Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document

Appendix M: Willamette River Mainstem and Major Tributaries 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 of thermal wasteload allocations, WLA cumulative effects modeling, attainment scenario modeling, and human use allowance and reserve capacity assignments for Willamette River mainstem and major tributaries model reaches. Additional information on WLAs for the McKenzie River is described in Technical Support Document Appendix L.

Modeling was performed using the Willamette Mainstem CE-QUAL-W2 models, which consist of nine models developed by Portland State University, U.S. Geological Survey, and DEQ at the direction of DEQ (DEQ, 2006) (Figure 1-1). CE-QUAL-W2 is a two-dimensional hydrodynamic and water quality model (Cole and Wells, 2019). The version of CE-QUAL-W2 used for the current modeling is 4.2, released in 2019. CE-QUAL-W2 was originally developed by the U.S. Army Corps of Engineers and is currently maintained by the Water Quality Research Group, Department of Civil and Environmental Engineering, Portland State University. Willamette Mainstem model reaches consist of the Willamette River plus the following major tributaries downstream from USACE operated dams and Portland General Electric operated River Mill Dam: the Coast and Middle Fork Willamette Rivers, Row River, Fall Creek, Blue River, South Fork McKenzie River, McKenzie River downstream from the confluence of the South Fork McKenzie River, Long Tom River, North and South Santiam Rivers, Santiam River, Clackamas River, and Multnomah Channel (see TSD Appendix J: Tetra Tech Model Calibration Report). Also included is a portion of the Columbia River from Port Westward USGS Gage near Quincy, Oregon (formerly known as Beaver Army Terminal) to Bonneville Dam. In this report Willamette Mainstem refers to rivers included as part of the Willamette Mainstem models.

Derivation and modeling of thermal wasteload allocations, current condition modeling, restored vegetation modeling, and attainment scenario modeling for the McKenzie River and South Fork McKenzie River are described in TSD Appendix L: DEQ McKenzie River Model Scenario Report.

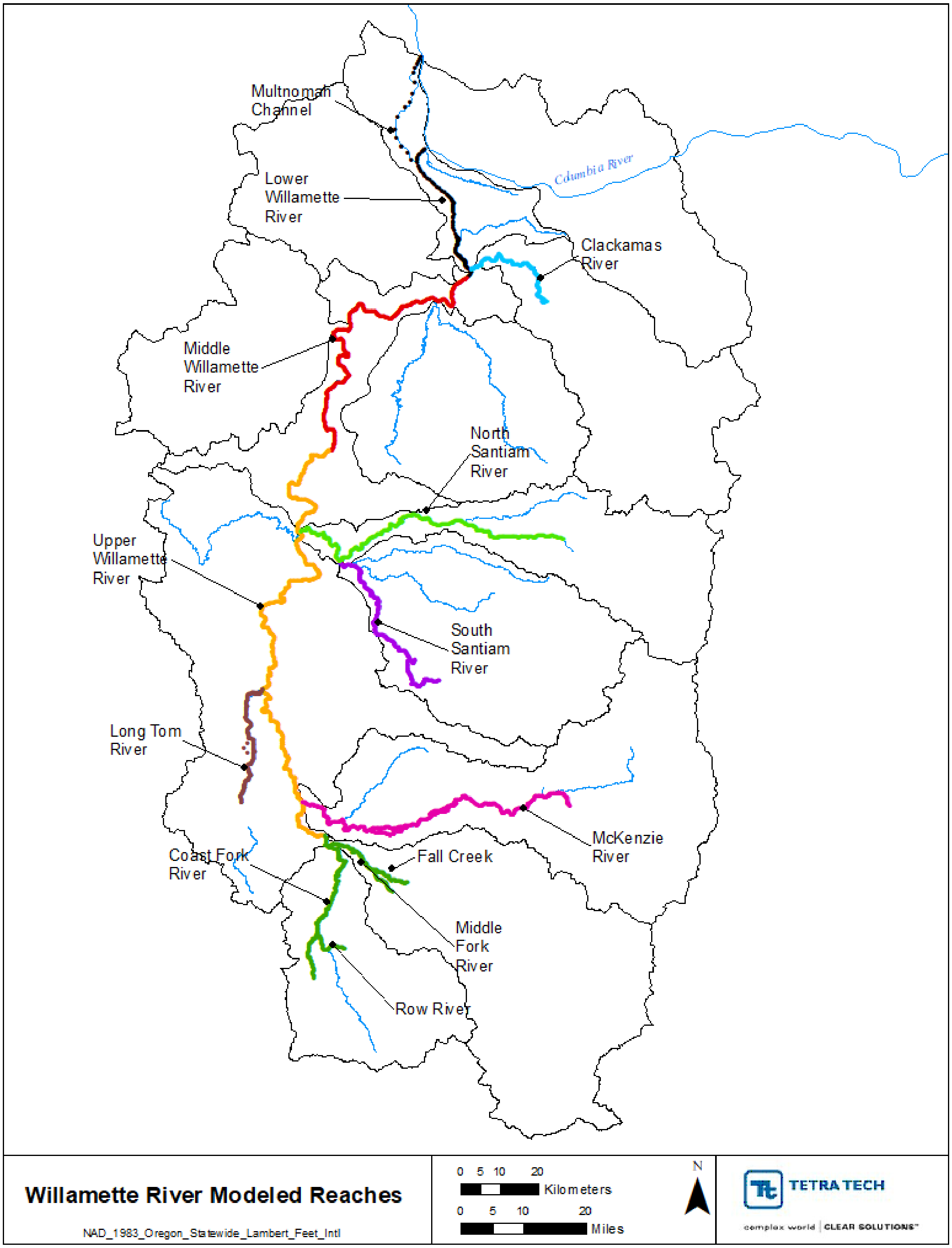

Figure 1-1. Willamette Mainstem Models.

2 Willamette Model Development and Calibration

The Willamette Mainstem CE-QUAL-W2 models were developed to derive 2006 Willamette TMDLs. The models for most reaches were developed and calibrated by Portland State University (Annear et al., 2004; Berger et al., 2004). A CE-QUAL-W2 model of the Santiam and North Santiam Rivers was developed and calibrated by the USGS (Sullivan and Rounds, 2004), while a CE-QUAL-W2 model of the South Santiam River was calibrated by DEQ (Bloom, 2016). Funding for model development was provided by the U.S. Army Corps of Engineers (USACE). Data collected for model calibration for 2001 and 2002 included data collected by DEQ, USGS, municipalities, utilities, and industry.

The CE-QUAL-W2 models incorporate both topographic and vegetative shade. Topographic characteristics evaluated to develop the models included the steepest inclination angle in eighteen directions around a model segment (Annear et al., 2004). Vegetation characteristics evaluated included tree top elevation, distance between the river channel centerline and the controlling vegetation, and the vegetation density in summer and winter. Vegetation characteristics were provided for both banks of the river. Vegetation and topographic characteristics for each model were developed using geographic information system (GIS) data supplied by DEQ, which developed shade and Heat Source shade (Shade-a-lator) models of all reaches (Annear et al., 2004). The data consists of thalweg points every 100 ft (30.48 m) along the centerline of the river. For each thalweg point, additional associated data included: channel width, land surface elevation, three topographic inclination angles, and nine vegetation compartments for each bank. Each vegetation compartment consists of vegetation height, distance from stream bank, and density. Detailed information on shade input development for both current and potential shade conditions is provided in the 2006 TMDL (Willamette Basin Total Maximum Daily Load Appendix C: Temperature, September 2006) and in TSD Appendices A and C of this TMDL (Heat Source Model Report and Potential Near-Stream Land Cover).

The Lower Willamette River and Columbia River CE-QUAL-W2 model did not have dynamic vegetation and topographic shade incorporated in the model. Although there may be some topography which shades the river, such as the West Hills, the Lower Willamette River is sufficiently wide and the volume large enough that shading will have little influence on the river temperature (Annear et al., 2004).

In addition to modeling current vegetation conditions, modeling was also performed for system potential shade targets based on assumed shade levels produced by riparian vegetation expected to occur in the absence of human disturbance (see Section 8 below). System potential vegetation and effective shade targets do not target mature vegetation throughout the basin. Simulations include an allowance for natural disturbance in model runs as lower tree heights and canopy densities. These disturbances were randomly distributed throughout the streamside area in model simulations and, to maintain model precision, were not changed once simulations began. The potential near-stream land cover in the Willamette Valley bottom is assigned a vegetation component defined by geomorphic unit or ecoregion. Each geomorphic unit or ecoregion unit is assigned unique vegetation characteristics such as height, density, and canopy overhang (see TSD Appendix A and 2006 TMDL Appendix C for detailed information). System potential simulations generally yielded higher levels of effective shade and lower levels of solar radiation input to the river than values used to calibrate the model to current conditions.

In some locations, system potential simulated shade levels were lower than shade levels measured and included in the model calibration. These patches of elevated solar radiation loading are the natural disturbance contribution to stream warming.

Six of the models were updated to CE-QUAL-W2 version 4.2 by the USGS and USACE and calibrated for several model years, including 2015 (Stratton et al., 2022). The remaining three models; Long Tom River, Clackamas River, and the lower Willamette River (downstream from Willamette Falls at Oregon City) were recently updated to CE-QUAL-W2 version 4.2 by Tetra Tech and the U.S. Environmental Protection Agency (USEPA) and calibrated for 2015 (Tetra Tech, 2023; provided as TSD Appendix J).

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. During spring, flow in 2015 was significantly less than flow in 2001 and 2002 (flow during months of April, May, and June 2015 were 57% to 79% of minimum of 2001 and 2002 flow during April, May and June) (Table 2-1). However, during critical months of July through September, when temperature criteria are exceeded, flows were similar (2015 flow 94% to 102% of minimum of 2001 and 2002 flow), so both 2015 and 2001 function well as critical low flow condition years.

Table 2-1 also provides general indications of the influence of USACE reservoir operations on river flow. As shown, during late-summer critical low flow periods river flow is presently significantly greater than prior to construction of dams.

Table 2-1: 2015 vs. 2001 and 2002 flows at Salem - USGS Gage 14191000

	Year	Apr	May	Jun	Jul	Aug	Sep	Oct
Monthly Mean Discharge (cfs):	2001	16,780	16,090	9,196	5,588	5,591	6,106	7,453
	2002	30,260	15,760	11,190	6,847	6,599	7,250	8,593
	2015	13,220	9,052	7,100	5,672	5,457	6,056	7,019
Mean of Monthly Discharge (cfs):	1909-2022	26,500	20,600	14,200	7,420	6,020	7,390	11,300
	1909-1949	28,700	21,000	14,100	6,970	4,190	4,380	7,220
	1950-2022	25,500	20,400	14,200	7,630	6,880	8,760	13,200
2015 as percent of min 2001/2002 discharge:		79%	57%	77%	102%	98%	99%	94%
Post-1950 vs Pre-1950:		89%	97%	101%	109%	164%	200%	183%

Modeling of impacts of the point sources based on 2015 conditions was performed by Tetra Tech and USEPA (Tetra Tech, 2024). The model was used by DEQ to model potential WLAs, as described below.

3 Willamette Mainstem wasteload allocations

Wasteload allocations (WLAs) for facilities covered by individual NPDES permits for Willamette Mainstem reaches, which are provided in the TMDL, are replicated in Table 3-1 below (grouped by receiving water and sorted by river mile). Note that WLAs for discharges to the McKenzie River are included but were previously developed as part of the Willamette Subbasins TMDL. Also included in Table 3-1 are WLAs for two fish hatcheries covered by 300-J General NPDES Permits (Industrial Wastewater: NPDES fish hatcheries): ODFW South Santiam Hatchery, which discharges to the South Santiam River, and ODFW Dexter Ponds, which discharges to the Middle Fork Willamette River.

Wasteload allocations are also provided for registrants of the 100-J (Industrial Wastewater: NPDES cooling water) and 200-J (Industrial Wastewater: NPDES filter backwash) general NPDES permits (see Section 9 of TMDL for WLAs and TSD Section 7.1 for analysis and discussion). WLAs for discharges covered by 100-J and 200-J permits are not included in Table 3-1, except for the WLA for 200-J registrant North Clackamas County Water Commission (110117 - ORG380011 - Clackamas River RM 2.75).

Table 3-1: Wasteload allocations for NPDES permitted points sources discharging to the Willamette mainstem and major tributaries within the CE-QUAL-W2 model extent.

NPDES Permittee WQ File Number - EPA Number - Outfall location	Temp Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 106 kcal/day)
ODFW - Clackamas River Hatchery - 64442 - OR0034266 Clackamas River RM 22.6	13.0	0.072	4/15	6/15	1186	42.1	216.342
	16.0	0.261	6/16	8/31	627	41.0	426.571
	13.0	0.283	9/1	10/31	645	42.0	475.683
North Clackamas County Water Commission - 110117 - ORG380011 (200-J discharge) Clackamas River RM 2.75	13.0 (10/15 – 5/15) 18.0 (5/16 – 10/14)	0.030	4/15	10/31	671	2.49	49.434
Cottage Grove STP - 20306 - OR0020559 Coast Fork Willamette River RM 20.6	13.0	0.154	4/1	5/15	61	2.1	23.775
	18.0	0.206	5/16	11/15	38	2.8	20.564
Monroe STP - 57951 - OR0029203 Long Tom River RM 6.9	18.0	0.08	4/1	4/30	55	1.2	11.00
	24.0	0.03	5/1	10/31	22	0.2	1.629
	24.0	0.03	11/1	11/15	55	1.2	4.125
USACE Dexter Project – 126714 - Middle Fork Willamette River RM 16.5	16.0	0.001	4/1	11/15	1002	0.7	2.453
	13.0	0.036	4/1	6/15	986	48.0	91.075

NPDES Permittee WQ File Number - EPA Number - Outfall location	Temp Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA perio d start	WLA perio d end	7Q10 River Flow (cfs)	Effluent discharg e (cfs)	7Q10 WLA (x 106 kcal/day)
ODFW Dexter Ponds - 64450 - ORG133514 - Middle Fork Willamette River RM 15.7	16.0	0.189	6/16	9/14	1002	48.0	485.541
	13.0	0.255	9/15	11/15	1301	48.0	841.641
Jasper Wood Products, LLC Outfall 001 - 100097 - OR0042994 - Middle Fork Willamette River RM 9	13.0	0.001	4/1	6/15	1097	0.01	2.684
	16.0	0.001	6/16	9/14	1089	0.01	2.664
	13.0	0.001	9/15	11/15	1589	0.01	3.888
USACE Big Cliff Project - 126715 - North Santiam River RM 58.6	16.0	0.004	4/1	11/15	859	1.1	8.418
ODFW - Minto Fish Facility - 64495 - OR0027847 - North Santiam River RM 41.13	13.0	0.03	4/1	6/15	987	30	72.446
	16.0	0.03	6/16	8/31	859	36	63.051
	13.0	0.03	9/1	11/15	957	41	70.244
Frank Lumber Co. INC. - 30904 - OR0000124 - North Santiam River RM 32.5	13.0	0.04	4/1	6/15	987	3.0	96.888
	16.0	0.04	6/16	8/31	859	3.0	84.361
	13.0	0.04	9/1	11/15	957	4.4	94.089
Stayton STP - 84781 - OR0020427 - North Santiam River RM 14.9	13.0	0.02	4/1	6/15	1482	1.8	72.607
	16.0	0.02	6/16	8/31	914	1.9	44.818
	13.0	0.02	9/1	11/15	1018	1.8	49.902
Jefferson STP - 43129 - OR0020451 - Santiam River	13.0	0.002	4/1	5/15	3275	0.6	16.029
	18.0	0.006	5/16	10/14	1144	0.8	16.806
	13.0	0.003	10/15	11/15	2278	0.6	16.725
USACE Foster Project - 126713 - South Santiam River RM 37.8	16.0	0.003	4/1	11/15	621	1.4	4.568
ODFW South Santiam Hatchery - 64560 - ORG133511 - South Santiam River RM 37.8	13.0	0.02	4/1	6/15	841	10.6	41.672
	16.0	0.02	6/16	8/31	621	25.9	31.655
	13.0	0.02	9/1	11/15	677	28.5	34.522
	13.0	0.02	4/1	6/15	841	2.6	41.280
	16.0	0.03	6/16	8/31	621	2.1	45.736

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Sweet Home STP - 86840 - OR0020346 - South Santiam River RM 31.5	13.0	0.04	9/1	11/15	667	3.5	65.620
Lebanon WWTP - 49764 - OR0020818 - South Santiam River RM 17.4	13.0	0.03	4/1	5/15	1043	4.1	76.857
Lebanon WWTP - 49764 - OR0020818 - South Santiam River RM 17.4	18.0	0.05	5/16	10/14	506	4.9	62.500
Lebanon WWTP - 49764 - OR0020818 - South Santiam River RM 17.4	13.0	0.08	10/15	11/15	726	12.3	144.510
City Of Eugene Public Library - 112467 - OR0044725 - Willamette River RM 179.5	13.0	0.001	4/1	5/15	1906	0.04	4.663
City Of Eugene Public Library - 112467 - OR0044725 - Willamette River RM 179.5	18.0	0.001	5/16	10/14	1508	0.04	3.690
City Of Eugene Public Library - 112467 - OR0044725 - Willamette River RM 179.5	13.0	0.001	10/15	11/15	1925	0.04	4.710
MWMC - Eugene/Springfield STP - 55999 - OR0031224 - Willamette River RM 178	13.0	0.118	4/1	5/15	1906	42.6	562.573
MWMC - Eugene/Springfield STP - 55999 - OR0031224 - Willamette River RM 178	18.0	0.093	5/16	10/14	1508	55.0	355.645
MWMC - Eugene/Springfield STP - 55999 - OR0031224 - Willamette River RM 178	13.0	0.188	10/15	11/15	1925	86.3	925.144
Harrisburg Lagoon Treatment Plant - 105415 - OR0033260 - Willamette River RM 158.4	13.0	0.002	4/1	4/30	5204	1.9	25.474
Harrisburg Lagoon Treatment Plant - 105415 - OR0033260 - Willamette River RM 158.4	18.0	0.004	5/1	10/31	3480	1.6	34.058
Harrisburg Lagoon Treatment Plant - 105415 - OR0033260 - Willamette River RM 158.4	13.0	0.003	11/1	11/15	3853	1.9	28.295
Cascade Pacific Pulp, LLC - 36335 - OR0001074 - Willamette River RM 147.7	13.0	0.024	4/1	5/15	5330	16.5	313.946
Cascade Pacific Pulp, LLC - 36335 - OR0001074 - Willamette River RM 147.7	18.0	0.049	5/16	10/14	3609	17.3	434.745
Cascade Pacific Pulp, LLC - 36335 - OR0001074 - Willamette River RM 147.7	13.0	0.037	10/15	11/15	4280	14.5	388.767
GP Halsey Mill - 105814 - OR0033405 - Willamette River RM 147.7	13.0	0.010	4/1	5/15	5330	5.3	130.537
GP Halsey Mill - 105814 - OR0033405 - Willamette River RM 147.7	18.0	0.016	5/16	10/14	3609	4.9	141.472
GP Halsey Mill - 105814 - OR0033405 - Willamette River RM 147.7	13.0	0.011	10/15	11/15	4280	4.0	115.297
Hollingsworth & Vose Fiber Co - Corvallis - 28476 - OR0000299 - Willamette River RM 132.5	13.0	0.001	4/1	5/15	5800	0.1	14.191
Hollingsworth & Vose Fiber Co - Corvallis - 28476 - OR0000299 - Willamette River RM 132.5	18.0	0.001	5/16	10/14	3683	0.2	9.012
Hollingsworth & Vose Fiber Co - Corvallis - 28476 - OR0000299 - Willamette River RM 132.5	13.0	0.001	10/15	11/15	4149	0.1	10.151
Corvallis STP - 20151 - OR0026361 - Willamette River RM 130.8	13.0	0.017	4/1	5/15	5800	18.9	242.027
Corvallis STP - 20151 - OR0026361 - Willamette River RM 130.8	18.0	0.017	5/16	10/14	3683	11.7	153.675
Corvallis STP - 20151 - OR0026361 - Willamette River RM 130.8	13.0	0.048	10/15	11/15	4149	33.3	491.169
	13.0	0.001	4/1	5/15	5800	0.9	14.193
	18.0	0.001	5/16	10/14	3683	1.2	9.014

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OSU John L. Fryer Aquatic Animal Health Lab - 103919 - OR0032573 - Willamette River RM 130	13.0	0.001	10/15	11/15	4149	0.9	10.153
Adair Village STP - 500 - OR0023396 - Willamette River RM 122	13.0	0.001	4/1	5/15	6308	1.3	15.437
	18.0	0.001	5/16	10/14	3877	0.2	9.486
	13.0	0.002	10/15	11/15	4443	1.3	21.747
AM WRF - Albany-Millersburg Water Reclamation Facility - 1098 - OR0028801 - Willamette River RM 118	13.0	0.010	4/1	5/15	6308	14.3	154.686
	18.0	0.017	5/16	10/14	3877	13.7	161.827
	13.0	0.037	10/15	11/15	4443	25.1	404.482
ATI Millersburg - 87645 - OR0001112 - Willamette River RM 118	13.0	0.010	4/1	5/15	6308	5.2	154.463
	18.0	0.011	5/16	10/14	3877	5.2	104.483
	13.0	0.012	10/15	11/15	4443	5.4	130.605
Independence STP - 41513 - OR0020443 - Willamette River RM 95.5	13.0	0.005	4/1	5/15	10688	3.9	130.797
	18.0	0.005	5/16	10/14	5684	3.8	69.581
	13.0	0.003	10/15	11/15	7133	6.2	52.402
Monmouth STP - 57871 - OR0020613 - Willamette River RM 95.5	13.0	0.004	4/1	5/15	10688	5.8	104.657
	18.0	0.005	5/16	10/14	5684	4.3	69.587
	13.0	0.003	10/15	11/15	7133	5.8	52.399
Salem Willow Lake STP - 78140 - OR0026409 - Willamette River RM 78.4	13.0	0.026	4/1	5/15	10688	59.5	683.684
	18.0	0.039	5/16	10/14	5684	41.1	546.289
	13.0	0.094	10/15	11/15	7133	112.5	1,666.367
Covanta Marion County Solid Waste-to-Energy Facility - 89638 - OR0031305 - Willamette River RM 72	13.0	0.001	4/1	5/15	10688	0.2	26.150
	18.0	0.002	5/16	10/14	5684	0.3	27.815
	13.0	0.001	10/15	11/15	7133	0.2	17.453
Brooks Sewage Treatment Plant - 100077 - OR0033049 - Willamette River RM 71.7	13.0	0.001	4/1	5/15	11955	1.6	29.254
	18.0	0.001	5/16	10/14	5684	0.4	13.908
	13.0	0.002	10/15	11/15	7133	1.6	34.912

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Dundee STP - 25567 - OR0023388 - Willamette River RM 51.7	18.0	0.002	6/1	9/30	5734	1.1	28.064
Newberg - Wynooski Road STP - 102894 - OR0032352 - Willamette River RM 49.7	20.0	0.006	6/1	9/30	5734	6.2	84.266
Newberg OR, LLC - 72615 - OR0000558 - Willamette River RM 49.7	20.0	0.000	6/1	9/30	5734	0.0	0.000
Century Meadows Sanitary System (CMSS) - 96010 - OR0028037 - Willamette River RM 42.8	20.0	0.001	6/1	9/30	5734	0.6	14.031
Wilsonville STP - 97952 - OR0022764 - Willamette River RM 38.5	20.0	0.005	6/1	9/30	5734	4.2	70.197
Canby STP - 13691 - OR0020214 - Willamette River RM 33	20.0	0.004	6/1	9/30	5790	3.1	56.695
Canby Regency Mobile Home Park - 97612 - OR0026280 - Willamette River RM 31.6	20.0	0.001	6/1	9/30	5790	0.06	14.166
Forest Park Mobile Village - 30554 - OR0031267 - Willamette River RM 28.2	20.0	0.001	6/1	9/30	5988	0.02	14.651
WES-Blue Heron - 72634 - OR0000566 - Willamette River RM 27.8	20.0	0.000	6/1	9/30	5988	0	0.000
Willamette Falls Paper Company - 21489 - OR0000787 - Willamette River RM 27.5	20.0	0.007	6/1	9/30	5988	6.5	102.666
WES Tri-city WPCP - 89700 - OR0031259 - Willamette River RM 25.5	20.0	0.015	6/1	9/30	5988	18.4	220.435

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Tryon Creek WWTP - 70735 - OR0026891 - Willamette River RM 20.3	20.0	0.004	6/1	9/30	6740	12.8	66.087
Oak Lodge Water Services Water Reclamation Facility - 62795 - OR0026140 - Willamette River RM 20.1	20.0	0.003	6/1	9/30	6740	4.0	49.501
WES Kellogg Creek WWTP - 16590 - OR0026221 - Willamette River RM 18.5	20.0	0.007	6/1	9/30	6740	15.5	115.699
OHSU Center For Health And Healing - 113611 - OR0034371 - Willamette River RM 14.5	20.0	0.001	6/1	9/30	6740	0.06	16.491
Univar Usa Inc - 100517 - OR0034606 - Willamette River RM 9	20.0	0.001	6/1	9/30	6740	0.04	16.491
Vigor Industrial - 70596 - OR0022942 - Willamette River RM 8.2	20.0	0.005	6/1	9/30	6740	2.4	82.482
Arkema - 68471 - OR0044695 - Willamette River RM 7.2	20.0	0.001	6/1	9/30	6740	0.14	16.491
SLLI - 74995 - OR0001741 - Willamette River RM 7	20.0	0.001	6/1	9/30	6740	0.04	16.491
Siltronic Corporation - 93450 - OR0030589 - Willamette River RM 6.6	20.0	0.007	6/1	9/30	6740	4.2	115.506
NW Natural Gas Site Remediation - 120589 - OR0044687 - Willamette River RM 6.4	20.0	0.001	6/1	9/30	6740	0.7	16.492
Evraz Oregon Steel - 64905 - OR0000451 - Willamette River RM 2.4	20.0	0.002	6/1	9/30	6740	1.2	32.987

NPDES Permittee WQ File Number - EPA Number - Outfall location	Temp Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 106 kcal/day)
Scappoose STP - 78980 - OR0022420 - Multnomah Channel RM 10.6	18.0	NA	5/15	10/15	NA	0.9	21.000

The human use allowances assigned to each point source (ΔT_{PS}) are converted to thermal wasteload allocations in terms of kcal/day by the following WLA equation (Equation 3-1, see TSD Section 9 of TSD):

Equation 3-1. WLA Equation

$$WLA = (\Delta T_{PS}) \cdot (Q_E + Q_R) \cdot C_F$$

where,

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

$\Delta T_{PS} =$ 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.

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

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

$Q_R =$ 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, Equation 3-1 may be used (see TSD Section 9).

In cases where the 7Q10 flow cannot be derived or it is otherwise inappropriate to provide thermal WLAs that vary with river flow, the WLA is derived as follows (Equation 3-2):

Equation 3-2. Alternative WLA Equation

$$WLA = A_F \cdot Q_E \cdot (T_E - T_C) \cdot C_F$$

where,

$A_F =$ Adjustment factor,

$Q_E =$ Effluent flow rate, cfs

$T_E =$ Effluent temperature, ^oC

$T_C =$ Applicable temperature criterion, ^oC

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

Equation 3-2 is used for the Scappoose STP discharge to Multnomah Channel. The 7Q10 of the tidally influenced Multnomah Channel is unknown. Therefore, the Scappoose STP is not provided a river flow based WLA. To derive a WLA for Scappoose STP that applies for all flow conditions, Equation 3-2 is applied. In this case effluent temperature was set to the maximum observed temperature in the permit evaluation report, effluent flow was set to the Permit Evaluation Report (PER) “current actual” ADWF, and an adjustment factor = 1.3 was applied to account for uncertainty.

3.1 Derivation of thermal wasteload allocations

Wasteload allocations (WLAs) for facilities covered by individual NPDES permits for Willamette Mainstem reaches were derived as follows:

1. Determine applicable criteria for all discharge locations;
2. Derive 7Q10 flow rates for each discharge location for summer non-spawning periods and, if applicable, spring and fall spawning periods;
3. Estimate point source maximum current thermal loads for summer non-spawning periods and, if applicable, spring and fall spawning periods using 7Q10 flows and applicable criteria;
4. Evaluate maximum current ΔT_{PS} values at point of discharge (see ΔT_{PS} Equation 3-3 below);
5. Set WLA equal to or greater than current ΔT_{PS} (or max acceptable ΔT_{PS}) by rounding up effluent flow and current ΔT_{PS} and, in some cases, applying explicit adjustment factors. Adjustment factors account for uncertainty associated with lack of data, mainly for small facilities (see additional information below).
6. Perform cumulative effects modeling to derive maximum cumulative ΔTs and points of Maximum Impact (POMIs);
7. Assign human use allowance (HUA), including reserve capacity;
8. Perform attainment scenario modeling to evaluate cumulative impacts on mainstem reaches of tributary load allocations (LAs) and wasteload allocations (WLAs) provided by the Willamette Subbasins TMDL plus Willamette Mainstem wasteload allocations and evaluate impacts on reserve capacity;
9. Revise mainstem WLAs and LAs and reserve capacity, as needed.

In order to estimate maximum current thermal loads, 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 (Equation 3-3), with river flow set to the applicable 7Q10 value (see TSD Section 9 for additional information):

Equation 3-3. 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:

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

Where sufficient daily or continuous (hourly or half-hourly) temperature is available, measured 7-day average effluent flow rates and 7DADM effluent temperatures were used to calculate ΔT_{PS} values for each day that data is available. The maximum observed ΔT_{PS} for the spring spawning period, summer non-spawning period, and fall spawning period indicated the effluent flow rate and temperature that corresponded to the maximum thermal load for each period.

For facilities for which sufficient daily or continuous effluent flow and temperature data were not available to do a detailed analysis, effluent flow and temperature were set to maximum values from discharge monitoring report data or other sources such as permit evaluation reports.

Derived thermal WLA values were adjusted upwards by rounding. In some case, explicit adjustment factors from 75% to 150% (0.75 to 1.50 in Table 3-2) were applied to derive WLAs. For example, in a case where adjustment factors of 1.5/1.5/1.5 are shown, assigned portions of the human use allowance and 7Q10 WLA are increased 50% from current maximum conditions for the spring spawning period, 50% for the summer non-spawning period, and 50% for the fall spawning period. In general, larger adjustment factors were applied to smaller facilities with less data to provide additional assurance that preliminary thermal wasteload allocations were set equal to or greater than current thermal loads. For two facilities with large thermal loads, adjustment factors of less than 100% were applied to reduce impacts at points of discharge to 0.20^{o}C or less and limit impacts at points of maximum impact (POMIs). For these, reductions in current thermal loads may be needed to meet assigned WLAs.

Information on derivation of thermal wasteload allocations for all individually NPDES permitted facilities which discharge to mainstem reaches is provided in Table 3-2 (grouped by receiving water and sorted by river mile). The table shows:

- **Effluent flow used for WLA** – The basis for this value (Table 3-2 column 2) is described in "Bases for derivation of WLAs" (column 6). Values are provided for Spring/Summer/Fall, if spawning is a designated use (spring spawning period/summer non-spawning period/fall spawning period). If spawning is not a designated use, then only one value is provided. This is the case for all facilities which discharge to the portion of the Willamette River impounded by Willamette Falls at Oregon City and known as Newberg Pool and the lower Willamette River downstream from Willamette Falls, including the Portland Harbor area. The effluent flow is generally rounded up to one decimal place, except for several small facilities which are rounded up to two decimal places. For larger facilities, the flow rate is usually the effluent flow rate that corresponds to the maximum 7-day average Delta T (ΔT_{PS} via Equation 3-3) for the time period (spring spawning period, summer non-spawning period, or fall spawning period). For facilities with less data and in reaches downstream from points of maximum impact, it may be the maximum measured flow rate provided in Discharge Monitoring Reports (DMRs), the maximum measured effluent flow rate as indicated by a Permit Evaluation Report (PER), the design flow rates such as the design average dry weather flow rate (ADWF), or some other method.

- **Observed or Estimated Effluent Temperature used to derive WLA** – The basis for this value (Table 3-2 column 3) is described in column 6. Like for effluent flow, for larger facilities the observed effluent temperature is usually the 7DADM effluent temperature that corresponds to the maximum 7-day average Delta T for the time period. For facilities with less data, it may be the maximum observed temperature from DMR or PER reports, a conservative maximum temperature estimated via other facilities, or some other method.
- **Effluent T that corresponds to WLA** – Due to upward rounding and application of adjustment factors, this value is generally greater than the observed effluent T. Adjustment factors are shown in column 6. For example, if adjustment factors are shown as 1.2/1.1/1.0, current WLAs were adjusted upwards 20% in spring, 10% in summer, and 0% in fall. If adjusted downward, a value less than 1.0 is shown. For example, if adjustment factors are shown as 1.0/1.0/0.75, current WLAs were not adjusted spring or summer, but reduced 25% in fall. The effluent T that corresponds to the WLA is generally the value used when performing cumulative effects modeling. In a few cases, this value is quite large (for example >> 30ºC). This is because all facilities with current maximum ΔT_{PS} less than 0.001 were provided WLAs as ΔT_{PS} of 0.001ºC. If current maximum ΔT_{PS} is quite a bit less than 0.001ºC, to produce a temperature impact of ΔT_{PS} of 0.001 may require quite a large effluent temperature. In such cases discharges were either not included in the model (some small discharges were not included in the model) or were provided an effluent temperature less than those shown that is more in line with absolute maximum temperatures expected for similar facilities. Note that, as discussed below, discharges covered by individual NPDES permits that were not included in the model comprise only 0.1% of the total thermal load from discharges covered by individual permits.
- **Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)** – This is the ΔT_{PS} that results from the Effluent Flow used for WLA (column 2) and the Observed Effluent T used to derive WLA (column 3), for 7Q10 flow conditions and with the river temperature set to the applicable criterion. Comparisons of values in Table 3-2 column 5 to values in the WLA table (Table 3-1 column 3) show that assigned human use allowances are usually greater than maximum current ΔTs. Therefore, the wasteload allocations provided are generally greater than current excess thermal loads, which indicates that most facilities likely meet WLAs provided.
- **Bases for derivation of WLAs** – For facilities with sufficient daily or continuous effluent flow and temperature to derive daily thermal loads, this column indicates "Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg flow

rate via max daily Delta T analysis." In cases where such detailed data is not available, such as many smaller facilities, other information used is indicated. Such information includes maximum measured values or values from permit evaluation reports or permits.

