Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document

Appendix L: DEQ McKenzie River Model Scenario Report

Amended, May 2025

State of Oregon
DEQ Department of Environmental Quality

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Table of contents

List of tables

List of figures

1 Introduction

This appendix describes derivation and modeling of thermal wasteload allocations (WLAs), current condition modeling, restored vegetation modeling, and attainment scenario modeling. WLAs described are for the three point sources with individual NPDES permits that discharge to reaches downstream from Cougar Reservoir that are modeled using the CE-QUAL-W2 model of the McKenzie River. These point sources are Oregon Department of Fish and Wildlife (ODFW) Leaburg Hatchery, ODFW McKenzie River Hatchery, and IP Springfield Paper Mill (**Figure 1-1** from Tetra Tech McKenzie River CE-QUAL-W2 Model Scenario Report - January 2024). Two other point sources were included in the WLA model: U.S Army Corp of Engineers Cougar project and the Eugene Water and Electric Board (EWEB) Hayden Bridge Filter Plant.

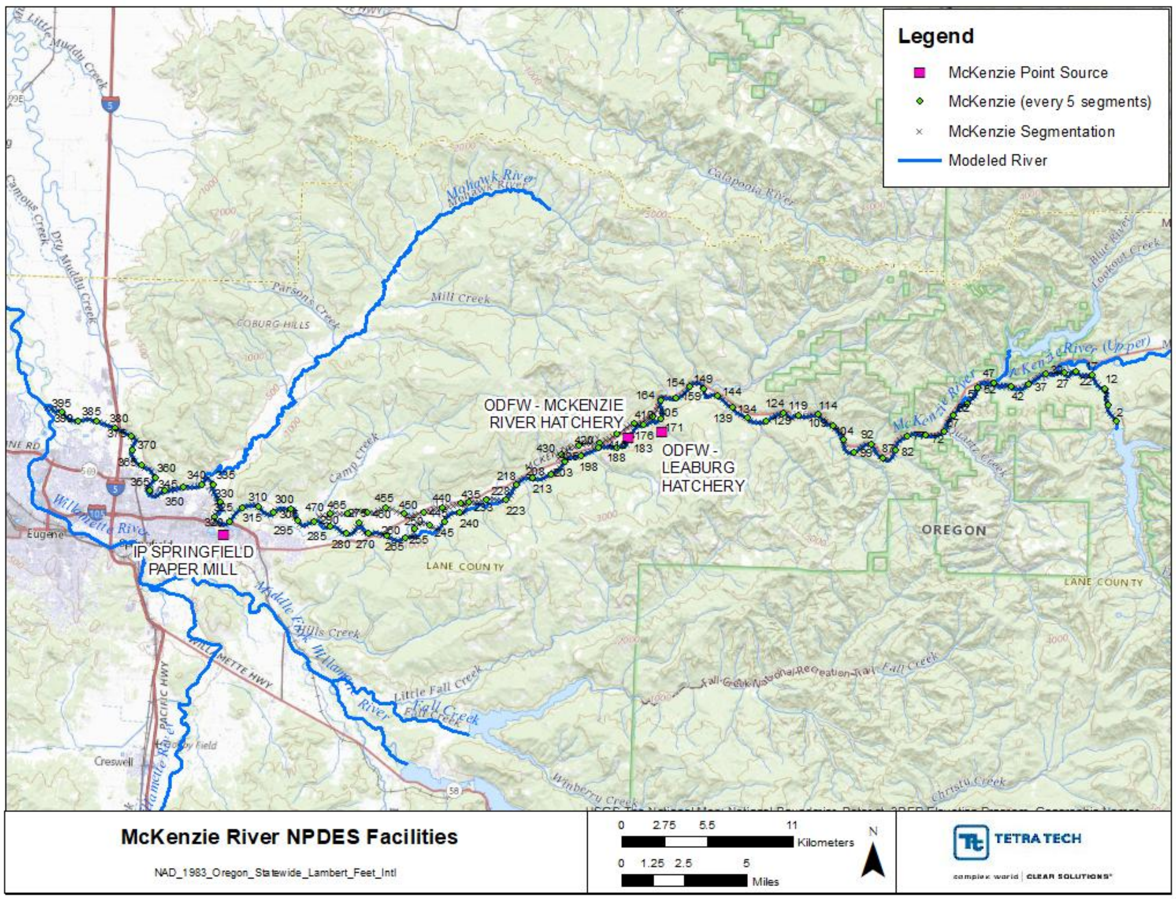

Figure 1-1: McKenzie River point sources modeled with CE-QUAL-W2 model.

The McKenzie CE-QUAL-W2 model was developed by Portland State University at the direction of Oregon Department of Environmental Quality (DEQ) as one of nine models that comprise Willamette Mainstem CE-QUAL-W2 models used to derive 2006 Willamette TMDLs. The model was calibrated for 2001 and 2002 model years by Portland State University (Berger et al., 2004). Funding for model development was provided by the U.S. Army Corps of Engineers (USACE). McKenzie River data collected for model calibration for 2001 and 2002 included data collected by EWEB, USACE, U.S. Geological Survey (USGS), Northwest Pulp and Paper Association, and DEQ. The model was updated to CE-QUAL-W2 version 4.2 by the USGS and

USACE and calibrated for several model years, including 2015 (Stratton Garvin et al., 2022). 2015 is the lowest flow year of the years for which the model was calibrated by USGS and is being used by DEQ to evaluate impacts of proposed WLAs. Modeling of impacts of the point sources based on 2015 conditions was performed by Tetra Tech and U.S. Environmental Protection Agency (USEPA) (Tetra Tech, 2024). The model was subsequently used by DEQ to model potential WLAs, as described below. Resultant WLAs for the point sources are shown in **Table 3-1**.

2 Modeling of current point source impacts

Model calculated maximum "current" temperature impacts (ΔTs) of the hatcheries as well as IP Springfield for the critical low-flow year of 2015 are shown in **Figure 2-1**. ΔTs are based on model calculated 7-day average daily maximum (7DADM) temperatures for a scenario with point sources present minus 7DADM temperatures for a scenario with no point sources. When comparing the hourly results from two model scenarios to determine temperature changes, differences between 7DADM temperatures (ΔTs) are only derived for days that exceed temperature criteria (16.0ºC during summer and 13.0ºC during spawning periods). The modeling is described in a technical memo (Tetra Tech, 2023).

The modeling indicates that current impacts do not exceed 0.15ºC. Note that modeling described below of cumulative wasteload allocation impacts indicate that, if all facilities utilize their entire WLAs during critical low-flow periods, impacts will be as much as 0.21ºC. However, the modeling performed for 2015 conditions indicates that actual impacts will be less.

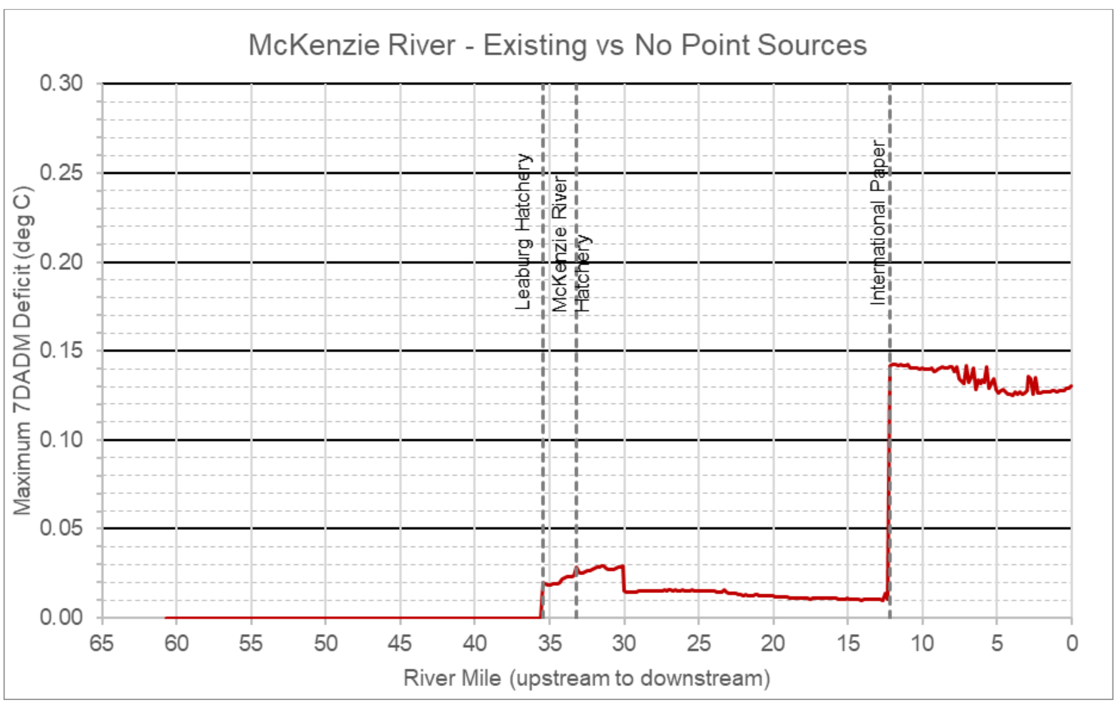

Figure 2-1: Maximum model calculated point source impacts for 2015 model year.

