given pollutant-impairment ~~combination~~ are insufficient to meet state numeric criteria or narrative criteria, or insufficient to protect the designated beneficial uses~~, DEQ will consider TMDL revisions.~~ .
- ~~Per OAR 340-042-0040(7),~~ DEQ will follow all public participation requirements, including convening a local technical or rulemaking advisory committee to provide input on TMDL revisions~~.~~ per OAR 340-042-0040(7).

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

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

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

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

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

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

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

The Lower Columbia-Sandy Subbasin TMDLs were developed to address both point and nonpoint sources with load reduction allocations proportional to estimated source contributions and in consideration of opportunities for effective measures to reduce those contributions. There are several elements that combine to provide the reasonable assurance to meet federal and state requirements, including for antidegradation. Education, outreach, technical and financial assistance, permit administration, permit enforcement, responsible person’s implementation and DEQ enforcement of TMDL implementation plans will all be used to ensure that the goals of this TMDL are met.

7.1 Accountability ~~Framework~~framework

Reasonable assurance that needed load reductions will be achieved for nonpoint sources is based primarily on an accountability framework incorporated into the WQMP, together with the implementation plans of persons responsible for implementation. This approach is similar to the accountability framework adopted by EPA for the Chesapeake Bay TMDL, which was adopted in 2010 (EPA, 2010). ~~Figure 4~~Figure 4 presents the accountability framework elements, which are intended to work in concert to demonstrate reasonable assurance of implementation.

Figure 4: Representation of the ~~Reasonable Assurance Accountability Framework Led~~reasonable assurance accountability framework led by DEQ

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

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

The persons, including Designated Management Agencies, responsible for implementation of pollutant reduction strategies are identified in Section 5. General timelines~~ for implementing management strategies and attaining the relevant water quality criteria are provided in Sections 3 and 4.2, respectively. More specific timelines~~, milestones and measurable objectives will be specified in each required implementation plan. Attaining the relevant water quality criteria are provided in Sections 3 and 4.2, respectively. These elements support timely action by both DEQ and other entities responsible for implementation so that enforcement and adaptive management actions can be triggered and evaluation of attainment of TMDL goals occurs.

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

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

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

7.2 Reasonable ~~Assurance Conclusions~~assurance conclusions

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

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

The rationale described in this document stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. In addition, DMAs and other groups have been continuing to implement on-the-ground actions since the establishment of the 2005 Sandy River Basin TMDL. Together this approach provides reasonable assurance to meet state and federal requirements, including for antidegradation, and attain the goals of the TMDL.

8. Legal Authorities

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

Clean Water Act, Section 303(d)

The DEQ is the Oregon state agency responsible for implementing the Clean Water Act in Oregon. The EPA delegates many Clean Water Act authorities to the State of Oregon which is administered by the Oregon Environmental Quality Commission through Oregon Revised Statute. Section 303(d) of the 1972 Federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. These waters are referred to as "water quality limited." Water quality limited waterbodies must be identified by the EPA or by a state agency which has been delegated this responsibility by EPA. In Oregon, the responsibility to delegate water quality limited waterbodies rests with DEQ and DEQ's list of water quality limited waters is updated every two years. The list is referred to as the 303(d) list. Section 303 of the Clean Water Act further requires that TMDLs be developed for all waters on the 303(d) list. The Oregon Environmental Quality Commission granted the DEQ Director authority to develop TMDLs and issue them as orders (OAR 340-042-0060). DEQ was granted authority by the commission to implement TMDLs through OAR 340-042 with special provisions for agricultural lands and nonfederal forestland as governed by the Agriculture Water Quality Management Act and the Forest Practices Act, respectively. The EPA has the authority under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must issue a TMDL within 30 days. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A WQMP is developed to describe a strategy for reducing water pollution to the level of the load allocations and waste load allocations prescribed in the TMDL, which is designed to restore the water quality and result in compliance with the water quality standards. In this way, the designated beneficial uses of the water will be protected for all citizens.

Endangered Species Act, Section 6

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

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

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

Oregon Revised Statute Chapter 468B

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

ORS 468B.020 Prevention of pollution

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

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

   a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and

b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

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

NPDES and WPCF Permits

DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the NPDES permits for waste discharge into waters of the United States; and Water Pollution Control Facilities permits for waste disposal on land. The NPDES permit is also a federal permit and is required under the Clean Water Act. The WPCF permit is a state program.

401 Water Quality Certification

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

USACE Dam Operation and Management

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

Oregon Forest Practices Act

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

Agricultural Water Quality Management Act

The Oregon Department of Agriculture is responsible for the prevention and control of water pollution from agricultural activities as directed and authorized through the Agricultural Water Quality Management Act, adopted by the Oregon legislature in 1993 (ORS 568.900 to ORS 568.933). It is the lead state agency for regulating agriculture for water quality (ORS 561.191). The Agricultural Water Quality Management Plan Act directs the ODA to work with local communities to develop water quality management plans for specific watersheds that have been identified as violating water quality standards and have agriculture water pollution contributions. The agriculture water quality management plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct the problems. Water Quality area rules for areas within the Sandy Basin include OAR 603-095-1300 to 1380.

Local Ordinances

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

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Appendix ~~A:~~A: List of Large Reservoirs in the Lower Columbia-Sandy Subbasin TMDL Project Area

DEQ compiled this list of dams from the U.S. Army Corps of Engineers National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department (OWRD), dam safety program. DEQ requires the dams in bold to conduct monitoring related to temperature. Depending on analytical or modeling results, reservoir owners or operators may be required to develop a TMDL plan for temperature.

No.	Reservoir Name	NID ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
1	Mt. Hood Community College Dam	OR02466	Mt. Hood Community College	Local Government	Irrigation	25
2	Kelly Creek Regional Detention Pond	OR03793	City of Gresham	Public Utility; Local Government	Irrigation	67
3	Bull Run Lake Dam	OR00300	City of Portland	Local Government	Water Supply	~~14500~~14,500
4	Belchers Dam	OR00726	Darrold Belcher/Dan Belcher	Private	Irrigation	30
5	Osburn Reservoir	OR00436	Tom Lehman	Private	Recreation	52
6	Trillium Lake	OR00350	Oregon Dept. of Fish and Wildlife	State	Recreation	380
7	Wahkeena Rearing Reservoir	OR00362	Oregon Dept. of Fish and Wildlife	State	Other	180
8	Diack Reservoir	OR01543	Samuel L. Diack	Private	Irrigation	20
9	Sester, William H. Reservoir 1	OR00450	William H. Sester	Private	Irrigation	55
10	Development No. 1 Dam	OR00327	City of Portland	Local Government	Water Supply	~~33760~~33,760
~~**Spillway Dam**~~		~~OR00317~~	~~City of Portland~~	~~Local Government~~	~~Water Supply~~	~~25000~~
11	Development No. 2 Dam	OR00317	City of Portland	Local Government	Water Supply	~~25000~~25,000