Table 3-2. Bases for derivation of WLAs

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
ODFW - Clackamas River Hatchery 64442 - OR0034266 Clackamas River RM 22.6	42.1	15.1	15.10	0.0717	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2020-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; WLA via adjusting and rounding up current thermal load.
	41.0	20.2	20.25	0.2601	
	42.0	17.6	17.63	0.2820	
North Clackamas County Water Commission 110117 - ORG380011 (200-J discharge) Clackamas River RM 2.75	2.49				see discussion on 200-J General NPDES permit registrants
Cottage Grove STP 20306 - OR0020559 Coast Fork Willamette River RM 20.6	2.1	17.6	17.63	0.1531	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2015-2016, 2018-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from obs T and Q
	2.8	21.0	21.00	0.2059	
Monroe STP 57951 - OR0029203 Long Tom River RM 6.9	1.2	20.8	21.37	0.0598	Basis for Max Effluent T and Flow Rate: Conservative max T and Max observed via PER; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.2/1.1/1; No discharge May-Oct; Need WLA Apr 15-30 and Nov 1-15
	0.2	27.0	27.33	0.0270	
	1.2	20.8	25.40	-0.0683	
ODFW - Leaburg Hatchery 64490 - OR0027642 - McKenzie River RM 33.7	92.4	15.0	15.03	0.0735	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2016-2017,2019-2020, 2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from obs T and Q 2016 2017 and 2023
	39.1	16.5	16.48	0.0113	
	78.3	13.6	13.57	0.0255	
ODFW - Mckenzie River Hatchery - 64500 - OR0029769 McKenzie River RM 31.5	12.7	13.3	13.39	0.0014	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2020-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round WLA derived from obs T and Q 2020-2023
	11.8	20.3	20.33	0.0328	
	1.0	14.8	16.26	0.0011	
IP Springfield Paper Mill 001+00 96244 - OR0000515 McKenzie River RM 14.7	28.9	22.2	23.26	0.1073	Basis for Max Effluent T and Flow Rate: 7DADM via max Delta T analysis, Flow weighted average for Outfall 001 + 002 and 7-day Avg via max Delta T analysis, combined flow of Outfalls 001 + 002;
	28.9	26.7	26.84	0.1966	

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
	28.9	25.0	23.91	0.2099	Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1.2/1.0175/0.908; WLAs for summer and fall adjusted to max that modeling indicates is OK
USACE Dexter Project 126714 Middle Fork Willamette River RM 16.5	0.7	17.2	17.43	0.0008	Basis for Max Effluent T and Flow Rate: Max observed T via permit application and Max observed Q via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from obs T and Q
ODFW Dexter Ponds - 64450 - ORG133514 - Middle Fork Willamette River RM 15.7	48.0	13.8	13.78	0.0353	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2016; Spring/Summer/Fall Adjustment Factors = 1/1/1; Facility receives supply-water from Dexter Reservoir. Round up WLA derived from obs T and Q 2016
	48.0	20.1	20.13	0.1885	
	48.0	20.1	20.17	0.2542	
Jasper Wood Products, LLC 100097 - OR0042994 Middle Fork Willamette River RM 9	0.01	26.0	122.70	0.0001	Basis for Max Effluent T and Flow Rate: Conservative max T est. and Total Peak Design Flow; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5; Stormwater runoff from wood treating facility and boiler condensate. Max estimated ΔT < 0.001 (round to 0.001)
	0.01	30.0	124.88	0.0001	
	0.01	26.0	171.91	0.0001	
USACE Big Cliff Project 126715 North Santiam River RM 58.6	1.1	18.8	19.13	0.0036	Basis for Max Effluent T and Flow Rate: Max observed T via permit application and Max observed Q via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = NA/1/NA; Round up WLA derived from permit app T and Q
ODFW - Minto Fish Facility 64495 - OR0027847 North Santiam River RM 41.13	30.0	13.4	14.02	0.0129	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily ETL analysis and 7-day Avg Q via max daily ETL analysis; Data years used: 2016, 2023; Spring/Summer/Fall Adjustment Factors = 1.6/1.5/NA; Allocated HUA set > max observed ΔT of 0.016 via 2016 data. Max potential ΔT due to facility = 0.069 via 2023 data. Teff < Tc all seasons in 2023
	36.0	16.4	16.75	0.0152	
	41.0	12.7	13.73	-0.0108	
Frank Lumber Co. Inc. 30904 - OR0000124 North Santiam River RM 32.5	3.0	22.5	26.20	0.0288	Basis for Max Effluent T and Flow Rate: Max observed T from limited data and Max daily Q from limited data; Data years used: 2015-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1; Round up from WLA based on obs T and Q
	3.0	24.5	27.49	0.0296	
	4.4	19.7	21.74	0.0307	
	1.8	22.2	29.49	0.0111	

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
Stayton STP 84781 - OR0020427 North Santiam River RM 14.9	1.9	22.5	25.64	0.0135	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily ETL analysis and 7-day Avg Q via max daily ETL analysis; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; Round up from WLA based on obs T and Q
	1.8	22.2	24.33	0.0162	
Jefferson STP 43129 - OR0020451 Santiam River (enters WR at RM 109) RM 9.2	0.6	18.0	23.92	0.0009	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily ETL analysis and 7-day Avg Q via max daily ETL analysis; Data years used: 2018-2020; Spring/Summer/Fall Adjustment Factors = 1.3/1.1/1.3; Round up from WLA based on obs T and Q
	0.8	25.5	26.59	0.0052	
	0.6	19.0	24.39	0.0016	
USACE Foster Project 126713 South Santiam River RM 37.8	1.4	17.2	17.33	0.0026	Basis for Max Effluent T and Flow Rate: Max observed T via permit application and Max observed Q via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = NA/1/NA; Round up WLA derived from permit app T and Q
ODFW South Santiam Hatchery 64560 - ORG133511 South Santiam River RM 37.8	10.6	11.6	14.61	-0.0178	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2016; Spring/Summer/Fall Adjustment Factors = NA/NA/NA; Effluent T never exceeds criterion and is less than u/s river T. Small allocation provided. Covered by 300-J General Permit
	25.9	11.3	16.50	-0.1898	
	28.5	11.6	13.50	-0.0557	
Sweet Home STP 86840 - OR0020346 South Santiam River RM 31.5	2.6	16.4	19.49	0.0106	Basis for Max Effluent T and Flow Rate: Max monthly T and Max monthly Q; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1.2/1.2/1; Round up from WLA based on obs T and Q
	2.1	22.6	24.90	0.0223	
	3.5	20.6	20.66	0.0397	
Lebanon WWTP 49764 - OR0020818 South Santiam River RM 17.4	4.1	18.2	20.66	0.0205	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2012-2016; Spring/Summer/Fall Adjustment Factors = 1.2/1.2/1; Round up from WLA based on obs T and Q
	4.9	21.7	23.21	0.0355	
	12.3	17.8	17.80	0.0800	
City Of Eugene Public Library 112467 - OR0044725 Willamette River RM 179.5	0.04	14.0	60.65	0.00002	Basis for Max Effluent T and Flow Rate: Via PER: treated 13°C groundwater will likely gain assumed max 3°C during treatment. and PER existing 95th percentile flow; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.5/1/1.5; Small allocation provided. Max estimated ΔT < 0.001 (round to 0.001)
	0.04	16.0	55.70	-0.00005	
	0.04	14.0	61.13	0.00002	

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
MWMC - Eugene/Springfield STP 55999 - OR0031224 Willamette River RM 178	42.6	18.4	18.40	0.1175	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1/1/0.75; Round up from WLA based on obs T and Q. Significant impacts at POMI.
	55.0	20.6	20.64	0.0927	
	86.3	18.8	17.38	0.2503	
Harrisburg Lagoon Treatment Plant 105415 - OR0033260 Willamette River RM 158.4	1.9	17.1	18.48	0.0015	Basis for Max Effluent T and Flow Rate: Conservative max T and Max Q for Sewage - less than 1 MGD flow permit category; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.2/NA/1.2; No discharge May-Oct; Need WLA Apr 15-30 and Nov 1-15; WLA also provided for May-Oct if needed.
	1.6	27.0	26.70	0.0041	
	1.9	17.1	19.09	0.0020	
Cascade Pacific Pulp 36335 - OR0001074 Willamette River RM 147.7	16.5	20.5	20.78	0.0230	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2014-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on obs T and Q
	17.3	28.1	28.27	0.0482	
	14.5	23.9	23.96	0.0370	
GP Halsey Mill 105814 - OR0033405 Willamette River RM 147.7	5.3	22.3	23.07	0.0093	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2022-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on obs T and Q
	4.9	29.2	29.80	0.0152	
	4.0	24.1	24.78	0.0104	
Hollingsworth & Vose Fiber Co – Corvallis 28476 - OR0000299 Willamette River RM 132.5	0.1	23.4	71.00	0.0002	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2018-2020; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5; Round up from WLA based on obs T and Q - use adj factor to account for 2006 WLA and uncertainty. Max estimated ΔT < 0.001 (round to 0.001)
	0.2	23.4	36.42	0.0003	
	0.1	14.0	54.49	0.0000	
Corvallis STP 20151 - OR0026361 Willamette River RM 130.8	18.9	17.5	18.23	0.0146	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2014-2022; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; Round up WLA derived from 2014-2022 obs T and Q; Expanded analysis time period (Apr 1 - Nov 15).
	11.7	22.6	23.37	0.0146	
	33.3	18.4	19.03	0.0429	
OSU John L. Fryer Aquatic Animal Health Lab	0.9	17.7	19.45	0.0007	Basis for Max Effluent T and Flow Rate: Max observed 7DADM T and Max observed 7-d Avg Q; Data years used: 2019-2020; Spring/Summer/Fall Adjustment Factors = 1.2/1.5/1.5; Round up
	1.2	18.7	21.07	0.0002	

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
103919 - OR0032573 Willamette River RM 130	0.9	14.6	17.61	0.0003	from WLA based on obs 2019-2020 T and Q. Max values used via 2 years NetDMR data. Max estimated ΔT < 0.001 (round to 0.001)
Adair Village STP 500 - OR0023396 Willamette River RM 122	1.3	16.0	17.85	0.0006	Basis for Max Effluent T and Flow Rate: Conservative max T and Design Average Dry Weather Flow ADWF; Data years used: ; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5; No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15. WLA also provided for May-Oct if needed.
	0.2	27.0	37.39	0.0005	
	1.3	16.0	19.84	0.0009	
AM WRF - Albany-Millersburg Water Reclamation Facility 1098 - OR0028801 Willamette River RM 118	14.3	17.3	17.42	0.0097	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2013-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on obs T and Q. AM WRF and ATI Millersburg discharge to the same outfall but each is assigned its own WLA.
	13.7	22.5	22.83	0.0160	
	25.1	19.4	19.59	0.0362	
ATI Millersburg 87645 - OR0001112 Willamette River RM 118	5.2	24.0	25.14	0.0090	Basis for Max Effluent T and Flow Rate: Highest 7 day average effluent temperature based on data provided by permittee and calculations provided by DEQ permitting. and Highest 7 day average effluent flow based on data provided by permittee and calculations provided by DEQ permitting; Data years used: 2019-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA based on obs T and Q by DEQ permitting. AM WRF and ATI Millersburg discharge to the same outfall but each is assigned its own WLA.
	5.2	26.0	26.21	0.0107	
	5.4	22.1	22.89	0.0110	
Independence STP 41513 - OR0020443 Willamette River RM 95.5	3.9	23.8	26.71	0.0039	Basis for Max Effluent T and Flow Rate: Max observed T (limited data) and Max observed Q (limited data); Data years used: 2015, 2016, 2019; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30. WLA also provided for Jun-Oct if needed.
	3.8	23.9	25.48	0.0039	
	6.2	16.1	16.45	0.0027	
Monmouth STP 57871 - OR0020613 Willamette River RM 95.5	5.8	19.4	20.38	0.0035	Basis for Max Effluent T and Flow Rate: Set to estimated max T (limited data) and Max observed Q (limited data); Data years used: 2019-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30. WLA also provided for Jun-Oct if needed.
	4.3	24.0	24.61	0.0045	
	5.8	16.0	16.69	0.0024	
	59.5	17.04	17.70	0.0224	

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
Salem Willow Lake STP 78140 - OR0026409 Willamette River RM 78.4	41.1	22.86	23.43	0.0349	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2014-2023; Spring/Summer/Fall Adjustment Factors = 1.15/1.1/1.1; Round up from WLA based on 2014-2023 obs T and Q. Expanded analysis time period (Apr 1 - Nov 15).
	112.5	18.46	19.05	0.0847	
Covanta Marion County Solid Waste-to-Energy Facility 89638 - OR0031305 Willamette River RM 72	0.2	36.0	66.44	0.0004	Basis for Max Effluent T and Flow Rate: Max observed T (limited data) and Max observed Q (limited data); Data years used: 2019-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on obs T and Q
	0.3	42.0	55.90	0.0013	
	0.2	36.0	48.67	0.0006	
Brooks Sewage Treatment Plant 100077 - OR0033049 Willamette River RM 71.7	1.6	18.6	20.47	0.0007	Basis for Max Effluent T and Flow Rate: Conservative max T and Design Average Dry Weather Flow ADWF; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.3/1.3/1.3; No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15. WLA also provided for May-Oct if needed.
	0.4	27.0	32.21	0.0006	
	1.6	18.6	21.92	0.0013	
Dundee STP 25567 - OR0023388 Willamette River RM 51.7	1.1	22.5	28.43	0.0009	Basis for Max Effluent T and Flow Rate: Max observed 7DADM T (limited data) and PER current actual ADWF; Data years used: 2018-2020; Adjustment Factor = 1.2; WLA using PER Actual ADWF effluent flow rate and current T - round up
Newberg - Wynooski Road STP 102894 - OR0032352 Willamette River RM 49.7	6.2	24.3	25.56	0.0046	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2017-2020; Adjustment Factor = 1.2; WLA using ADWF effluent flow rate and current T - round up
Newberg OR, LLC 72615 - OR0000558 Willamette River RM 49.7	0.0	NA	NA	NA	Basis for Max Effluent T and Flow Rate: NA and ; Data years used: NA; Adjustment Factor = NA; WLA set to zero since facility no longer active
Century Meadows Sanitary System (CMSS) 96010 - OR0028037 Willamette River RM 42.8	0.6	23.3	29.56	0.0003	Basis for Max Effluent T and Flow Rate: Max observed T (limited data) and Max observed Q (limited data); Data years used: 2017-2020; Adjustment Factor = 1.5; Round up from WLA based on obs T and Q. Max estimated ΔT < 0.001 (round to 0.001)

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
Wilsonville STP 97952 - OR0022764 Willamette River RM 38.5	4.2	25.1	26.83	0.0038	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2007-2011, 2020; Adjustment Factor = 1.1; Round up from WLA based on obs T and Q
Canby STP 13691 - OR0020214 Willamette River RM 33	3.1	26.4	27.47	0.0034	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2014-2016, 2018-2020; Adjustment Factor = 1.1; Round up from WLA based on obs T and Q
Canby Regency Mobile Home Park 97612 - OR0026280 Willamette River RM 31.6	0.06	21.7	116.50	0.0000	Basis for Max Effluent T and Flow Rate: PER max observed T and Max observed Q (limited data); Data years used: 2016-2020; Adjustment Factor = 1.5; Round up from WLA based on obs T and Q. Max estimated ΔT < 0.001 (round to 0.001)
Forest Park Mobile Village 30554 - OR0031267 Willamette River RM 28.2	0.02	28.0	319.41	0.0000	Basis for Max Effluent T and Flow Rate: Conservative max T and Max observed Q (limited data); Data years used: ; Adjustment Factor = 1.5; Round up from WLA based on obs T and Q. Max estimated ΔT < 0.001 (round to 0.001)
WES - Blue Heron 72634 - OR0000566 Willamette River RM 27.8	0.0	NA	NA	NA	Basis for Max Effluent T and Flow Rate: NA and NA; Data years used: ; Adjustment Factor = ; WLA set to zero since facility no longer active
Willamette Falls Paper Company 21489 - OR0000787 Willamette River RM 27.5	6.5	25.5	26.46	0.0060	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2019-2020; Adjustment Factor = 1.1; Round up from WLA based on obs T and Q
WES Tri-City WPCP 89700 - OR0031259 Willamette River RM 25.5	18.4	24.7	24.90	0.0145	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2015-2020; Adjustment Factor = 1; Round up from WLA based on obs T and Q
Tryon Creek WWTP 70735 - OR0026891 Willamette River RM 20.3	12.8	22.0	22.11	0.0038	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2012-2016; Adjustment Factor = 1; Round up from WLA based on obs T and Q

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
Oak Lodge Water Services Water Reclamation Facility 62795 - OR0026140 Willamette River RM 20.1	4.0	23.6	25.06	0.0021	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Permit Evaluation Report Current Actual ADWF; Data years used: 2019-2020; Adjustment Factor = 1; Increase to similar 2006 WLA
WES Kellogg Creek Water Resource Recovery Facility 16590 - OR0026221 Willamette River RM 18.5	15.5	22.6	23.05	0.0060	Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Flow via Design Average Dry Weather Flow; Data years used: 2015-2020; Adjustment Factor = 1; Increase to similar 2006 WLA
OHSU Center For Health And Healing 113611 - OR0034371 Willamette River RM 14.5	0.06	32.0	132.34	0.0001	Basis for Max Effluent T and Flow Rate: Conservative max T and Flow via DMR Summer Max 7-day average flow rate (limited data); Data years used: NA; Adjustment Factor = 1.5; Obs T does not exceed 18 so WLA may not needed. WLA using current effluent flow rate and max acute T - round up. Max estimated ΔT < 0.001 (round to 0.001)
Univar USA Inc 100517 - OR0034606 Willamette River RM 9	0.04	32.0	188.50	0.0001	Basis for Max Effluent T and Flow Rate: Conservative max T and Max observed Q (limited data); Data years used: NA; Adjustment Factor = 1.5; WLA using current effluent flow rate and T=32 - round up. Max estimated ΔT < 0.001 (round to 0.001)
Vigor Industrial 70596 - OR0022942 Willamette River RM 8.2	2.4	32.0	34.05	0.0043	Basis for Max Effluent T and Flow Rate: Estimated Max via PER and DMRs and Estimated Max via PER and DMRs; Data years used: NA; Adjustment Factor = 1; WLA based on limited data in PERs. Effluent T=32 - round up
Arkema 68471 - OR0044695 Willamette River RM 7.2	0.14	32.1	68.14	0.0003	Basis for Max Effluent T and Flow Rate: Max observed T and Max observed Q; Data years used: 2015-2020; Adjustment Factor = 1.5; Round up from WLA based on obs T and Q. Max estimated ΔT < 0.001 (round to 0.001)
SLLI 74995 - OR0001741 Willamette River RM 7	0.04	32.0	188.50	0.0001	Basis for Max Effluent T and Flow Rate: Conservative max T and Max permitted Q; Data years used: NA; Adjustment Factor = 1.5; Round up from WLA based on obs T and Q. Max estimated ΔT < 0.001 (round to 0.001)

NPDES Permittee WQ File Number - EPA Number Outfall location	Effluent Flow used for WLA (cfs)	Observed or Estimated Effluent Temperature used to derive WLA (ºC)	Effluent T that corresponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
Siltronic Corporation 93450 - OR0030589 Willamette River RM 6.6	4.2	30.4	31.24	0.0065	Basis for Max Effluent T and Flow Rate: Max combined outfall T and Max combined outfall Q; Data years used: 2004-2017; Adjustment Factor = 1; WLA using design ADWF effluent flow rate and current T - round up
NW Natural Gas Site Remediation 120589 - OR0044687 Willamette River RM 6.4	0.7	19.4	29.63	-0.0001	Basis for Max Effluent T and Flow Rate: Max observed T is less than 20C criterion and Max observed Q; Data years used: 2015-2020; Adjustment Factor = 1.5; Observed T < 20C criterion. WLA using current effluent flow rate and T=22C. Max estimated ΔT < 0.001 (round to 0.001)
Evraz Oregon Steel 64905 - OR0000451 Willamette River RM 2.4	1.2	25.9	31.24	0.0011	Basis for Max Effluent T and Flow Rate: Max observed T and Permit max allowed Q; Data years used: NA; Adjustment Factor = 1.1; Round up from WLA based on obs T and Q
Scappoose STP 78980 - OR0022420 Multnomah Channel RM 10.6	0.9	25.0	25.00	0.5780	Basis for Max Effluent T and Flow Rate: PER max observed T and PER current actual ADWF; Data years used: NA; Adjustment Factor = 1.3; WLA using PER current ADWF effluent flow rate and PER max current T. Since 7Q10 unknown and model shows 2015 impacts of all pt sources in Mult Channel <0.10 C, flow based WLAs not provided. See Equation 3-2.

3.2 Summaries of bases for thermal wasteload allocations

Wasteload allocations (WLAs) for facilities covered by individual NPDES permits for Willamette Mainstem reaches, as well as for several facilities covered by 200-J and 300-J general NPDES permits, were derived as described below (facilities in alphabetical order). Section headers show NPDES permittee name, DEQ Water Quality file number, EPA permit number, and outfall location. The five largest facilities; IP Springfield paper mill, Salem Willow Lake STP, Cascade Pacific Pulp, MWMC Eugene/Springfield STP, and Wes Tri-City WPCP; provide more than half of the allocated total excess thermal load to the system. WLAs for summer 7Q10 conditions for these facilities range from 220 to 766 million kcal/day and allocated HUAs range from 0.015 to 0.20ºC. Several other facilities which discharge to lower flow reaches, while provided smaller WLAs in terms of excess thermal loads, are provided relatively large portions of the HUA. These include Cottage Grove STP, which discharges to the Coast Fork Willamette River and is provided 0.206ºC of the HUA, and Lebanon WWTP, which discharges to the South Santiam River and is provided 0.05ºC of the HUA. The information is this section below is duplicated in TSD Section 9.2.

As described above, derived maximum thermal WLA values for current conditions were adjusted upwards by rounding. In some case, explicit adjustment factors from 75% to 150% (0.75 to 1.50) were applied to derive WLAs. For example, in a case where adjustment factors of 1.5/1.5/1.5 are shown, assigned portions of the human use allowance and 7Q10 WLA are increased 50% from current maximum conditions for the spring spawning period, 50% for the summer non-spawning period, and 50% for the fall spawning period. For two facilities with large thermal loads, adjustment factors of less than 100% were applied to reduce impacts at points of discharge to 0.20ºC or less and limit impacts at points of maximum impact (POMIs). For these, reductions in current thermal loads may be needed to meet assigned WLAs.

Delta T (ΔT_{PS}) values described below are derived using Equation 3-3. Therefore, river flow is the applicable 7Q10 river flow condition and river temperature is the applicable criterion, so ΔT_{PS} is a maximum Delta T value.

3.2.1 Adair Village STP - 500 - OR0023396

Basis for maximum effluent temperature and flow rate: Conservative maximum temperature and Design Average Dry Weather Flow ADWF; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5 (assigned portions of the human use allowance and 7Q10 WLA increased 50% from current maximum conditions for the spring spawning period, 50% for the summer non-spawning period, and 50% for the fall spawning period); No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15. WLA also provided for May-Oct if needed.

3.2.2 AM WRF - Albany-Millersburg Water Reclamation Facility - 1098 - OR0028801

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis (Delta T = ΔT_{PS} via Equation 3-3); Data years used: 2013-2020. For summer, the maximum ΔT_{PS} for AM WRF occurred on 2013-09-11 (7-day average Q_E= 13.70 cfs, 7DADM T_E= 22.55ºC, ΔT_{PS}= 0.016ºC).

Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on observed temperature and flow rate. AM WRF and ATI Millersburg discharge to the same outfall but each is assigned its own WLA.

3.2.3 Arkema - 68471 - OR0044695

Basis for maximum effluent temperature and flow rate: Maximum observed temperature and Maximum observed flow rate; Data years used: 2015-2020; Adjustment Factor = 1.5; Round up from WLA based on observed temperature and flow rate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.4 ATI Millersburg - 87645 - OR0001112

Basis for maximum effluent temperature and flow rate: Data provided by permittee and calculations provided by DEQ permitting; Data years used: 2019-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA based on observed temperature and flow rate by DEQ permitting. AM WRF and ATI Millersburg discharge to the same outfall but each is assigned its own WLA.

3.2.5 Brooks Sewage Treatment Plant - 100077 - OR0033049

Basis for maximum effluent temperature and flow rate: Conservative maximum temperature and Design Average Dry Weather Flow ADWF; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.3/1.3/1.3; No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15. WLA also provided for May-Oct if needed.

3.2.6 Canby Regency Mobile Home Park - 97612

Basis for maximum effluent temperature and flow rate: DEQ Permit Evaluation Report (PER) maximum observed temperature and Maximum observed flow rate (limited data); Data years used: 2016-2020; Adjustment Factor = 1.5; Round up from WLA based on observed temperature and flow rate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.7 Canby STP - 13691 - OR0020214

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2014-2016, 2018-2020; Adjustment Factor = 1.1; Round up from WLA based on observed temperature and flow rate.

3.2.8 Cascade Pacific Pulp, LLC - 36335 - OR0001074

Cascade Pacific Pulp provides relatively large excess thermal loads to the Willamette River (similar to those from Salem Willow Lake and MWMC Eugene/Springfield municipal WWTPs). The facility discharges upstream from the point of maximum impact (POMI) of point sources, which occurs between RM 115 and the confluence of the Santiam River at RM 109, and contributes to temperature impacts at the POMI. Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2014-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on observed temperature and flow rate. For summer, the maximum ΔT_{PS} for Cascade Pacific Pulp occurred on 2015-07-09 (7-day average Q_E= 17.3 cfs, 7DADM T_E= 28.1ºC, ΔT_{PS}= 0.048ºC).

3.2.9 Century Meadows Sanitary System (CMSS) - 96010 - OR0028037

Basis for maximum effluent temperature and flow rate: Maximum observed T (limited data) and Maximum observed flow rate (limited data); Data years used: 2017-2020; Adjustment Factor = 1.5; Round up from WLA based on observed temperature and flow rate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.10 City Of Eugene Public Library - 112467 - OR0044725

Basis for maximum effluent temperature and flow rate: Via PER: treated 13°C groundwater will likely gain assumed maximum 3°C during treatment. and PER existing 95th percentile flow; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.5/1/1.5; Small allocation provided. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.11 Corvallis STP - 20151 - OR0026361

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2014-2022; Date of max Delta T for time period 2022-07-19, 7-day Avg Flow for date of max Delta T = 11.62 cfs, 7DADM T for date of max Delta T = 22.61ºC, Max ΔT_{PS} = 0.0145ºC; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; Round up WLA derived from 2014-2022 observed temperature and flow rate; Expanded analysis time period (Apr 1 - Nov 15).

3.2.12 Cottage Grove STP - 20306 - OR0020559

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2015-2016, 2018-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from observed temperature and flow rate.

3.2.13 Covanta Marion County Solid Waste-to-Energy Facility - 89638 - OR0031305

Basis for maximum effluent temperature and flow rate: Maximum observed T (limited data) and Maximum observed flow rate (limited data); Data years used: 2019-2020; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on observed temperature and flow rate

3.2.14 Dundee STP - 25567 - OR0023388

Basis for maximum effluent temperature and flow rate: Maximum observed 7DADM temperature (limited data) and PER current actual ADWF; Data years used: 2018-2020; Adjustment Factor = 1.2; WLA using PER Actual ADWF effluent flow rate and current T - round up

3.2.15 Evraz Oregon Steel - 64905 - OR0000451

Basis for maximum effluent temperature and flow rate: Maximum observed T and Permit maximum allowed flow rate; Data years used: NA; Adjustment Factor = 1.1; Round up from WLA based on observed temperature and flow rate.

3.2.16 Forest Park Mobile Village - 30554 - OR0031267

Basis for maximum effluent temperature and flow rate: Conservative maximum T and Maximum observed flow rate (limited data); Adjustment Factor = 1.5; Round up from WLA based on observed temperature and flow rate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.17 Frank Lumber Co. Inc. - 30904 - OR0000124

Basis for maximum effluent temperature and flow rate: Maximum observed T from limited data and Maximum daily flow rate from limited data; Data years used: 2015-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1; Round up from WLA based on observed temperature and flow rate.

3.2.18 GP Halsey Mill - 105814 - OR0033405

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2022-2023; Date of max Delta T for time period 2022-08-01, 7-day Avg Flow for date of max Delta T = 4.85 cfs, 7DADM T for date of max Delta T = 29.2C, ΔT_{PS} = 0.0150°C; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up from WLA based on observed temperature and flow rate.

3.2.19 Harrisburg Lagoon Treatment Plant - 105415 - OR0033260

Basis for maximum effluent temperature and flow rate: Conservative maximum T and Maximum flow rate for Sewage - less than 1 MGD flow permit category; Spring/Summer/Fall Adjustment Factors = 1.2/NA/1.2; No discharge May-Oct; Need WLA Apr 15-30 and Nov 1-15; WLA also provided for May-Oct if needed.

3.2.20 Hollingsworth & Vose Fiber Co - Corvallis - 28476 - OR0000299

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2018-2020; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5; Round up from WLA based on observed temperature and flow rate - use adj factor to account for 2006 WLA and uncertainty. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.21 Independence STP - 41513 - OR0020443

Basis for maximum effluent temperature and flow rate: Maximum observed T (limited data) and Maximum observed flow rate (limited data); Data years used: 2015, 2016, 2019; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30. WLA also provided for Jun-Oct if needed.

3.2.22 IP Springfield Paper Mill 001+002 - 96244 - OR0000515

IP Springfield is provided the largest WLAs of all facilities included in Willamette Mainstem model reaches. TSD Appendix L describes derivation of WLAs for McKenzie River reaches that are modeled using the McKenzie River CE-QUAL-W2 model, including IP Springfield. WLAs for IP Springfield are provided for Outfall 001 and 002 combined. WLAs for summer and fall are set to the maximums that modeling indicates are acceptable, based on impacts on the McKenzie River. For the summer non-spawning period, the portion of the HUA assigned is 0.20°C. For the fall spawning period, the portion of the HUA assigned is 0.19°C. During the spring, calculated current impacts are less and the portion of the HUA assigned is set 20% greater than calculated current impacts. Based on data provided by IP Springfield for 2017-2020, during the summer the maximum ΔT_{PS} of outfall 001 occurred on 2018-07-18 (Q_E=20.70 cfs, T_E=27.6°C, ΔT_{PS}=0.154°C) and the maximum ΔT_{PS} of outfall 002 occurred on 2020-07-28 (Q_E=8.16 cfs, T_E=24.3°C, ΔT_{PS}=0.044°C). Spring/Summer/Fall adjustment factors = 1.2/1.0175/0.908. Therefore, during the spring the WLA is set 20% greater than calculated current impacts, during the summer the WLA is set slightly greater than calculated current impacts, and during the fall the WLA is set about 10% less than current impacts. As discussed in TSD Appendix L, the permittee has indicated that calculated current ΔT_{PS} values likely underestimate actual effluent impacts. 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.

3.2.23 Jasper Wood Products, LLC - 100097 - OR0042994

Basis for maximum effluent temperature and flow rate: Conservative maximum estimated temperature and Total Peak Design Flow; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.5/1.5/1.5; Stormwater runoff from wood treating facility and boiler condensate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.24 Jefferson STP - 43129 - OR0020451

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily ETL analysis and 7-day Avg flow rate via maximum daily ETL analysis; Data years used: 2018-2020; Spring/Summer/Fall Adjustment Factors = 1.3/1.1/1.3; Round up from WLA based on observed temperature and flow rate.

3.2.25 Lebanon WWTP - 49764 - OR0020818

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2012-2016; Spring/Summer/Fall Adjustment Factors = 1.2/1.2/1; Round up from WLA based on observed temperature and flow rate.

3.2.26 Lowell STP – 51447 - OR0020044

The City of Lowell treats wastewater and discharges it into the penstock of Dexter Dam on the Middle Fork Willamette River. WLAs for this facility were provided in the Willamette Subbasins temperature TMDL, prior to amendments to address Willamette Mainstem reaches (including the Middle Fork Willamette River downstream from Dexter Dam). Therefore, this facility is discussed in the main body of the TSD and not in this appendix. 0.013^{o}C of the HUA was provided to this facility as a WLA.

3.2.27 Monmouth STP - 57871 - OR0020613

Basis for maximum effluent temperature and flow rate: Set to estimated maximum T (limited data) and Maximum observed flow rate (limited data); Data years used: 2019-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30. WLA also provided for Jun-Oct if needed.

3.2.28 Monroe STP - 57951 - OR0029203

Basis for maximum effluent temperature and flow rate: Conservative maximum T and Maximum observed via PER; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1.2/1.1/1; No discharge May-Oct; Need WLA Apr 15-30 and Nov 1-15.

3.2.29 MWMC - Eugene/Springfield STP - 55999

MWMC Eugene/Springfield STP is the second largest municipal WWTP source of excess thermal load to the Willamette River (after Salem Willow Lake STP). The facility discharges upstream from the point of maximum impact (POMI) of point sources, which occurs between RM 115 and the confluence of the Santiam River at RM 109, and, therefore, contributes to temperature impacts at the POMI. Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: DMS data from 2012-2016 and daily values from 2017-2020; Spring/Summer/Fall Adjustment Factors = 1/1/0.75; Round up from WLA based on observed temperature and flow rate. For summer, the maximum ΔT_{PS} for MWMC occurred on 2019-09-19 (7-day average Q_E= 55.0 cfs, 7DADM T_E= 20.63^{o}C, ΔT_{PS}= 0.0927^{o}C). For fall spawning period, the maximum ΔT_{PS} occurred on 2016-10-21 (7-day average Q_E= 86.3 cfs, 7DADM T_E= 18.8^{o}C, ΔT_{PS}= 0.25^{o}C). For the fall spawning period, a 0.75 adjustment factor (25% reduction from maximum current impacts) applied to limit immediate impact to less than 0.19^{o}C.