Flow and water temperature data were not available for the 2015 model year for Leaburg and McKenzie River hatcheries. For the 2015 existing conditions scenario, the hatcheries were configured using continuous (half-hourly) river and discharge temperatures for 2016 that were provided by ODFW.

Effluent flow model inputs for the hatcheries were set to 2016 95th percentile 7-day average effluent flow rates for spring spawning, summer non-spawning, and fall spawning periods. 95th percentiles are very similar to maximum values.

Effluent water temperature model inputs for the hatcheries were based on temperature deltas (T_{eff}-T_{inf}) derived using 2016 continuous effluent and influent hatchery temperatures, plus the hourly model calculated water temperature from the model segment upstream of where the hatchery discharges. Influent temperatures were assumed to equal river temperatures measured upstream from where water is diverted. Temperature deltas (T_{eff}-T_{inf}) were derived using 7DADM influent and effluent temperatures for each day. Upper 95th percentile deltas were then derived for both hatcheries for each of three periods: spring spawning (through June 15), summer non-spawning (June 16 – August 31), and fall spawning (starting September 1). Use of upper 95th percentiles is designed to ensure that the modeling accounts for the full temperature impacts of the hatcheries, while avoiding outliers associated with selecting maximum values.

For Leaburg Hatchery, since it has three outfalls, flow weighted averages were derived. For McKenzie River Hatchery, averaging was not needed since it only has one outfall. T_{eff}-T_{inf} temperature deltas as well as 95th percentile effluent flow rates for Leaburg Hatchery are shown in **Table 2-1** and for McKenzie River Hatchery in **Table 2-2**.

Table 2-1: Leaburg Hatchery effluent flows and temperature deltas via 2016 data.

Time Period	95th Percentile Total Effluent Flow (cfs)	Flow Weighted Average of 95th Percentile T_{eff}-T_{inf} (°C)
June 1-15	74.0	0.12
July	43.0	0.24
August	85.9	0.24
September 1-30	88.0	0.21

Table 2-2: McKenzie River Hatchery effluent flows and temperature deltas via 2016 data.

Time Period	95th Percentile Effluent Flow (cfs)	95th Percentile T_{eff}-T_{inf} (°C)
June 1-15	53.8	0.240
July	52.3	0.087
August	NA	NA
September 1-30	51.5	0.083

An initial modeling simulation was run to extract the hourly temperature from the model segment upstream of where the hatchery discharges. T_{eff}-T_{inf} deltas shown in **Table 2-1** and **Table 2-2** were then added to upstream model segment temperatures to create hatchery water temperature time-series input files.

Model calculated point source impacts shown in **Figure 2-1** do not include the impact of the EWEB Trail Bridge Powerhouse (NPDES permit file number 28393, Outfall 002). Heat Source modeling indicates that a WLA for this discharge that corresponds to a temperature impact (ΔT) of 0.03°C will have up to 0.015°C of impact in the McKenzie River near at its confluence with the South Fork McKenzie River near USGS gage 14159110 (McKenzie River above South Fork, Near Rainbow). The McKenzie River CE-QUAL-W2 model indicates that this impact will decrease to less than 0.01°C at Leaburg Dam. The results presented also do not include the impacts of any facilities covered by general permits. Up to 0.01°C of the human use allowance (HUA) is allocated to facilities covered by general permits.

Note that the T_{eff}-T_{inf} temperature deltas are small and could be significantly impacted by accuracy of temperature probes. In addition, T_{eff}-T_{inf} values are from only one year. Values based on data from other years with different flow and meteorological conditions could be different. While conservative upper 95th percentile temperature deltas and effluent flow rates were used for modeling, it would be helpful if data from other years were available.

The following is an update of Leaburg Hatchery values using monitoring data from years 2017 and 2023, in addition to 2016 (**Table 2-3**). Note that changes associated with decommissioning the hydroelectric project appear to have had minimal impact on Leaburg Fish Hatchery, so it is appropriate to continue to use data from before elimination of diversions through the hydroelectric project.

Table 2-3: Leaburg Hatchery effluent flows and temperature deltas via 2016, 2017, and 2023 data.

Time Period	95th Percentile Total Effluent Flow (cfs)	Flow Weighted Average of 95th Percentile T_{eff}-T_{inf} (°C)
June 1-15	92.6	0.19
July	66.2	0.29
August	83.4	0.28
September 1-30	93.6	0.21

Comparison of **Table 2-3** to **Table 2-1** suggests that heating of pass-through water as it flowed through the hatchery may have been slightly greater in more recent years. However, differences are likely within measurement error of temperature probes, so it is difficult to draw conclusions based on the measurements.

Values for McKenzie River Hatchery flow based on data from 2022 and 2023 are shown in **Table 2-4** (NA indicates insufficient data). Comparison of **Table 2-4** to **Table 2-2** shows that flow has decreased significantly in recent years, which suggests significant impacts of hydroelectric project decommissioning on hatchery operations.

Table 2-4: McKenzie River Hatchery effluent flows via 2022 and 2023 data.

Time Period	95th Percentile Effluent Flow (cfs)
June 1-15	14.7
July	7.1
August	NA
September 1-30	1.0

Table 2-4 does not show values for T_{eff}-T_{inf}. This is because McKenzie River water is no longer diverted through the hatchery (all water is from Cogswell Creek). Therefore, the approach of estimating effluent temperature as a function of McKenzie River temperature is no longer applicable to this hatchery.

3 Wasteload allocation derivation and modeling

Wasteload allocations (WLAs) for the fish hatcheries are based on current thermal loads. WLAs for IP Springfield are based on current thermal loads during the spring spawning season. For the summer and fall, WLAs are set to maximum thermal loads that cumulative effects modeling showed will not result in exceedance of the human use allowance. WLAs are shown in **Table 3-1.**

Table 3-1: Wasteload allocations for NPDES permitted points sources discharging to the McKenzie River and South Fork McKenzie River within the CE-QUAL-W2 model extent.

NPDES Permittee WQ File Number : EPA Number Outfall location	Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (kcal/day)
EWEB Hayden Bridge Filter Plant 28385: ORG383503 McKenzie River RM 11	13.0 16.0	0.011	4/1	11/15	1538	2.09	41.449E+6
ODFW Leaburg Hatchery 64490: OR0027642 McKenzie River RM 33.7	13.0	0.074	4/1	6/15	2,442	92.4	458.861E+6
	16.0	0.012	6/16	8/31	1,537	39.1	46.274E+6
	13.0	0.026	9/1	11/15	1,630	78.3	108.671E+6
ODFW McKenzie River Hatchery 64500: OR0029769 McKenzie River RM 31.5	13.0	0.002	4/1	6/15	2,442	12.7	12.012E+6
	16.0	0.033	6/16	8/31	1,537	11.8	125.05E+6
	13.0	0.002	9/1	11/15	1,630	1.0	7.981E+6
International Paper - Springfield (Outfall 001 + Outfall 002) 96244: OR0000515 McKenzie River RM 14.7	13.0	0.12	4/1	6/15	2,442	28.9	725.456E+6
	16.0	0.20	6/16	8/31	1,537	28.9	766.247E+6
	13.0	0.19	9/1	11/15	1,630	28.9	771.167E+6
U.S. Army Corp of Engineers Cougar Project 126712 : Not Assigned South Fork McKenzie River RM 4.5	16.0 13.0	0.01	5/1	10/31	236	0.21	5.779E+6

Thermal WLAs for point sources are calculated using the following WLA equation:

$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F$ WLA Equation

where,

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

$\Delta T =$ The assigned portion of the human use allowance and the maximum temperature increase (ºC) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined.

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

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

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

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

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

Thermal WLAs calculated using this equation that apply for the river flow rates equal to or less than 7Q10 low-flow conditions are shown in **Table 3-1**. For river flow rates greater than 7Q10, the WLA equation above may be used. Derivation of the allocated HUA ΔT and effluent discharge (cfs) for the Leaburg and McKenzie River hatcheries are described below.

