Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document Appendix M: Willamette River Mainstem and Major Tributaries

Model Scenario Report - Draft

August 2024

State of Oregon
DEQ Department of Environmental Quality

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1 Introduction

This appendix describes derivation of thermal wasteload allocations (WLAs), WLA cumulative effects modeling, attainment scenario modeling, and human use allowance (HUA) and reserve capacity assignments for Willamette River mainstem and major tributaries model reaches, other than for the McKenzie River which is described in Appendix L. Willamette Mainstem model reaches consist of the Willamette River plus the following major tributaries downstream from U.S. Army Corps of Engineers (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 Technical Support Document (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 (WLAs), current condition modeling, restored vegetation modeling, and attainment scenario modeling for the McKenzie River and South Fork McKenzie River are described in a separate appendix: TSD Appendix L: DEQ McKenzie River Model Scenario Report.

Modeling was performed using the Willamette Mainstem CE-QUAL-W2 models, which consist of nine models developed by Portland State University at the direction of Oregon Department of Environmental Quality (DEQ, 2006). CE-QUAL-W2 is a two-dimensional hydrodynamic and water quality model (Cole and Wells, 2019). CE-QUAL-W2 version 4.2 was released in 2019. The model was originally developed by the USACE and is currently maintained by PSU.

The Willamette Mainstem models were developed to derive 2006 Willamette TMDLs. The models were calibrated for 2001 and 2002 model years by Portland State University (Annear et al., 2004, Berger et al., 2004) and the USGS (Sullivan and Rounds, 2004). 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. 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 updated to CE-QUAL-W2 version 4.2 by the Tetra Tech and U.S. Environmental Protection Agency (USEPA) calibrated for 2015 (Tetra Tech, 2023; provided as 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. 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.

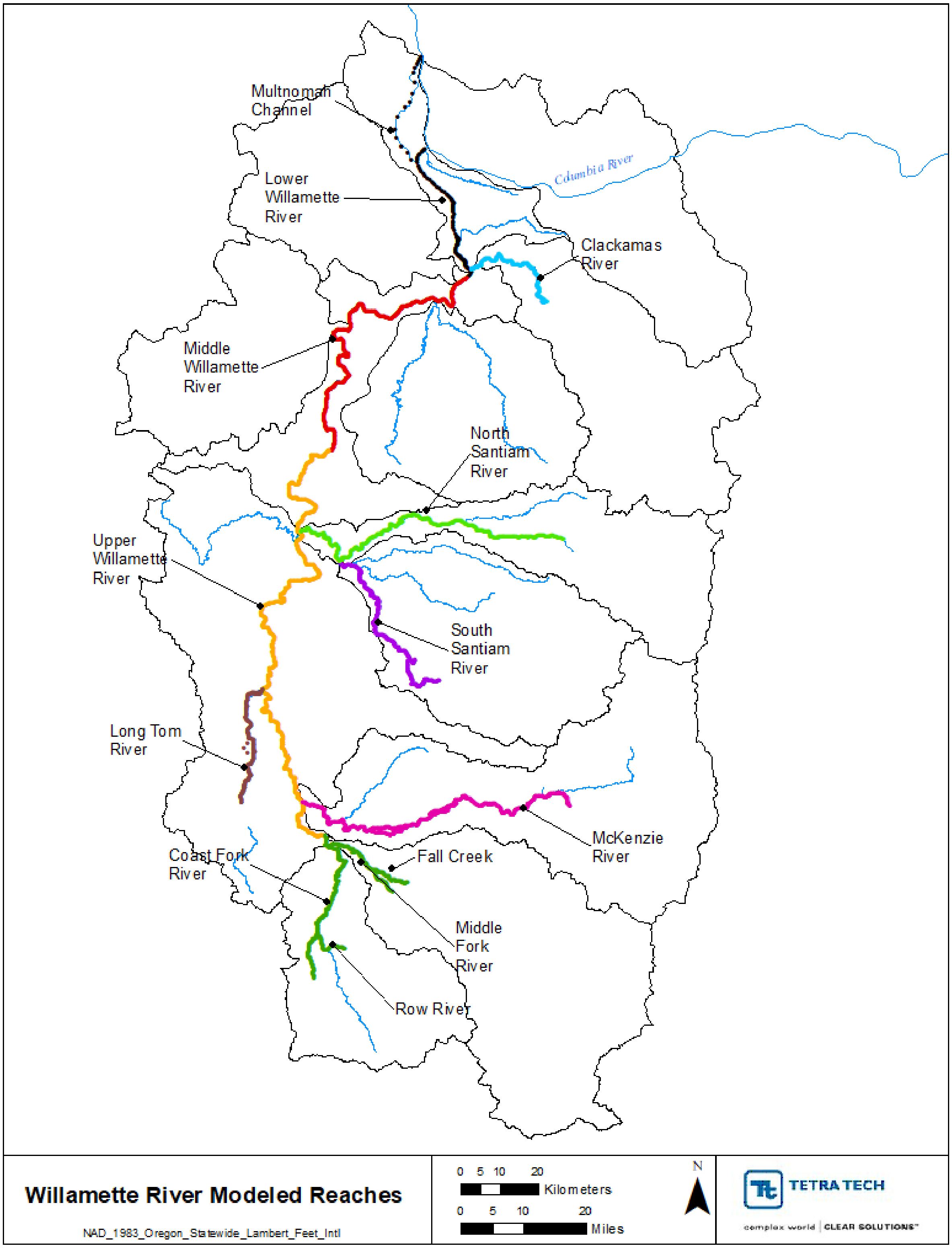

Figure 1-1. Willamette Mainstem Models.

2 Willamette Mainstem wasteload allocations

Wasteload allocations (WLAs) for facilities covered by individual NPDES permits for Willamette Mainstem reaches are shown in Table 2-1. Note that WLAs for discharges to the McKenzie River are included, but were previously developed as part of the Willamette Subbasins TMDL.

Table 2-1: 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	Criterion (°C)	Assigned Human Use Allowance (ΔT) (°C)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 10^6 kcal/day)
ODFW - CLACKAMAS RIVER HATCHERY - 64442 - OR0034266 - Clackamas River RM 22.6	13.0	0.072	4/1	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	11/15	645	42.0	475.683
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	1.615
	24.0	0.03	11/1	11/15	55	1.2	4.125
ODFW - LEABURG HATCHERY - 64490 - OR0027642 - McKenzie River RM 33.7	13.0	0.074	4/1	6/15	2442	92.4	458.861
	16.0	0.012	6/16	8/31	1537	39.1	46.274
	13.0	0.026	9/1	11/15	1630	78.3	108.671
ODFW - MCKENZIE RIVER HATCHERY - 64500 - OR0029769 - McKenzie River RM 31.5	13.0	0.002	4/1	6/15	2442	12.7	12.012
	16.0	0.033	6/16	8/31	1537	11.8	125.050
	13.0	0.002	9/1	11/15	1630	1.0	7.981
IP SPRINGFIELD PAPER MILL 001+002 - 96244 - OR0000515 - McKenzie River RM 14.7	13.0	0.12	4/1	6/15	2442	28.9	725.456
	16.0	0.20	6/16	8/31	1537	28.9	766.247
	13.0	0.19	9/1	11/15	1630	28.9	771.167
USACE Dexter Project - 126714 - OR3960000054 - Middle Fork Willamette River RM 16.5	16.0	0.001	4/1	11/15	1002	0.7	2.453
ODFW Dexter Ponds - 64450 - - Middle Fork Willamette River RM 15.7	13.0	0.036	4/1	6/15	986	48.0	91.075
	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
USACE Big Cliff Project - 126715 - OR5960000052 - North Santiam River RM 58.6	16.0	0.004	4/1	11/15	859	1.1	8.418