3.2.30 Newberg - Wynooski Road STP - 102894 - OR0032352

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2017-2020; Adjustment Factor = 1.2; WLA using ADWF effluent flow rate and current T - round up.

3.2.31 Newberg OR, LLC - 72615 - OR0000558

WLA set to zero since facility no longer active.

3.2.32 North Clackamas County Water Commission - 110117 - ORG380011

This has a relatively large potential impact for a 200-J General NPDES permit registrant (Industrial Wastewater: NPDES filter backwash). See discussion on WLAs for facilities covered by General NPDES permits (TSD Section 7.1.2).

3.2.33 NW Natural Gas Site Remediation - 120589 - OR0044687

Basis for maximum effluent temperature and flow rate: Maximum observed T is less than 20ºC criterion and Maximum observed flow rate; Data years used: 2015-2020; Adjustment Factor = 1.5; Observed T < 20C criterion. WLA using current effluent flow rate and T=22C. Maximum estimated ΔT_{PS} < 0.001. Round assigned HUA to 0.001.

3.2.34 Oak Lodge Water Services Water Reclamation Facility - 62795 - OR0026140

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and Permit Evaluation Report Current Actual ADWF; Data years used: 2019-2020; Adjustment Factor = 1; WLA increased to similar to 2006 WLA.

3.2.35 ODFW - Clackamas River Hatchery - 64442 - OR0034266

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2020-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; WLA via adjusting and rounding up current thermal load. Assigned HUA and maximum fish hatchery impacts on river temperature are shown by Table 3-3, columns 2 and 5. The assigned HUA (0.072ºC during spring spawning period, 0.261ºC during the summer, and 0.283ºC during the fall spawning period) is relatively large because the temperature of diverted river water exceeds applicable criteria, which results in relatively large ΔT_{PS} values as calculated via Equation 3-3. However, the maximum amount of potential river temperature increase due to heating of river water as it passes through the hatchery (0.007ºC during spring spawning period, 0.024ºC during the summer, and 0.015ºC during the fall spawning period) is considerably less (Table 3-3, column 5). This indicates that most of the excess thermal load is due to river temperature upstream from the hatchery exceeding criteria rather than heating by the hatchery.

3.2.36 ODFW Leaburg Hatchery - 64490 - OR0027642

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2016-2017,2019-2020, 2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from observed temperature and flow rate 2016 2017 and 2023. For additional information, see Section 3.4 Fish Hatcheries and TSD Appendix L, which describes derivation of WLAs for McKenzie River reaches that are modeled using the McKenzie River CE-QUAL-W2 model.

3.2.37 ODFW McKenzie River Hatchery - 64500 - OR0029769

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2020-2023; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round WLA derived from observed temperature and flow rate 2020-2023. For additional information, see Section 3.4 Fish Hatcheries and TSD Appendix L, which describes derivation of WLAs for McKenzie River reaches that are modeled using the McKenzie River CE-QUAL-W2 model.

3.2.38 ODFW Minto Fish Facility - 64495 - OR0027847

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily ETL analysis and 7-day Avg flow rate via maximum daily ETL analysis; Data years used: 2016, 2023; Spring/Summer/Fall Adjustment Factors = 1.6/1.5/NA; Allocated HUA set > maximum observed ΔT_{PS} of 0.016 via 2016 data. Maximum potential ΔT due to facility = 0.069 via 2023 data, however $T_E < T_C$ for all seasons in 2023. Data from 2023 indicates that the facility could warm pass-through water up to 1.63°C during the summer which, after dilution, could increase river temperature up to 0.068°C (Table 3-3). This increase could exceed the allocated HUA of 0.03°C. However, in 2023 effluent temperature never exceeded applicable criteria. Therefore, the excess thermal load of the discharge did not exceed 0.00°C and the 0.03°C based wasteload allocation was not exceeded.

3.2.39 ODFW Dexter Ponds - 64450 - ORG133514

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2016; Spring/Summer/Fall Adjustment Factors = 1/1/1; Facility receives supply-water from Dexter Reservoir. Round up WLA derived from observed temperature and flow rate 2016. Assigned HUA and maximum fish hatchery impacts on river temperature are shown by Table 3-3, columns 2 and 5. The assigned HUA (0.036°C during spring spawning period, 0.189°C during the summer, and 0.255°C during the fall spawning period) is relatively large because the temperature of diverted river water exceeds applicable criteria, which results in relatively large ΔT_{PS} values as calculated via Equation 3-3. However, the maximum amount of potential river temperature increase due to heating of river water as it passes through the hatchery (0.000°C during the summer and 0.004 °C during the fall spawning period) is considerably less (Table 3-3, column 5). This indicates that most of the excess thermal load is due to supply-water from Dexter Reservoir exceeding criteria rather than heating by the hatchery.

3.2.40 ODFW South Santiam Hatchery - 64560 - ORG133511

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2016; Spring/Summer/Fall Adjustment Factors = NA/NA/NA; Effluent T never exceeds criterion and is less than u/s river T. Small allocation provided. This facility is covered by 300-J General Permit. For a discussion of this and other WLAs for fish hatcheries, see Section 3.4 Fish Hatcheries.

3.2.41 OHSU Center For Health And Healing - 113611

Basis for maximum effluent temperature and flow rate: Conservative estimated maximum effluent temperature and flow via DMR Summer Max 7-day average flow rate (limited data); Data years used: NA; Adjustment Factor = 1.5; observed temperature does not exceed 18°C so WLA not needed. WLA using current effluent flow rate and maximum acute T - round up. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.42 OSU John L. Fryer Aquatic Animal Health Lab - 103919 - OR0032573

Basis for maximum effluent temperature and flow rate: Maximum observed 7DADM temperature and Maximum observed 7-d Avg flow rate; Data years used: 2019-2020; Spring/Summer/Fall

Adjustment Factors = 1.2/1.5/1.5; Round up from WLA based on observed 2019-2020 T and flow rate. Maximum values used via 2 years NetDMR data. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.43 Salem Willow Lake STP - 78140 - OR0026409

Salem Willow Lake STP is provided the second largest WLAs of facilities included in Willamette Mainstem model reaches. Since Salem discharges downstream the point of maximum impact (POMI) of point sources, which occurs between RM 115 and the confluence of the Santiam River at RM 109, modeling indicates that the facility can be provided WLAs slightly greater than current ETLs. Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2014-2023; Spring/Summer/Fall Adjustment Factors = 1.15/1.1/1.1; Round up from WLA based on 2014-2023 observed temperature and flow rate. Expanded analysis time period (Apr 1 - Nov 15). For summer, the maximum ΔT_{PS} occurred on 2014-08-29 (Q_E=41.07 cfs, T_E=22.86ºC, ΔT_{PS}=0.0348ºC).

3.2.44 Scappoose STP - 78980 - OR0022420

Basis for maximum effluent temperature and flow rate: PER maximum observed T and PER current actual ADWF; Data years used: NA; Adjustment Factor = 1.3; WLA using PER current ADWF effluent flow rate and PER maximum current T. Since 7Q10 for Multnomah Channel is unknown and since model shows impacts of all point sources in Multnomah Channel <0.10 C, flow based WLAs are not provided (the WLA in terms of kcal/day applies for all river flow conditions).

3.2.45 Siltronic Corporation - 93450 - OR0030589

Basis for maximum effluent temperature and flow rate: Maximum combined outfall T and Maximum combined outfall flow rate; Data years used: 2004-2017; Adjustment Factor = 1; WLA using design ADWF effluent flow rate and current T - round up

3.2.46 SLLI - 74995 - OR0001741

Basis for maximum effluent temperature and flow rate: Conservative maximum T and Maximum permitted flow rate; Data years used: NA; Adjustment Factor = 1.5; Round up from WLA based on observed temperature and flow rate. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.47 Stayton STP - 84781 - OR0020427

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily ETL analysis and 7-day Avg flow rate via maximum daily ETL analysis; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1.1/1.1/1.1; Round up from WLA based on observed temperature and flow rate

3.2.48 Sweet Home STP - 86840 - OR0020346

Basis for maximum effluent temperature and flow rate: Maximum monthly T and Maximum monthly flow rate; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 1.2/1.2/1; Round up from WLA based on observed temperature and flow rate

3.2.49 Tryon Creek WWTP - 70735 - OR0026891

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2012-2016; Adjustment Factor = 1; Round up from WLA based on observed temperature and flow rate.

3.2.50 Univar USA Inc - 100517 - OR0034606

Basis for maximum effluent temperature and flow rate: Conservative maximum T and Maximum observed flow rate (limited data); Data years used: NA; Adjustment Factor = 1.5; WLA using current effluent flow rate and T=32 - round up. Maximum estimated ΔT < 0.001. Round assigned HUA to 0.001.

3.2.51 USACE - Big Cliff Project - 126715

Basis for maximum effluent temperature and flow rate: Maximum observed T via permit application and Maximum observed flow rate via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from permit app T and flow rate.

3.2.52 USACE - Dexter Project - 126714

Basis for maximum effluent temperature and flow rate: Maximum observed T via permit application and Maximum observed flow rate via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from observed temperature and flow rate.

3.2.53 USACE - Foster Project - 126713

Basis for maximum effluent temperature and flow rate: Maximum observed T via permit application and Maximum observed flow rate via permit application; Data years used: NA; Spring/Summer/Fall Adjustment Factors = 1/1/1; Round up WLA derived from permit app T and flow rate.

3.2.54 Vigor Industrial - 70596 - OR0022942

Basis for maximum effluent temperature and flow rate: Estimated Maximum via PER and DMRs and Estimated Maximum via PER and DMRs; Data years used: NA; Adjustment Factor = 1; WLA based on limited data in PERs. Effluent T=32 - round up.

3.2.55 WES - Kellogg Creek Water Resource Recovery Facility - 16590 - OR0026221

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and flow via Design Average Dry Weather Flow; Data years used: 2015-2020; Adjustment Factor = 1; Increase to similar 2006 WLA.

3.2.56 WES - Tri-city WPCP - 89700 - OR0031259

WES Tri-city WPCP is one of the larger sources of excess thermal load among point sources and the largest in the Lower Willamette. Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2015-2020; Adjustment Factor = 1; Round up from WLA based on observed temperature and flow rate.

3.2.57 WES - Blue Heron - 72634 - OR0000566

WLA set to zero since facility no longer active.

3.2.58 Willamette Falls Paper Company - 21489 - OR0000787

Basis for Max Effluent T and Flow Rate: 7DADM T via max daily Delta T analysis and Design Average Dry Weather Flow; Data years used: 2019-2020; Date of max Delta T for time period 2019-09-03, 7DADM T for date of max Delta T 25.5 C, Flow via Design Average Dry Weather Flow = 6.50 cfs, Adjustment Factor = 1.1; Round up from WLA based on observed temperature and design flow rate.

3.2.59 Wilsonville STP - 97952 - OR0022764

Basis for maximum effluent temperature and flow rate: 7DADM temperature via maximum daily Delta T analysis and 7-day Avg flow rate via maximum daily Delta T analysis; Data years used: 2007-2011, 2020; Adjustment Factor = 1.1; Round up from WLA based on observed temperature and flow rate.

3.3 7Q10 river flow rates

7Q10 river flow rates for each discharge location were derived for summer non-spawning periods and, if applicable, spring and fall spawning periods. Most reaches upstream from the Willamette River Newberg Pool are designated for salmonid spawning use during cooler months of the years. An exception is Long Tom River downstream from Fern Ridge Reservoir, which does not support salmonid spawning (see TSD Section 4 for designated uses for the Long Tom River). Bases for derivation of 7Q10 flow rates for all facilities are described in TSD Section 6. In all cases, 7Q10s for Willamette Mainstem reaches are derived from discharge data from USGS gage stations.

3.4 Fish Hatcheries

WLAs for ODFW fish hatcheries are set to estimates of maximum current thermal loads in the same manner as other point sources.

For fish hatcheries which operate as pass-through facilities that withdraw water from a river, pass the water through hatchery facilities, and then discharge the water back to the river from which it was withdrawn, much of the excess thermal load due to a facility may be due to the river temperature at the point of withdrawal at times being greater than applicable criteria. For such cases, cumulative effects modeling is performed differently than for other facilities. Measured differences between upstream river temperature and effluent temperature are used to determine temperature increases caused by the hatcheries. In order to provide a reasonable estimated of maximum impact, 95th percentile $T_{eff} – T_{inf}$ (effluent temperature minus influent temperature) values are used for spring, summer and fall. Effluent temperature is then estimated by adding the river temperature increase provided by the hatchery ($T_{eff} – T_{inf}$) to the model calculated river temperature upstream from the outfall location to derive effluent temperature.

Assigned HUA and maximum fish hatchery impacts on river temperature are shown by Table 3-3, columns 2 and 5. The assigned HUA in some cases is relatively large because the temperature of diverted river water exceeds applicable criteria, which results in relatively large ΔT_{PS} values as calculated via Equation 3-3. However, the maximum amount of potential river temperature increase due to heating of river water as it passes through the hatcheries is generally considerably less (Table 3-3, column 5). This indicates that most of the excess thermal load is due to river temperature upstream from hatcheries exceeding criteria rather than heating of pass-through water by the hatcheries.

For the ODFW Minto Fish Facility, data from 2023 indicates that the facility could warm pass-through water up to 1.63°C during the summer, which, after dilution, could increase river temperature up to 0.068°C (Table 3-3). This increase could exceed the allocated HUA of 0.03°C. However, in 2023 effluent temperature never exceeded applicable criteria. Therefore, the excess thermal load of the discharge did not exceed 0.00°C and the 0.03°C based wasteload allocation was not exceeded.

For additional information on ODFW Leaburg Hatchery and ODFW Mckenzie River Hatchery, see TSD Appendix L, which describes derivation of WLAs for McKenzie River reaches that are modeled using the McKenzie River CE-QUAL-W2 model.

Table 3-3. Fish hatcheries maximum impact on river temperature.

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Assigned Human Use Allowance (ΔT) (ºC)	Fish Hatchery 95th Percentile Teff-Tinf (ºC)	Fish Hatchery Dilution Ratio	Fish Hatchery Potential increase in River T due to heating of pass-through water (ºC)
ODFW - Clackamas River Hatchery 64442 - OR0034266 Clackamas River RM 22.6	0.072	0.199	28.2	0.007
	0.261	0.367	15.3	0.024
	0.283	0.226	15.4	0.015
ODFW - Leaburg Hatchery 64490 - OR0027642 McKenzie River RM 33.7	0.074	0.194	26.4	0.007
	0.012	0.286	39.3	0.007
	0.026	0.213	20.8	0.010
ODFW - Mckenzie River Hatchery 64500 - OR0029769 McKenzie River RM 31.5	0.002	No longer pass through - all via small tributary		
	0.033			
	0.002			
ODFW - Minto Fish Facility 64495 - OR0027847 North Santiam River RM 41.1	0.03	1.35	32.9	0.041
	0.03	1.63	23.9	0.068
	0.03	0.92	23.3	0.039
ODFW Dexter Ponds 64450 - ORG133514 Middle Fork Willamette River RM 15.7	0.036	NA	20.5	NA
	0.189	0.00	20.9	0.000
	0.255	0.111	27.1	0.004
ODFW South Santiam Hatchery 64560 - ORG133511 S. Santiam River RM 37.8	0.020	0.00	79.3	0.000
	0.020	0.00	24.0	0.000
	0.020	0.00	23.8	0.000

4 Cumulative effects modeling

WLA cumulative effects modeling was performed by DEQ for the 2015 modeling year in a similar manner as current conditions modeling performed by Tetra Tech. This modeling is described in TSD Appendix K: Tetra Tech Model Scenario Report, August 2024 (provided to DEQ as March 8, 2024 memorandum titled: Willamette River Model Point Source Updates and Scenario Simulation). Figure 1-1 is a map from this document which shows reaches modeled.

Appendix K describes “current” point source scenario modeling in which point sources at current thermal loads (current condition calibration scenario) are compared to a scenario without point sources (no point sources scenario). The modeling was performed for the 2015 model year, which is a critical low flow year.

When comparing the hourly results from two model scenarios to determine the temperature changes, the following steps are taken:

1. Calculate the 7DADM temperatures for scenario 1 at every model segment for every day during the model period (March 20-October 31);

2. Calculate the 7DADM temperatures for scenario 2 at every model segment for every day during the model period;
3. Compute differences between 7DADM temperatures for scenario 1 and scenario 2 only for days that exceed the applicable criterion. In this manner, at each segment a ΔT is computed for every 7DADM temperature from each scenario for each day where the criterion is exceeded;
4. The max ΔT for each segment location is derived and plotted longitudinally as 7DADM delta plots.

The same models, post-processing tools, and methodologies used by Tetra Tech to model current conditions were used to model WLAs. The difference was that for the point source scenario, point sources flow rates and temperatures were changed to the “Effluent Flow used for WLA” (Table 3-2, column 2) and the “Effluent T that corresponds to WLA” (Table 3-2, column 4).

Several point sources not included by Tetra Tech were added to the models and any point sources no longer active or provided a WLA equal to zero were either removed or zeroed out (flow set to zero).

A number of small point sources covered by individual NPDES permits were not included in the model. Of the individually permitted facilities provided WLAs (Table 3-1), current thermal loads of facilities included in the model comprise 99.9% of the total thermal load (facilities not modeled comprise 0.1% of the thermal load).

Output plots for most reaches are provided as single plots for the full period modeled (late March through October 31). For reaches with potential points of maximum impact for which spawning is a designated use, such as the upper Willamette River, plots are presented for the spring spawning period, summer non-spawning period, and fall spawning period. This allows WLAs to be adjusted on a seasonal basis. For example, it the HUA is potentially exceeded only during the fall, WLAs that apply during the fall can be reduced.

For the fall spawning period, compliance is evaluated starting the 7th day of the spawning period. Therefore, plots presented exclude the first 6-days. This is accordance with the DEQ Temperature Water Quality Standard Implementation – A DEQ Internal Management Directive, April 2008 (DEQ, 2008). The following is an excerpt from Section 2.3 of this document:

Seasonal criteria

There are several temperature criteria that apply seasonally, or during specific time periods. The most notable of these is the criterion for salmon and steelhead spawning through fry emergence use. The spawning criterion applies to all the full 7-day periods within the dates specified for spawning use on the “Beneficial Use Designations – Fish Uses” tables and the “Salmon and Steelhead Spawning Use Designations” maps referenced in the basin specific criteria (OAR 340-041-0101-0340). These tables and maps may be found on DEQ’s web site, or by contacting any DEQ office.

Other seasonal temperature criteria include:

- the narrative bull trout spawning criterion, which applies from Aug 15 to May 15 in specific locations,
- the summer cold water protection criterion, and

- the spawning cold water protection criterion, which applies during the specified salmon and steelhead spawning use dates.

Because the criteria are 7-day averages, they apply to the full 7-day periods that occur within the specified designated use times. When evaluating data where the 7dAM value is reported on the 7th day, the numeric criterion must be met on the 7th day after the beginning of spawning use through the last day of emergence. For example, if spawning begins on September 1st, the first 7-day period of spawning use is September 1st to 7th, and because the 7dAM value is reported on the 7th day, the 13 °C criterion must be met beginning on September 7th. If the last day of spawning use is May 15, the last 7-day period for spawning through emergence use is May 9th to 15th. The 7dAM value would be reported on May 15th and that is the last day 13 °C criterion must be met.

The following is an excerpt from Section 3.2 of Temperature Water Quality Standard Implementation – A DEQ Internal Management Directive, April 2008 (DEQ, 2008):

How to calculate and report the 7dAM stream temperature

The 7dAM (7-day average maximum) stream temperature is calculated by averaging the daily maximum instream water temperatures for 7 consecutive days. Because the criteria apply to every 7 day period, it is referred to as the rolling 7dAM. For the second 7-day period, the first day is dropped and another day is added to the end date. For example, one 7-day period is August 4 to 10, the next 7-day period is August 5 to 11, and so on.

The average daily maximum temperature value for each 7-day period will be reported on the 7th day. This means that the average of the daily maximum temperatures for the first 7 days of the spawning period will be reported on the 7th day after spawning use begins. Therefore, that 7th day of spawning is the first day that the 7dAM value must meet 13 °C

Because the 7-day average daily maximum criteria for the fall applies starting on the 7th day of the spawning period, plots for fall spawning periods are provided which summarize maximum delta T values starting on the 7th day.

Cumulative effects of WLAs on the Willamette River and major tributaries modeled using the Willamette Mainstem model are shown below. Maximum WLA impacts for all assessment units are provided in Table 5-1 below.

As discussed above, for fish hatcheries which operate as pass-through facilities that withdraw water from rivers that they discharge to, much of the thermal loads due to the facilities may be due to the temperature of water withdrawn from the rivers being greater than applicable criteria. For such facilities, WLAs set to estimates of maximum current thermal loads in the same manner as other point sources. However, cumulative effects modeling is performed differently. Measured differences between upstream river temperature and effluent temperature are used to determine temperature increases caused by the hatcheries. Effluent temperature is then estimated by adding the river temperature increase provided by the hatchery to the model calculated influent (upstream river) temperature to derive effluent temperature. Conservative upper 95th percentile differences between effluent and influent temperatures are used to ensure that maximum impacts of the facilities are modeled.

4.1 Maximum cumulative effects without modeling

The following presents an approach for evaluating cumulative effects without modeling. This approach was used during TMDL development to quickly assess potential allocation options prior to modeling.

Maximum potential increases in river temperature (ΔT) due to point sources may be calculated by summing thermal loads due to point sources and effluent flow rates, as follows (Equation 4-1):

Equation 4-1

$$T_R = \left(\Sigma\left(Q_{eff} \times T_{eff}\right) + \left(Q_R - \Sigma Q_{eff}\right)T_C\right) / Q_R$$

$$\Delta T = T_R - T_C$$

Where:

T_R = River temperature downstream from an outfall, ^oC

ΔT = River temperature increase downstream from an outfall due to all effluent thermal loads at or above outfall location, ^oC

$\Sigma(Q_{eff} \times T_{eff})$ = Summation of all effluent thermal load at and above outfall, cfs·^oC

ΣQ_{eff} = Summation of all effluent flow at or above outfall, cfs

Q_R = River flow downstream from outfall, cfs

T_C = Applicable river temperature criterion, ^oC

Maximum potential impacts of current point source thermal loads for 7Q10 river flow conditions for summer non-spawning conditions are presented in Table 4-1. For the analysis, Q_R is set to 7Q10 design river low flow rates. ΔT is converted to a maximum thermal load due to point sources as follows:

Excess Thermal Load (kcal/day) = ΔT x $Q_{R,7Q10}$ x 2,446,665

This is a maximum potential impact analysis. It accounts for dilution, but not loss of heat, such as due to heat flux to the atmosphere. Therefore, derived maximum potential ΔT values are likely greater than actual. Loss of heat, such as to the atmosphere, in addition to dilution, may be calculated by modeling, as discussed below.

As shown, in a few major tributaries, impacts may exceed 0.20^{o}C, but in the Willamette River impacts are less than 0.20^{o}C. During the spring spawning period, maximum potential impacts are less than during the summer (Table 4-2). However, during the fall spawning period, maximum potential impacts are greater (Table 4-3). During the fall, maximum potential impacts exceed 0.30^{o}C.

Table 4-1. Maximum cumulative effects of point sources during summer non-spawning period

WQ File Number	Stream Name	River Mile	Major Tributary	Major Tributary River Mile	7Q10 (cfs)	Max Potential ΔT (ºC)	Cumulative thermal ETL (kcal/day)
64442	Clackamas River	22.6			627	0.277	425,098,526
20306	Coast Fork Willamette River	20.6			38	0.219	20,404,885
57951	Long Tom River	6.9			22	0.019	1,022,080
96244	McKenzie River	14.7			1,537	0.200	751,858,858
100097	Middle Fork Willamette River	9			1,089	0.008	21,767,482
49764	South Santiam River	17.4			506	0.054	67,229,354
84781	North Santiam River	14.9			914	0.041	91,684,454
NA	North Santiam + South Santiam	11.8	North and South Santiam Rivers	11.8	1,144	0.048	135,175,319
43129	Santiam River (enters WR at RM 109)	9.2			1,144	0.051	143,444,612
NA	Willamette River	187	Coast and Middle Forks	187	1,508	0.010	36,158,017
55999	Willamette River	178			1,508	0.106	390,689,260
NA	Willamette River	174.9	McKenzie River	174.9	3,480	0.118	1,001,357,149
105415	Willamette River	158.4			3,480	0.122	1,035,422,066
NA	Willamette River	149	Long Tom	149	3,609	0.118	1,038,488,305
36335	Willamette River	147.7			3,609	0.166	1,465,489,283
105814	Willamette River	147.7			3,609	0.181	1,598,544,328
28476	Willamette River	132.5			3,683	0.178	1,600,407,708
20151	Willamette River	130.8			3,683	0.192	1,731,637,030
103919	Willamette River	130.6			3,683	0.192	1,733,715,717
500	Willamette River	122			3,877	0.183	1,736,781,560
1098	Willamette River	118			3,877	0.199	1,889,219,289
NA	Willamette River	108	Santiam	108	5,684	0.146	2,032,663,901
41513	Willamette River	95.5			5,684	0.150	2,086,656,340
57871	Willamette River	95.5			5,684	0.155	2,149,494,757
78140	Willamette River	78.4			5,684	0.190	2,637,545,201
89638	Willamette River	72			5,684	0.191	2,653,126,237
100077	Willamette River	71.7			5,684	0.191	2,661,727,628
25567	Willamette River	51.7			5,734	0.191	2,672,740,134
102894	Willamette River	49.7			5,734	0.122	1,718,467,193
72615	Willamette River	49.7			5,734	0.122	1,718,467,193
96010	Willamette River	42.8			5,734	0.123	1,723,089,264

WQ File Number	Stream Name	River Mile	Major Tributary	Major Tributary River Mile	7Q10 (cfs)	Max Potential ΔT (ºC)	Cumulative thermal ETL (kcal/day)
97952	Willamette River	38.5			5,734	0.126	1,766,517,079
13691	Willamette River	33			5,790	0.126	1,790,573,406
97612	Willamette River	31.6			5,790	0.126	1,790,781,910
30554	Willamette River	28.2			5,988	0.122	1,790,999,954
72634	Willamette River	27.8			5,988	0.122	1,790,999,954
21489	Willamette River	27.5			5,988	0.127	1,857,738,946
89700	Willamette River	25.5			5,988	0.135	1,972,914,713
NA	Willamette River	24.8	Clackamas	24.8	5,988	0.136	1,996,760,179
70735	Willamette River	20.3			6,740	0.123	2,026,445,321
62795	Willamette River	20.1			6,740	0.125	2,059,025,357
16590	Willamette River	18.5			6,740	0.129	2,122,095,144
109444	Willamette River	15.8			6,740	0.129	2,122,095,144
113611	Willamette River	14.5			6,740	0.129	2,123,685,046
100517	Willamette River	9			6,740	0.129	2,124,602,646
70596	Willamette River	8.2			6,740	0.133	2,195,012,576
68471	Willamette River	7.4			6,740	0.133	2,195,012,576
68471	Willamette River	7.2			6,740	0.133	2,198,869,482
74995	Willamette River	7			6,740	0.133	2,199,906,183
93450	Willamette River	6.6			6,740	0.137	2,264,812,089
120589	Willamette River	6.4			6,740	0.137	2,263,875,450
3690	Willamette River	3.3			6,740	0.137	2,263,875,450
64905	Willamette River	2.4			6,740	0.138	2,281,652,486

Table 4-2. Maximum cumulative effects of point sources during spring spawning period

WQ File Number	Stream Name	River Mile	Major Tributary	Major Tributary River Mile	Spring Spawning 7Q10 (cfs)	Spring Max Potential Delta T (ºC)	Cumulative thermal ETL (kcal/day)
64442	Clackamas River	22.6			1,186	0.074	215,482,526
20306	Coast Fork Willamette River	20.6			61	0.158	23,529,665
57951	Long Tom River	6.9			55	0.058	7,819,016
96244	McKenzie River	14.7			2,442	0.100	597,703,279
100097	Middle Fork Willamette River	9			1,097	0.023	61,889,898
49764	South Santiam River	17.4			1,433	0.021	73,454,586
84781	North Santiam River	14.9			1,482	0.030	108,921,734

WQ File Number	Stream Name	River Mile	Major Tributary	Major Tributary River Mile	Spring Spawning 7Q10 (cfs)	Spring Max Potential Delta T (ºC)	Cumulative thermal ETL (kcal/day)
NA	North Santiam + South Santiam	11.8	North and South Santiam Rivers	11.8	3,821	0.020	182,376,320
43129	Santiam River (enters WR at RM 109)	9.2			3,821	0.020	189,157,254
NA	Willamette River	187	Coast and Middle Forks	187	1,906	0.018	85,419,563
55999	Willamette River	178			1,906	0.138	644,972,943
NA	Willamette River	174.9	McKenzie River	174.9	5,204	0.098	1,242,676,221
105415	Willamette River	158.4			5,204	0.099	1,261,220,784
NA	Willamette River	149	Long Tom	149	5,330	0.098	1,283,002,328
36335	Willamette River	147.7			5,330	0.121	1,583,661,672
105814	Willamette River	147.7			5,330	0.131	1,704,061,764
28476	Willamette River	132.5			5,800	0.120	1,705,939,081
20151	Willamette River	130.8			5,800	0.135	1,912,786,672
103919	Willamette River	130.6			5,800	0.135	1,922,763,967
500	Willamette River	122			6,308	0.125	1,932,266,625
1098	Willamette River	118			6,308	0.135	2,081,658,735
NA	Willamette River	108	Santiam	108	10,688	0.087	2,270,815,990
41513	Willamette River	95.5			10,688	0.091	2,371,866,159
57871	Willamette River	95.5			10,688	0.094	2,461,922,023
78140	Willamette River	78.4			10,688	0.117	3,050,086,189
89638	Willamette River	72			10,688	0.117	3,058,356,394
100077	Willamette River	71.7			10,688	0.118	3,079,064,835

Table 4-3. Maximum cumulative effects of point sources during fall spawning period

WQ File Number	Stream Name	River Mile	Major Tributary	Major Trib River Mile	Fall Spawning 7Q10 (cfs)	Fall Max Potential Delta T (°C)	Cumulative thermal ETL (kcal/day)
64442	Clackamas River	22.6			645	0.300	474,011,005
20306	Coast Fork Willamette River	20.6					
57951	Long Tom River	6.9					
96244	McKenzie River	14.7			1,630	0.212	847,445,095
100097	Middle Fork Willamette River	9			1,589	0.016	61,889,898
49764	South Santiam River	17.4			817	0.104	208,257,852
84781	North Santiam River	14.9			1,018	0.045	111,143,524
NA	North Santiam + South Santiam	11.8	North and South Santiam Rivers	11.8	1,926	0.068	319,401,375
43129	Santiam River (enters WR at RM 109)	9.2			1,926	0.069	326,939,308
NA	Willamette River	187	Coast and Middle Forks	187	1,925	0.013	61,889,898
55999	Willamette River	178			1,925	0.275	1,293,272,853
NA	Willamette River	174.9	McKenzie River	174.9	3,853	0.227	2,140,717,948
105415	Willamette River	158.4			3,853	0.229	2,159,262,510
NA	Willamette River	149	Long Tom	149	4,280	0.206	2,159,262,510
36335	Willamette River	147.7			4,280	0.243	2,547,051,522
105814	Willamette River	147.7			4,280	0.254	2,655,517,135
28476	Willamette River	132.5			4,149	0.262	2,655,761,376
20151	Willamette River	130.8			4,149	0.305	3,093,830,491
103919	Willamette River	130.6			4,149	0.305	3,097,013,533
500	Willamette River	122			4,443	0.286	3,106,516,191
1098	Willamette River	118			4,443	0.322	3,501,206,230
NA	Willamette River	108	Santiam	108	7,133	0.219	3,828,145,538
41513	Willamette River	95.5			7,133	0.222	3,875,330,074
57871	Willamette River	95.5			7,133	0.224	3,917,298,052
78140	Willamette River	78.4			7,133	0.311	5,419,165,190
89638	Willamette River	72			7,133	0.311	5,427,435,395
100077	Willamette River	71.7			7,133	0.312	5,448,143,836

4.2 Cumulative effects on major tributaries

Cumulative effects of WLAs on major tributaries modeled using the Willamette Mainstem models are shown in Figure 4-1 to Figure 4-4 (WLA14 indicates scenario 14 of 15 WLA modeling scenarios performed). Included are the Clackamas River, North and South Santiam Rivers, South Santiam River, and Long Tom River. Cumulative effects on the McKenzie are described in Appendix L.

Plots presented provide maximum increase in 7DADM due to WLAs for all seasons. As shown, maximum impacts in the Clackamas River, North and South Santiam Rivers, South Santiam River, and Long Tom River rarely exceed 0.10ºC (Figure 4-1 to Figure 4-4).

As discussed in Appendix L, impacts on the McKenzie river exceed 0.20ºC. As shown by plots below for the Willamette, WLAs for the McKenzie River contribute to cumulative impacts in the Willamette River downstream from the confluence of the McKenzie River.

The only individual NPDES permitted point source that discharges to the Clackamas River is the ODFW Clackamas River Hatchery, which discharges at Clackamas River RM 22.6. The maximum potential increase in river temperature due to the hatchery for summer 7Q10 conditions is 0.024ºC (Table 3-3). The model shows a maximum impact of the discharge of 0.023ºC (Figure 4-1). The maximum impact decreases to 0.012ºC at the Clackamas River mouth. Therefore, half of the temperature impact of the potential impact of the hatchery remains at the river mouth.