3.1 Critical period

For the lower McKenzie River, the critical period during which temperature criteria are exceeded is May 1 to October 31 (monitoring location USGS gage No. 14164900, McKenzie River above Hayden Bridge, at Springfield, RM 11, Monitoring period 2009-2022) (**Figure 3-2**). However, because the thermal loads discharged to the McKenzie River impact temperature downstream in the Willamette River, time periods for which WLAs are provided for the McKenzie River are extended to the critical period for the Willamette River, which is April 1 through November 15 (**Figure 3-3** and **Figure 3-4**).

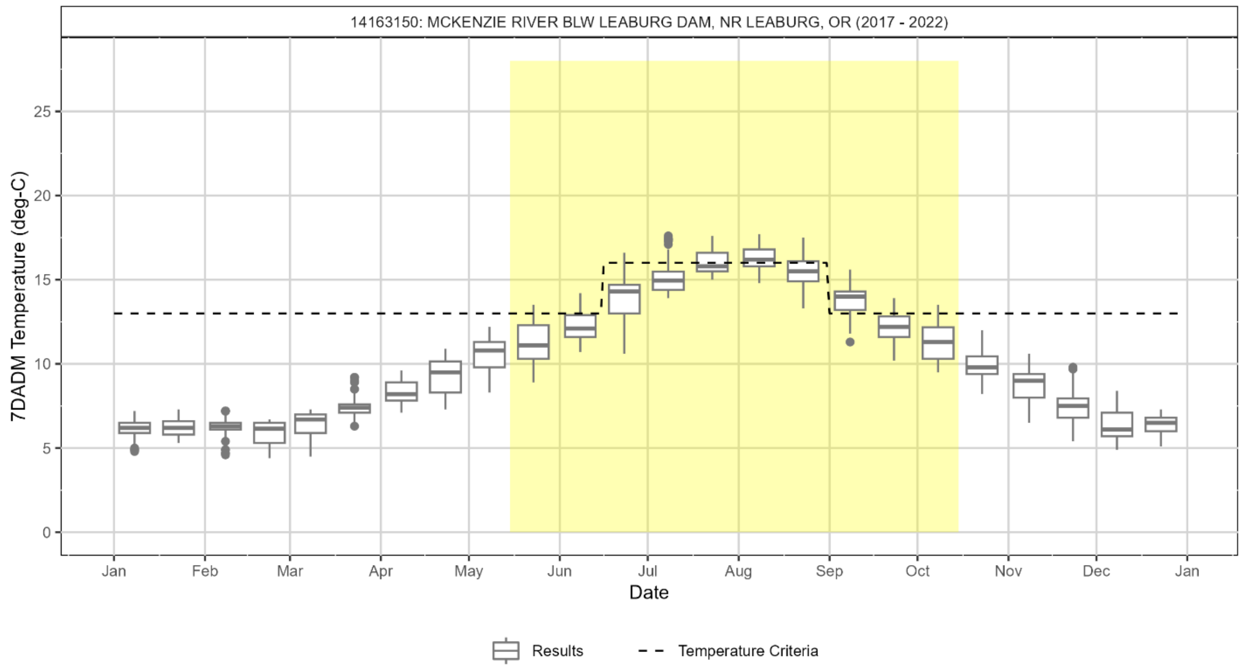

Figure 3-1: Seasonal variation at McKenzie River below Leaburg Dam.

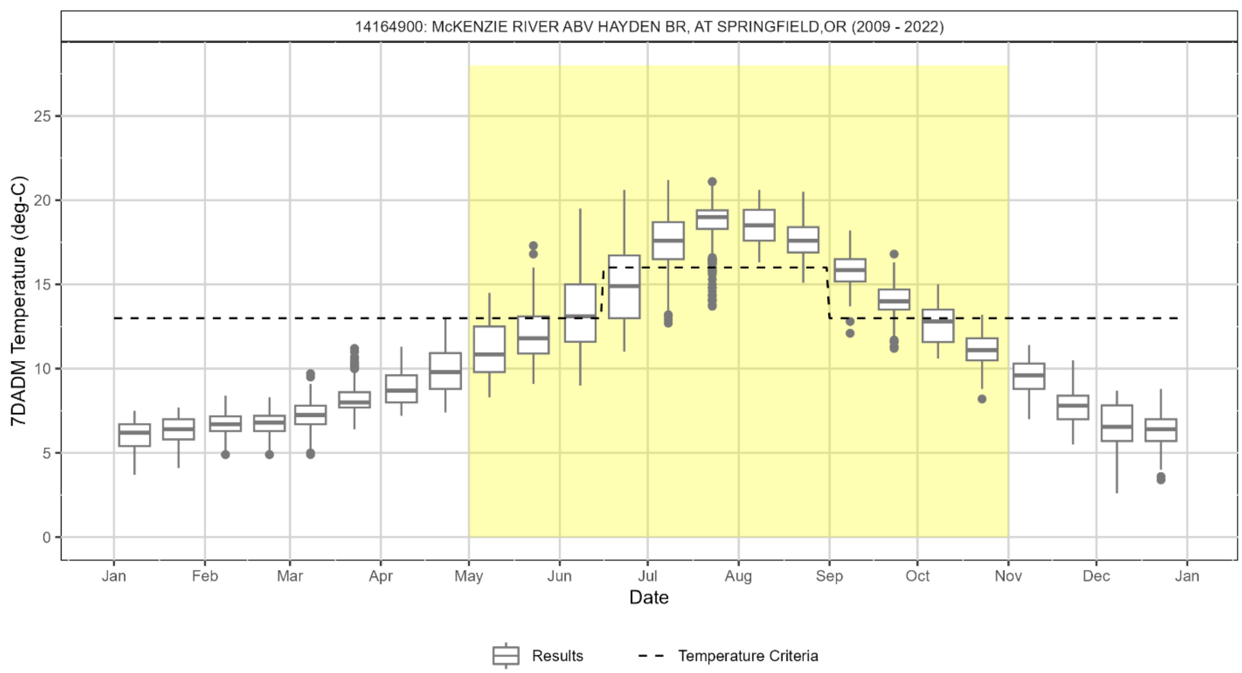

Figure 3-2: Seasonal variation at McKenzie River above Hayden Bridge.

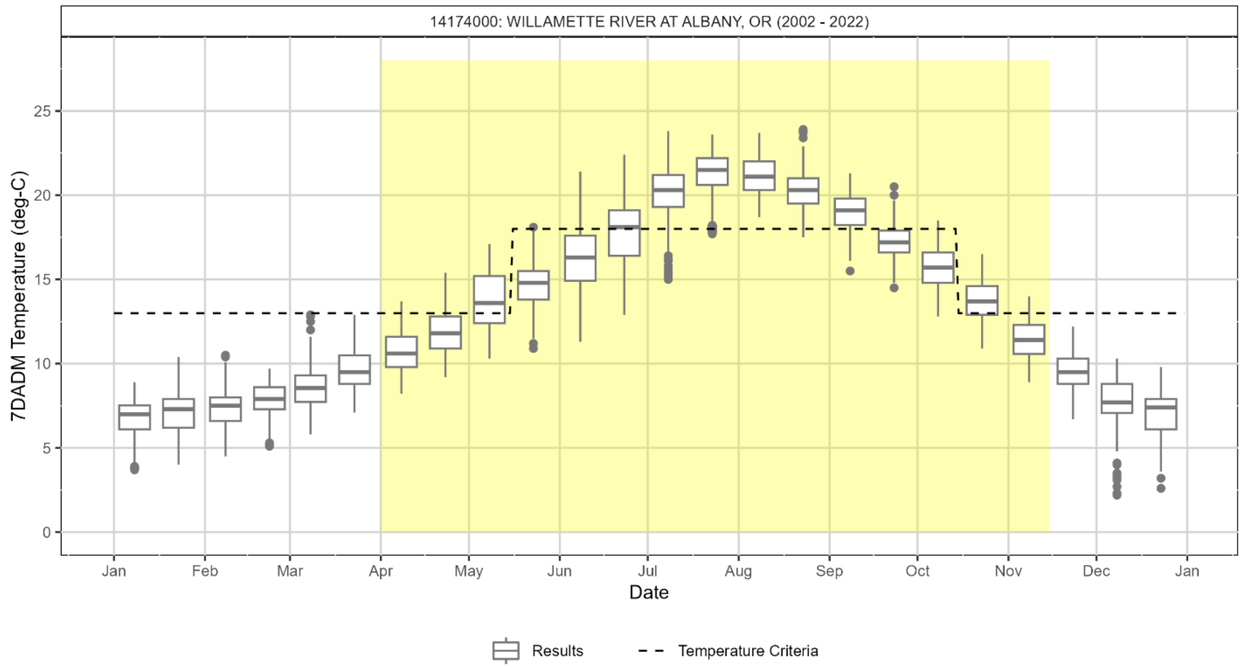

Figure 3-3: Seasonal variation at 14174000 Willamette River at Albany.