NPDES Permittee WQ File Number - EPA Number - Outfall location	Criterion (°C)	Assigned Human Use Allowance (ΔT) (°C)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 10^6 kcal/day)
ODFW - Minto Fish Facility - 64495 - OR0027847 - North Santiam River RM 41.13	13.0	0.03	4/1	6/15	987	0.0	72.446
	16.0	0.03	6/16	8/31	859	0.0	63.051
	13.0	0.03	9/1	11/15	957	0.0	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 (enters WR at RM 109) RM 9.2	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 - OR8210800043 - South Santiam River RM 37.8	16.0	0.003	4/1	11/15	621	1.4	4.568
ODFW South Santiam Hatchery - 64560 - - South Santiam River RM 37.8	13.0	0.02	4/1	6/15	841	0.0	41.153
	16.0	0.02	6/16	8/31	621	25.9	31.655
	13.0	0.02	9/1	11/15	677	0.0	33.128
SWEET HOME STP - 86840 - OR0020346 - South Santiam River RM 31.5	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
	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
	18.0	0.05	5/16	10/14	506	4.9	62.500
	13.0	0.08	10/15	11/15	726	12.3	144.510
MWMC - EUGENE/SPRINGFIELD STP - 55999 - OR0031224 - Willamette River RM 178	13.0	0.118	4/1	5/15	1906	42.6	562.573
	18.0	0.093	5/16	10/14	1508	55.0	355.645
	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
	18.0	0.004	5/1	10/31	3480	0.0	34.058
	13.0	0.003	11/1	11/15	3853	1.9	28.295

NPDES Permittee WQ File Number - EPA Number - Outfall location	Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 10^6 kcal/day)
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	0.015	4/1	5/15	5800	15.3	213.421
CORVALLIS STP - 20151 - OR0026361 - Willamette River RM 130.8	18.0	0.015	5/16	10/14	3683	11.7	135.595
CORVALLIS STP - 20151 - OR0026361 - Willamette River RM 130.8	13.0	0.031	10/15	11/15	4149	24.0	316.508
OSU JOHN L. FRYER AQUATIC ANIMAL HEALTH LAB - 103919 - OR0032573 - Willamette River RM 130	13.0	0.001	4/1	5/15	5800	0.9	14.193
OSU JOHN L. FRYER AQUATIC ANIMAL HEALTH LAB - 103919 - OR0032573 - Willamette River RM 130	18.0	0.001	5/16	10/14	3683	1.2	9.014
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
ADAIR VILLAGE STP - 500 - OR0023396 - Willamette River RM 122	18.0	0.001	5/16	10/14	3877	0.2	9.486
ADAIR VILLAGE STP - 500 - OR0023396 - Willamette River RM 122	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
AM WRF - ALBANY-MILLERSBURG WATER RECLAMATION FACILITY - 1098 - OR0028801 - Willamette River RM 118	18.0	0.017	5/16	10/14	3877	13.7	161.827
AM WRF - ALBANY-MILLERSBURG WATER RECLAMATION FACILITY - 1098 - OR0028801 - Willamette River RM 118	13.0	0.037	10/15	11/15	4443	25.1	404.482
ATI Millersburg (Teledyne Wah Chang Albany) - 87645 - - Willamette River RM 118	13.0	0.010	4/1	5/15	6308	5.2	154.463
ATI Millersburg (Teledyne Wah Chang Albany) - 87645 - - Willamette River RM 118	18.0	0.011	5/16	10/14	3877	5.2	104.483
ATI Millersburg (Teledyne Wah Chang Albany) - 87645 - - Willamette River RM 118	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
INDEPENDENCE STP - 41513 - OR0020443 - Willamette River RM 95.5	18.0	0.005	5/16	10/14	5684	3.8	69.581
INDEPENDENCE STP - 41513 - OR0020443 - Willamette River RM 95.5	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

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	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	0.024	4/1	5/15	10688	52.9	630.705
	18.0	0.036	5/16	10/14	5684	38.3	504.020
	13.0	0.058	10/15	11/15	7133	80.2	1,023.600
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
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	1/0	1/0	5988	0	0.000
WILLAMETTE FALLS PAPER COMPANY -	20.0	0.007	6/1	9/30	5988	6.5	102.666

NPDES Permittee WQ File Number - EPA Number - Outfall location	Criterion (ºC)	Assigned Human Use Allowance (ΔT) (ºC)	WLA period start	WLA period end	7Q10 River Flow (cfs)	Effluent discharge (cfs)	7Q10 WLA (x 10^6 kcal/day)
21489 - OR0000787 - Willamette River RM 27.5							
WES Tri-city WPCP - 89700 - OR0031259 - Willamette River RM 25.5	20.0	0.015	6/1	9/30	5988	18.4	220.435
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
SCAPPOOSE STP - 78980 - OR0022420 - Multnomah Channel RM 10.6	18.0	NA	6/1	9/30	10	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 (see TSD Section 9 of TSD):

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

where,

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

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

$Q_E =$ 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

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

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 2-1. For river flow rates greater than 7Q10, the WLA equation above may be used (see TSD Section 9).

2.1 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 below);
5. Set WLA equal to or greater than current ΔT_{PS} (or max acceptable ΔT) 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. Such factors range from 0 to 50%. In some cases, negative reduction factors were used to reduce impacts at points of discharge to 0.20°C or less.
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 and wasteload provided by the Willamette Subbasins TMDL and evaluate impacts on reserve capacity;
9. Revise mainstem wasteload allocations (WLAs) and load allocations (LAs), 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 (see TSD Section 9), with river flow set to the applicable 7Q10 value:

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 was available, measured 7-day average effluent flow rates and 7DADM effluent temperatures were used to calculate ΔT_{PS} values for each day that data was available. The maximum observed ΔT_{PS} for 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 in 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 values were adjusted upwards by rounding. In some case explicit adjustment factors from 10% to 50% (0.10 to 0.50, in Table 2-2) were applied to derive preliminary thermal wasteload allocations. 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.

Information on derivation of thermal wasteload allocations for all individually NPDES permitted facilities which discharge to mainstem reaches is provided in Table 2-2. The table shows:

- **Effluent flow used for WLA** – The basis for this value is described in "Bases for derivation of WLAs" (column 6 of Table 2-2). 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 (as 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). Effluent flow is generally rounded up to one decimal place, except for several small facilities which are rounded up to two decimal places.

- **Observed Effluent T used to derive WLA** – The basis for this value is described in Table 2-2, Column 6).
- **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 Table 2-2, Column 6. For example, if adjustment factors are shown as 0.2/0.1/0, current WLAs were adjusted upwards 20% in spring, 10% in summer, and 0% in fall. If adjusted downward, a negative value is shown. For example, if adjustment factors are shown as 0/0/-0.25, current WLAs were not adjusted spring or summer, but reduced 25% in fall. The effluent T that corresponds to WLA is generally the value used when performing cumulative effects modeling. In a few cases, this value is quite large (for example >> 30°C). This is because all facilities with current maximum ΔT_{PS} less than 0.001 were provided WLAs as ΔT_{PS} of 0.001°C. If current maximum ΔT_{PS} is quite a bit less than 0.001°C, 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 (°C)** – 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 this column to values in the WLA table (Table 2-1) provide insight into whether WLAs are greater than maximum current excess thermal loads.
- **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 Q 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 2-2: Additional information on derivation of WLAs.