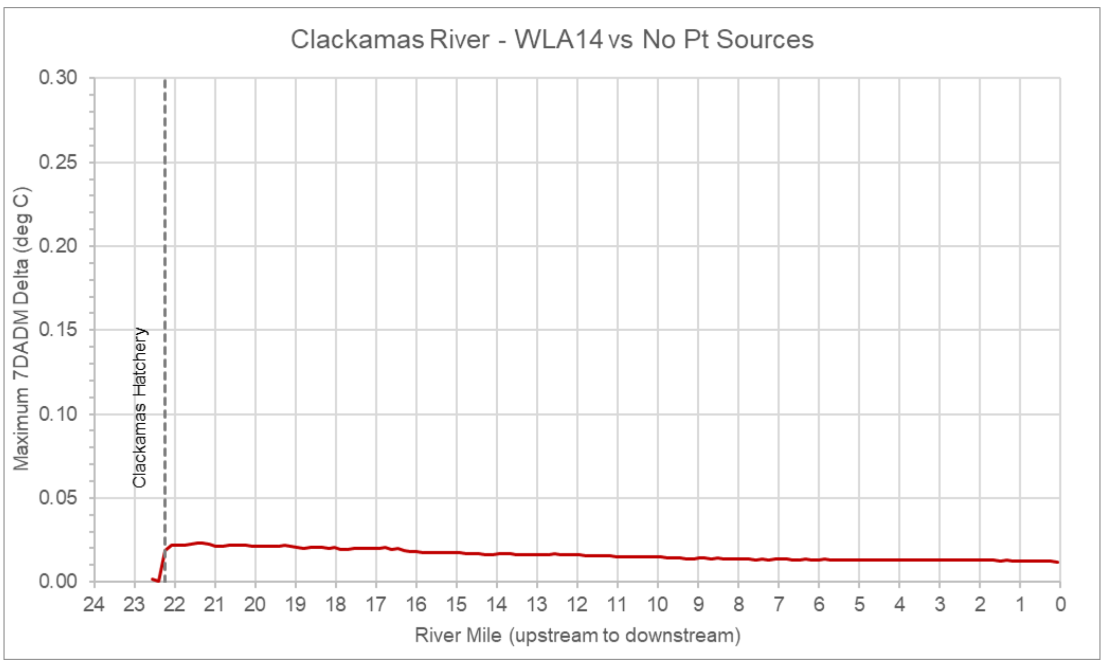

Figure 4-1: Clackamas River maximum 7DADM change in temperature from wasteload allocations.

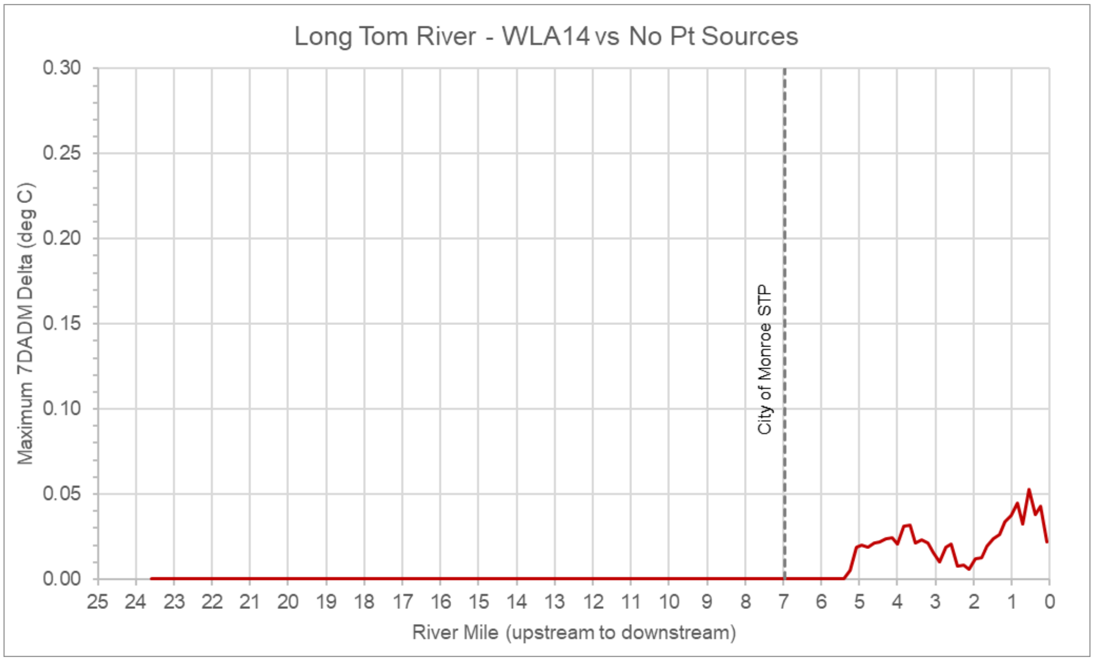

Figure 4-2: Long Tom River maximum increase in 7DADM temperature due to wasteload allocations.

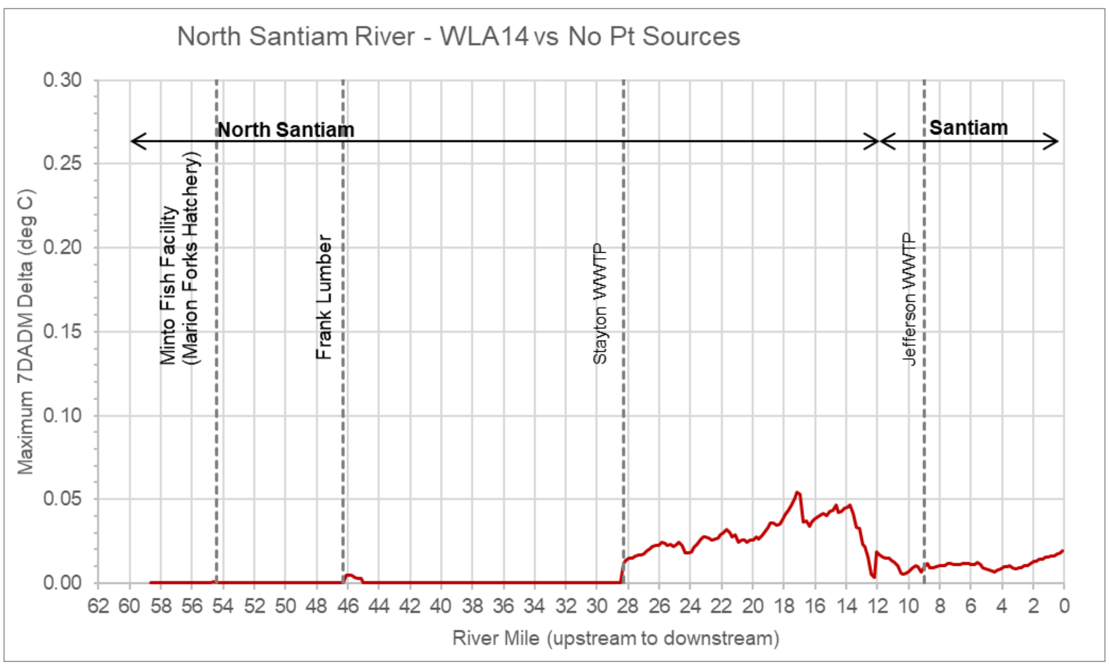

Figure 4-3: North Santiam and Santiam Rivers maximum increase in 7DADM temperature due to wasteload allocations.

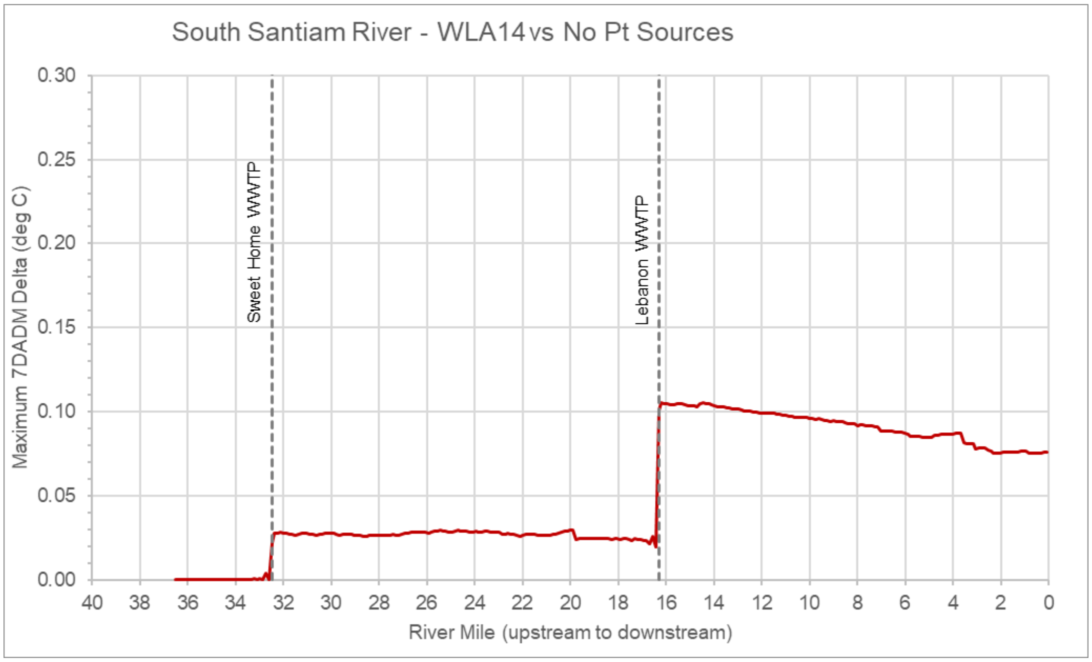

Figure 4-4: South Santiam River maximum increase in 7DADM temperature due to wasteload allocations.

4.3 Cumulative effects on Coast and Middle Forks

Cumulative effects of WLAs on the Coast Fork Willamette River, Row River and Fall Creek (all included in the Coast and Middle Forks Willamette River model), are shown in Figure 4-5 to Figure 4-8. As shown, impacts of the City of Cottage Grove WWTP are a relatively large 0.20°C for a short distance (Figure 4-5). Downstream from the Row River impacts are reduced to no more than 0.06°C. Impacts on the other streams, including the Middle Fork Willamette River, are small due to the lack of other large point sources.

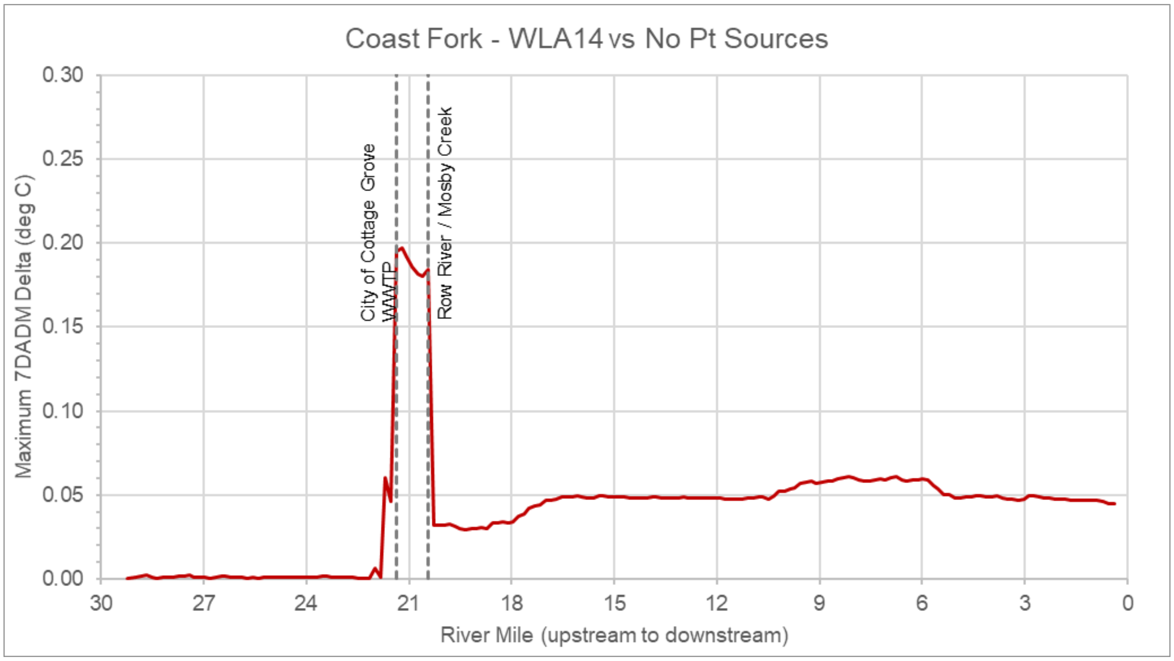

Figure 4-5: Coast Fork Willamette River maximum increase in 7DADM temperature due to wasteload allocations.

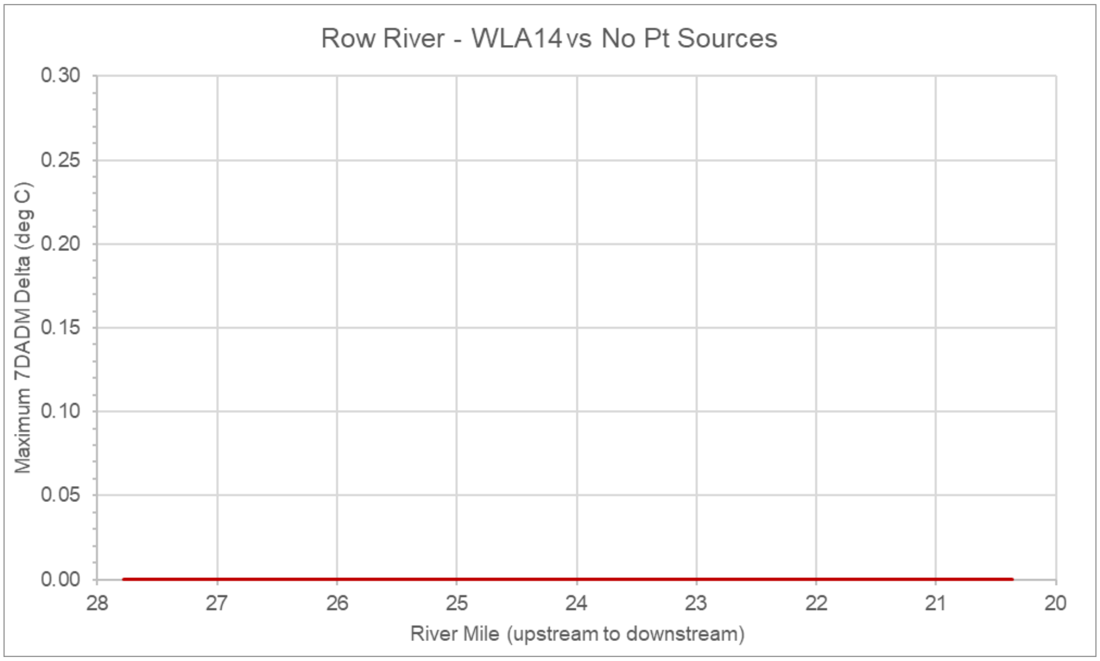

Figure 4-6: Row River maximum increase in 7DADM temperature due to wasteload allocations.

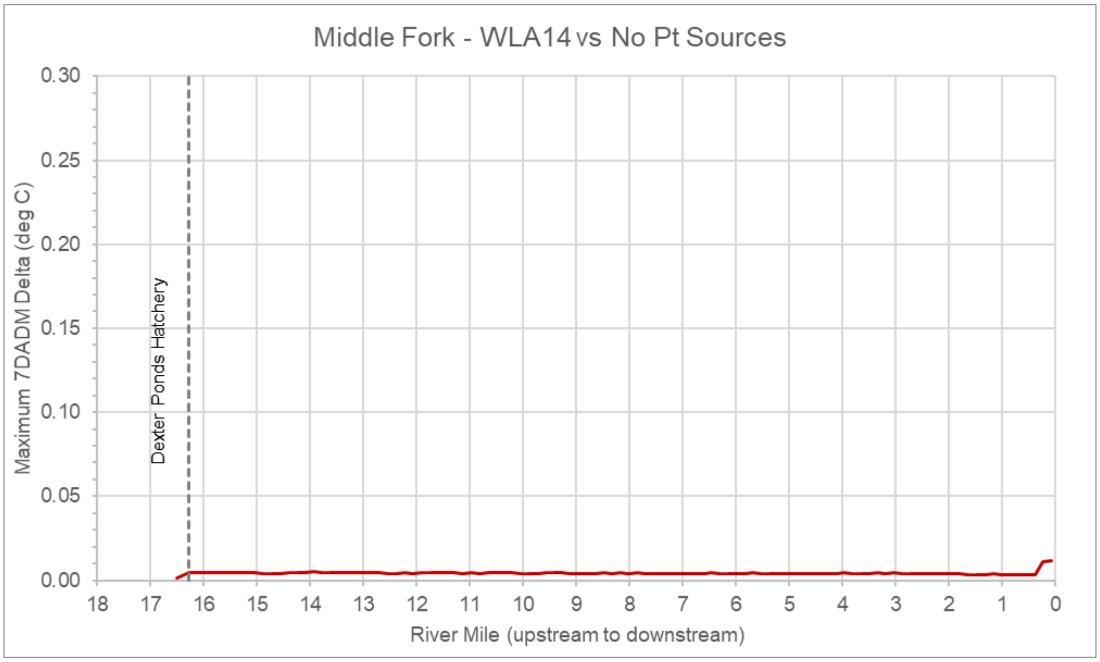

Figure 4-7. Middle Fork Willamette River maximum increase in 7DADM temperature due to wasteload allocations

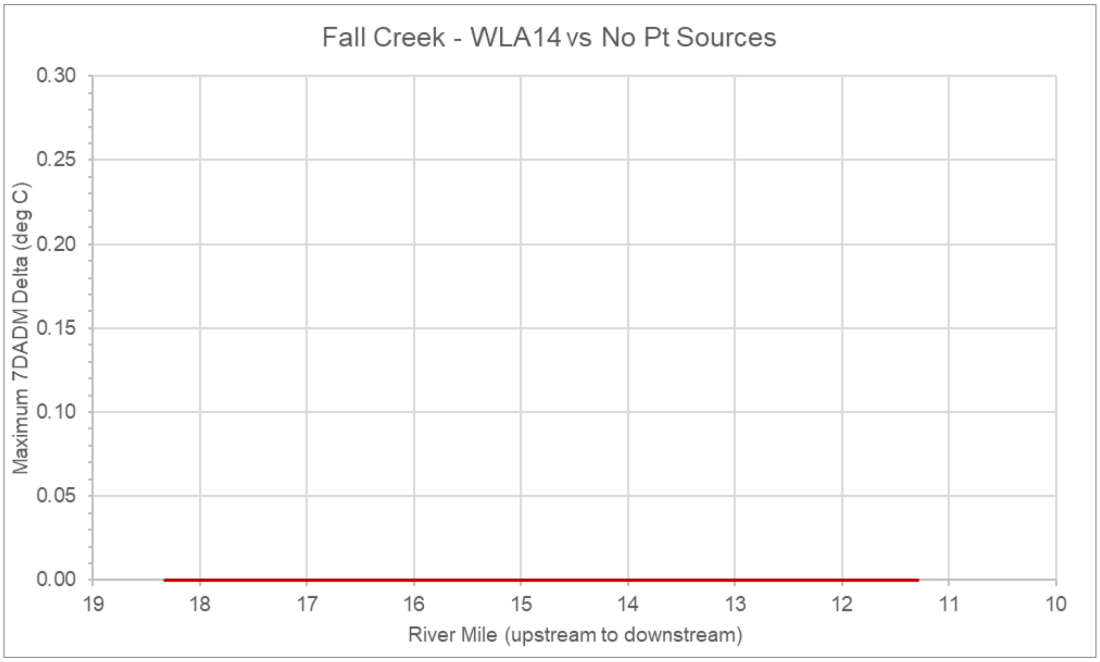

Figure 4-8: Fall Creek maximum increase in 7DADM temperature due to wasteload allocations.

4.4 Cumulative effects on the Willamette River

Cumulative effects of WLAs on the Willamette River are relatively large due to the presence of a number of large municipal and industrial point sources. Plots are presented for spring and fall spawning periods in addition to summer non-spawning periods for the upper and middle Willamette Rivers (modeled using the Upper Willamette and Middle Willamette CE-QUAL-W2 models) (Figure 4-9, Figure 4-10, and Figure 4-12 through Figure 4-19). For the lower Willamette River, only a single plot is presented since spawning is not a designated use.

WLA15 indicates scenario 15. The only difference between WLA15 and WLA14 (presented for major tributaries, Figure 4-1 through Figure 4-8) is that for WLA14 the Albany-Millersburg Water Reclamation Facility, which discharges to the Willamette River, is modeled as discharging at RM 118.8 and the ATI Millersburg discharge at RM 117.7, whereas for WLA15 both are modeled as discharging at RM 118.8. RM 118.8 is the location of the AMWRF discharge based on digitization of the channel for modeling. At the time of initial model development, AMWRF was modeled as discharging at RM 118.8 while ATI was modeled as discharging at RM 117.7, based on the facility location (WLA14). Currently, ATI effluent is piped upstream and discharged with AMWRF effluent at river mile 118.8. Therefore, the model was rerun with both discharges at RM 118.8 (WLA15, Figure 4-9, Figure 4-10, and Figure 4-12 through Figure 4-19). The point of maximum impact (POMI) of point sources is between RM 115 and the confluence of the Santiam River at RM 109. Cumulative impacts at the POMI for WLA14 and WLA15 are identical. Therefore, DEQ has provided the option that WLAs for ATI and AMWRF may be incorporated into the permit either as separate WLAs or as combined WLAs that are expressed as the sum of WLAs for the two facilities.

Spawning is also not a designated use in the Middle Willamette downstream from Yamill River confluence at RM 55.3. The applicable criterion changes from 18^{o}C to 20^{o}C downstream from Chehalem Creek at RM 51.2. The applicable criterion remains 20^{o}C thorough the Newberg Pool to the Willamette Falls and downstream through the lower Willamette River (which is modeled using the Lower Willamette River CE-QUAL-W2 model).

The point of maximum impact (POMI) for the Willamette River occurs upstream from the Santiam River confluence (Figure 4-10). During the summer non-spawning period as well as the fall spawning period maximum impacts are both 0.22^{o}C (Figure 4-10 and Figure 4-14). For the fall, only ΔTs for dates starting October 21, when seven days of spawning period values are available to calculate a spawning period 7DADM temperature, are presented. During the spring, maximum impacts are 0.16^{o}C (Figure 4-9).

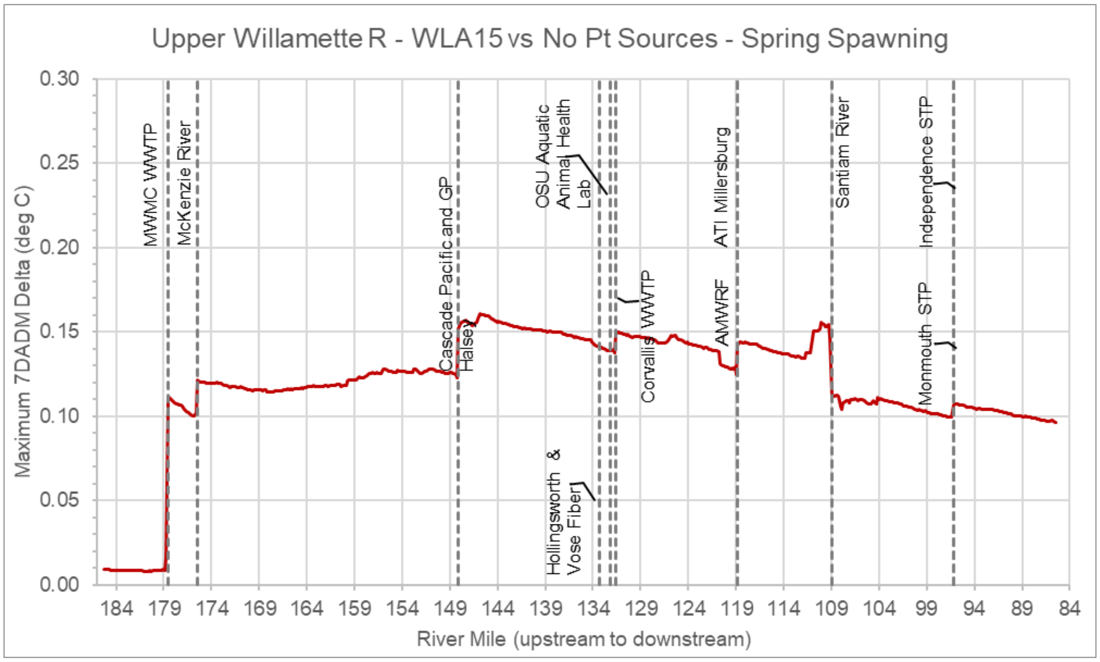

Figure 4-9: Upper Willamette River maximum increase in 7DADM temperature due to wasteload allocations during spring spawning period.

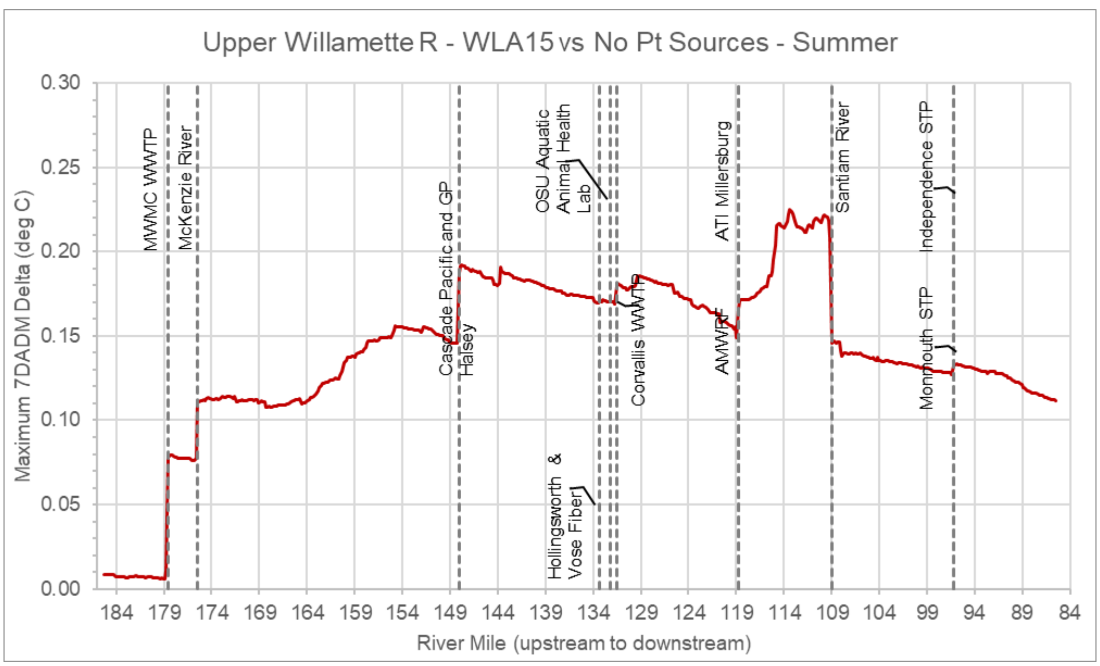

Figure 4-10: Upper Willamette River maximum increase in 7DADM temperature due to wasteload allocations during summer.

The increase in temperature impact between Albany and the confluence of the Santiam River is due to the cumulative effects of all upstream point sources, including those on the McKenzie River, as well as seasonal influences. Maximum ΔTs occur in the second and fourth weeks of

September, after the river has cooled from July and August median highs of 21-23ºC to the September levels of 18-19ºC that occur at the times of maximum impact (see Figure 4-11 which shows observed temperatures for the period of record, Figure 4-12 which shows model calculated temperatures for the upper Willamette River for July, and Figure 4-13 which shows model calculated temperatures for September). River flow rates are also relatively low at this time. In addition, only ΔTs when temperature is equal to or greater than the 18ºC applicable criteria are considered when determining maximum impacts. Maximum impacts therefore are likely to occur when river flow rates are low and when river temperature is close to the applicable criterion. Additional discussion of contributors to increases in river temperature due to point sources at the POMI and other locations is provided below.

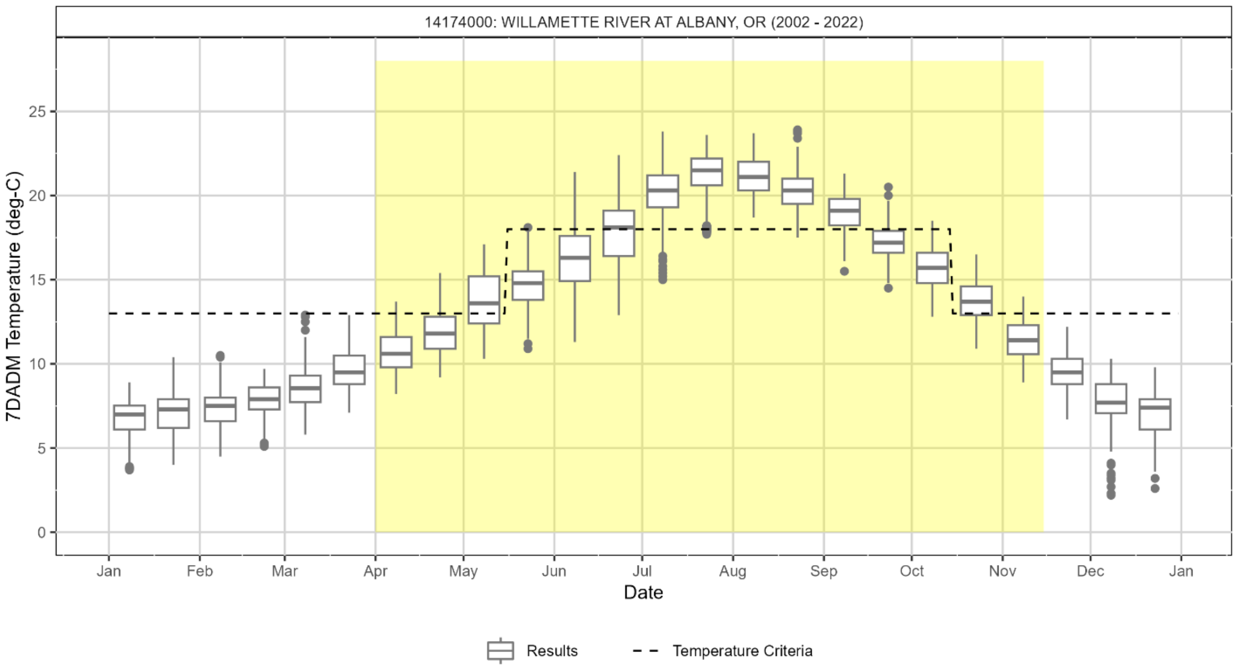

Figure 4-11. Seasonal variation on the Willamette River at Albany (RM 119.3)

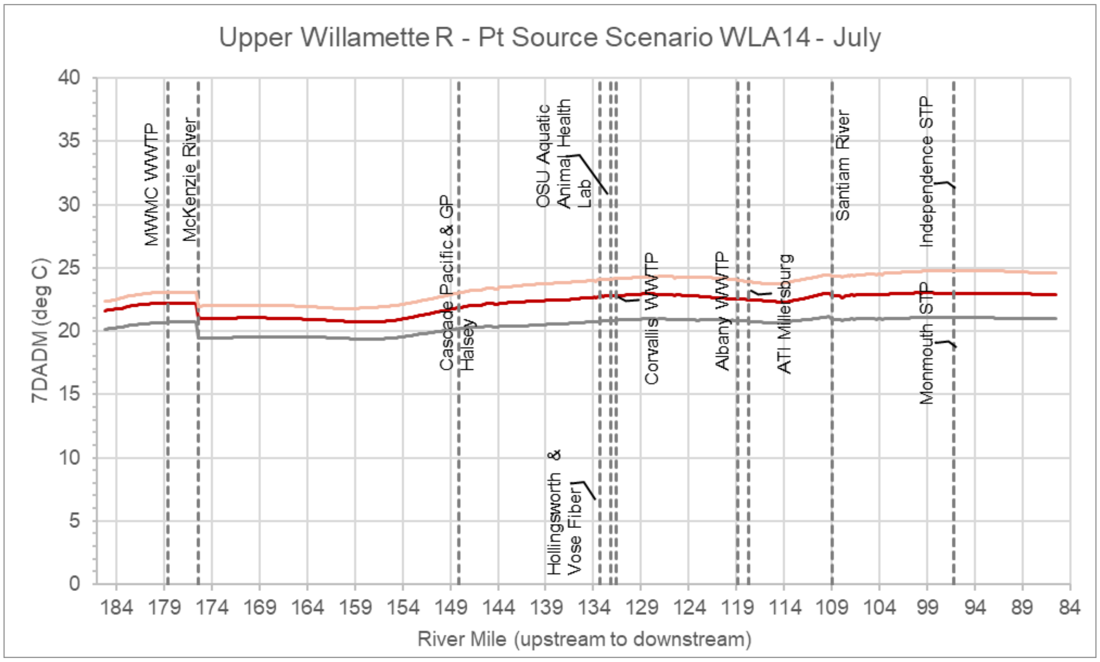

Figure 4-12. Upper Willamette River minimum, median, and maximum 7DADM temperature for July

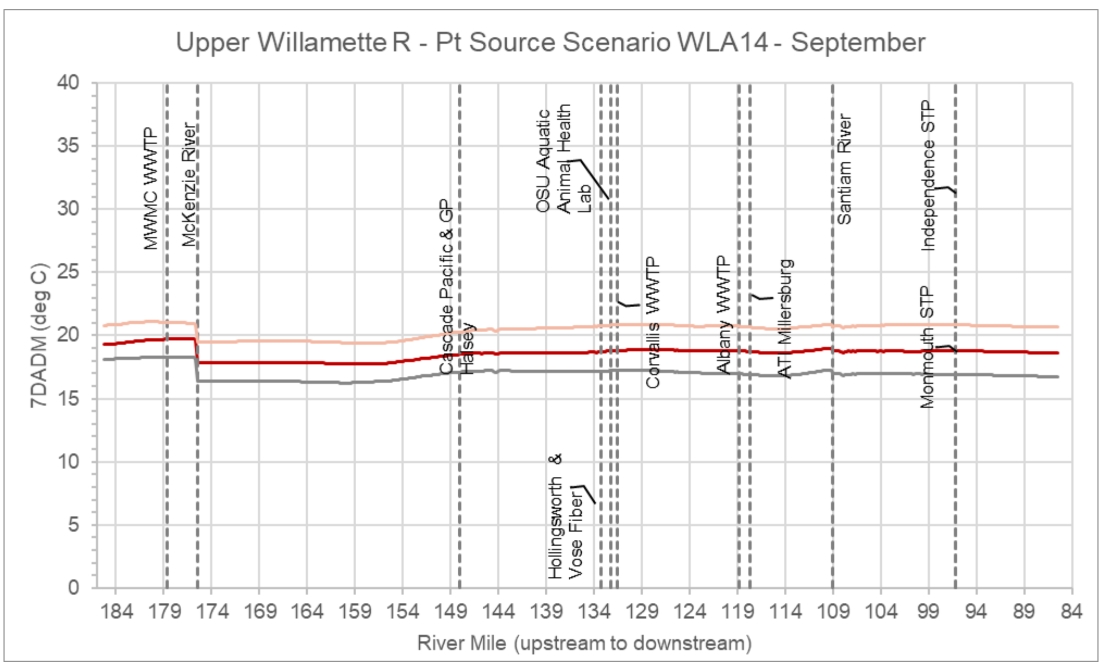

Figure 4-13. Upper Willamette River minimum, median, and maximum 7DADM temperature for September

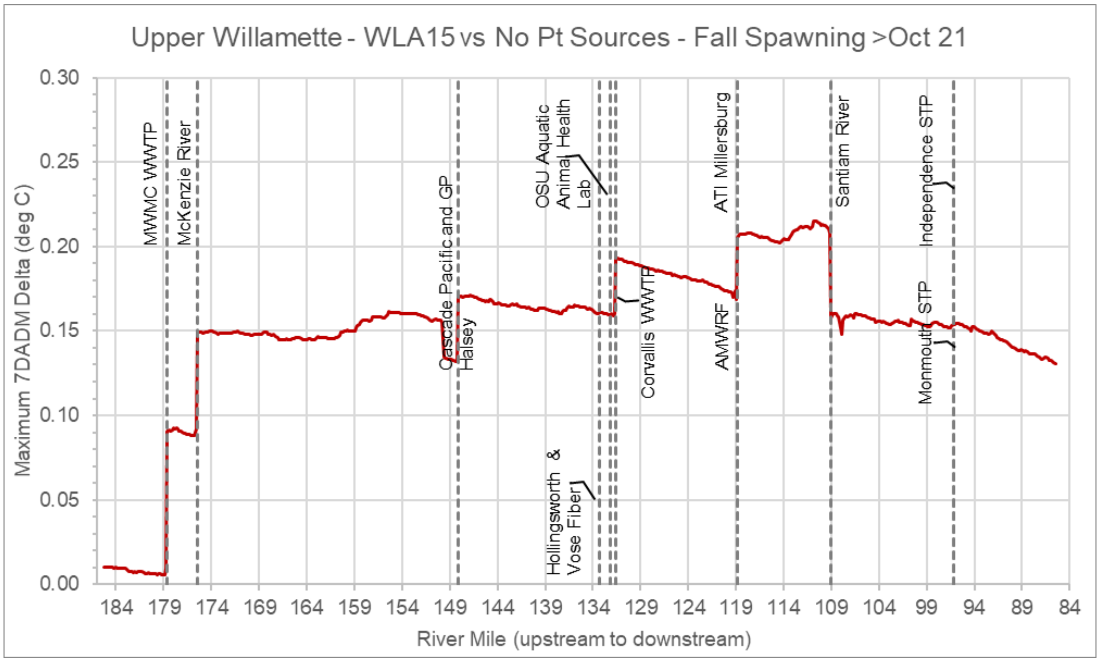

Figure 4-14: Upper Willamette River maximum increase in 7DADM temperature due to wasteload allocations during fall spawning period

In the Middle Willamette River WLA impacts are less than in the Upper Willamette River during the spring and summer (Figure 4-15 and Figure 4-16), and similar in the fall. Impacts don't exceed 0.11 during the spring spawning period (as discussed above, spawning is not a designated use in the Middle Willamette downstream from Yamill River confluence at RM 55.3).