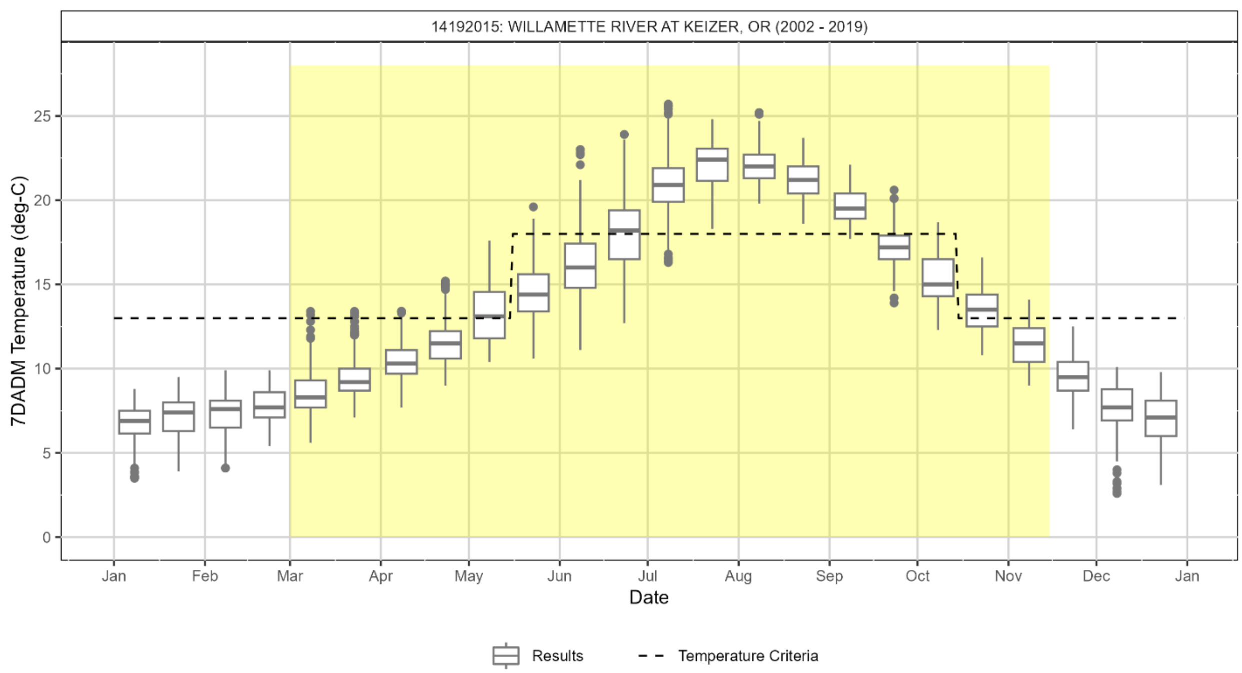

Figure 3-4: Seasonal variation at 14192015 Willamette River at Keizer.

3.2 Design 7Q10 low river flow conditions

Design 7Q10 low-flow conditions for all three facilities are set to 7Q10s developed from data collected at USGS Gage 14164900, McKenzie River Abv Hayden Br, at Springfield (see **Table 3-1**). Previously, design 7Q10 low-flow conditions for the fish hatcheries were based on USGS gage 14163150 (McKenzie River Blw Leaburg Dam, NR Leaburg, OR) which measures flow in the natural channel “bypass reach” downstream from Leaburg Dam. Flow in the bypass reach is reduced by any diversions to the power canal for the EWEB Leaburg Hydroelectric facility. Therefore, flow rates in the bypass reach have historically been significantly less than at the USGS gage further downstream, which measures the full flow of the river. While in the past, diversions through the power canal significantly reduced flow in the bypass reach, EWEB has indicated that it plans to decommission the Leaburg facility (EWEB, 2024). Following EWEB Leaburg decommissioning, 7Q10 flow rates will be similar to those measured further downstream at gage 14164900, McKenzie River Abv Hayden Br, at Springfield.

3.3 Derivation of WLAs for ODFW fish hatcheries

The Leaburg Hatchery (DEQ WQ File Number 64490, River Mile 33.7) is located near Leaburg Dam. The facility has three outfalls: 001, 002, and 003. The facility withdraws water from the impounded reach upstream from Leaburg Dam, while outfalls discharge to the McKenzie River bypass reach downstream from the dam (DEQ 11/13/2023 Public Notice for ODFW Leaburg Hatchery NPDES permit modification).

The McKenzie River Hatchery (DEQ WQ File Number 64500, RM 31.5) is located about two miles downstream from Leaburg Hatchery. It also discharges to the McKenzie River bypass reach downstream from Leaburg Dam. Process water for the facility includes water from Cogswell Creek. Historically process water also included McKenzie River water diverted from the Leaburg power canal (DEQ 11/13/2023 Public Notice for ODFW McKenzie Hatchery NPDES permit modification). The facility discharges from one outfall, located southwest of the facility.

WLAs for ODFW fish hatcheries are set to estimates of maximum current thermal loads. McKenzie River ODFW Leaburg and McKenzie River fish hatcheries are located near Leaburg, Oregon. Both hatcheries discharge to the McKenzie River downstream from Leaburg Dam. WLAs for the facilities are designed to accommodate thermal loads from the hatcheries associated with current operations and for cumulative thermal impacts of all point sources to not exceed the portions of the HUA allocated to point sources.

Flow in the natural channel “bypass reach” is reduced by any diversions to the power canal for the EWEB Leaburg hydroelectric facility. Analyses described in this memo use detailed data from 2016 collected prior to decommissioning as well as limited data from 2019 and 2020 which may reflect changes associated with decommissioning. The analyses were updated to include additional data collected in 2021 through 2023.

Elimination of flow through the hydroelectric project appears to have had minor impact on Leaburg Fish Hatchery operations. Impacts on McKenzie River Hatchery, however, appear to have been significant, since currently only water from Cogswell Creek is available for hatchery operations.

Note that the effluent flow rates in **Table 3-1** differ from those used for the 2015 point source impact modeling presented above. The effluent flow rates used for modeling are upper 95th percentile flow rates, while those used for **Table 3-1** are effluent flow rates that correspond to maximum river temperature impacts. Note that the effluent flow rates in **Table 3-1** are example rates. If effluent rates are greater than this and the WLA equation is applied, the actual effluent flow rate is used to calculate the WLA.

In order to derive maximum current thermal loads for the hatcheries, available data was used to calculate maximum potential ΔTs for conditions of 7Q10 river flow and river temperature equal to applicable criteria using the following equation:

ΔT_{PS} Equation:

$$\Delta T_{PS} = \left(\frac{Q_E}{Q_E + Q_{R,7Q10}}\right)(T_E - T_C)$$

where:
ΔT_{PS} = change in river temperature due to effluent
$Q_{R,7Q10}$ = 7Q10 design low river flow rate upstream from point source
Q_E = effluent flow rate
T_C = applicable temperature criterion
T_E = effluent temperature

In terms of dilution factor, D_F

$$\Delta T_{PS} = \left(\frac{T_E - T_C}{D_F}\right)$$

Where:

$$D_F = \frac{Q_E + Q_R}{Q_E}$$

Measured 7-day average effluent flow rates and 7DADM effluent temperatures were used to calculate ΔT_{PS} values for each day that data was available. The maximum observed ΔT_{PS} for each hatchery for the spring spawning period (May 1 to June 15), summer non-spawning period (June 16 – August 31), and fall spawning period (September 1 to October 15), rounded to three decimal places, is the allocated human use allowance, ΔT. These are the values shown in Table 3-1.

7-day average effluent rates that, along with corresponding 7DADM effluent temperatures, produce the largest ΔTs for each hatchery and time period are the effluent flow rates in Table 3-1. Note that these generally are less than the 95th percentile flow values used for 2015 temperature modeling. This is because effluent temperatures are at times greater at low effluent flow rates than at high effluent flow rates (an inverse correlation), so impacts on river temperature may be greater for certain low effluent flow conditions than for high effluent flow conditions.