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (°C)	Effluent T that corres-ponds to WLA (°C)	Actual ΔT based on Effluent Flow and Observed Effluent T (°C)	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 = 0/0/0; 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	
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 = 0/0/0; Round up WLA derived from obs T and Q
	2.8	21.0	21.00	0.2059	
	2.1	21.0	21.00	0.0998	
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 = 0.2/0.1/0; 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 = 0/0/0; 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 = 0/0/0; 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+002 - 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 averaqge for Outfall 001 + 002 and 7-day Avg via max Delta T analysis, combined flow of Outfalls 001 + 002; Data years used: 2017-2020; Spring/Summer/Fall Adjustment Factors = 0.2/0.0175/-0.092; WLA for spring and fall adjusted to max that modeling indicates is OK
	28.9	26.7	26.84	0.1966	
	28.9	25.0	23.91	0.2099	

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (°C)	Effluent T that corres-ponds to WLA (°C)	Actual ΔT based on Effluent Flow and Observed Effluent T (°C)	Bases for derivation of WLAs
USACE Dexter Project - 126714 - OR3960000054 - 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 = 0/0/0; Round up WLA derived from obs T and Q
ODFW Dexter Ponds - 64450 - - 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 = 0/0/0; 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	
USACE Big Cliff Project - 126715 - OR5960000052 - 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 = 0/0/0; Round up WLA derived from obs 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 Delta T analysis and 7-day Avg Q via max daily Delta T analysis; Data years used: 2016, 2023; Spring/Summer/Fall Adjustment Factors = 0/0/0; Round up from WLA based on obs T and Q
	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 = 0.1/0.1/0; 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	
STAYTON STP - 84781 - OR0020427 - North Santiam River RM 14.9	1.8	22.2	29.49	0.0111	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 = 0/0.1/0; Round up from WLA based on obs T and Q
	1.9	22.5	25.64	0.0135	
	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 = 0.3/0.1/0.3; 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	

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (°C)	Effluent T that corres-ponds to WLA (°C)	Actual ΔT based on Effluent Flow and Observed Effluent T (°C)	Bases for derivation of WLAs
USACE Foster Project - 126713 - OR8210800043 - 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 = 0/0/0; Round up WLA derived from obs T and Q
ODFW South Santiam Hatchery - 64560 - - 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. Consider coverage via 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 = 0.2/0.2/0; 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 = 0.2/0.2/0; 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	
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 = 0/0/-0.25; Round up from WLA based on obs T and Q
	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 = 0.2//0.2; No discharge May-Oct; Need WLA Apr 15-30 and Nov 1-15
	1.6	27.0	26.70	0.0041	
	1.9	17.1	19.09	0.0020	
CASCADE PACIFIC PULP, LLC - 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 = 0/0/0; 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	
	5.3	22.3	23.07	0.0093	

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (°C)	Effluent T that corres-ponds to WLA (°C)	Actual ΔT based on Effluent Flow and Observed Effluent T (°C)	Bases for derivation of WLAs
GP HALSEY MILL - 105814 - OR0033405 - Willamette River RM 147.7	4.9	29.2	29.80	0.0152	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 = 0//0; Round up from WLA based on obs T and Q
	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 = 0.5/0.5/0.5; Round up from WLA based on obs T and Q - use adj factor to account for 2006 WLA and uncertainty
	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	15.3	18.5	18.70	0.0145	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: 2018-2022; Spring/Summer/Fall Adjustment Factors = 0/0/0; Round up WLA derived from 2018-2022 obs T and Q
	11.7	22.6	22.74	0.0146	
	24.0	18.2	18.39	0.0301	
OSU JOHN L. FRYER AQUATIC ANIMAL HEALTH LAB - 103919 - OR0032573 - Willamette River RM 130	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 = 0.2/0.5/0.5; Round up from WLA based on obs 2019-2020 T and Q. Max values used via 2 years NetDMR data
	1.2	18.7	21.07	0.0002	
	0.9	14.6	17.61	0.0003	
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 = 0.5/0.5/0.5; No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15.
	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 = 0/0/0; 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 (Teledyne Wah Chang Albany) - 87645 - - Willamette River RM 118	5.2	24.0	25.14	0.0090	Basis for Max Effluent T and Flow Rate: Based on data provided by permittee and calculations provided by DEQ permitting: and Based on data provided by permittee and calculations provided by DEQ permitting:; Data years used: 2019-2023; Spring/Summer/Fall Adjustment Factors = 0/0/0; Round up WLA based on obs T and Q
	5.2	26.0	26.21	0.0107	
	5.4	22.1	22.89	0.0110	

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (°C)	Effluent T that corres-ponds to WLA (°C)	Actual ΔT based on Effluent Flow and Observed Effluent T (°C)	Bases for derivation of WLAs
					by DEQ permitting. AM WRF and ATI Millersburg discharge to the same outfall but each is assigned its own WLA.
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 = 0.1/0.1/0.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30.
	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 = 0.1/0.1/0.1; No discharge Jun-Oct. Need WLA Apr 1 - May 30 and Nov 1-15. Non-spawning WLA applies May 15-30.
	4.3	24.0	24.61	0.0045	
	5.8	16.0	16.69	0.0024	
SALEM WILLOW LAKE STP - 78140 - OR0026409 - Willamette River RM 78.4	52.9	17.4	17.87	0.0217	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: 2019-2023; Spring/Summer/Fall Adjustment Factors = 0.1/0.1/0; Round up from WLA based on obs T and Q
	38.3	22.8	23.38	0.0318	
	80.2	18.2	18.22	0.0577	
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 = 0/0/0; 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 = 0.3/0.3/0.3; No discharge May-Oct. Need WLA Apr 1-30 and Nov 1-15.
	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 = 0.2; WLA using PER Actual ADWF effluent flow rate and current T - round up

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (ºC)	Effluent T that corres-ponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
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 = 0.2; WLA using ADWF effluent flow rate and current T - round up - no adjustment since Delta T > observed Delta T and WLA > 2006 WLA
NEWBERG OR, LLC - 72615 - OR0000558 - Willamette River RM 49.7	0.0	NA	NA	NA	No longer active, WLA set to zero
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 = 0.5; Round up from WLA based on obs T and Q
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 = 0.1; 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 = 0.1; 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 = 0.5; Round up from WLA based on obs T and Q
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 = 0.5; Round up from WLA based on obs T and Q
WES-BLUE HERON - 72634 - OR0000566 - Willamette River RM 27.8	0.0	NA	NA	NA	No longer active, WLA set to zero

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Effluent Flow used for WLA (cfs)	Observed Effluent T used to derive WLA (ºC)	Effluent T that corres-ponds to WLA (ºC)	Actual ΔT based on Effluent Flow and Observed Effluent T (ºC)	Bases for derivation of WLAs
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 7-day Avg Q via max daily Delta T analysis; Data years used: 2019-2020; Adjustment Factor = 0.1; 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 7-day Avg Q via max daily Delta T analysis; Data years used: 2015-2020; Adjustment Factor = 0; 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 7-day Avg Q via max daily Delta T analysis; Data years used: 2012-2016; Adjustment Factor = 0; Round up from WLA based on obs T and Q
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 7-day Avg Q via max daily Delta T analysis; Data years used: 2019-2020; Adjustment Factor = 0; Increase to similar 2006 WLA
WES Kellogg Creek WWTP - 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 7-day Avg Q via max daily Delta T analysis; Data years used: 2015-2020; Adjustment Factor = 0; 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 Max observed Q (limited data); Data years used: NA; Adjustment Factor = 0.5; Obs T does not exceed 18 so WLA not needed. WLA using current effluent flow rate and max acute T - round up
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 = 0.5; WLA using current effluent flow rate and T=32 - round up
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 = 0; WLA based on limited data in PERs. Effluent T=32 - round up

NPDES Permittee - WQ File Number - EPA Number – Outfall location	**Effluent Flow used for WLA (cfs)**	**Observed Effluent T used to derive WLA (°C)**	**Effluent T that corres-ponds to WLA (°C)**	**Actual ΔT based on Effluent Flow and Observed Effluent T (°C)**	**Bases for derivation of WLAs**
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 = 0.5; Round up from WLA based on obs T and Q
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 = 0.5; Round up from WLA based on obs T and Q
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 = 0; 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 = 0.5; Observed T < 20C criterion. WLA using current effluent flow rate and T=22C
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 = 0.1; 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	NA	Basis for Max Effluent T and Flow Rate: PER max observed T and PER current actual ADWF; Data years used: NA; Adjustment Factor = 0.3; 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.

2.2 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.

2.3 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 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 2-2 (columns 2 and 5). The assigned HUA in some cases is large because river temperature diverted exceeds applicable criteria. However, the amount of potential river temperature increase that is due to the hatchery is generally considerably less (column 5), which indicates that most of the excess thermal load is due to river temperature exceeding criteria upstream from the discharge.

Table 2-3. Fish hatcheries maximum impact on river temperature.