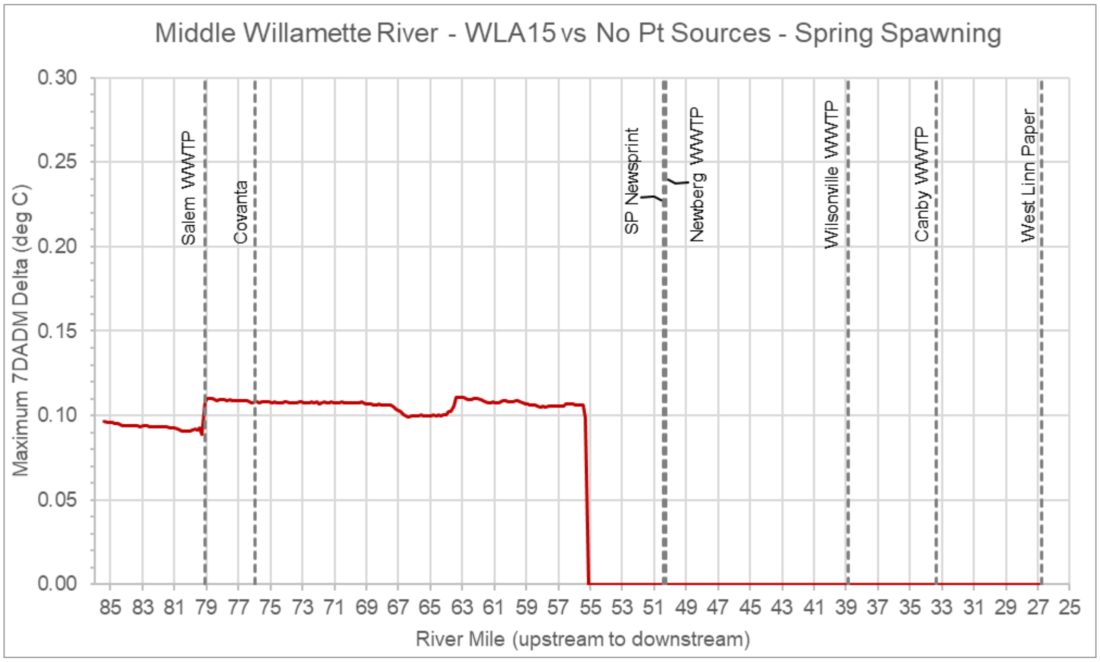

Figure 4-15: Middle Willamette River maximum increase in 7DADM temperature due to wasteload allocations during spring spawning period.

The POMI for the Middle Willamette is downstream from Salem. During the summer, the maximum impact of WLAs does not exceed 0.17ºC, and gradually decreases downstream from RM 75. At RM 51.2, where the criterion increases from 18 to 20ºC, there is an increase in ΔT due to two discharges at Newberg, then a decrease in impact to about 0.10ºC.

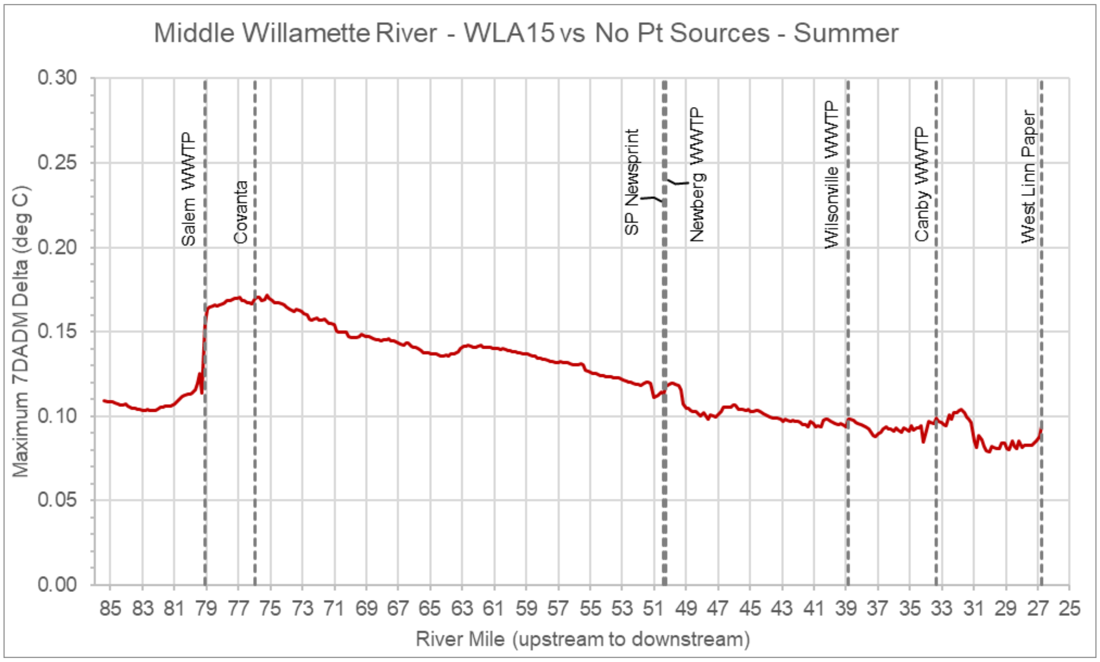

Figure 4-16: Middle Willamette River maximum increase in 7DADM temperature due to wasteload allocations during summer.

For the fall plot, only ΔTs for dates starting October 21, when seven days of spawning period values are available to calculate a spawning period 7DADM temperature, are presented (Figure 4-17). The maximum impact of WLAs is 0.22°C at the Salem Willow Lake STP discharge. The impact is greater during the fall than the summer because the Salem effluent flow is much greater. The Salem effluent flow that, combined with effluent temperature, produces the greatest temperature impact during the summer is 41.1 cfs, while the fall effluent flow, combined with effluent temperature, produces the greatest temperature impact is 112.5 cfs.

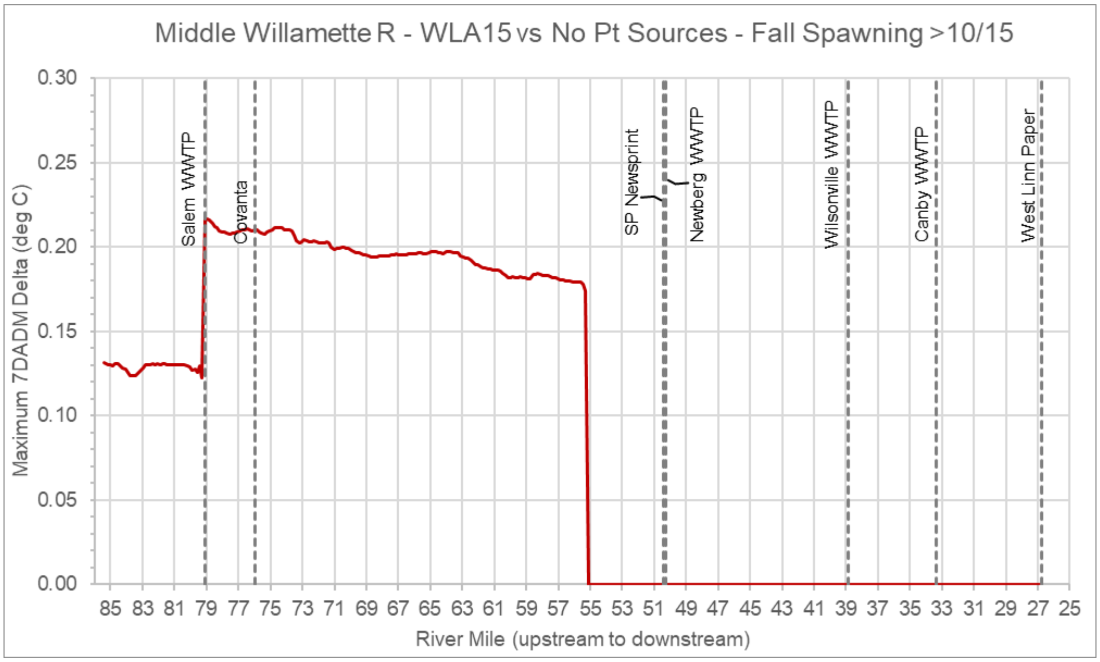

Figure 4-17: Middle Willamette River maximum increase in 7DADM temperature due to wasteload allocations during fall spawning period excluding first 6 days.

In the lower Willamette (downstream from Willamette Falls), maximum WLA impacts do not exceed 0.11°C (Figure 4-18).

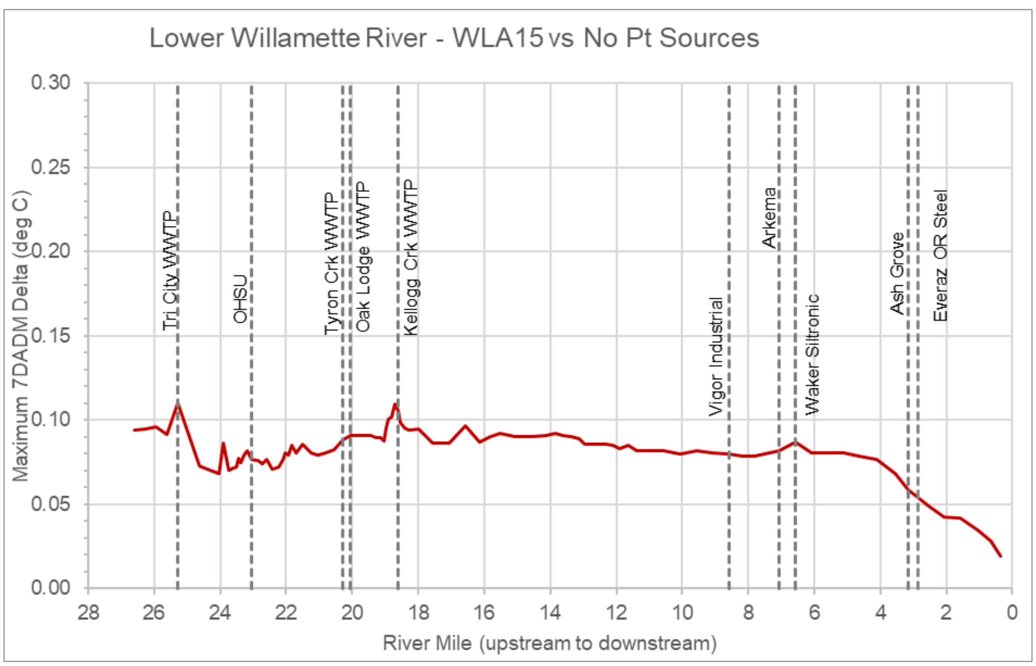

Figure 4-18: Lower Willamette River maximum increase in 7DADM temperature due to wasteload allocations.

Impacts in Multnomah Channel do not exceed 0.07°C (Figure 4-19).

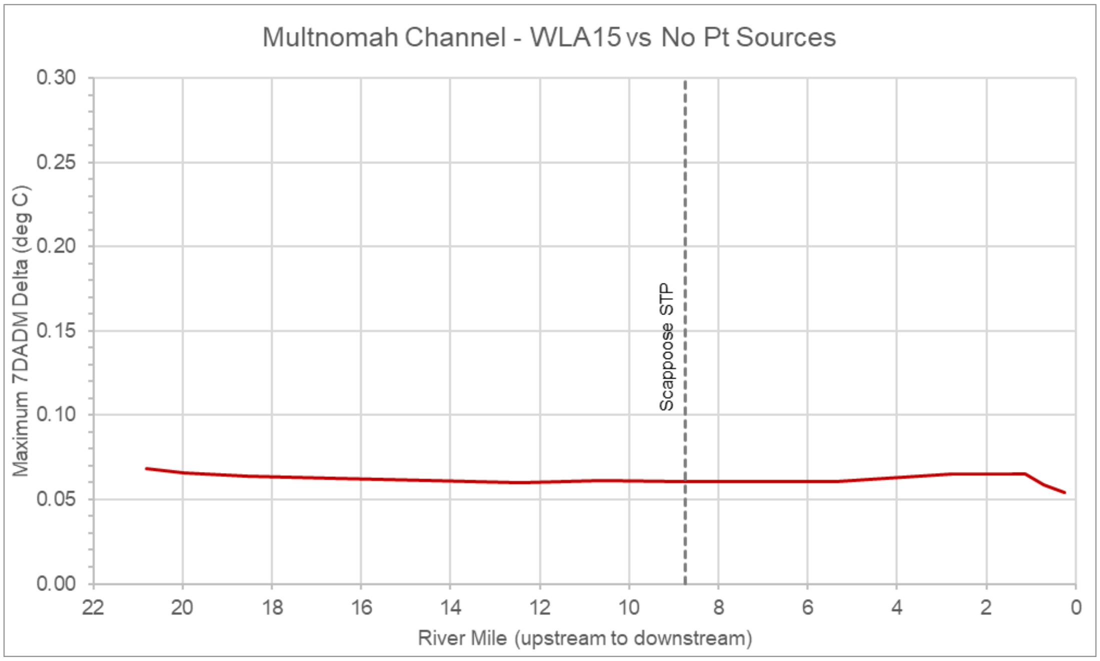

Figure 4-19. Multnomah Channel maximum increase in 7DADM temperature due to wasteload allocations.

As shown in Figure 4-10, temperature impacts of point sources reach a maximum between RM 115 and 109 (the confluence of the Santiam River). In order to understand why temperature impacts increase in this area, in spite of the absence of large point sources in the immediate area, three additional modeling scenarios were performed: 1) a scenario with only McKenzie River thermal loads including the IP Springfield Paper Mill industrial discharge (Figure 4-20), 2) a scenario with only the Metropolitan Wastewater Management Commission (MWMC, Cities of Eugene and Springfield) municipal discharge (Figure 4-22), and 3) a scenario with only Cascade Pacific Pulp and GP Halsey Mill industrial discharges (Figure 4-21). IP Springfield, MWMC, and combined Cascade Pacific and GP discharges comprise the largest thermal loads to the system.

Temperature impacts with only thermal loads from McKenzie River point sources are shown in in Figure 4-20. Only point sources to the McKenzie River were included in this scenario. Effluent flows for all other point sources were set to zero. While McKenzie River point sources include several other point sources, including fish hatcheries, most of the temperature impacts of McKenzie River point sources on the Willamette River are due to IP Springfield. As shown, McKenzie point sources increase Willamette River temperatures a maximum of 0.093°C during the summer. Downstream from the McKenzie River confluence, impacts decrease to a maximum impact at the POMI between RM 115 and 109 of 0.062°C.

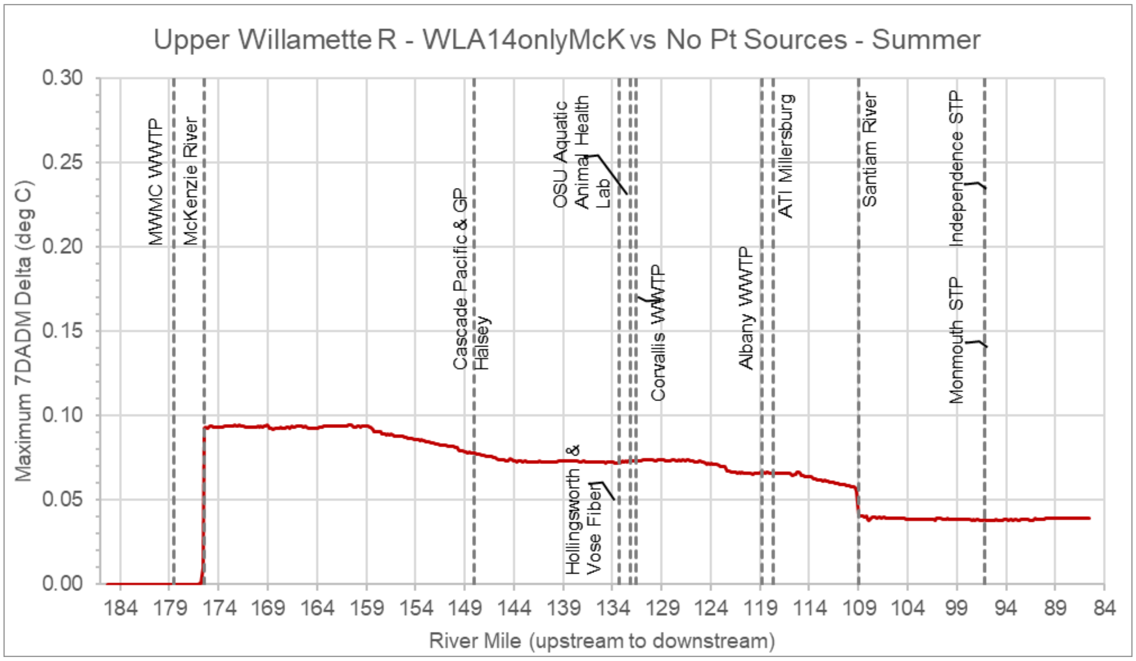

Figure 4-20. Upper Willamette River maximum increase in 7DADM temperature due to McKenzie River wasteload allocations during summer.

Maximum combined impacts of Cascade Pacific and GP Halsey are shown in Figure 4-21. At the discharge location maximum summer impacts are 0.063ºC. Impacts remain steady to RM 129 then gradually decrease to a maximum impact at the POMI between RM 115 and 109 of 0.055ºC.

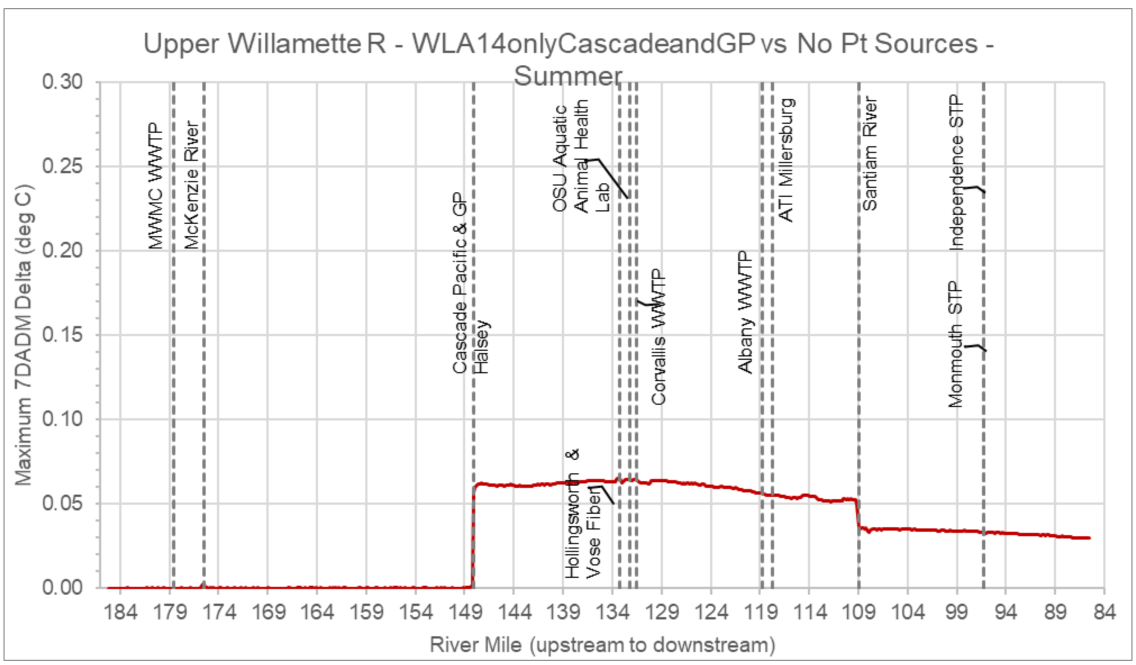

Figure 4-21. Upper Willamette River maximum increase in 7DADM temperature due to Cascade Pacific & GP Halsey wasteload allocations during summer.

Impacts of the MWMC discharge are more variable than the other major discharges (Figure 4-22). Maximum summer impacts at the point of discharge are 0.073ºC at the discharge location. Impacts decrease to less than 0.04ºC downstream from the confluence of the McKenzie River then increase to a maximum 0.077ºC near RM 151 before gradually decreasing to less than 0.05ºC. At the POMI, impacts increase again to a maximum of 0.076ºC at RM 113.5. This increase is a primary reason that the POMI is at this location.

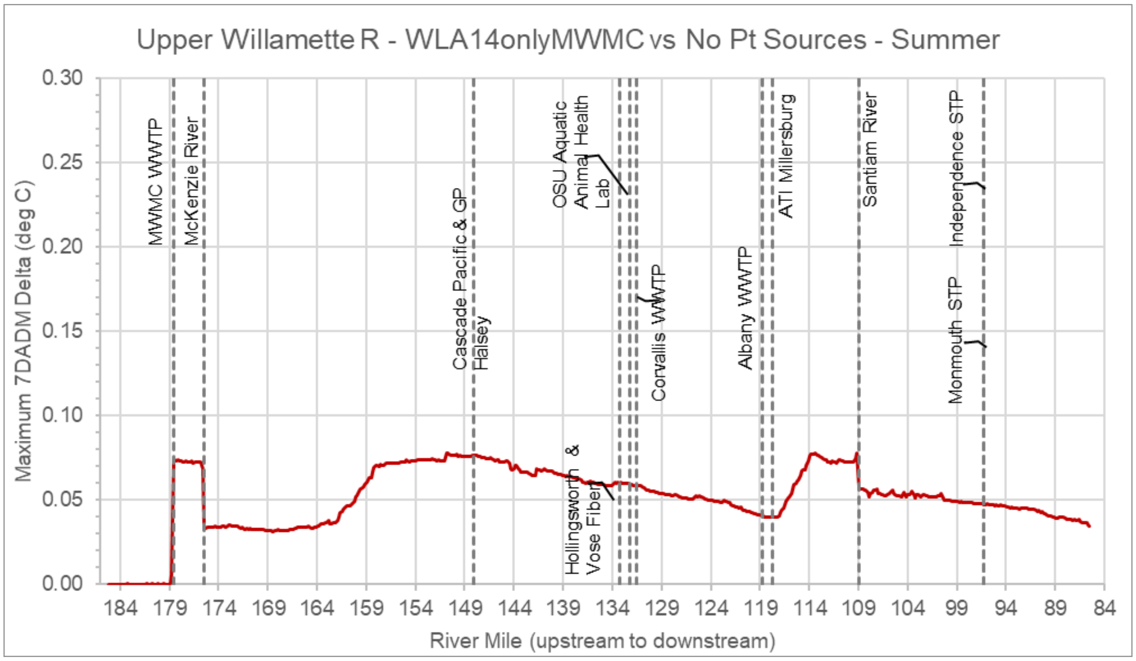

Figure 4-22. Upper Willamette River maximum increase in 7DADM temperature due to MWMC wasteload allocation during summer.

It is not fully clear why MWMC impacts are more longitudinally variable than other discharges. It appears to be mainly due to MWMC effluent temperature being less and effluent flow being greater than for other major discharges (Table 4-4). Effluent temperatures and flow rates are set to constant values for each period modeled (spring spawning period, summer non-spawning period, and fall spawning period) and will only increase river temperatures if effluent temperature is greater than river temperature. At the point of discharge, MWMC effluent temperature is greater than 7DADM river temperature only about half of the time for the 2015 summer period, while the IP Springfield and combined average Cascade Pacific and GP Halsey effluent temperatures are greater than 7DADM river temperature all of the time. Therefore, the MWMC discharge does not heat the river all of the time, at least during the warmest time of the day. Note, however, that since the river cools at night, the discharge may heat the river at night and in the early morning even if the effluent temperature is less than 7DADM river temperature. It is also important to note that the plots only consider temperature impacts on days for which temperature criteria are exceeded. Therefore, when river temperature decreases, such as downstream from the McKenzie River, temperature criteria will be exceeded on fewer dates, so fewer ΔT values will be considered when deriving maximum ΔTs. Temperature impacts in cooler reaches may manifest themselves further downstream as parcels of water warm to temperatures greater than criteria.

Table 4-4. Major point source effluent characteristics

Facility / Location	Effluent flow rate (cfs)	Effluent Temperature (ºC)	Median 7DADM River T (ºC)	Max 7DADM River T (ºC)	Max ΔT near discharge location (ºC)	Max ΔT near POMI (ºC)
MWMC Willamette River RM 178	55.0	20.6	20.4	23.1	0.073	0.076
IP Springfield, etc. McKenzie River RM 12.2 Willamette River RM 175.5	28.9	26.8	McK: 15.3 WR: 19.7	McK: 20.7 WR: 22.3	McK: 0.22 WR: 0.094	0.062
Cascade Pac & GP Halsey Willamette River RM 147.7	22.2	28.6	20.3	23.5	0.063	0.055
POMI Willamette River RM 113.5	-	-	21.2	24.5	-	-

5 Human use allowance (HUA) assignments

The TMDL presents the portions of the HUA assigned to anthropogenic source categories across different AUs and stream extents in the Willamette Subbasins (see Section 9 of the TMDL). Assignments are also provided for reserve capacity. The amount available for reserve capacity is dependent on the portion of the HUA that is utilized by point source WLAs as well as the portions assigned to non-point source categories. Table 5-1 shows assignments to various sectors for assessment units (AUs) or groups of AUs. The third column, “WLA SCENARIO: Model calculated max ΔT due to mainstem WLAs,” shows maximum impacts of WLAs derived via cumulative effects modeling (as discussed above).

The assigned HUA for NPDES point sources is the maximum for all NPDES individual permittees plus the amounts provided to registrants covered by general NPDES permits. Therefore, in addition to the impacts of WLAs provided to point sources with individual NPDES permits (derived through cumulative effects modeling as discussed above), a portion of the HUA is assigned to point sources covered by general NPDES permits. This ranges from 0.01 to 0.02ºC (column 4, NPDES General point sources). Adding this to column 3 provides the total HUA assigned to NPDES point sources (column 5).

Other source categories assigned portions of the HUA include dam and reservoir operations (column 6), consumptive use water management activities and water withdrawals (column 7), solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure (column 8), and solar loading from other non-point sectors (column 9). For AUs upstream from river mile 51 (near the upper extent of Willamette River Newberg Pool), solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure is allocated 0.03ºC of the HUA. Downstream from river mile 51 in the Newberg Pool and the lower Willamette River downstream from Willamette Falls, where the river is wider and less sensitive to shade from streamside vegetation, this sector is allocated 0.02ºC of the HUA. Solar loading from all other nonpoint source sectors is allocated 0.0°C. These HUA allocations are consistent with allocations provided recently in the Total Maximum Daily Loads for the Lower Columbia-Sandy Subbasin (DEQ 2024). Sandy River modeling showed a maximum 7DADM temperature increase due to existing transportation corridors, buildings, and utility infrastructure of 0.03°C from the headwaters (RM 44) to river RM 2 (just upstream of the I-84 bridge). Other source categories assigned portions of the HUA assignments for dam and reservoir operations, consumptive use water management activities and water withdrawals, solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure, and solar loading from other non-point sectors are discussed in more detail in Section 9 of the TMDL.

The amount available to assign to reserve capacity is the HUA minus the sum of the assignments to point source WLAs and non-point source LAs (column 10). As shown in Table 5-1, the amount of reserve capacity available ranges from 0.02 to 0.18ºC. In the middle Willamette River, little to no increases in WLAs can be provided without eliminating reserve capacity.

In the lower Willamette River, impacts of point source WLAs are less than in upstream reaches. Therefore, a portion of the HUA may be assigned to current impacts from the PGE Willamette Falls Project.

In the Row River and lower Willamette River, WLAs and LAs provided to tributaries consume some of the assimilative capacity. To accommodate this impact, reserve capacity is reduced from 0.24ºC (shown in parenthesis) to 0.20ºC for the Row River and 0.03ºC (shown in parentheses) to 0.02ºC for the lower Willamette River (see Section 6 Attainment Scenario Modeling below).

Table 5-1. WLA maximum temperature impacts and HUA assignments for source or source categories

Assessment Unit Name	RM	WLA SCENARIO Model calculated max ΔT due to mainstem WLAs	NPDES General point sources	NPDES point sources	Dam and Reservoir operations	Consumptive use water management activities and water withdrawals	Solar loading from existing transport corridors, buildings, and utility infra-structure	Solar loading from other non-point sectors	Reserve capacity	Total HUA
Fall Creek	8-0	0.00	0.01	0.01	0.00	0.02	0.03	0.00	0.24	0.30
Coast Fork Willamette River	30-21	0.20	0.01	0.21	0.00	0.02	0.03	0.00	0.04	0.30
Coast Fork Willamette River	21-0	0.06	0.01	0.07	0.00	0.02	0.03	0.00	0.18	0.30
Middle Fork Willamette River	17-0	0.02	0.02	0.04	0.00	0.02	0.03	0.00	0.21	0.30
Row River	8-0	0.00	0.01	0.01	0.00	0.02	0.03	0.00	(0.24)[1] 0.20	0.30
Long Tom River	23.6-0	0.05	0.01	0.06	0.00	0.02	0.03	0.00	0.19	0.30
South Santiam River	37-0	0.11	0.02	0.13	0.00	0.02	0.03	0.00	0.12	0.30
North Santiam River	58-11.5	0.06	0.02	0.08	0.00	0.02	0.03	0.00	0.17	0.30
Santiam River	11.5-0	0.02	0.02	0.04	0.00	0.02	0.03	0.00	0.21	0.30
Willamette River	187-107.5	0.22	0.01	0.23	0.00	0.02	0.03	0.00	0.02	0.30
Willamette River	107.5-84.5	0.16	0.01	0.17	0.00	0.02	0.03	0.00	0.08	0.30

[1] Reserve Capacity reduced in response to Attainment Scenario modeling (see Section 6 below)

Willamette River	84.5-51	0.22	0.01	0.23	0.00	0.02	0.03	0.00	0.02	0.30
Willamette River	51-45	0.12	0.01	0.13	0.00	0.02	0.02	0.00	0.13	0.30
Willamette River	45-0	0.11	0.01	0.12	0.11	0.02	0.02	0.00	(0.03) 0.02	0.30
Clackamas River	23-0	0.05	0.03	0.08	0.15	0.02	0.03	0.00	0.02	0.30

Summaries of values in Table 5-1:

HUA: WLAs and LAs will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3ºC (0.5ºF) above the applicable criteria after complete mixing and at the POMI

WLA Scenario (Column 3): WLA scenario minus No Point Source scenario. Values shown are at Point of Maximum Impact (POMI) for each AU POMI

NPDES General Pt Sources (Column 4): 0.01-0.02ºC

NPDES Pt Sources (Column 5): WLA Scenario + General NPDES

Dam and Reservoir Operations (Column 6): 0.11ºC for PGE Willamette Falls project

Consumptive use water management and withdrawals (Column 7): NPS impacts due to consumptive use withdrawal of water (diversion minus return) and warming of such water before return

Solar loading from existing transport corridors, buildings, and utility infra-structure (Column 8): Less in Newberg Pool and Willamette (where river is wider)

Solar loading from other non-point sectors (Column 9): Zero allocated

Reserve Capacity (Column 10): 0.3 minus sum of NPDES Point Sources and LAs to non-point sources

Total HUA (Column 11): Sum of NPDES Point Sources plus LAs plus RC (prior to any reduction due to tributary LA and WLA impacts)

6 Attainment scenario modeling

Attainment scenario modeling is a cumulative effects analysis similar to cumulative effects modeling performed to evaluate impacts of WLAs. It is an evaluation to determine if the cumulative impact of all wasteload and load allocations (WLAs and LAs) for mainstem reaches and tributaries do not exceed the HUA and if there is sufficient assimilative capacity for reserve capacity. For the scenario, modeling is performed with Willamette Mainstem point sources set to WLAs and with tributary temperatures increased by the amounts caused by tributary LAs and WLAs, as follows (Equation 6-1):

Equation 6-1

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

Where:

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

Upper dam boundary conditions are unchanged for the scenarios. Like for the WLA Scenario, model calculated river temperatures for the attainment scenario are compared to a scenario with no point sources. The modeling shows the impacts of tributary WLAs + tributary LAs + mainstem WLAs. Subtracting ΔTs for this scenario from the HUA indicates the amount of remaining HUA that is available for mainstem LAs and Reserve Capacity (Table 6-1).