Some of the temperature increase of Leaburg Hatchery is at times due to river water diverted through the hatchery exceeding applicable criteria. The maximum potential increase in river temperature due to the facility heating pass-through water is shown by **Table 3-2**. As shown, during spring and fall, since the potential increase in river T due to heating of pass-through water in **Table 3-2** is less than the WLA ΔT in **Table 3-1**, much of the excess thermal load is due river water exceeding criteria. However, during the summer, since the potential increase in river T due to heating of pass-through water in **Table 3-2** is similar to the WLA ΔT in **Table 3-1**, much of the excess thermal load may be due to heating of pass-through water in the hatchery. Note that the potential increase in river temperature due to heating of pass-through water is less than 0.02^{o}C.

Table 3-2: Leaburg Hatchery - Temperature increase due to heating of pass-through water in hatchery.

NPDES Permittee WQ File Number : EPA Number Outfall location	WLA period start	WLA period end	7Q10 River flow (cfs)	95th Percentile Total Effluent Flow (cfs)	95th Percentile Teff-Tinf (ºC)	Dilution Ratio	Potential increase in River T due to heating of pass-through water (ºC)
ODFW Leaburg Hatchery 64490: OR0027642 McKenzie River RM 33.7	5/15	6/15	2,442	92.55	0.194	26.4	0.007
	6/16	8/31	1,537	83.40	0.286	18.4	0.016
	9/1	10/15	1,630	93.58	0.213	17.4	0.012

3.4 Derivation of WLAs for IP Springfield

Like for the hatcheries, in order to derive maximum current thermal loads for IP Springfield, available data was used to calculate maximum potential ΔTs for conditions of 7Q10 river flow and river temperature equal to applicable criteria. Based on available data, the maximum potential ΔTs are 0.10 deg-C during the spring spawning period, 0.20 deg-C during the summer, and 0.21 during the fall spawning period.

The permittee indicated that these ΔTs likely underestimate actual ΔTs for the effluent. This is because temperatures used for the analysis are not daily maximum values but were measured earlier in the day than the time of daily maximum. DEQ therefore increased the allocated ΔT for the spring spawning period by 20% to 0.12 deg-C. However, modeling showed that no increase could be provided for the summer and that a reduction was needed during the fall in order to avoid exceeding the portion of the HUA available to point sources (see below). Final WLAs are as shown in Table 3-1

3.5 Modeling of wasteload allocations

Modeling was performed for the critical low-flow year of 2015 to evaluate the warming from point source discharges set at the TMDL wasteload allocation thermal loads. In this scenario, two point sources discharges were added to the model. The U.S Army Corp of Engineers submitted an individual NPDES permit application to DEQ for non-contact cooling water, filter backwash, and powerhouse sump discharges at Cougar Dam. The effluent temperatures and flow rates in the model are based on an assigned human use allowance of 0.01ºC. The second point source added to the model is EWEB Hayden Bridge Filter Plant (NPDES permit file number 28385). EWEB's Hayden Bridge Filter plant is a registrant on the 200-J general permit and discharges downstream of Hayden Bridge at about McKenzie River mile 11. EWEB received a numeric wasteload allocation equal to an assigned human use allowance of 0.011ºC (see discussion in Technical Support Document (TSD) Section 7.1.2.2).

The wasteload allocation scenario also includes the EWEB's Trail Bridge Powerhouse (NPDES permit file number 28393, Outfall 002). As summarized in TSD Appendix A, Section 4.10.2, Heat Source modeling indicates that a WLA for this discharge that corresponds to a 7DADM temperature impact of 0.03ºC will have up to 0.015ºC of impact in the McKenzie River near at its confluence with the South Fork McKenzie River near USGS gage 14159110 (McKenzie River above South Fork, Near Rainbow). This impact was added to the CE-QUAL-W2 McKenzie River boundary condition temperatures. The modeling also includes impacts of the ODFW Leaburg and McKenzie River fish hatcheries. Several modeling iterations were needed to derive acceptable WLAs for IP Springfield. The final scenario modeled is referred to as WLA11TB (Wasteload Allocation scenario 11 plus impacts of EWEB Trail Bridge Powerhouse).

Note that flow rates for September 2015 were quite low relative to other years. The monthly average flow rate for September 2015 for USGS 14164900 McKenzie River abv Hayden Br, at Springfield was 1,579 cfs, which is less than the fall spawning period 7Q10 of 1,630 cfs. The next lowest September average flow rate for the 2008-2023 period of record was 1,756 cfs and the average September flow rate for all months for the period of record was 2,300 cfs. Because flow rates for the modeled year are less than 7Q10, modeled impacts during the fall spawning period may exceed allocated ΔTs. Note that this is acceptable, since ΔTs may exceed allocated ΔTs during the occasional time periods when river flow rates are less than 7Q10.

Figure 3-5 through **Figure 3-7** show 7DADM temperature impacts for the WLA11TB scenario for the spring spawning period, summer non-spawning period, and the fall spawning period. Shown are maximum differences between 7DADM temperature for the WLA scenario and 7DADM temperature for a scenario with no point sources. The only 7DADM temperature impacts included are for days when the temperature criteria (16ºC during summer non-spawning period and 13ºC during spawning periods) are exceeded for either scenario (with or without point sources). 7DADM temperature impacts at times when model calculated river temperatures are less than criteria may be greater than those shown.

The plots show the impact of the Trail Bridge WLA. The impact is 0.01ºC at the confluence of the McKenzie River with the South Fork McKenzie River (~RM 54). The impact slowly decreases but is still close to 0.01ºC near Leaburg and McKenzie River Hatcheries (~RM 35). The impact is 0.005ºC at the river mouth.

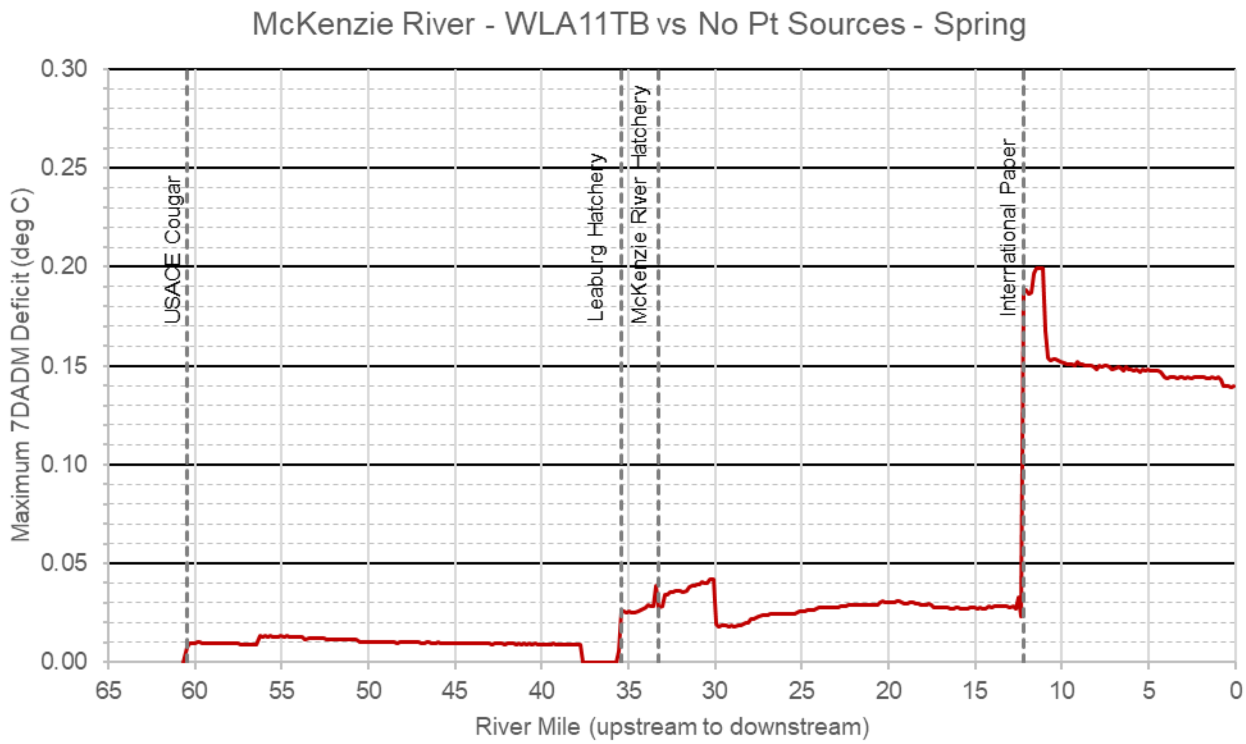

Figure 3-5: McKenzie River maximum 7DADM change in temperature from wasteload allocations during the spring spawning period.