NPDES Permittee - WQ File Number - EPA Number – Outfall location	Assigned Human Use Allowance (ΔT) (°C)	Fish Hatchery 95th Percentile Teff-Tinf (°C)	Fish Hatchery Dilution Ratio	Fish Hatchery Potential increase in River T due to heating of pass-through water (°C)
ODFW - CLACKAMAS RIVER HATCHERY - 64442 - 102663 - 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 - 101914 - 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 - 101918 - McKenzie River RM 31.5	0.002	No longer pass through - all via small tributary		
	0.033			
	0.002			
ODFW - Minto Fish Facility - 64495 - 101917 - 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 - ? - 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 - GEN03: Ind. ; NPDES fish hatcheries - 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

3 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” (column 2) and the “Effluent T that corresponds to WLA” (column 4) shown in Table 2-2.

Several point sources not included by Tetra Tech were added to the models and any point sources no longer active or provided 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 2-1), 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 Oct 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 potentially 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 (OAR340-041-0101-0340). These tables and maps may be found on DEQ’s web site http://www.deq.state.or.us/wq/wqrules/wqrules.htm , 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 15$^{th.}$ 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 as shown below. 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 4-1 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.

3.1 Cumulative effects on major tributaries

Cumulative effects of WLAs on major tributaries modeled using the Willamette Mainstem model are shown in Figure 3-1 to Figure 3-4. 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 0.10°C (Figure 3-1 to Figure 3-4).

As discussed in Appendix L, impacts on the McKenzie river exceed 0.20°C. 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.

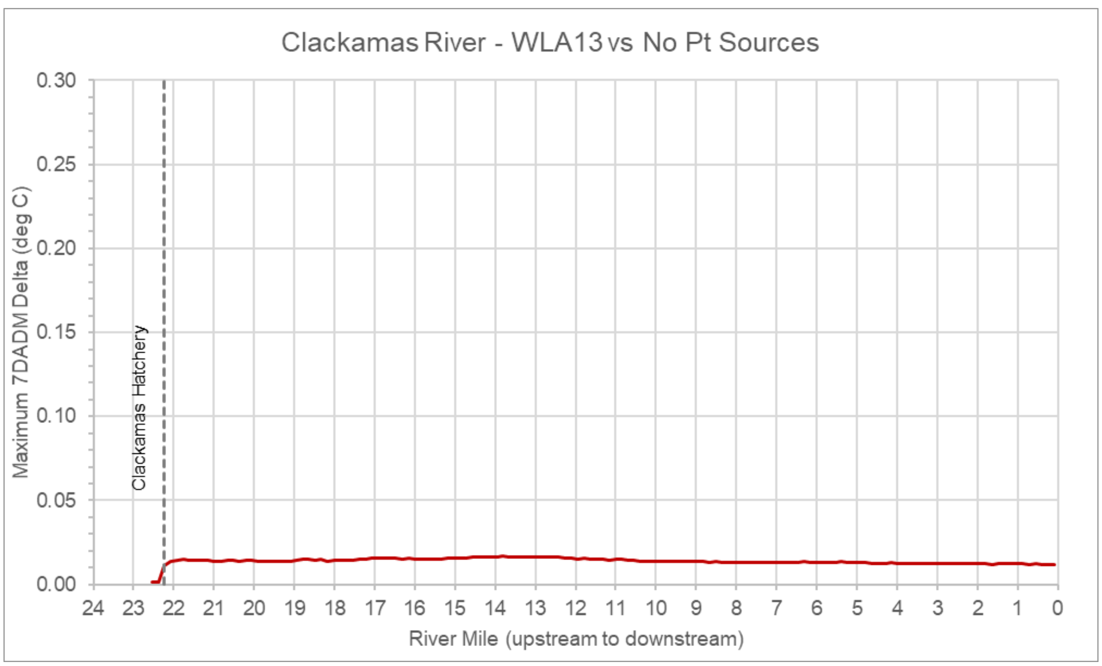

Figure 3-1: Clackamas River maximum 7DADM change in temperature from wasteload allocations.

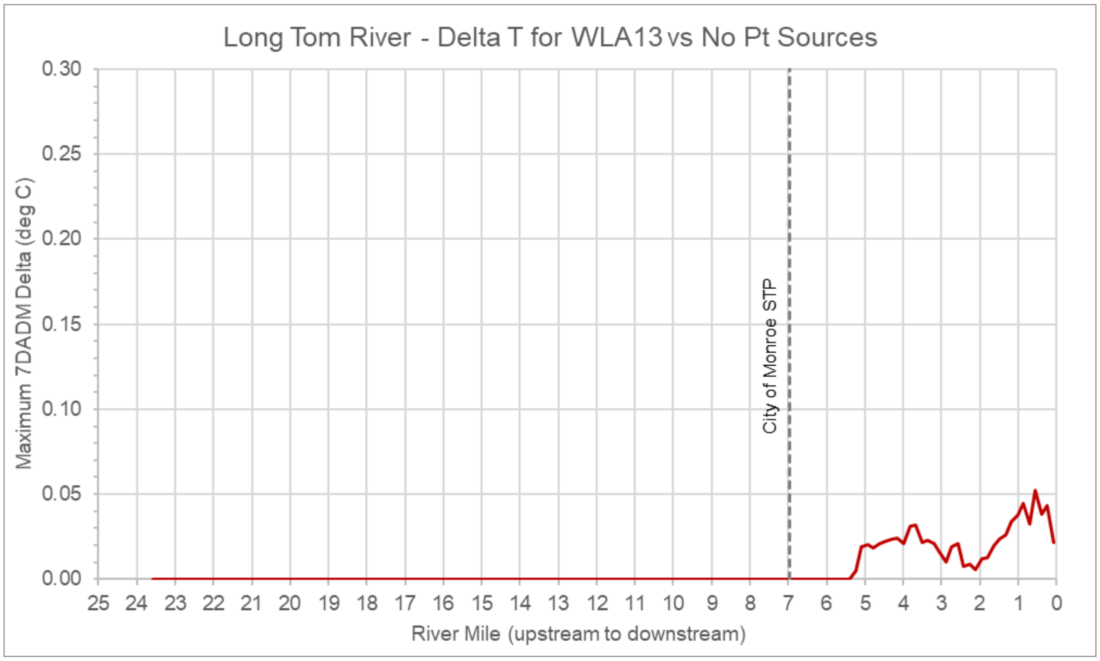

Figure 3-2: Long Tom River maximum 7DADM change in temperature from wasteload allocations.

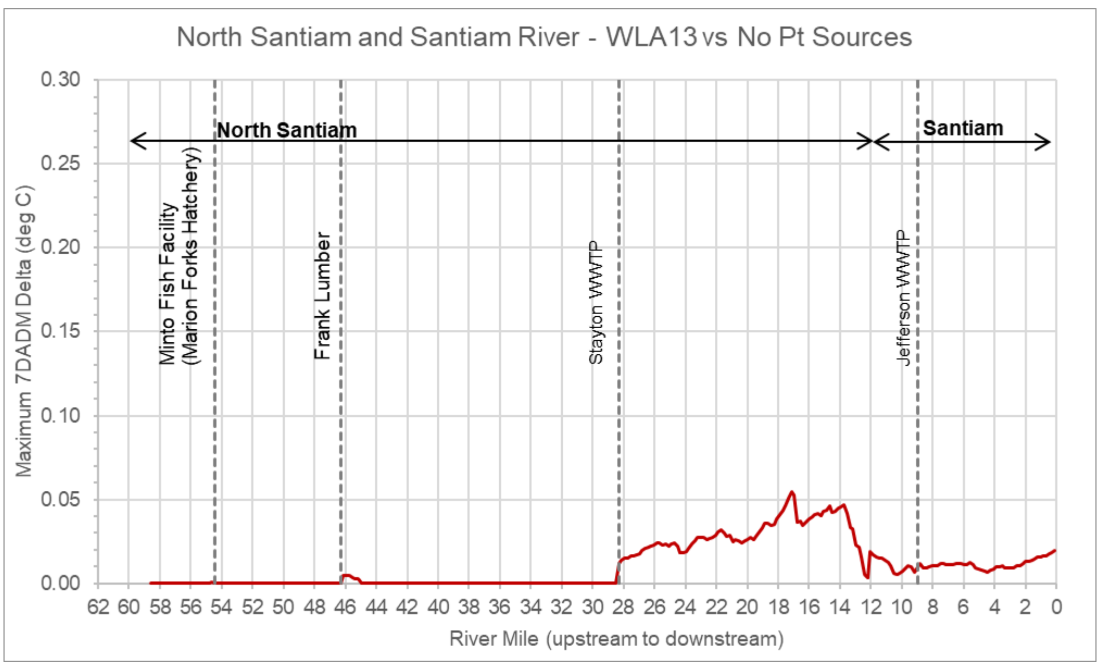

Figure 3-3: North Santiam and Santiam Rivers maximum 7DADM change in temperature from wasteload allocations.