Plots for points of maximum impact (POMIs) are provided below (Figure 6-1 to Figure 6-8). The attainment scenario plot for Coast Fork Willamette River (Figure 6-1), when compared with the WLA scenario (Figure 4-5), shows that some of the available HUA is reduced by tributary WLAs and LAs downstream from the Row River.

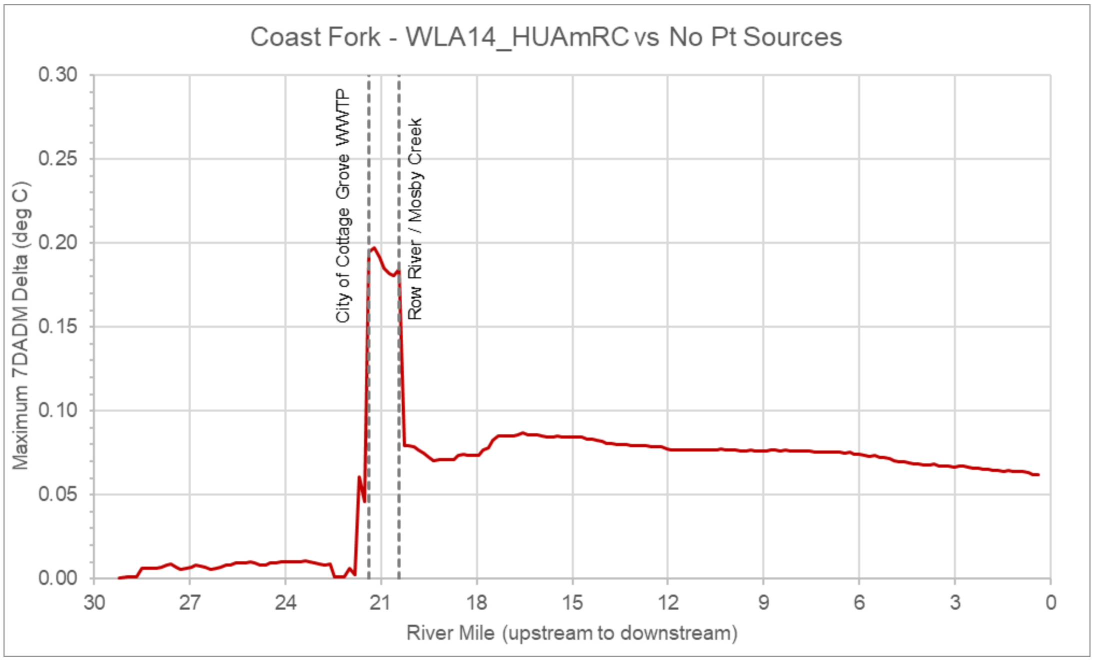

Figure 6-1: Coast Fork Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

An attainment scenario plot of the Row River downstream from Dorena Reservoir is shown in Figure 6-2 (the Row River is a tributary to the Coast Fork Willamette River, Figure 6-1). Figure 6-2 shows the maximum impacts of tributary WLAs and LAs, which are due to a 0.145^{o}C increase in Mosby Creek temperature associated with allocations provided to Mosby Creek thermal load sources (Mosby Creek enters the Row River at RM 24.2 – Note that river miles shown on the plot are based on the distance from the confluence of the Middle Fork with the Coast Fork to form the Willamette River). No WLAs are provided to individual mainstem Row River point sources, so the impact is all due to Mosby Creek. As shown, the maximum impact is 0.061^{o}C.

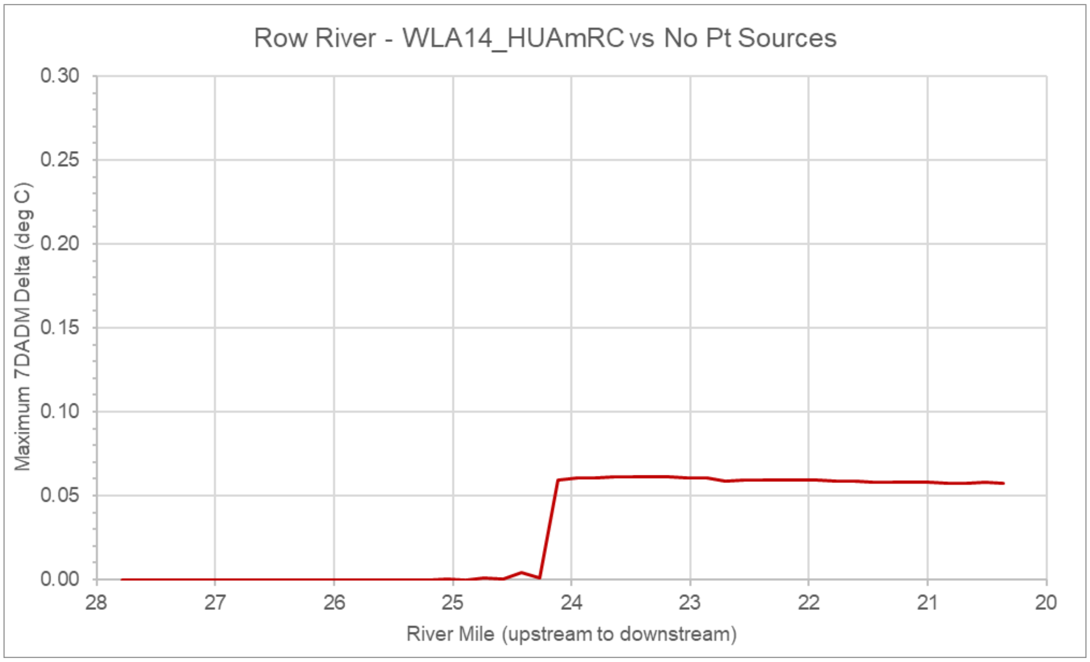

Figure 6-2: Row River - Maximum Impacts of tributary WLAs and LAs plus mainstem WLAs

Use of the attainment scenario maximum impact of 0.061°C results in an available Reserve Capacity of 0.20°C for Row River. Note that the maximum impact of Mosby Creek on the Row River of 0.061°C (Figure 6-2) is unusually large, since Mosby Creek generally does not contribute more than 10% of the flow of the Row River and the impact of a 0.145°C HUA allocation to Mosby Creek generally would not exceed 0.02°C. During the summer when Mosby Creek flow is less, the impact of a 0.145°C HUA allocation to Mosby Creek does not exceed 0.01°C. However, during the spring when flow released from Dorena Reservoir is maintained at a minimum, impacts can at times be larger. On May 1, 2015, the impact is 0.061°C. This decreases to 0.02°C by May 9, 2015. As shown in Figure 6-3, upper 95th percentile temperature impacts of the 0.145°C HUA allocation to Mosby Creek on the Row River do not exceed 0.024°C. If this 0.024°C impact is used for Reserve Capacity calculations for the Row River discussed below, rather than the maximum impact of 0.061°C, reserve capacity can be increased to 0.24 (Table 6-1). The Reserve Capacity is set to 0.20 for Row River, which results in allocated HUA plus RC summing to 0.26°C, rather than the full 0.3°C of HUA available. The remaining 0.04°C of HUA is neither allocated nor assigned as RC and provides additional assurance that the available 0.3°C of HUA will not be exceeded.

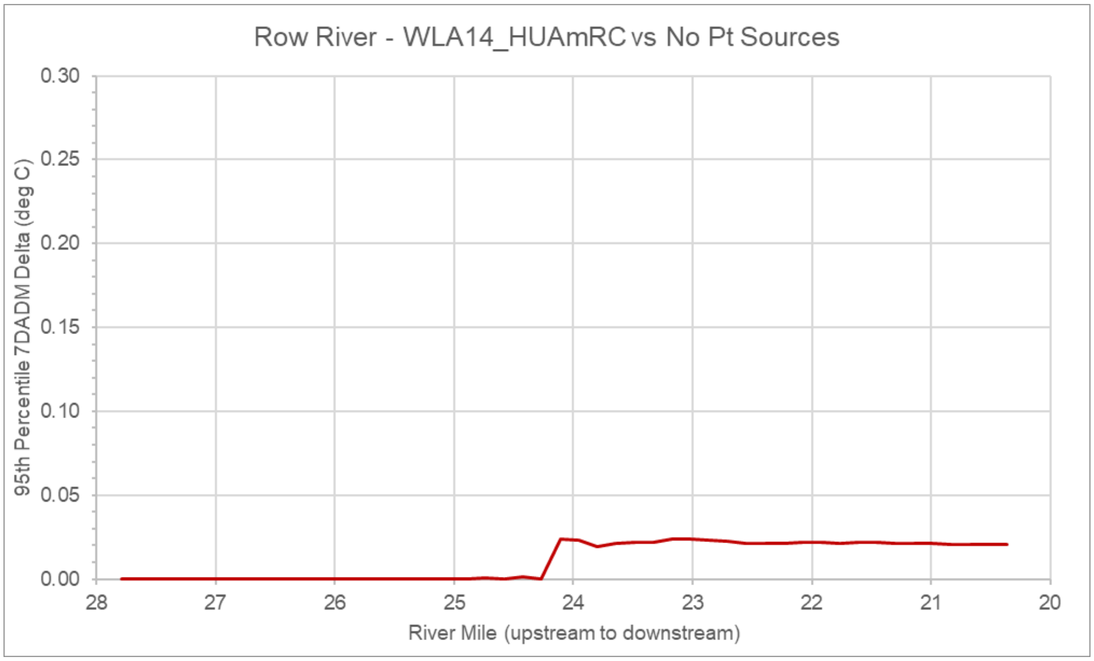

Figure 6-3: Row River - 95th Percentile Impacts of tributary WLAs and LAs plus mainstem WLAs

For rivers with significant tributary WLA and LA impacts, including the South Santiam River (Figure 6-4 vs. Figure 4-4), upper Willamette River (Figure 6-5 vs. Figure 4-10), middle Willamette River (Figure 6-6 vs. Figure 4-16), and lower Willamette River (Figure 6-8 vs. Figure 4-18), less of the available HUA remains for the attainment scenario than for the WLA scenario.

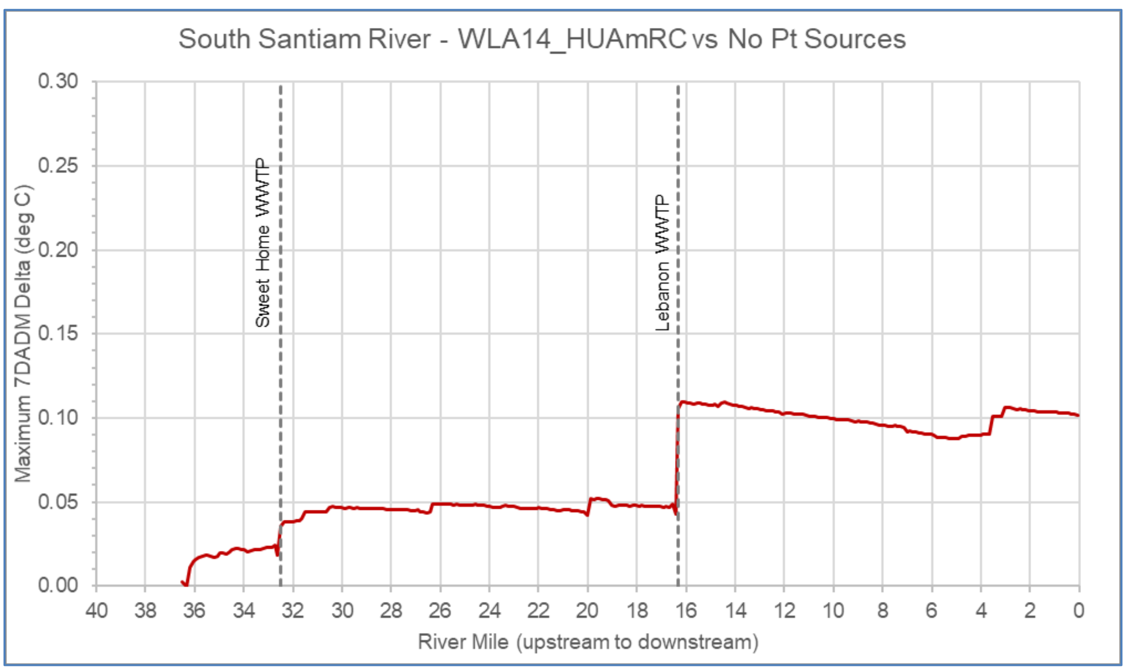

Figure 6-4: South Santiam River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

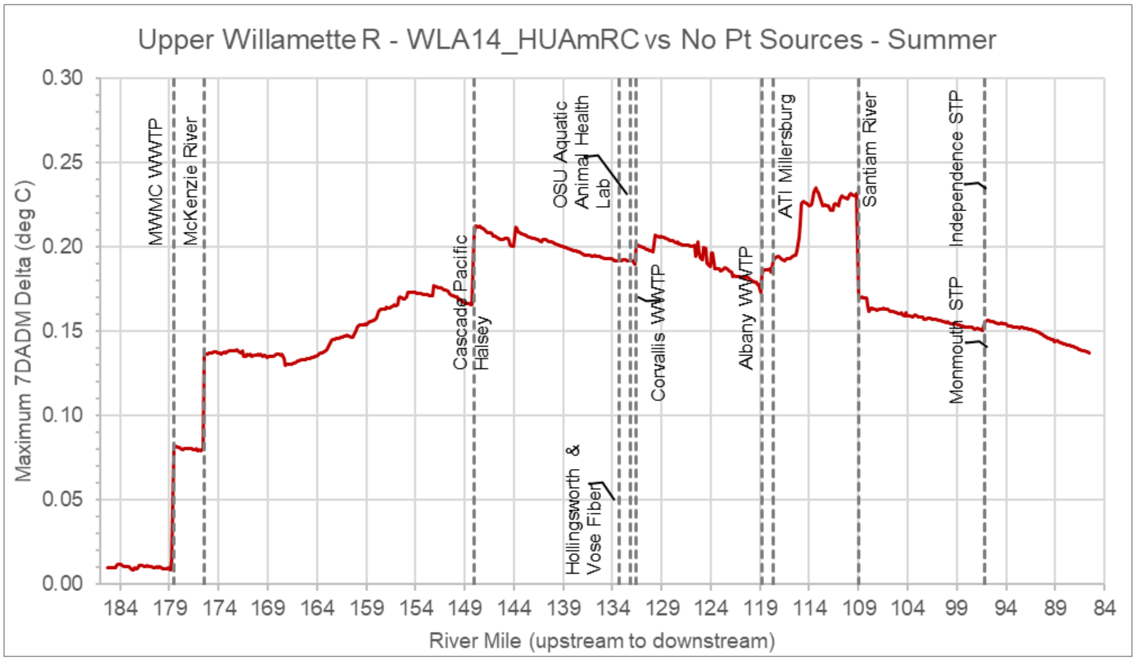

Figure 6-5: Upper Willamette R - Impacts of tributary WLAs and LAs plus mainstem WLAs.

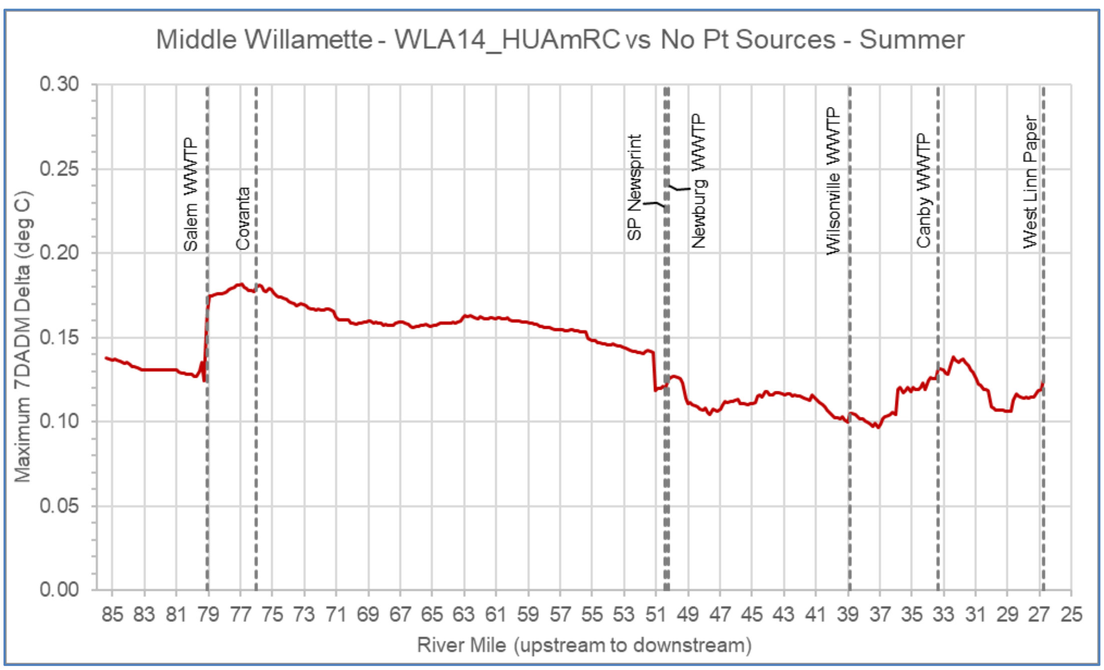

Figure 6-6: Middle Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs

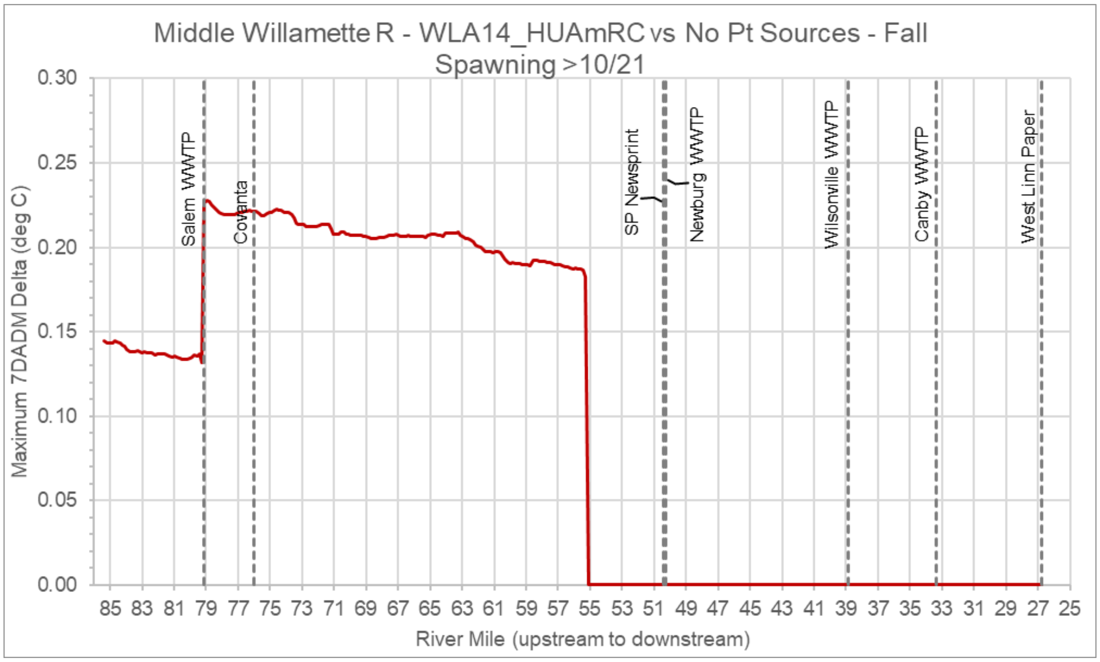

Figure 6-7. Middle Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs - Fall

As discussed above, the greatest impacts of point source WLAs in the Middle Willamette model are during the fall.

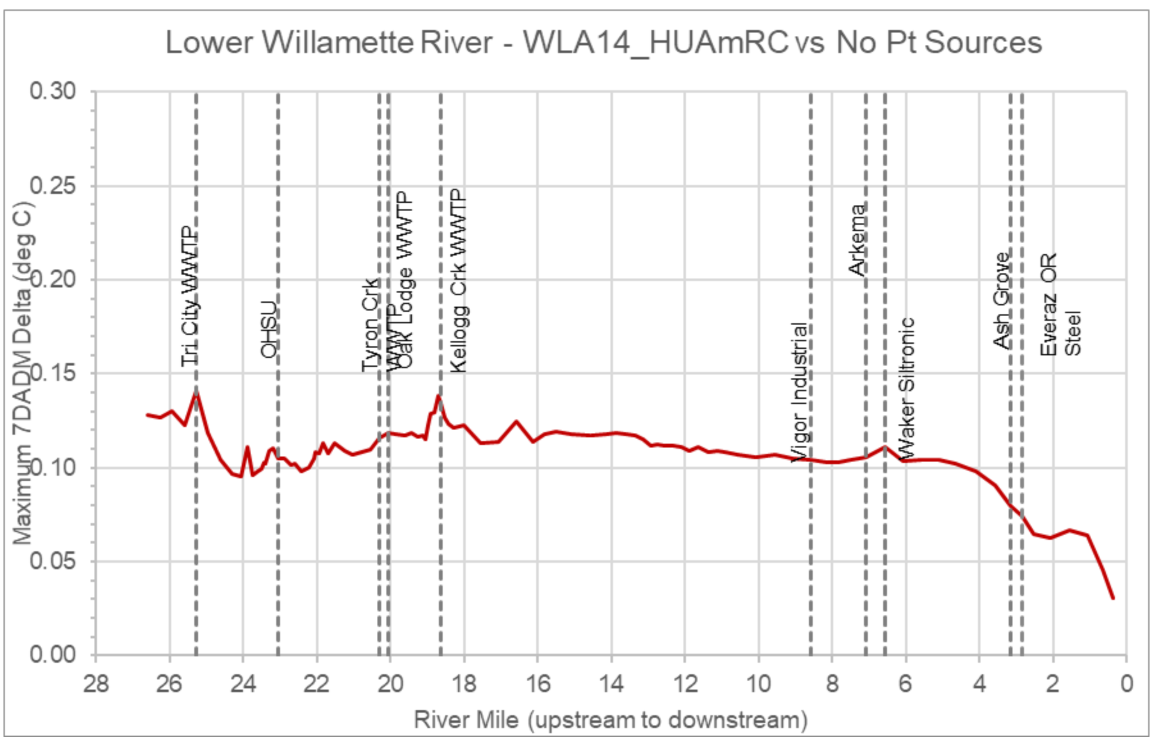

Figure 6-8: Lower Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs

The attainment scenarios show that less of the HUA may be available for reserve capacity in some cases than the amount suggested by WLA cumulative effects modeling (Section 3). Table 6-1 shows the reserve capacity provided by the TMDL (column 3). Table 6-1 column 4 shows the Attainment Scenario model calculated maximum ΔT due to WLAs (mainstem + tributary) plus tributary LAs (maximum 7DADM changes in Figure 6-1 to Figure 6-8) . Column 4 plus the portion of the HUA assigned to NPDES general permits (column 5) is the ΔT due to WLAs including those for general permits plus tributary LAs (column 6).

Column 7 of Table 6-1 shows difference between attainment scenario ΔTs and WLA scenario ΔTs. It, therefore, shows the impacts of tributary WLA and LAs on the mainstem. As shown, impacts range from 0.00 to 0.03°C. This impact reduces the amount of reserve capacity available in some reaches.

Column 8 of Table 6-1 shows the HUA available to allocate to non-point source sectors (such as to sectors dam and reservoir operations, consumptive use due to water management activities, and solar loading from existing transportation corridors, etc.) and reserve capacity. It is derived by subtracting column 6 (attainment scenario plus NPDES General Point Sources WLAs) from 0.30°C.

Column 9 of Table 6-1 are the portions of the HUA assigned to non-point source sectors (sum of HUA assigned to dam and reservoir operations + consumptive use due to water management activities + solar loading from existing transportation corridors, etc.).

Columns 10 and 11 of Table 6-1 show the unallocated HUA that may be assigned to reserve capacity. Column 10 is the most conservative scenario. It is the HUA available to allocate (column 8) minus the HUA assigned non-point source LAs (column 9). Column 11 of Table 6-1 is a less conservative but more realistic scenario. It is expected that a significant portion of the HUA allocated to “Other water management activities and water withdrawals” and 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 tributary temperature increases included for the attainment scenario. The values in column 11 assume that 50% of the HUA assigned to non-point source sectors (consumptive use due to water management activities + solar loading from existing transportation corridors, etc.) is due to tributary non-point source LAs and the rest due to mainstem sources. If the reserve capacity in column 3 is in the range suggested as available by Table 6-1 columns 10 and 11, then it is considered to be a reasonable value. This is the case for all reserve capacity values except for Willamette River RM 45-0. For Willamette River RM 45-0, Reserve Capacity is reduced from 0.03°C (shown in parentheses) to 0.02°C. Similarly, for Row River, Reserve Capacity is reduced from 0.24°C (shown in parentheses) to 0.20°C. For all other reaches, it is reasonable to specify the amounts calculated using WLA cumulative effects analyses as reserve capacity.

Table 6-1: Attainment scenario influence on HUA assignments and reserve capacity.

Assessment Unit Name	RM	Reserve capacity	Attainment scenario: Model calculated max ΔT due to individual WLAs (mainstem + tributary) plus tributary LAs	NPDES General point sources	Attainment scenario: model calculated max ΔT due to all WLAs (mainstem + tributary) plus tributary LAs	Attainment scenario: minus WLA scenario: Trib WLA + Trib LA	HUA available to allocate	HUA assigned to non-point source LAs	Minimum Un-allocated HUA	Un-allocated HUA if 50% of the HUA assigned to non-point source LAs is due to trib NPS LAs
Fall Creek	8-0	0.24	0.00	0.01	0.01	0.00	0.29	0.05	0.24	0.27
Coast Fork Willamette	30-21	0.04	0.20	0.01	0.21	0.00	0.09	0.05	0.04	0.07
Coast Fork Willamette	21-0	0.18	0.09	0.01	0.10	0.03	0.20	0.05	0.15	0.18
Middle Fork Willamette	17-0	0.21	0.02	0.02	0.04	0.00	0.26	0.05	0.21	0.24
Row River	8-0	(0.24) 0.20	0.06	0.01	0.07	0.06	0.23	0.05	0.18	0.20
Long Tom River	23.6-0	0.19	0.05	0.01	0.06	0.00	0.24	0.05	0.19	0.21
South Santiam	37-0	0.12	0.11	0.02	0.13	0.01	0.17	0.05	0.12	0.15
North Santiam	58-11.5	0.17	0.06	0.02	0.08	0.00	0.22	0.05	0.17	0.20
Santiam River	11.5-0	0.21	0.05	0.02	0.07	0.03	0.23	0.05	0.18	0.21
Willamette River	187-107.5	0.02	0.24	0.01	0.25	0.01	0.06	0.05	0.00	0.03
Willamette River	107.5-84.5	0.08	0.17	0.01	0.18	0.01	0.12	0.05	0.07	0.09
Willamette River	84.5-51	0.02	0.23	0.01	0.24	0.01	0.06	0.05	0.01	0.04

Willamette River	51-45	0.13	0.13	0.01	0.14	0.01	0.16	0.04	0.12	0.14
Willamette River	45-0	(0.03) 0.02	0.14	0.01	0.15	0.03	0.15	0.15	0.00	0.02
Clackamas River	23.0	0.02	0.06	0.03	0.09	0.01	0.21	0.20	0.01	0.03

Summaries of values in Table 6-1:

Reserve Capacity (Column 3): Reserve Capacities, reduced as necessary in response to Attainment Scenario analysis. Examples: RC of 0.02 in upper Willamette RM 187-107.5 is not reduced since in range 0.00 (column 10) to 0.03 (column 11). RC 0.02 in middle Willamette RM 84.5-51 is not reduced since in range 0.01 to 0.04. As discussed above, for Willamette River RM 45-0, RC is reduced from 0.03^{o}C (shown in parentheses) to 0.02^{o}C since 0.03^{o}C exceeds 0.02^{o}C (column 11).

ATTAINMENT SCENARIO (Column 4): Provides model calculated estimate of the amount of HUA consumed by allocations provided to tributaries (point and non-point) plus allocations provided to individual mainstem point sources

NPDES General point sources (Column 5): Amount of Mainstem HUA reserved for NPDES general permits

ATTAINMENT SCENARIO Model calculated max ΔT due to all WLAs (mainstem + trib) plus trib LAs (Column 6): ATTAINMENT SCENARIO plus NPDES General Point Sources WLAs. Provides model calculated estimate of the amount of HUA consumed by allocations provided to tributaries (point and non-point) plus allocations provided to all mainstem point sources (individual plus general). Derived by adding HUA provided to NPDES General point sources (generally 0.01 – 0.02^{o}C) (Table 6-1 Column 5) to Attainment Scenario (Table 6-1 Column 4)

ATTAINMENT SCENARIO minus WLA SCENARIO (Column 7): Impacts of tributary WLA and LAs on Mainstem

HUA available to allocate (Column 8): 0.3 minus ATTAINMENT SCENARIO Model calculated max ΔT due to all WLAs (mainstem + tributary) plus tributary LAs

HUA assigned to non-point source LAs (Column 9): Sum of Dam and Reservoir ops + CU due to water management activities + Solar loading due to existing trans corridors, etc.

Minimum Unallocated HUA (Column 10): HUA available to allocate minus HUA assigned to NPS LAs.

Unallocated HUA if 50% of the HUA allocated to non-point sources is due to tributary non-point source LAs and rest to due mainstem sources (Column 11): If Reserve Capacity exceeds this, reduce assigned RC to this value.

7 Compliance with Columbia River Temperature TMDL

The USEPA Columbia and Lower Snake Rivers Temperature Total Maximum Daily Load (TMDL) (USEPA, 2021) limits the impact of load and wasteload allocations provided for the Willamette River to a daily average temperature impact of 0.5ºC. Willamette River attainment scenario modeling shows that the maximum impact of tributary load and wasteload allocations plus Willamette Mainstem wasteload allocations at the river mouth does not exceed 0.04ºC as a daily average (Table 7-1). The impact as a daily average is less than the 0.07ºC impact as a 7-day average daily maximum (7DADM) and slightly more than the 0.03ºC impact as a 7-day average.

In addition to tributary load and wasteload allocations plus Willamette Mainstem wasteload allocations, 0.09ºC of the HUA near the river mouth is assigned to dam and reservoir operations; 0.02ºC to consumptive use water management activities and water withdrawals; and 0.02 to Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure. Adding these values to the impacts of load and wasteload allocations adds up to 0.17ºC, as follows:

$$0.04 + 0.09 + 0.02 + 0.02 = 0.17^{o}C$$

An additional 0.06ºC is specified for reserve capacity. Adding this to 0.017ºC equates to 0.23ºC. This indicates that, even if reserve capacity is fully allocated in the future, the impact of Willamette River thermal allocations will not exceed 0.5ºC.

Table 7-1. Increase in daily average temperature due to Willamette River load and wasteload allocations.

Willamette River Locations	Maximum ΔT via Daily Averages (>= 20˚C only) (˚C)	Maximum ΔT via 7-day Averages (>= 20˚C only) (˚C)	Maximum ΔT via 7DADM (>= 20˚C only) (˚C)
Willamette River at RM 12.6 USGS Gage at Portland	0.12	0.11	0.11
Willamette River at RM 0 Mouth	0.04	0.03	0.07

Table 7-1 also shows the maximum impact of tributary load and wasteload allocations plus Willamette Mainstem wasteload allocations in the vicinity of the Morrison Bridge at Portland (USGS Gage No. 14211720) as a daily average, in addition to as a 7-day average and as a 7DADM. While the impact is greater at this location, the impact of Willamette River thermal allocations at this location also will not exceed 0.5ºC as a daily average. This provides additional assurance that requirements for the Willamette River specified by the USEPA Columbia and Lower Snake Rivers Temperature Total Maximum Daily Load will be met.