Note that the spawning period begins September 1 in all reaches but ends May 15 in some reaches and June 15 in others. Such differences in when and where the 13°C spawning criterion applies vs. when and where the 16°C non-spawning criterion applies can explain some of the variability in the plots. For example, from about RM 37 to RM 35 (upstream from Leaburg Hatchery impact) near RM 35, the spawning period ends May 15. However, above RM 37 and from RM 35 to RM 11 spawning ends June 15. This may explain why ΔT is zero between RM 37 and RM 35, but greater above and below this reach. It also may explain why the impact of IP Springfield is greater from RM 14.7 to RM 11 than downstream from RM 11.

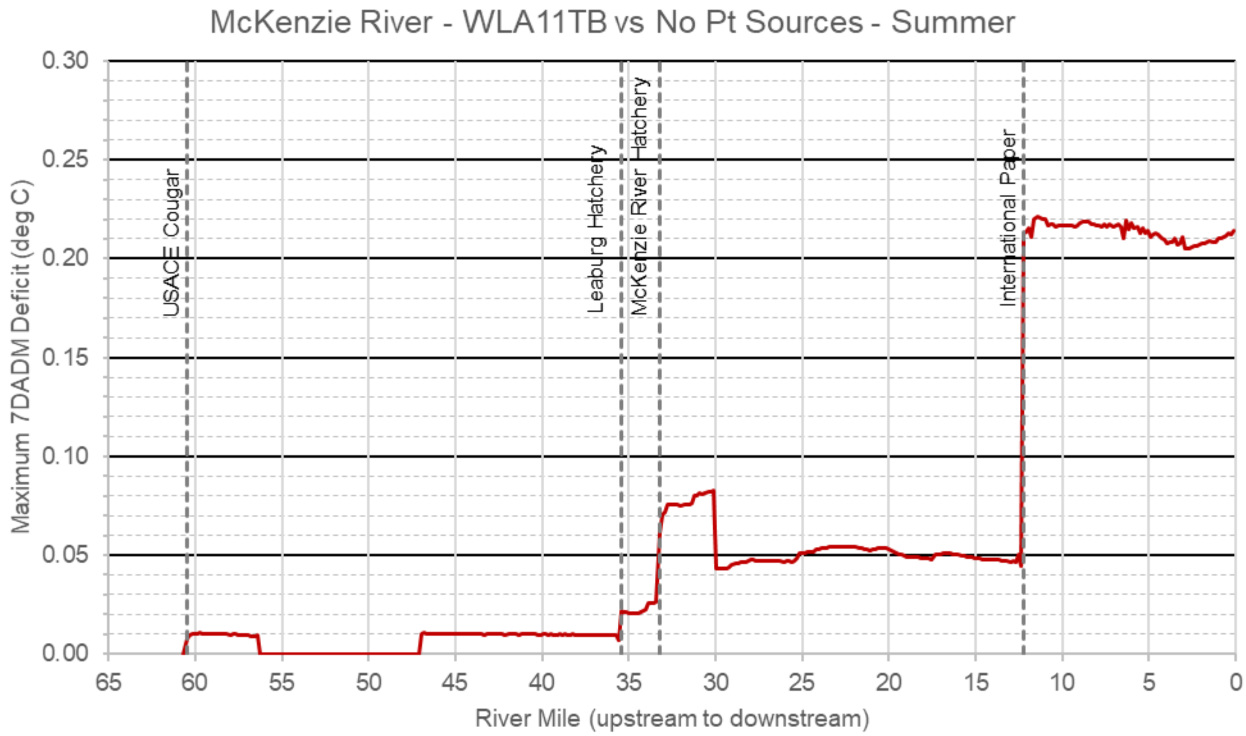

Figure 3-6: McKenzie River maximum 7DADM change in temperature from wasteload allocations during the summer period.

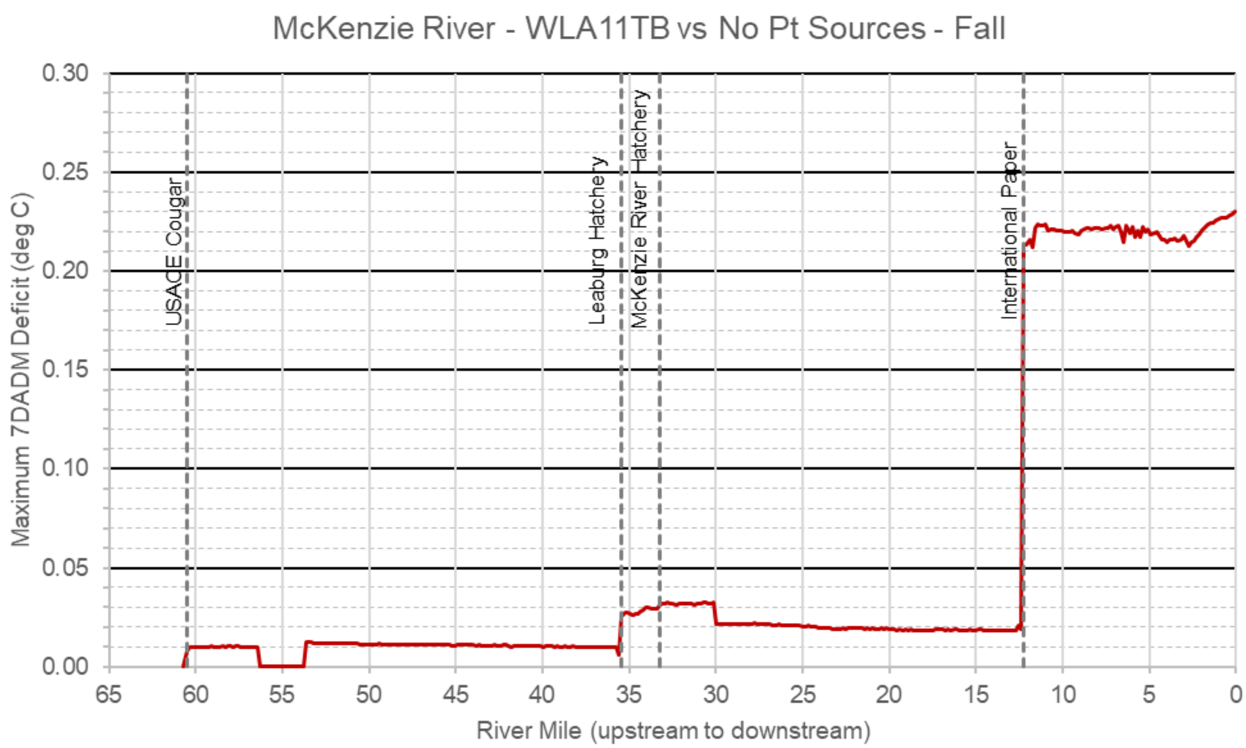

Figure 3-7: McKenzie River maximum 7DADM change in temperature from wasteload allocations during the fall spawning period.

The maximum impact of modeled point source at their WLAs does not exceed 0.23°C. The point of maximum impact (POMI) is located near the mouth of the McKenzie River during the fall spawning period. For the majority of days, the maximum impact does not exceed 0.22°C. The impact of 0.23°C occurred on two days: October 5 and 6, 2015. Via data from the USGS gage near the outfall (USGS 14164900 McKenzie River abv Hayden Br, at Springfield), the 7-day average river flow was 1,551 and 1,550 cfs on October 5 and 6, which equate to 95% of the fall spawning period 7Q10 of 1,630 cfs. When flow is greater than or equal to 7Q10, the impact of point source WLAs is not expected to exceed 0.22°C. A summary of maximum 7DADM temperature impacts is shown in **Table 3-3**.

Table 3-3: McKenzie River maximum 7DADM change in temperature from wasteload allocations.