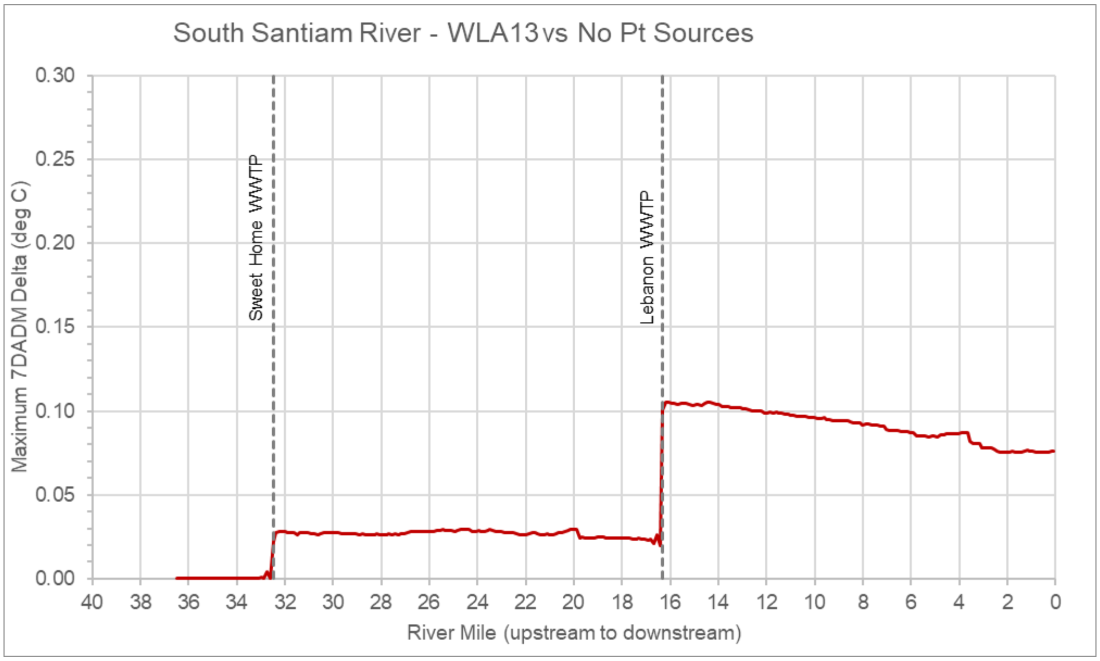

Figure 3-4: South Santiam River maximum 7DADM change in temperature from wasteload allocations.

3.2 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 3-5 to Figure 3-7. As shown impacts of the City of Cottage Grove WWTP are a relatively large 0.20^{o}C for a short distance (Figure 3-5). Downstream from the Row River impacts are reduced to no more than 0.06^{o}C. Impacts on the other streams, including the Middle Fork Willamette River, are small due to the lack of other large point sources.

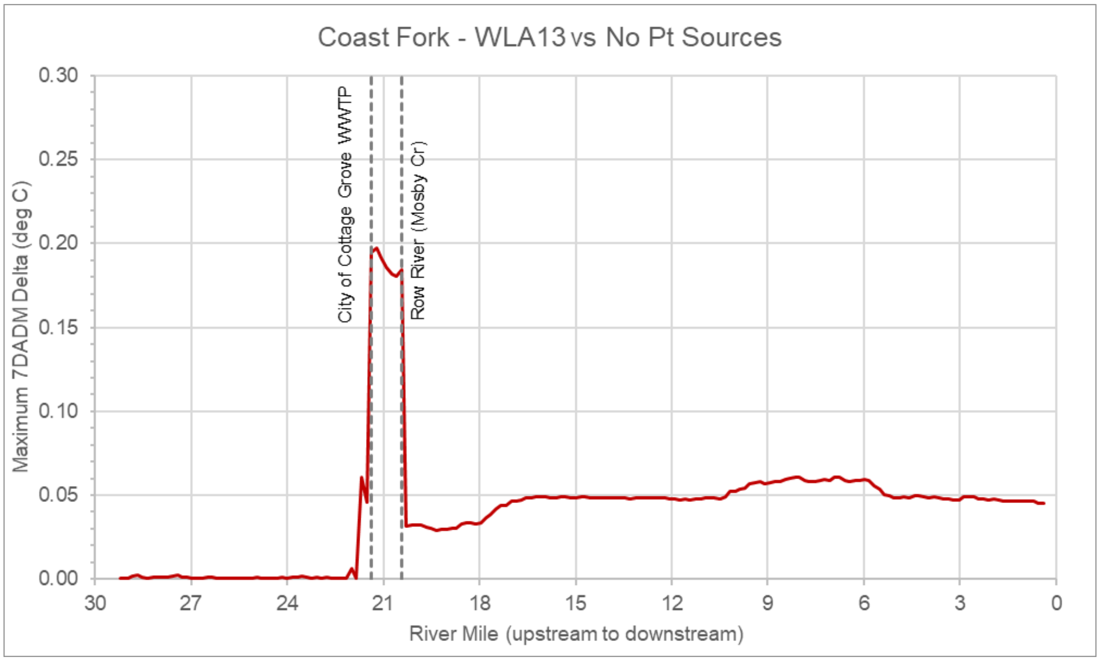

Figure 3-5: Coast Fork Willamette River maximum 7DADM change in temperature from wasteload allocations.

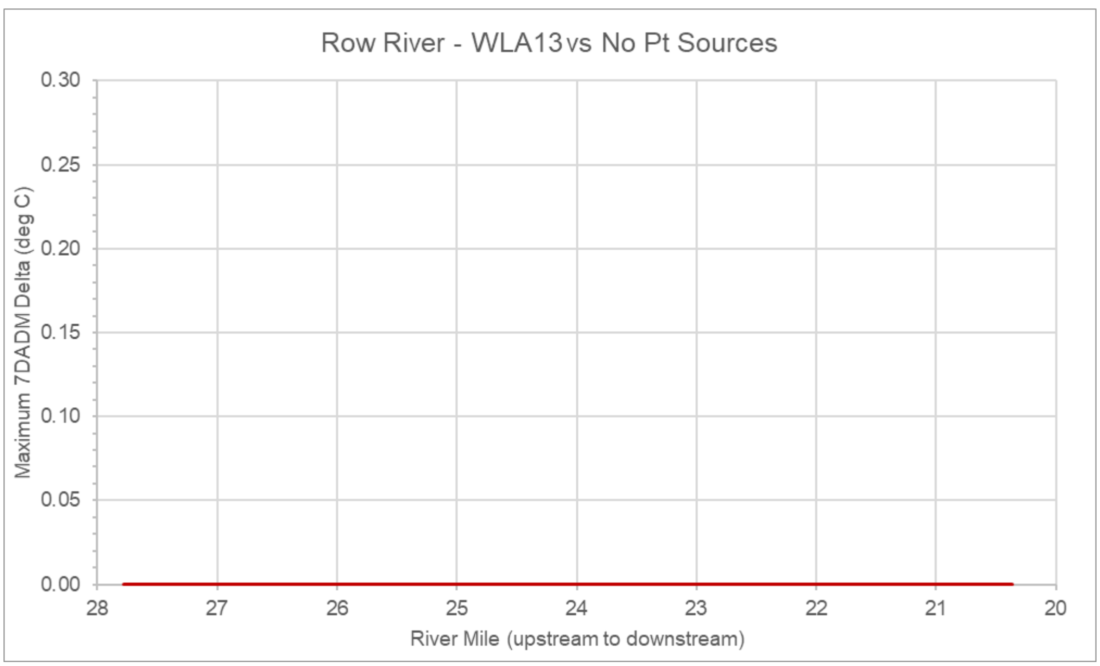

Figure 3-6: Row River maximum 7DADM change in temperature from wasteload allocations.