8 Sensitivity to shade, flow, and temperature

8.1 Restored vegetation scenario

Modeling completed for the 2006 Willamette Basin TMDL (DEQ, 2006) was used to evaluate temperatures from current condition and site potential vegetation (system potential vegetation) shade. System potential shade targets are based on assumed shade levels produced by riparian vegetation expected to occur in the absence of human disturbance. System potential vegetation and effective shade targets do not target mature vegetation throughout the basin. Simulations include an allowance for natural disturbance in model runs as lower tree heights and canopy densities. These disturbances were randomly distributed throughout the streamside area in model simulations and, to maintain model precision, were not changed once simulations began. The potential near-stream land cover in the Willamette Valley bottom is assigned a vegetation component defined by geomorphic unit or ecoregion. Each geomorphic unit or ecoregion unit is assigned unique vegetation characteristics such as height, density, and canopy overhang, (see TSD Appendix A and TSD Appendix C for additional information). System potential simulations generally yielded higher levels of effective shade and lower levels of solar radiation input to the river than values used to calibrate the model to current conditions. In some locations, system potential simulated shade levels were lower than shade levels measured and included in the model calibration. These patches of elevated solar radiation loading are the natural disturbance contribution to stream warming.

Figure 8-1 illustrates the difference between current effective shade levels and system potential shade levels for river mile 187 to river mile 26 at Willamette Falls. See TSD Appendix A for shade model documentation. Current shade levels were not included in the calibrated model below Willamette Falls.

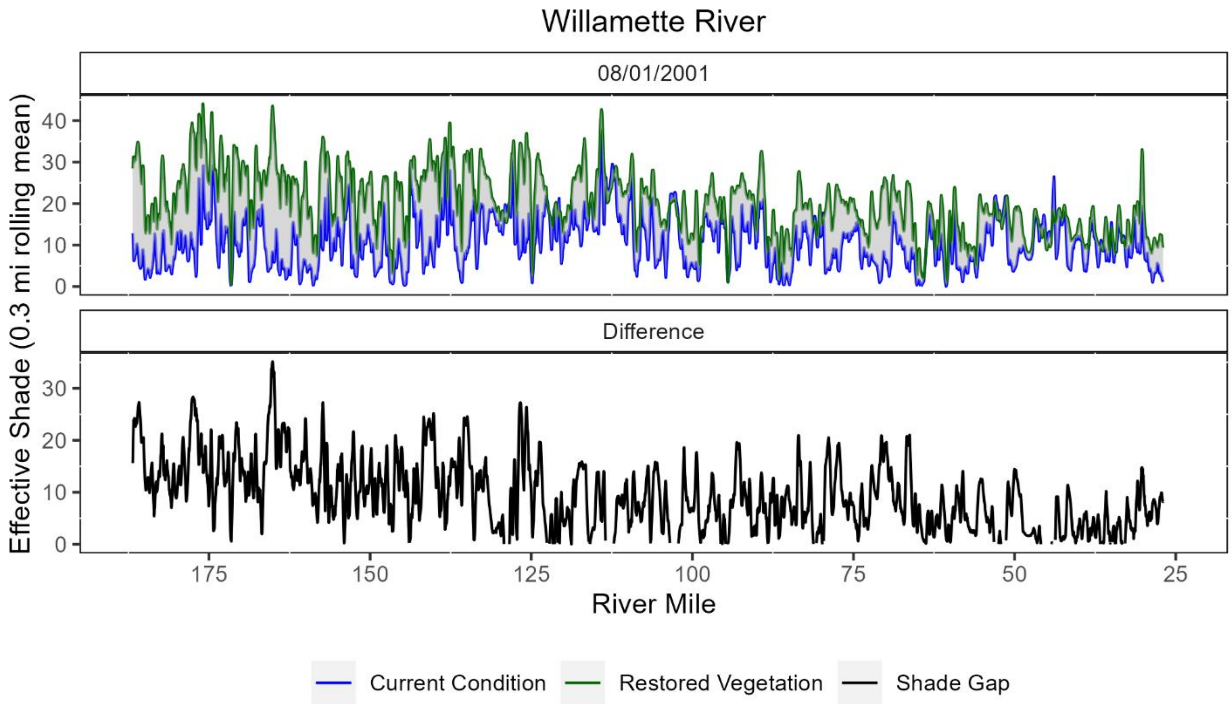

Figure 8-1: Current and restored vegetation effective shade relationship for the Willamette River.

Nonpoint source heat loads were determined by quantifying differences between solar radiation heat loads for current vegetation conditions and solar radiation heat loads for system potential vegetation conditions. Heat loads associated with potential near stream land cover and effective shade were considered the natural or background heat load for each stream system. Heat loads above this background level were attributed to anthropogenic disturbance of streamside vegetation and, thus, nonpoint source activities.

Relationships between total solar radiation heat load, natural or background heat load and anthropogenic heat loads are described in Table 8-1. For the Willamette and its largest tributaries, background heat load from solar radiation exceeds anthropogenic loads by an order of magnitude. Nevertheless, August average daily energy input from anthropogenic activities that diminish effective shade is estimated at 23×10^9 kcal/day. Table 8-1 does not reflect an energy balance for each river reach or through time. Energy gains and losses are continuous through each reach and the table only reflects energy inputs through direct solar radiation. Furthermore, heat loading capacity of the river increases in a downstream direction as a function of river volume and simple solar radiation inputs are not a predictor of maximum stream temperature.

Heat loads as reported in Table 8-1 are in kcal/day. These values were calculated by multiplying the wetted surface area of the river reach by the solar flux received by the stream. Wetted surface area was calculated through interpolation of remote imagery, modeling, and by field measurements.

Solar loading as displayed in Table 8-1 is largely a function of stream surface area. Longer river reaches have larger loads than shorter river reaches because of greater surface area. Emphasis should be placed on the difference between natural background loads and current loads. The decrease in solar radiation to reach system potential reflects the daily reduction in kilocalories necessary to realize background heat loads.

Current solar loading values for the lower Willamette River (RM 0 to 27) do not reflect actual vegetation conditions. No streamside vegetation was included in this portion of the model and the only shade provided in this reach is from topographic features. It was assumed that vegetation has little impact on overall stream temperatures in the lower river because of the width of the river, the volume of water, and the effects of tidal dilution. System potential shade values are very low downstream of Willamette Falls and is likely to have negligible effect on mainstem model outputs (DEQ, 2006).

Table 8-1: Heat load from solar radiation in August (DEQ 2006).

River	River Mile	Current Condition Solar Loading kcals/day x10^9	Restored Vegetation Solar Loading kcals/day x10^9	Anthropogenic Solar Loading kcals/day x10^9	Portion from Anthropogenic Nonpoint Sources
Willamette River	**187-0**	**287.93**	**265.01**	**22.92**	**8.0%**
	187-171.8	13.52	11.37	2.15	15.9%
	171.8-161.2	9.11	7.59	1.52	16.7%
	161.2-149	11.25	9.81	1.44	12.8%
	149-132.1	14.52	12.41	2.11	14.5%
	132.1-119.4	12.04	11.07	0.98	8.1%
	119.4-109	10.45	9.60	0.84	8.1%
	109-84.1	32.99	30.48	2.51	7.6%
	84.1-54.9	40.35	36.96	3.39	8.4%
	54.9-35.7	30.68	29.61	1.06	3.5%
	35.7-24.8	23.93	22.22	1.71	7.2%
	24.8-13.1	30.40	27.88	2.51	8.3%
	13.1-3.4	43.56	41.50	2.05	4.7%
	3.4-0	15.14	14.50	0.64	4.2%
Clackamas River	23.4 - 0	11.99	8.89	3.09	25.8%
	23.4-5.1	9.53	7.14	2.40	25.1%
	5.1-0	2.45	1.76	0.70	28.3%
Coast Fork Willamette River	29.4 - 0	5.78	4.31	1.47	25.4%
	29.4-20.8	0.64	0.39	0.25	39.4%
	20.8-0	5.14	3.92	1.22	23.7%
Row River	7.5-0	1.78	1.12	0.66	37.4%
Middle Fork Willamette River	11.2 - 0	9.98	8.85	1.13	11.3%
	11.2-16.8	2.84	2.44	0.39	13.8%
	11.2-0	7.15	6.41	0.74	10.3%
Fall Creek	7.1-0	1.18	0.92	0.26	21.8%
North Santiam	27-0	11.19	10.63	0.56	5.0%
Santiam River	11.7-0	9.19	8.44	0.75	8.2%
South Santiam River	37.7-0	21.51	18.33	3.18	14.8%
Long Tom River	25.7-0	3.80	2.25	1.54	40.6%

Figure 8-2 illustrates the effects of nonpoint source activities that influence shade along the river segments included in the mainstem model. The figure shows how much warmer the Willamette River is at current shade levels during the summer than it would be if shade were restored to system potential levels. The increase in seven day average daily maximum (7DADM) stream temperatures is due to the increase in solar radiation load that results from shade being less than system potential levels. During the summer, nonpoint source loads of solar radiation along the mainstem Willamette and its largest tributaries cause a maximum of 0.83°C warming at river mile 137 near Corvallis, based on modeling for 2001. Effects diminish downstream as the river width and volume increases and current condition solar loads approach those of system potential. However, even at Willamette Falls (RM 26.7), nonpoint solar loads cause warming of river temperatures in excess of the 0.3°C HUA.

For Figure 8-2, the Delta 7DADM temperatures shown are different than those in plots above. For Figure 8-2, all Delta Ts are included, rather than only those that exceed the applicable biologically-based numeric criterion. The upper curve shows the 95th percentile Delta Ts for each model segment, the lower the 5th percentile Delta T, and the middle the Median Delta T.

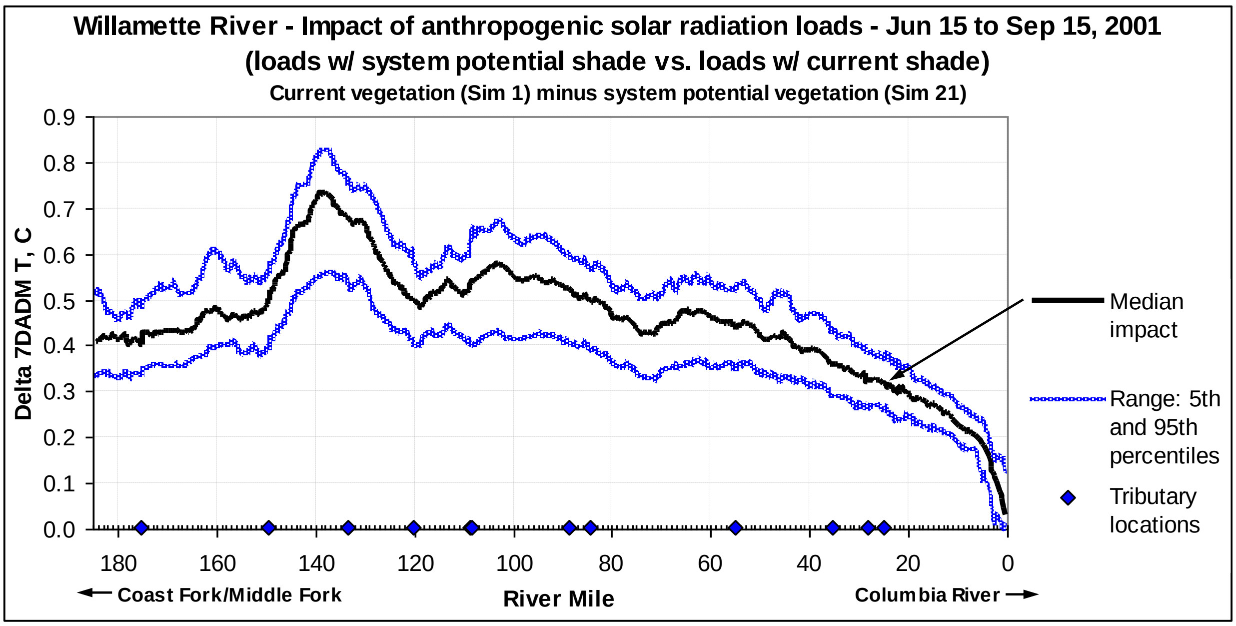

Figure 8-2: Maximum difference in seven day average of the daily maximum temperatures between 2001 calibrated model and 2001 calibrated model with system potential vegetation.

Additional information on the influence of shade on stream temperature is provided in the 2006 TMDL (DEQ, 2006) and associated appendices.

8.2 Influence of upper boundary flow

The 2006 Willamette Basin TMDL provides information on modeling performed to evaluate the sensitivity of river temperature to river flow. Changes in upper boundary condition flow (flow from reservoirs) generally result in temperature changes that become more pronounced as the water moves downstream. Modeling showed that in the Upper Willamette, a 20% flow reduction results in a 0.6°C increase in temperature at RM 145 (estimated by dividing the temperature difference on the plot by 2) and a 0.9°C increase at RM 115 (Figure 8-3). The greatest impact of flow on temperature for is at RM 82 (Figure 8-4). Below RM 52 in the Newberg Pool, the impact of flow on temperature gradually diminishes.

Some of the impacts in temperature are due to time-of-travel related shifts in locations of maximum and minimum temperatures. This is illustrated by temperatures in the Upper Willamette at RM 126, where the difference between the temperatures for the model runs is relatively small, versus RM 115 where it is quite large.

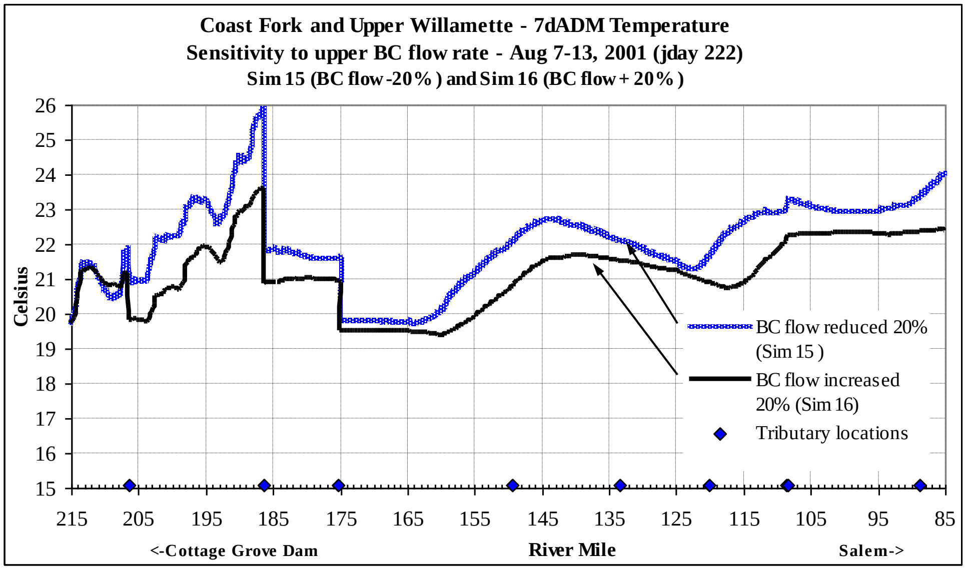

Figure 8-3. Sensitivity of Willamette temperature to +/-20% boundary flow adjustment for Aug 7-13, 2001.

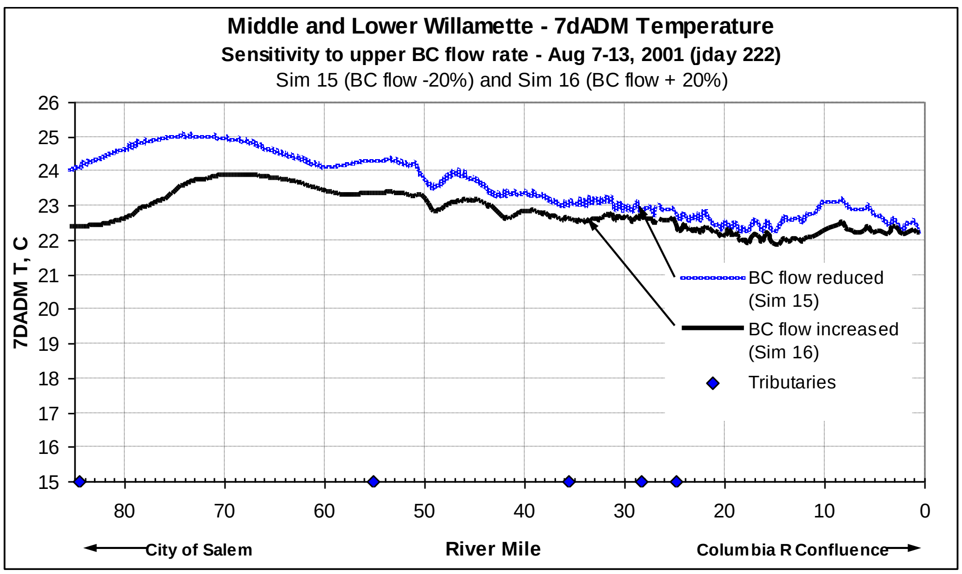

Figure 8-4. Sensitivity of Willamette temperature to +/-20% boundary flow adjustment for Aug 7-13, 2001.

During much of the fall, river temperatures leaving reservoirs are warmer than they would be in the absence of reservoirs. At such times, river temperatures may decrease as water flows downstream. During such times modeling presented in the 2006 Willamette Basin TMDL shows that reductions in river flow may result in decreases in river temperature, rather than increases.

8.3 Influence of upper boundary temperature

The 2006 Willamette Basin TMDL provides information on modeling performed to evaluate the sensitivity of river temperature to the temperature of water released from reservoirs (upper boundary temperature. Changes in upper boundary condition temperature generally result in temperature changes that become less pronounced as the water moves downstream.

Upper boundary temperatures influence temperature all the way to the Willamette River's confluence with the Columbia River. In order to evaluate the degree of influence, modeling simulations were performed with +/- 5^{o}C dam tailrace temperature adjustments made at all dams. The simulations were performed for 2001 flow conditions.

Unit Delta T, based on the calculated difference between +5^{o}C and -5^{o}C model runs divided by 10^{o}C, is presented for the Willamette River for June 15 through September 15, 2001 in Figure 8-5 and Figure 8-6. As shown, the model indicates that a 1.0^{o}C increase in temperature at upper boundaries results in median temperature increases of 0.75^{o}C near the confluence of the Coast Fork and Middle Fork Willamette, 0.25^{o}C near Salem (RM 85), and a little over 0.10^{o}C upstream at the Willamette Falls (RM 26.7).

5th and 95th percentile percentiles are also shown on the plots. The 5th percentile is a low value for which only 5% of values are less than, while the 95th percentile is a high value which 95% of the values are less than (5% are greater than). These values are generally better to use than minimums and maximums because they are less likely to be influenced by outliers.

In the lower Willamette below the Falls, the influence increases to about 0.15^{o}C per degree of boundary condition temperature increase, presumably due to the influence of the Clackamas River (the upper boundary for the Clackamas River is only 23.4 miles above the Willamette). At the Willamette River mouth the influence diminishes to zero due to the influence of the Columbia River.

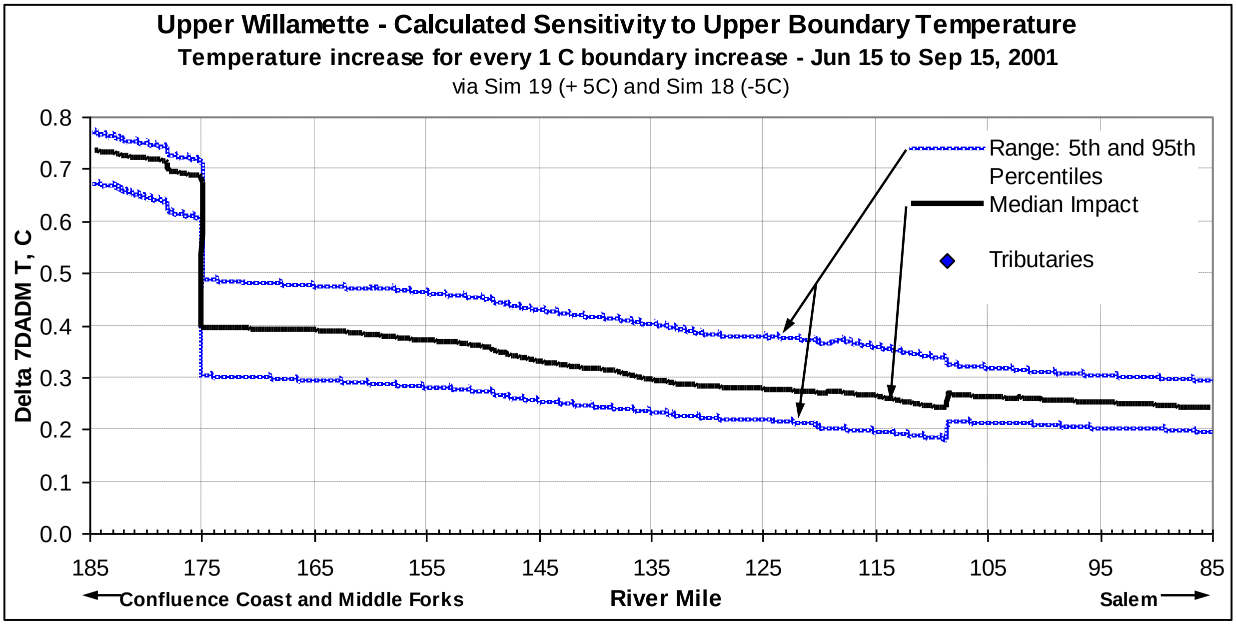

Figure 8-5. Impact of 1.0°C increase in upper boundary temperature on Upper Willamette.

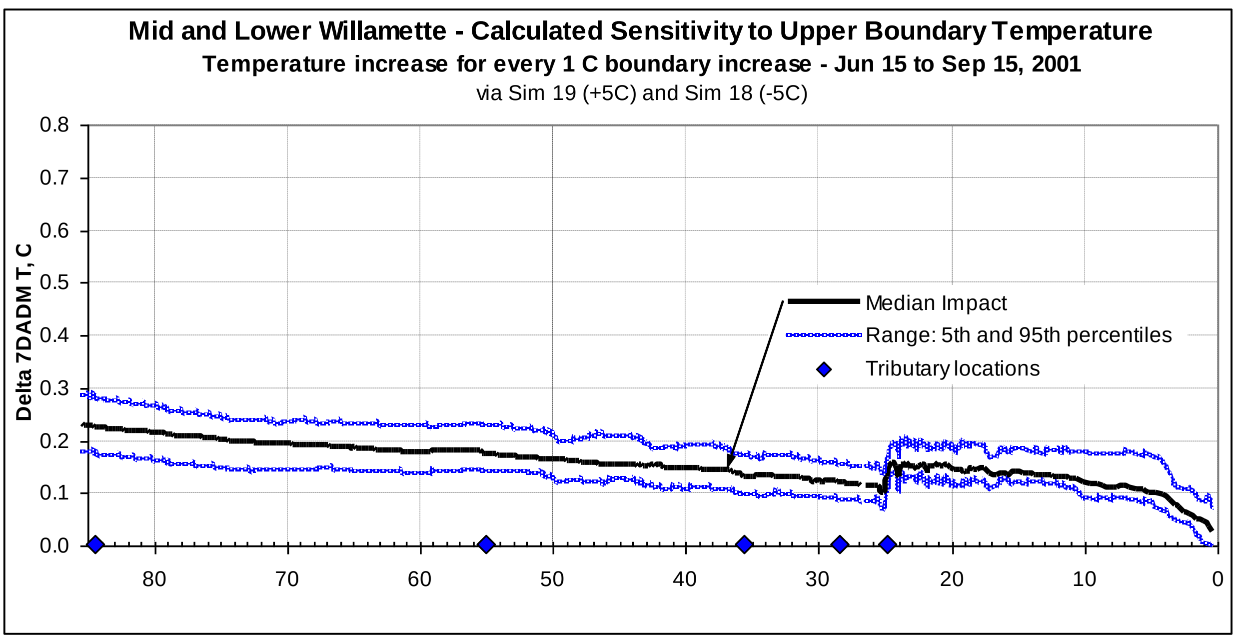

Figure 8-6. Impact of 1.0°C increase in upper boundary temperature on Mid and Lower Willamette.

Modeling performed for all seasons shows the seasonal influence of boundary temperature. Figure 8-7 shows overall average unit impacts for the upper, middle, and lower Willamette. This is calculated by averaging, for each day modeled, the difference between calculated 7DADM temperatures for two simulation for all model segments for each reach. As shown, the influence of boundary temperature is least in the early summer and greatest in the early fall.

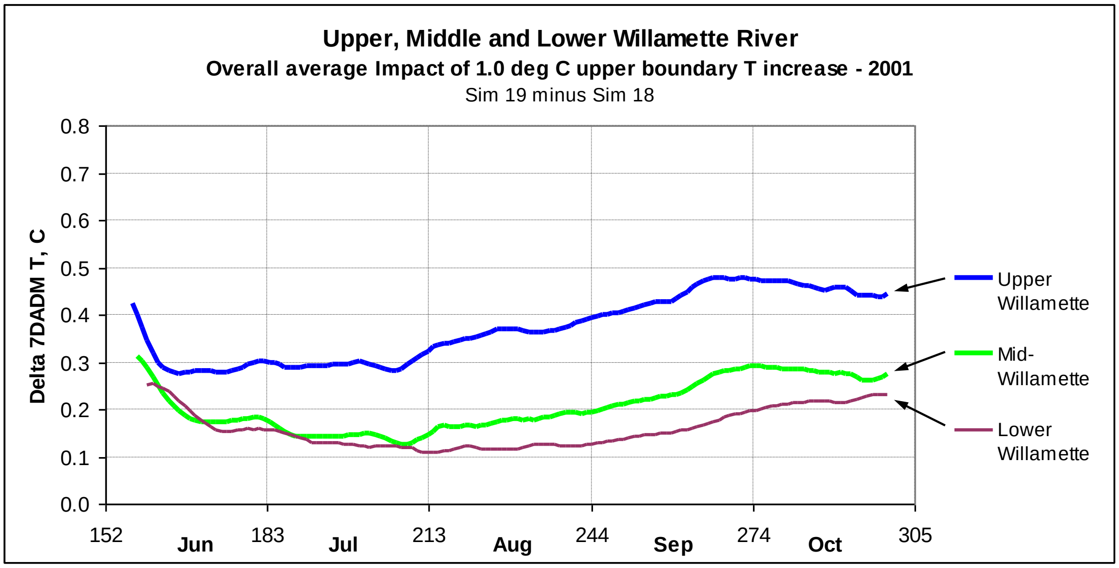

Figure 8-7. Overall average impact of boundary condition temperature impact on river temperature

8.4 Influence of PGE Clackamas River and Willamette Falls Hydroelectric Projects

Modeling shows that the Portland General Electric (PGE) Clackamas River Hydroelectric Project influences temperature in the Clackamas River and that both the PGE Clackamas River Project and the PGE Willamette Falls Project influence temperature in the Willamette River.

The PGE Clackamas River Hydroelectric Project (FERC Project No. 2195) includes several reservoirs, including Estacada Lake, Faraday Lake, North Fork Reservoir, and Timothy Lake. The River Mill Dam at RM 23.4 is the lowermost dam in the Project.

The PGE Willamette Falls Hydroelectric Project (FERC Project No. 2233) is a run-of-the-river project located at the Willamette Falls at RM 26.5. A concrete cap on the basalt formation that creates the Willamette Falls is supplemented in summer low flow periods with flashboards. The increased water level provided by the project increases the volume of water in the Newberg Pool (the impounded reach behind the Falls which extends to about RM 56) and increases the time-of-travel through the reach.

Modeling and other analyses were performed by PGE consultants and DEQ of the impacts of the projects on river temperature and other water quality parameters in order to provide information needed to support DEQ Section 401 water quality certifications to accompany new Federal Energy Regulatory Commission operating licenses. Section 401 of the federal Clean Water Act (CWA) authorizes state water quality programs to certify that federal actions involving the award of licenses or permits will not violate applicable state water quality requirements. In the case of hydroelectric projects, the Federal Energy Regulatory Commission (FERC) administers the licensing program and DEQ certifies project applications for licensing. Procedures for processing applications for 401 certifications are described in Oregon Administrative Rules Chapter 340, Division 48. Water quality certifications typically include operating conditions intended to provide reasonable assurance that project operations will not violate water quality standards. DEQ issued 401 water quality certifications for the PGE Clackamas River Project in June 2009 and the PGE Willamette Falls project in November 2004. Additional modeling was performed by DEQ of the impacts of these projects to provide information for the 2006 TMDL and to determine appropriate Load Allocations for the projects.

Modeling of the Clackamas River Project was performed for model years 2000 and 2001 by PGE consultants and DEQ to provide information for the application for 401 certification and for development of the TMDL to address temperature criteria exceedances. Results are presented in the 2006 TMDL, Chapter 4, Appendix 4.6 (see below). 2001 was a critical low flow year similar to 2015, while 2000 was a higher flow year. The major effect of the Clackamas Project on the lower Clackamas River is that the water discharged at River Mill has a lower daily maximum temperature but higher daily average temperature and less diel variation relative to the variation that would occur at this location if the Project were not in place. The 2006 TMDL assigned the Clackamas River Project a Load Allocation of 0.15°C of the 0.3°C HUA for temperature in the Clackamas River below River Mill Dam.

Because the Clackamas River Project, as described in the June 2008 application for 401 certification, will not always meet temperature standards in the lower Clackamas River in the near term, DEQ required PGE to develop a temperature TMDL implementation plan for the project that shows how the TMDL load allocations will be met (PGE 2009). PGE submitted a TMDL Implementation Plan to address the Clackamas Project's heat contribution to the lower Clackamas River (PGE 2008, PGE 2009). The TMDL implementation plan is a companion document to the Water Quality Management and Monitoring Plan included in PGE's final application for 401 certification (Final 401 Application; PGE 2008) and the Settlement Agreement filed with FERC on March 29, 2006 (PGE 2006a). As described in the TMDL implementation plan, the Clackamas Project's heat contribution to the lower Clackamas River will be addressed through the following measures: lowering the elevation of Faraday Lake during the summer or similar measures that provide at least as much cooling; implement the gravel augmentation program described in the Settlement Agreement, Proposed License Article 46; implement a riparian shading program in tributaries; and restore side channels through two habitat enhancement projects (PGE 2008, PGE 2009). Together, these measures are predicted to reduce river temperatures and increase the amount of cold water habitat available to salmonids in the lower river. In June 2009, DEQ approved the TMDL Implementation plan (TMDL Order signed by Dick Pedersen, DEQ Director, June 12, 2009).

For the PGE Willamette Falls Project, modeling was performed for model years 2001 and 2002. Results are presented in the 2006 TMDL, Chapter 4, Appendix 4.6. 2001 was a critical low flow year similar to 2015, while 2002 was a higher flow year. The major effect of the Willamette Falls Project on the Willamette River is to increase the volume of water impounded by the Falls in the Newberg Pool, increase the time-of-travel of water through Newberg Pool, and at times increase the temperature in the Willamette River downstream from the Falls. The 2006 TMDL assigned the Willamette Falls Project a Load Allocation of 0.11°C. Since modeling indicates that Willamette Falls Project currently meets this LA, no certification conditions to meet the LA were provided by the Section 401 water quality certification.

As stated in both water quality certifications, DEQ may reconsider water quality certifications and add, delete, or modify certification conditions as necessary to address TMDLs. Therefore, if the TMDL is replaced with a TMDL with revised Load Allocations, DEQ may reconsider water quality certifications and add, delete, or modify certification conditions as necessary to attain the revised LAs.

8.4.1 Influence of PGE Clackamas River Project

The PGE Clackamas River Hydroelectric Project influences temperature in the Clackamas River and lower Willamette River. In order to quantify the influence, modeling of the lower Clackamas River (River Mill Dam at RM 23.4 to the mouth) and the Lower Willamette River was performed for two scenarios: a **“with-project” scenario** with flows and temperatures at the River Mill Dam tailrace set to model calculated conditions with the hydroelectric project as it currently operates (Special Simulation 22), and a **“without-project” scenario** with flows and temperatures set to model calculated natural conditions temperatures with the project removed (Special Simulation 23). For both the **with-project** and **without-project** scenarios, vegetation in the lower Clackamas below River Mill Dam was set to site potential conditions. Therefore, differences between Special Simulations 22 and 23 are strictly due to boundary condition differences (2006 TMDL, Chapter 4, Appendix 4.6 and section entitled Influence of PGE Clackamas River Hydroelectric Project).

Boundary condition temperatures and flow rates at the River Mill Dam location for both with and without project scenarios are model calculated values provided by PGE consultants. The values were calculated using a version of a Clackamas River model that covers all reaches of the Clackamas River potentially influenced by the hydroelectric project, including Oak Grove Fork up to Timothy Lake. For the **with-project** scenario, the project was modeled as it currently operates. Therefore, calculated River Mill Dam tailrace flow rates and temperatures are similar to current conditions. For the **without-project** scenario the system was simulated with all dams, diversions, artificial lakes or impoundments and their effects on temperature removed from the calibrated model. Model calculated temperatures for the **without-project** scenario represent estimates of natural condition temperatures.

As shown in Figure 8-8, modeling indicates that the Clackamas River hydroelectric project reduces daily maximum temperatures immediately downstream of River Mill Dam, but results in significantly warmer temperatures farther downstream. For the critical 2001 period, the median change in temperatures is negative upstream of river mile 21 (project generally results in cooler daily maximum river temperatures), but downstream of that location median impacts are positive. From river mile 17 downstream to river mile 10, simulated temperatures with the project are always warmer than without the project. Downstream of river mile 2, the project reduces daily maximum temperature nearly as often as it increases it and median delta T values are nearly zero. Project impacts are partially due to heating that occurs in reaches above River Mill Dam due to project and non-project impacts and partly due to suppression of the natural diel temperature fluctuation at the River Mill Dam tailrace location (RM 23.4).