Extent AU ID	W2 Segments	Max 7DADM Change (°C)	Spring Spawning Max 7DADM Change (°C)	Summer Max 7DADM Change (°C)	Fall Spawning Max 7DADM Change (°C)
South Fork McKenzie River Cougar Dam to confluence with McKenzie River OR_SR_1709000403_02_104590	2 - 29	0.01	0.01	0.01	0.01
McKenzie River River Mile 56.4 - 53.6 South Fork McKenzie River to Blue River OR_SR_1709000405_02_103869	30 - 46	0.01	0.01	0.00	0.00
McKenzie River River Mile 53.6 - 48.2 Blue River to Ennis Creek OR_SR_1709000405_02_103866	47 - 83	0.01	0.01	0.00	0.01
McKenzie River River Mile 48.2 - 35.7 Ennis Creek to Leaburg Diversion OR_SR_1709000407_02_103884	83 - 164	0.01	0.01	0.01	0.01
McKenzie River River Mile 35.7 - 12.4 Leaburg Diversion to IP Springfield Outfall OR_SR_1709000407_02_103884	167 - 320	0.08	0.04	0.08	0.03
McKenzie River River Mile 12.4 – 0 IP Springfield outfall to confluence with Willamette River OR_SR_1709000407_02_103884	321 - 339	0.23	0.20	0.22	0.23

Note also that the modeling was performed for 2015 conditions with EWEB Leaburg Hydroelectric Project operating as it did in 2015. Therefore, impacts in the bypass reach downstream from Leaburg Dam are greater than they would be today without the diversion.

However, it is assumed that the impact downstream from RM 30, where diverted flow returns, would be similar regardless of whether water was diverted.

4 Attainment scenario modeling

A cumulative effects analysis performed using the CE-QUAL-W2 model of the McKenzie Rivers shows that cumulative effects of McKenzie River mainstem and tributary load and wasteload allocations will not exceed the 0.3 deg-C human use allowance. For the analysis, tributary temperatures were increased an amount equal to the allocated portion of the HUA, as follows:

$$\Delta T_{trib} = \Delta T_{LA} + \Delta T_{WLA} = HUA - RC$$

Where:

$\Delta T_{trib} =$	Amount tributary temperature increased, °C
$\Delta T_{LA} =$	Tributary temperature increase due to nonpoint source and background load allocations, °C
$\Delta T_{WLA} =$	Tributary temperature increase due to point source wasteload allocations, °C
$HUA =$	Human use allowance=0.3°C
$RC =$	Reserve Capacity, °C

Tributary temperature increases modeled are shown in **Table 4-1**.

Table 4-1: Tributary temperature increases modeled.

Tributary	HUA consumed by Point Source Wasteload Allocation (WLA) at mouth ΔT_{WLA} (ºC)	HUA consumed by NPS and Bgd Load Allocation (LA) at mouth ΔT_{WLA} (ºC)	Reserve Capacity (RC) at mouth (ºC)	Trib T Increase modeled ΔT_{trib} (ºC)
McKenzie R above SF McKenzie R	0.030	0.05	0.220	0.080
Quartz Creek	0.075	0.07	0.155	0.145
Deer Creek	0.075	0.07	0.155	0.145
Bear Creek	0.075	0.07	0.155	0.145
Gate Creek	0.075	0.07	0.155	0.145
Finn Creek	0.075	0.07	0.155	0.145
Camp Creek	0.075	0.07	0.155	0.145
Mohawk River	0.075	0.07	0.155	0.145

Point source WLAs included for the analysis included those for EWEB Trail Bridge powerhouse, WLAs for the ODFW Leaburg and McKenzie River hatcheries, and WLAs for IP Springfield. These are shown in **Table 3-1**. The attainment scenario was compared to the No Point sources scenario.

Modeling was performed for 2015 using the McKenzie River CE-QUAL-W2 model, see TSD Appendix J for details. 2015 was used for modeling because it is a conservative low-flow year. River temperature impacts due to WLAs plus tributary temperature increases are shown in **Figure 4-1** shows the maximum 7DADM impacts for all seasons.

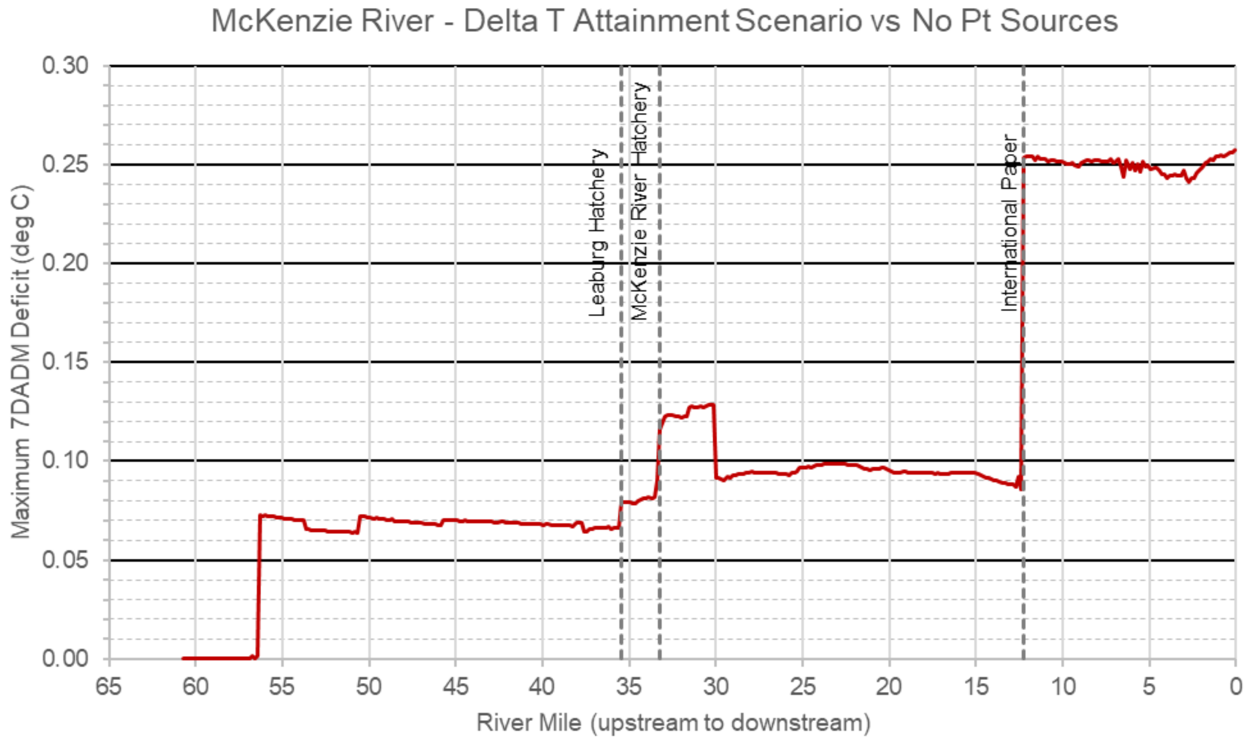

Figure 4-1: McKenzie River - Impacts of tributary WLA + LA plus mainstem WLA.

Figure 4-1 shows the maximum impact of tributary wasteload allocations and load allocations plus McKenzie River mainstem wasteload allocations on river temperature. As shown, the maximum impact is about 0.25 deg-C. As discussed above, the small increase beyond 0.25 deg-C at the mouth occurs during the during the fall spawning period on two days when river flow rates are less than 7Q10 conditions. When flow is greater than or equal to 7Q10, the impact of modeled point source impacts plus ΔT_{trib} impacts does not exceed 0.25^{o}C.

The WLAs modeled do not include any impacts of point sources covered by general NPDES permits. Such impacts are expected to be less than 0.01 deg-C, so the maximum impact of tributary wasteload allocations and load allocations plus McKenzie River mainstem WLAs on river temperature is up to 0.26 deg-C at the IP Springfield discharge location at RM 14.7. Therefore, 0.16 deg-C or more of the HUA remains upstream from the IP Springfield discharge at RM 14.7 and about 0.04 deg-C remains downstream.

HUA allocations on the McKenzie River Assessment Unit (McKenzie Subbasin) from International Paper Springfield's outfall to the mouth (Table 9-18 of the TMDL) are shown in Table 4-2. As shown, in the reach downstream from IP Springfield, during the fall spawning period: 0.02 deg-C of the HUA is allocated to "Other water management activities and water withdrawals"; 0.02 deg-C of the HUA is allocated to "Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure"; 0.02 deg-C is allocated to the EWEB Walterville project (both NPS and NPDES), and 0.01 deg-C is specified as reserve capacity.

Table 4-2: HUA assignments on the McKenzie River AU (McKenzie Subbasin) from International Paper Springfield's outfall to the mouth.

Portion of HUA (°C)	Source or source category
0.20 0.22 0.23	NPDES point sources (Spring spawning period) NPDES point sources (Summer non-spawning period) NPDES point sources (Fall spawning period)
0.00	NPS dam and reservoir operations
0.02	EWEB Walterville project NPS and NPDES increases
0.00	EWEB Leaburg project NPS increases
0.02	Other water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.04 0.02 0.01	Reserve capacity (Spring spawning period) Reserve capacity (Summer non-spawning period) Reserve capacity (Fall spawning period)
0.30	**Total**
AU OR_SR_1709000407_02_103884 from McKenzie River Mile 0 – 10.8.	