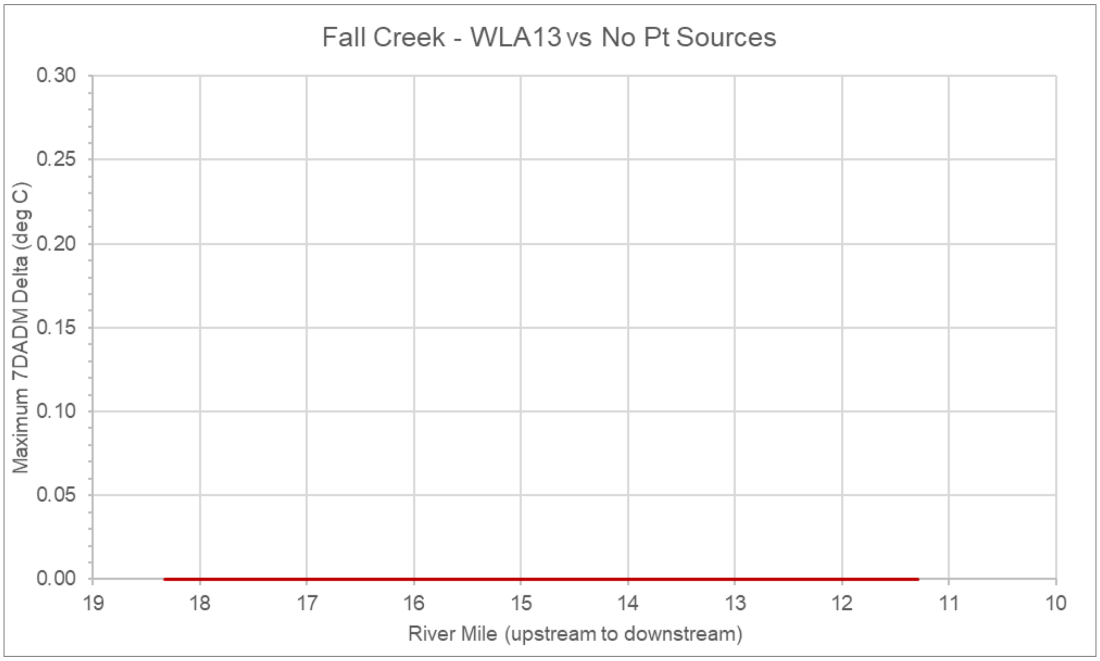

Figure 3-7: Fall Creek maximum 7DADM change in temperature from wasteload allocations.

3.3 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. Due to the large impacts, plots are presented for spring and fall spawning periods, as well as summer non-spawning periods for the upper and middle Willamette Rivers (modeled using the Upper Willamette and Middle Willamette CE-QUAL-W2 models) (Figure 3-8 to Figure 3-10). For the lower Willamette River, only a single plot is presented since spawning is not a designated use.

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°C to 20°C downstream from Chehalem Creek at RM 51.2. The applicable criterion remains 20°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 3-9). During the summer non-spawning period the maximum impact is 0.22°C. During the fall spawning period the maximum impact is 0.20°C. During the spring, impacts are less (Figure 3-8).

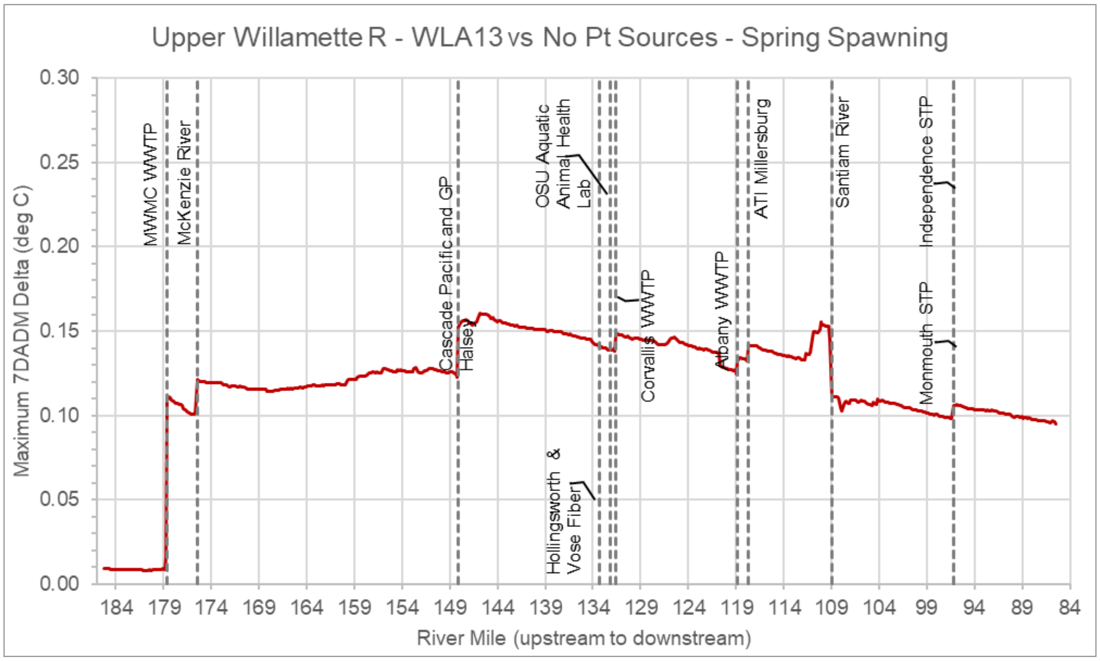

Figure 3-8: Upper Willamette River maximum 7DADM change in temperature from wasteload allocations during spring spawning period.

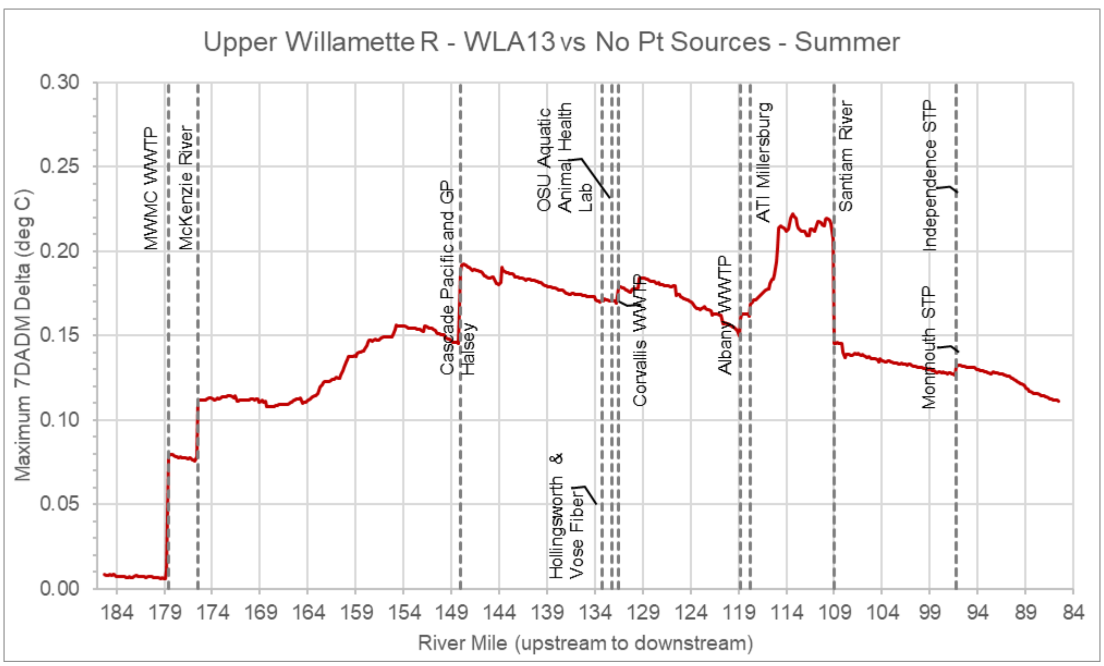

Figure 3-9: Upper Willamette River maximum 7DADM change in temperature from wasteload allocations during summer.