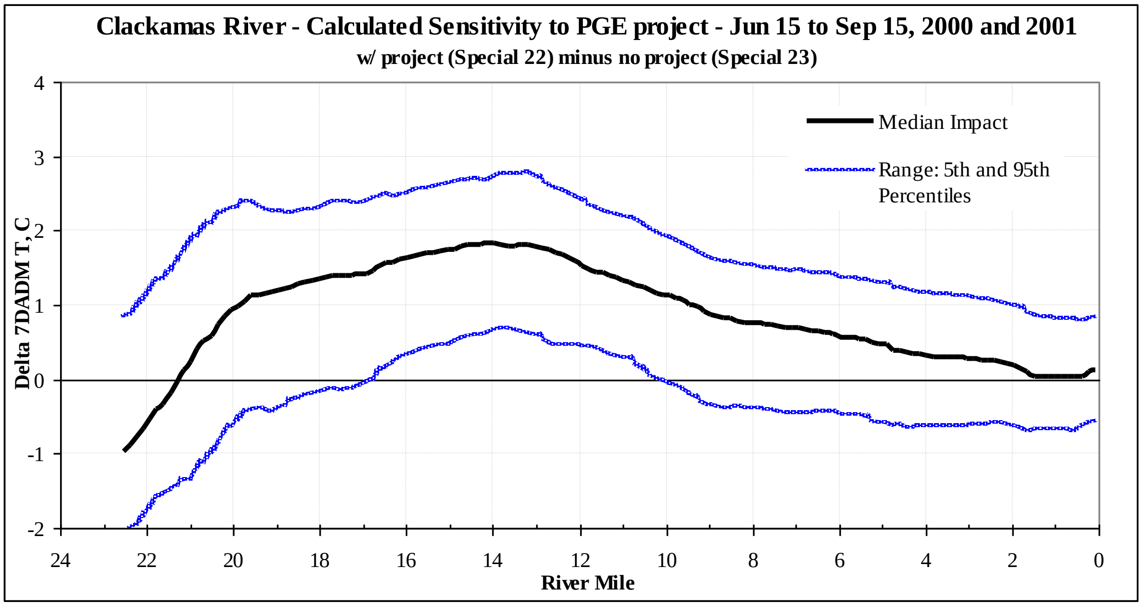

Figure 8-8. Impact of the Clackamas R. Hydroelectric Project on lower Clackamas R. temperatures during the summer, model years 2000 and 2001 combined.

Impacts continue into the Lower Willamette, although dilution results in impacts that are much less than in the Clackamas (Figure 8-9). Note that only output for 2001 presented, since a calibrated model is not available for the lower Willamette for 2000. Current median summer impacts exceed 0.15ºC in much of the river.

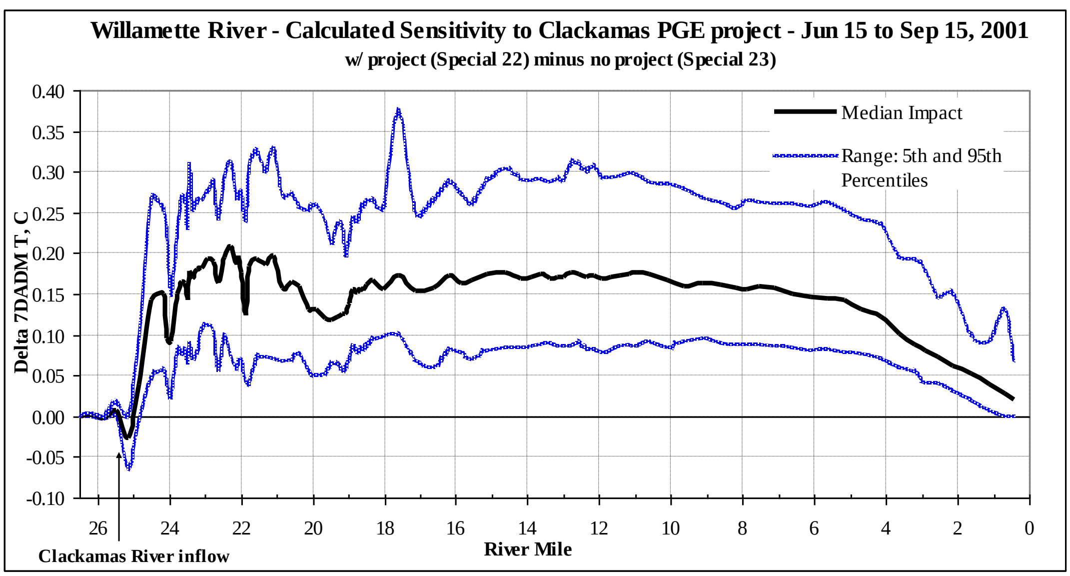

Figure 8-9. Calculated impact of PGE Clackamas Project on the Willamette River during the summer.

In order to evaluate the overall impact of the project for time periods of concern, cumulative frequency distribution plots were developed of calculated 7DADM temperatures with and without the project. The reach from RM 8 to 23 has more stringent criteria than the lower reach and criteria exceedances occur for a greater period of the year. Based on the cumulative frequency distribution plots, the greatest impacts of the project occur during the June 16 through August 31 period. The maximum impact during this summer, non-spawning period for model year 2000 is 1.3ºC, model year 2001 is 1.8ºC, and the two years combined is 1.5ºC (Figure 8-10 to Figure 8-12) .

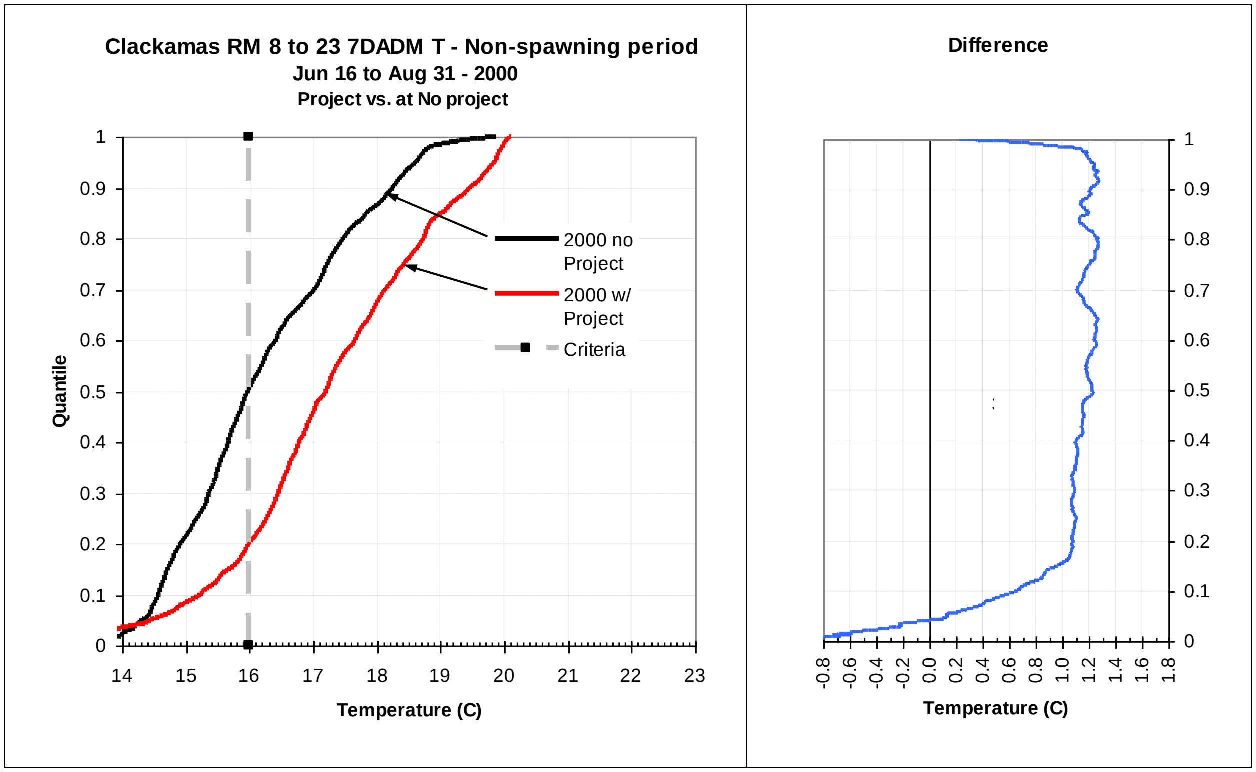

Figure 8-10. Clackamas River RM 8 to 23, Project impacts during June 16 to August 31, 2000.

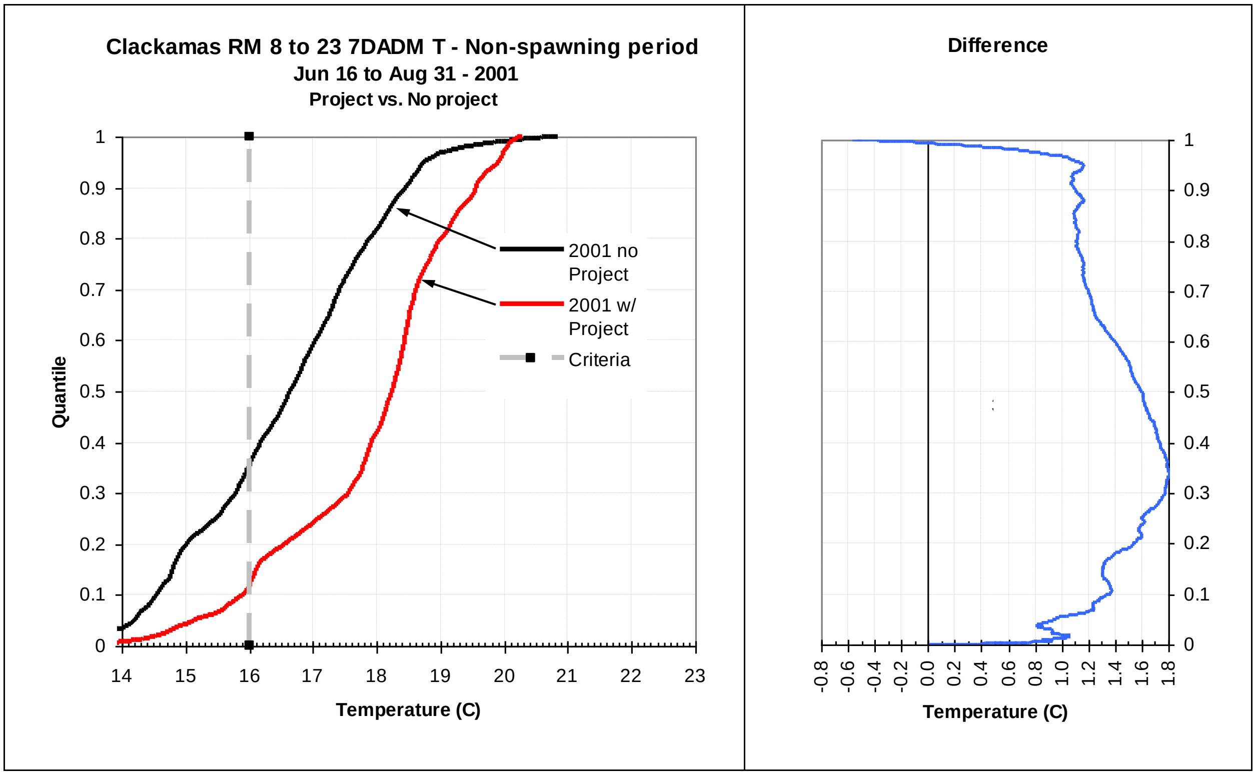

Figure 8-11. Clackamas River RM 8 to 23, Project impacts during June 16 to August 31, 2001.

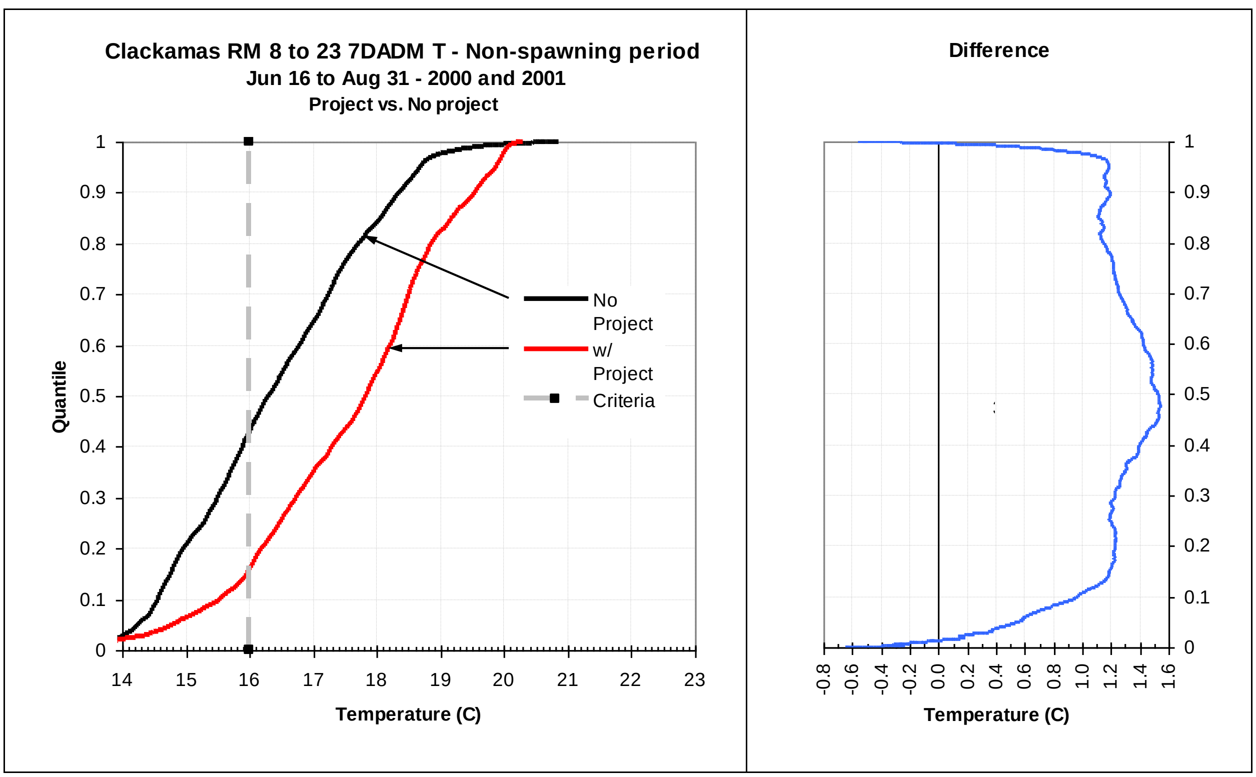

Figure 8-12. Clackamas River RM 8 to 23, Project impacts during June 16 to August 31, 2000 and 2001.

Clackamas River modeling indicates that summer impacts of the Clackamas Project on Lower Willamette River temperatures for 2001 currently range from 0.05 to 0.3ºC and median impacts are as much as 0.2ºC, prior to dilution with Columbia River water near the mouth (2006 TMDL, Chapter 4, p. 4-200). In the Clackamas River, current overall Clackamas Project impacts for 2001 are as much as 1.8ºC in the reach from RM 23 to RM 8. If these are reduced to meet a load allocation of 0.15 ºC, it is likely that the impact of the project on the Willamette River will be reduced a similar percentage amount. Therefore, it is reasonable to assume that median impacts on the lower Willamette River will be reduced to 0.0167ºC, or less than 0.02ºC. 0.02ºC of the HUA for the Lower Willamette is, therefore, provided for the PGE Clackamas River Hydroelectric Project.

8.4.2 Influence of PGE Willamette Falls Project

The PGE Willamette Falls Project is a run-of-the-river project located at the Willamette Falls at RM 26.5. A concrete cap on the basalt formation that creates the Willamette Falls is supplemented in summer low flow periods with flashboards. The increased water level provided by the project increases the volume of water in the Newberg Pool, the impounded reach behind the Falls which extends to about RM 56, and increases the time-of-travel through the reach.

Modeling simulations were performed to evaluate the impact of the project on temperatures in the Newberg Pool and in the lower Willamette downstream of the Falls for model years 2001 and 2002. For the “with-project” scenario, the river is modeled with both concrete cap and temporary flashboards present. For the “without project” scenario, both flashboards and cap are removed and Newberg Pool water levels are restored to natural levels. The modeling shows that project results in temperatures that are warmer at some times and locations and cooler at other. In general, the project results in cooler overall temperatures in Newberg Pool (upstream from the Falls) and warmer overall temperatures downstream from the Falls.

In order to evaluate overall project impacts, cumulative frequency distributions of calculated 7DADM temperatures in Newberg Pool and the lower Willamette River are presented for scenarios with and without the project (Figure 8-13 to Figure 8-16). To derive cumulative frequency distributions, calculated 7DADM temperatures (flow-weighted) for all segments in the reach of interest are grouped and ranked. A quantile of 0.9 corresponds to a temperature for which calculated temperatures are less than 90% of the time and a quantile of 0.5 corresponds to the median calculated temperature. Since no spawning criteria apply for Newberg Pool or the Lower Willamette River, the analysis was limited to the summer period (June 15 to Sept 15) during which the 20ºC biologically based numeric criteria is frequently exceeded. Outside of this summer period no criteria exceedances occur.

Figure 8-13 shows combined summer data for 2001 and 2002 for Newberg Pool. As shown, the project results in a negative shift in the cumulative frequency distribution. This indicates that the project results in slightly cooler overall summer temperatures in Newberg Pool.

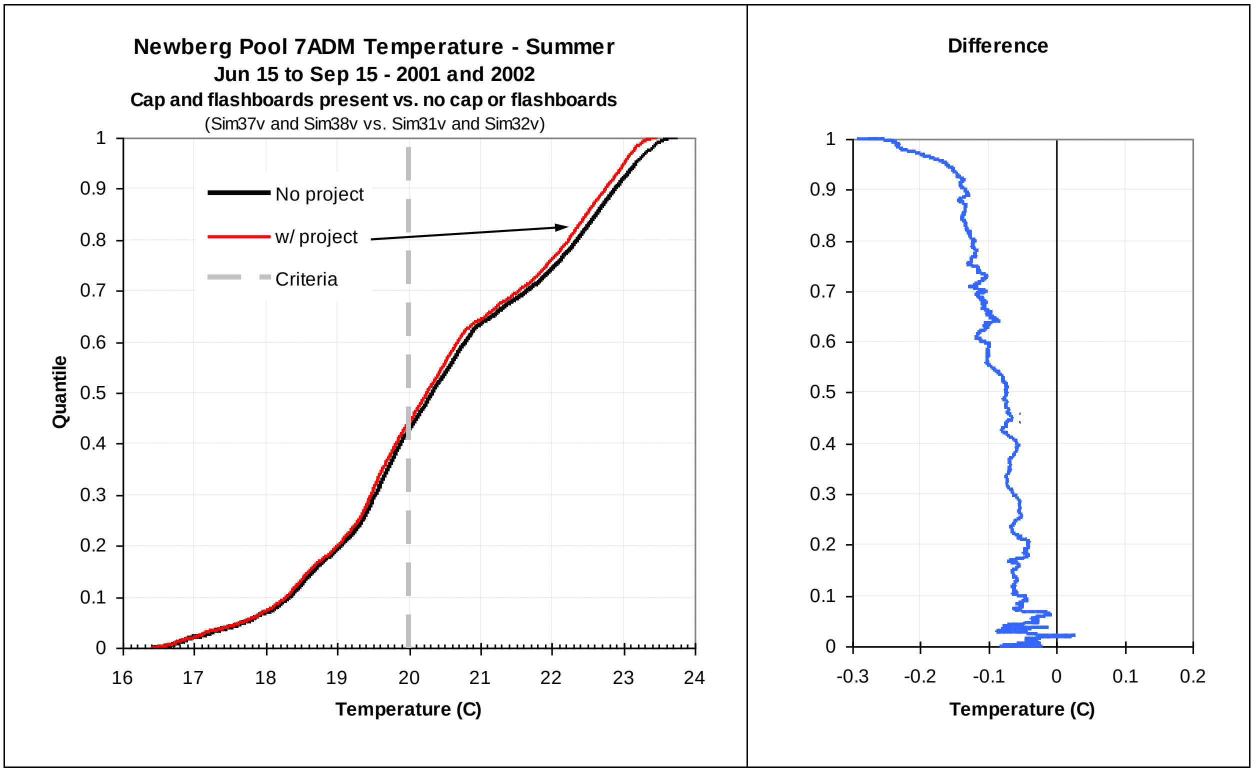

Figure 8-13. Impact of Falls Project on Newberg Pool during June 15 to September 15, 2000 and 2001.

Overall impacts on the Lower Willamette (downstream from Willamette River), using combined summer data for 2001 and 2002, are shown in Figure 8-14. As shown, the project at times results in a positive shift in the cumulative frequency distribution and at times a negative shift. This indicates that at times the project results in warmer overall summer temperatures in the Lower Willamette. Note, however, that when temperatures exceed the 20ºC biological based numeric criteria, the shift does not exceed 0.08ºC. For individual years, the model indicates that the impact of the project was greater in 2002 than in the critical low flow year of 2001 (Figure 8-15 and Figure 8-16). For 2001, for which river flow during the summer is similar to 2015, the maximum shift is 0.06ºC (Figure 8-15), while for the higher flow year of 2002 the maximum shift is 0.11ºC (Figure 8-16).

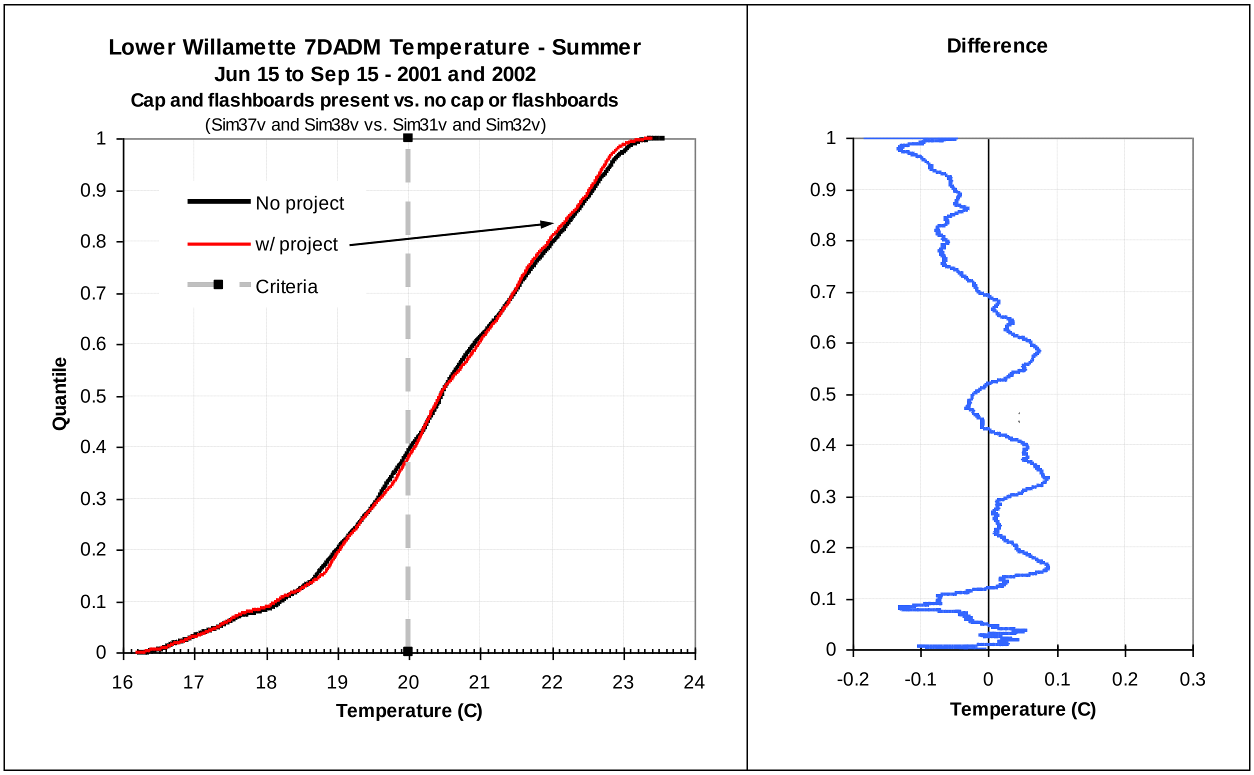

Figure 8-14. Impact of Falls Project on Lower Willamette during June 15 to September 15, 2001 and 2002.

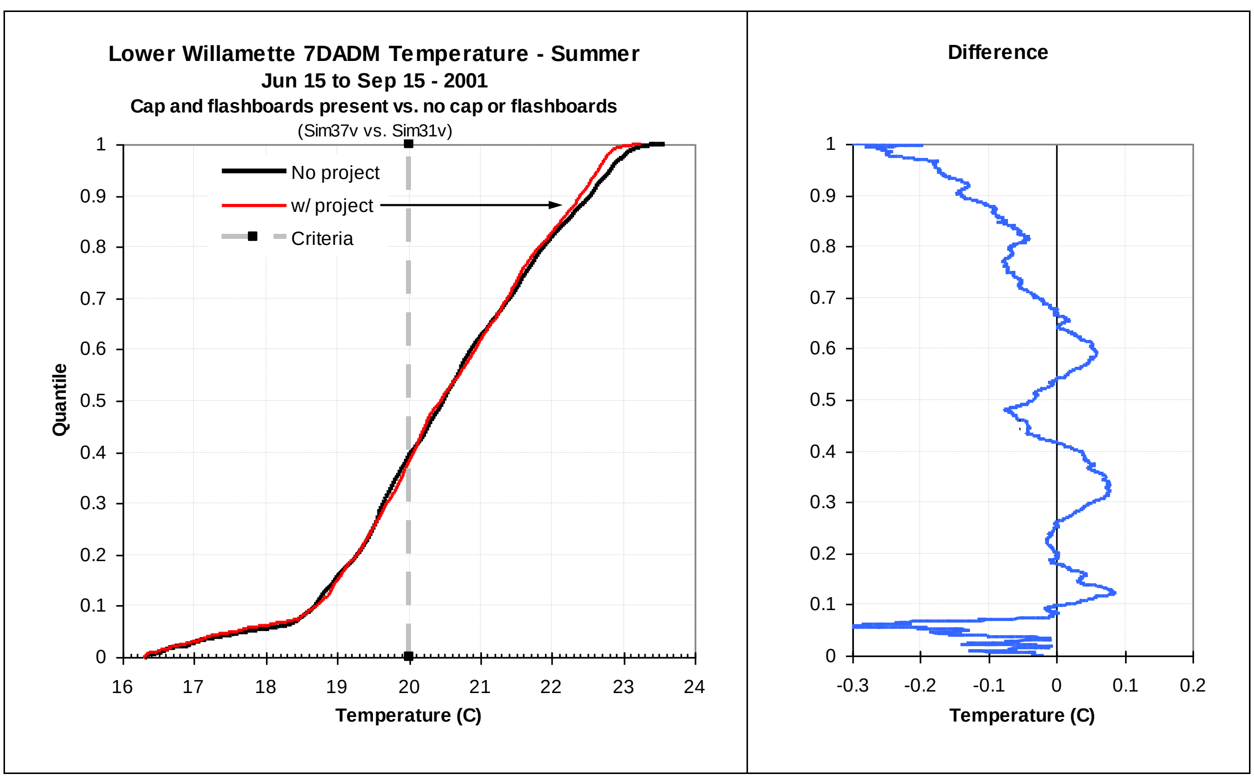

Figure 8-15. Impact of Falls Project on Lower Willamette during June 15 to September 15, 2001.

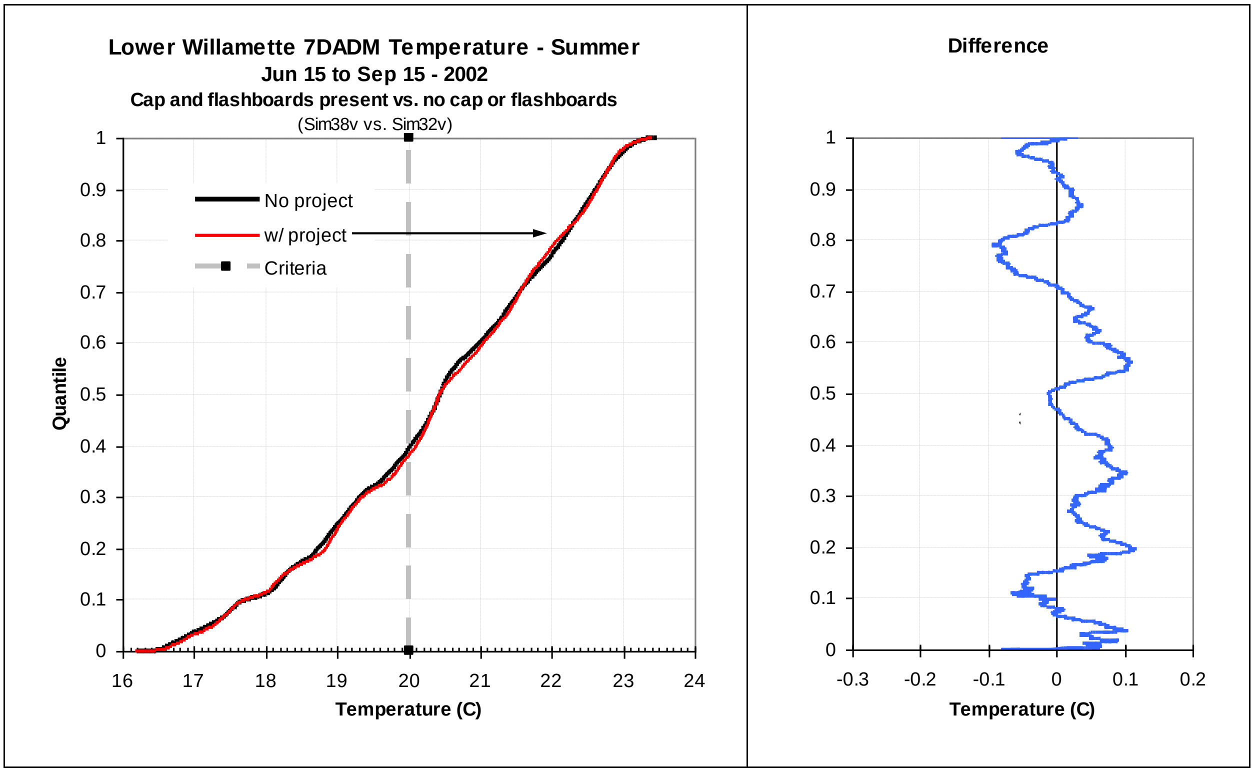

Figure 8-16. Impact of Falls Project on Lower Willamette during June 15 to September 15, 2002.

In addition to retaining sufficient capacity to assimilate Willamette Falls Project and Willamette River point source impacts (as allocated by WLAs), sufficient assimilative capacity must be retained in the lower Willamette to accommodate Clackamas River Hydroelectric Project temperature impacts. Clackamas River modeling indicates that summer impacts of the Clackamas Project on Lower Willamette River temperatures currently range from 0.05 to 0.3ºC and median impacts range from 0.1 to 0.2ºC, prior to dilution with Columbia River water near the mouth. In the Clackamas River, current overall Clackamas Project impacts are as much as 1.8ºC in the reach from RM 23 to RM 8. If these are reduced to meet the proposed load allocation of 0.15ºC of impact, it is likely that the impact of the project on the Willamette River will be reduced a similar percentage amount. Therefore, it is reasonable to assume that maximum impacts on the lower Willamette will be reduced to less than 0.03 ºC and that median impacts will be reduced to less than 0.02ºC.

8.4.3 Load Allocations for PGE Clackamas River and Willamette Falls Projects

In the 2006 TMDL, 0.11ºC of the HUA in Willamette River was provided as a Load Allocation to the PGE Willamette Falls Project, but none of the HUA in the Willamette River was provided to the PGE Clackamas River Project. As described above, if the 0.15ºC Load Allocation for the Clackamas River is met, Clackamas River Project impacts on the lower Willamette River will be reduced to less than 0.02ºC. In order that the combined impact of the PGE Clackamas River Project and PGE Willamette Falls Project does not exceed 0.11ºC, the Load Allocation of the Willamette Falls Project is reduced to 0.09ºC.

Attainment scenario modeling indicates that for the reach Willamette River reach downstream from the Clackamas River (RM 25.0 to 18.5), the model calculated maximum ΔT due to all WLAs (mainstem + tributary) plus tributary LAs is 0.154°C (see Section 5 above). Therefore, 0.146°C (0.3 – 0.154) of the HUA is available to allocate to non-point sources, including the PGE projects, and/or assign to reserve capacity.

0.02°C of the HUA is assigned to the category "Consumptive use water management activities and water withdrawals" and 0.02°C of the HUA is assigned to "Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure." Assuming that half of the impact of consumptive use and solar loading from existing infrastructure is due to impacts in tributaries, in order to maintain at least 0.02°C of reserve capacity the LA for PGE projects cannot exceed 0.11°C. As described in Section 5 Attainment Scenario Modeling above, this is calculated as follows:

> HUA available to allocate = 0.3 - Model calculated max ΔT due to WLAs plus tributary LAs = 0.3 – 0.154 = 0.146°C (rounded to 0.15°C in Section 5 Attainment Scenario Modeling above).
>
> Unallocated HUA if 50% of the HUA assigned to non-point source LAs is due to trib NPS LAs = HUA available to allocate – 0.50 x (Consumptive use + solar loading from existing infrastructure) = 0.146 – 0.5 x (0.02 + 0.02) = 0.126°C
>
> If 0.02°C of the unallocated HUA is reserve capacity, then 0.106°C of the unallocated HUA may be allocated to the PGE Clackamas River and Willamette Falls projects.

As discussed above, a 0.15°C LA for the PGE Clackamas River Project corresponds to 0.0167°C of impact on the lower Willamette River. Subtracting this from the 0.106°C of unallocated HUA results in 0.089°C of HUA that may be allocated to the PGE Willamette Falls Project. Rounding HUA assignments to 2 decimal places, the LA for PGE Willamette Falls is 0.09°C. A LA of 0.09°C allows sufficient assimilative capacity to remain for point and non-point sources while retaining 0.02°C of the HUA for the Clackamas Project and 0.02°C for reserve capacity.

Modeling indicates that overall impacts of the PGE Willamette Falls Project do not exceed this load allocation for critical conditions (2001) and based on multiple model years (2001 and 2002) (Figure 8-14 and Figure 8-15), but may slightly exceed this amount based on 2002 modeling (Figure 8-16). While modeling indicates that current impacts of the PGE Willamette Falls Project rarely exceed a 0.09°C Load Allocation, the modeling suggests that any changes in Willamette Falls operations that increase water levels in Newberg Pool, such as by increasing cap and/or flash board elevations, may result in exceedance of this LA.

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