It is expected that a significant portion of the 0.02 deg-C of HUA allocated to "Other water management activities and water withdrawals" and the 0.02 deg-C of the HUA allocated to "Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure" is due to impacts on the tributaries that are part of the 0.05 to 0.07 deg-C of tributary temperature increases. Assuming that 75% of these allocations are for tributaries and included in the ΔT_{trib} increases modeled and 25% are for the McKenzie River mainstem, the available amount of HUA that must remain downstream from the IP Springfield outfall is as follows:

HUA that must remain downstream from IP Springfield:
0.02 + (25% x 0.02) + (25% x 0.02) + 0.01 = 0.04 deg-C

This suggests that the 0.04 deg-C of the HUA that is available downstream from IP Springfield is sufficient to accommodate the warming from the source categories not explicitly included in the model.

5 Restored vegetation scenario

Modeling was performed with the shade improved from that for current conditions to that for site potential vegetation (SPV). The SPV shade file is the same as that used for the 2006 TMDL. The difference between modeled calculated temperature for current condition vegetation conditions and that for SPV is the temperature increase due to anthropogenic solar radiation. This is shown in **Figure 5-1**.

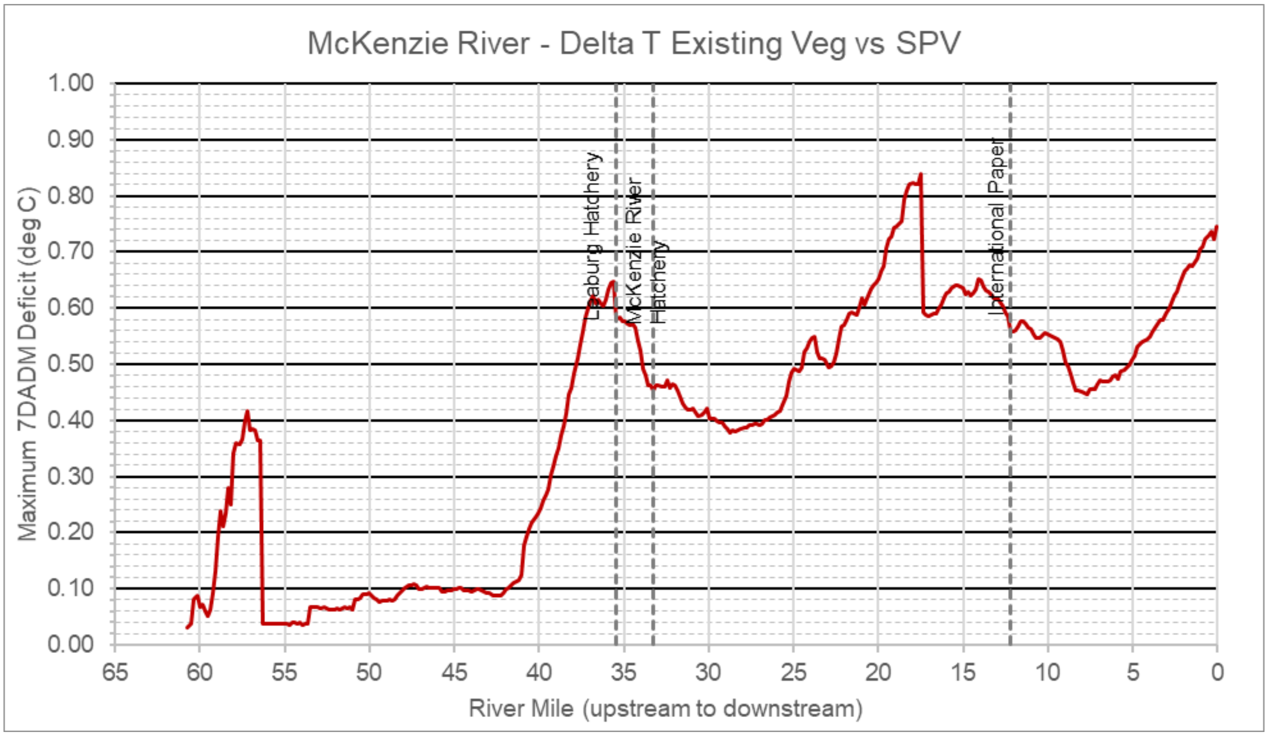

Figure 5-1: Stream temperature impact of current vs. site potential vegetation.

Table 5-1 shows that lack of sufficient streamside vegetation is associated with a mean effective shade gap of 14 percentage points. Based on the plot above, this corresponds to a 7DADM water temperature increase of 0.84 deg-C at the POMI at river mile 17.5 and 0.74 deg-C at the mouth.

Figure 5-2 compares effective shade predictions from the current and site potential vegetation scenarios for the McKenzie River.

Table 5-1: Summary of mean effective shade for current and site potential vegetation scenarios on the McKenzie River.

Scenario	Mean Effective Shade (%)
Current Condition	12
Restored Vegetation	26
Change	14

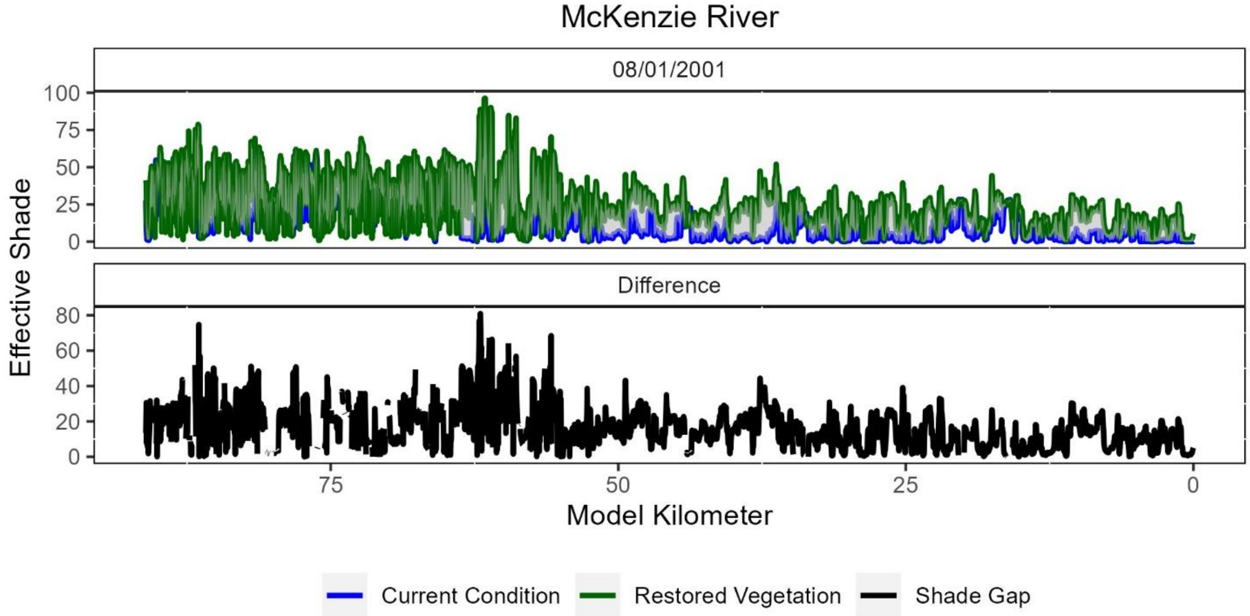

Figure 5-2: Comparison of effective shade from the current and site potential vegetation scenarios for the McKenzie River.

6 References

Berger C., M. McKillip, R. Annear, S.J. Khan, and S. Wells; Willamette River Basin Temperature TMDL Model: Model Calibration; Technical Report EWR-02-04; School of Engineering and Applied Science; Department of Civil and Environmental Engineering; Portland State University Portland, Oregon 97201-0751; May, 2004.

EWEB. 2024. Website

Stratton Garvin, L.E., S.A. Rounds, and N.L. Buccola. 2022. Updates to models of streamflow and water temperature for 2011, 2015, and 2016 in rivers of the Willamette River Basin, Oregon: U.S. Geological Survey Open-File Report 2022–1017, 73 p.,

Tetra Tech. 2023. Memo: Willamette River Model Point Source Updates and Scenario Simulation. December 28, 2023.

Tetra Tech. 2024. McKenzie River CE-QUAL-W2 Model Scenario Report. January 2024.