The increase in temperature impact between Albany and the confluence of the Santiam River is due to the cumulative effects of point sources upstream, 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 August highs of 22°C to 17-19°C at the times of maximum impact. River flow rates are also relatively low at this time. In addition, only ΔTs when temperature is equal to or greater than the 18°C 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.

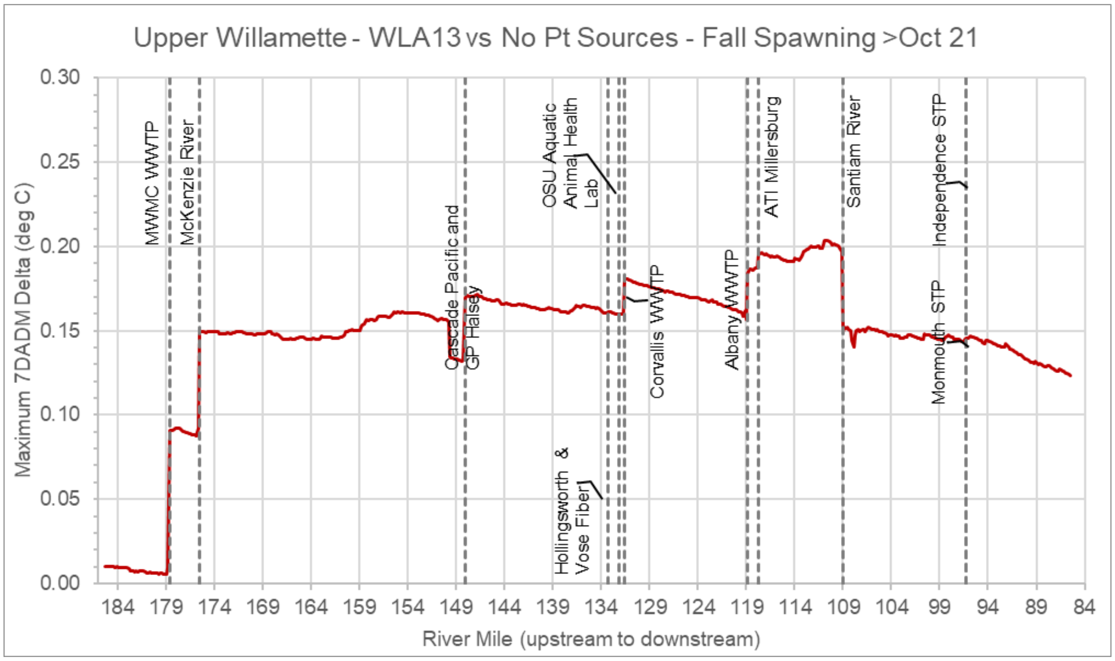

Figure 3-10: Willamette River maximum 7DADM change in temperature from wasteload allocations during fall spawning period.

In the Middle Willamette Rive WLA impacts are less (Figure 3-11 to Figure 3-14). 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).

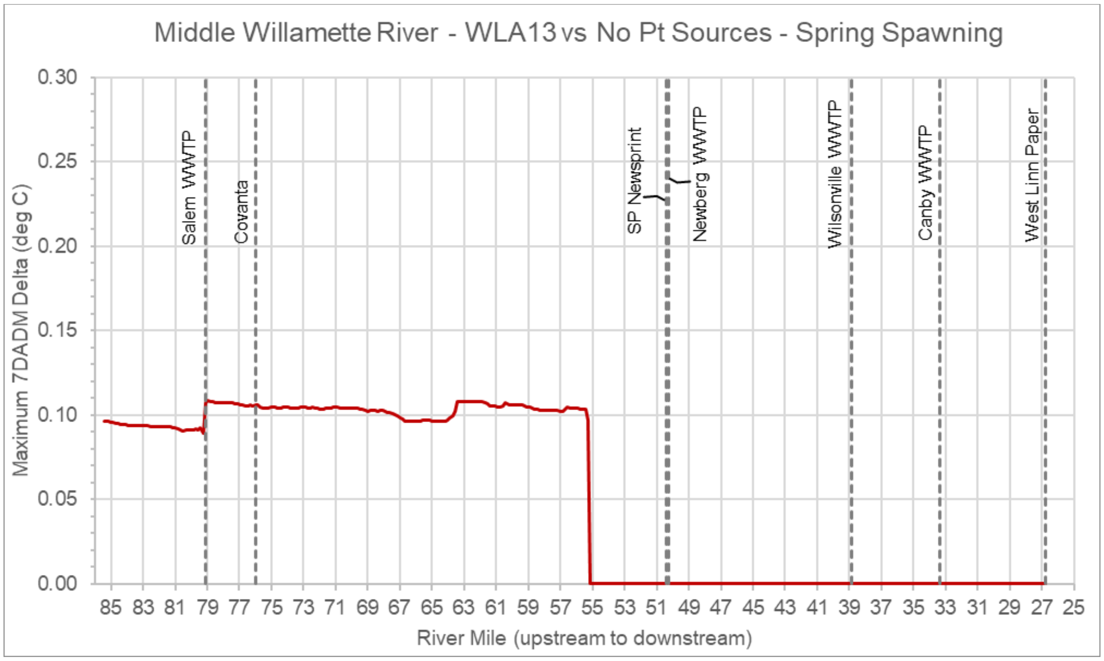

Figure 3-11: Middle Willamette River maximum 7DADM change in temperature from wasteload allocations during spring spawning period.

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

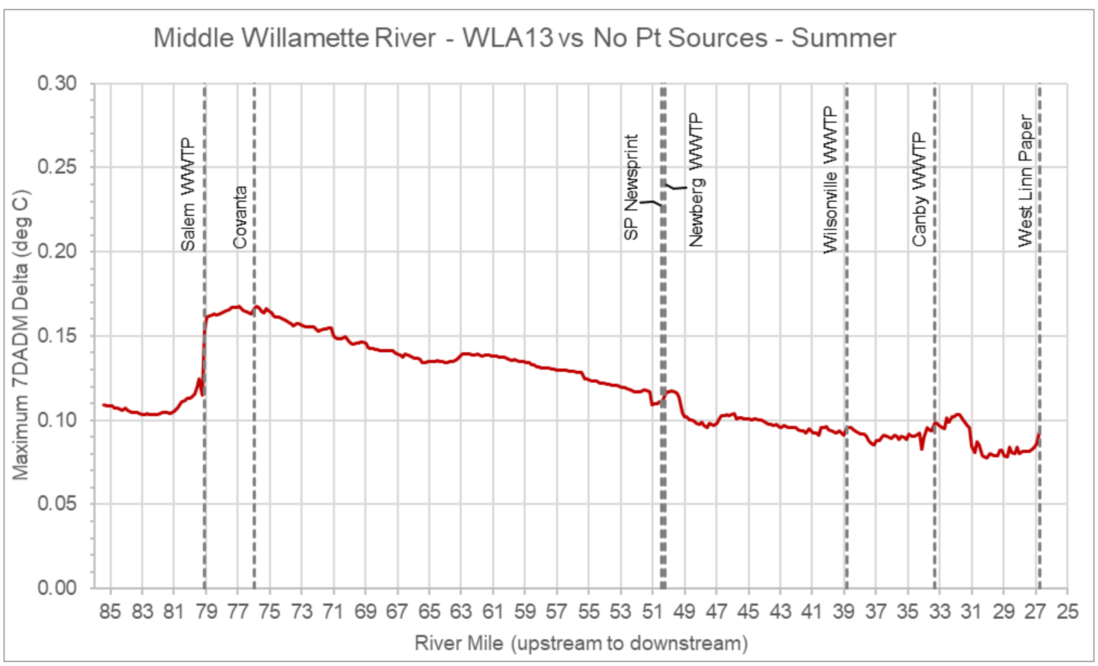

Figure 3-12: Middle Willamette River maximum 7DADM change in temperature from wasteload allocations during summer.

Two plots are presented for the fall spawning period. The first applies the spawning criterion of 13°C starting October 15 (Figure 3-13). The second applies it starting October 21, when seven days of spawning period values are available to calculate a spawning period 7DADM temperature (Figure 3-14). For the first plot, when spawning is applied starting October 15, the maximum impact of WLAs is 0.19°C. For the second plot, when spawning is applied starting October 21, the maximum impact of WLAs is 0.17°C. Note that for development of HUA assignments in the TMDL, a maximum impact of 0.19°C was used, which provides a margin of safety.

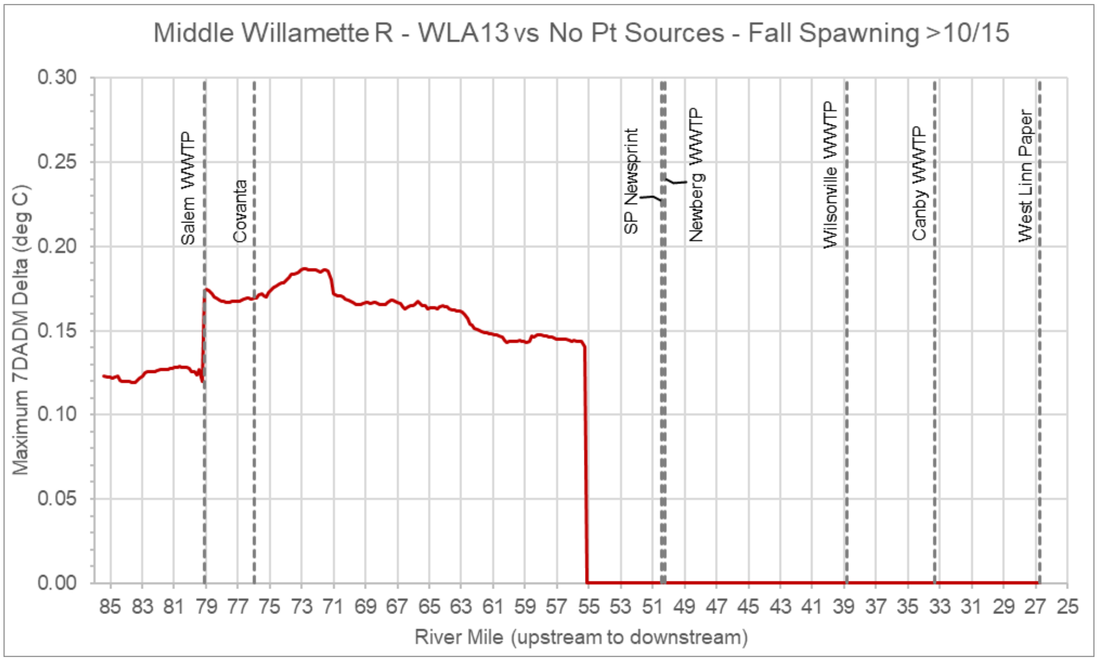

Figure 3-13: Middle Willamette River maximum 7DADM change in temperature from wasteload allocations during fall spawning period including first 6 days.

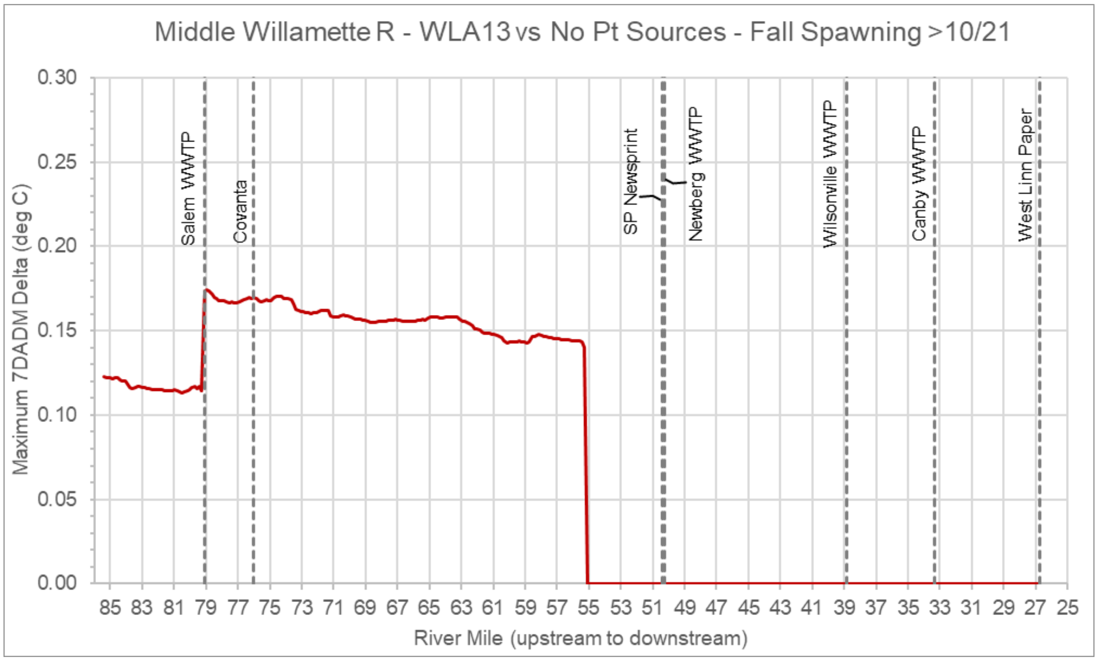

Figure 3-14: Middle Willamette River maximum 7DADM change in temperature from wasteload allocations during fall spawning period excluding first 6 days.

In the lower Willamette (downstream from Willamette Falls), maximum WLA impacts do not exceed 0.11°C (Figure 3-15).

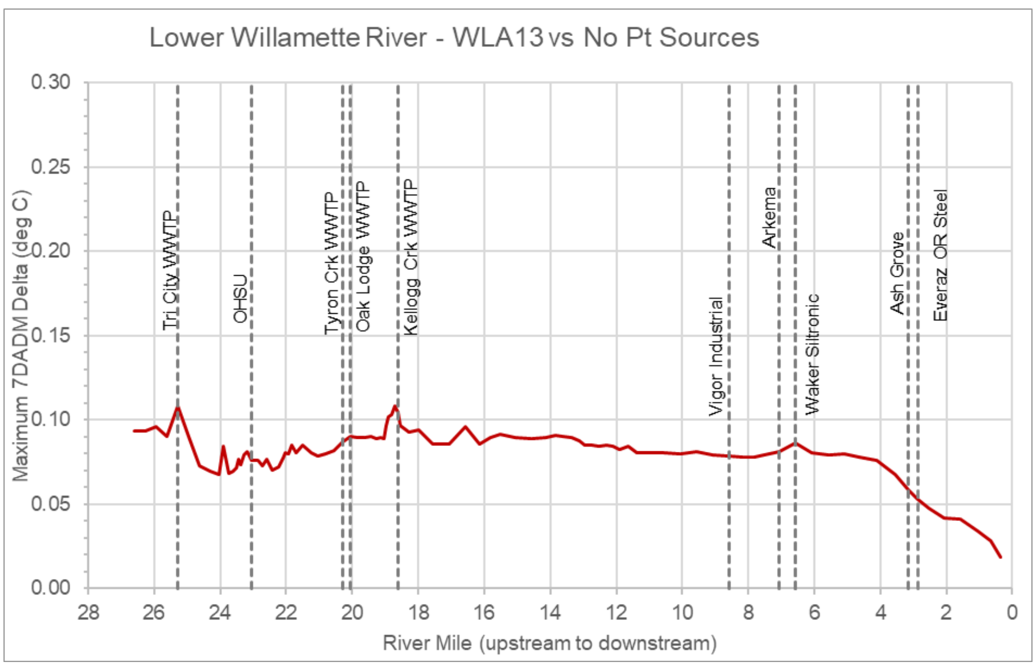

Figure 3-15: Lower Willamette River maximum 7DADM change in temperature from wasteload allocations.

4 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 4-1 shows assignments to various sectors for assessment units (AUs) or groups of AUs. "WLA SCENARIO: Model calculated max ΔT due to mainstem WLAs" (column 3) 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 0.02°C (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), and solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure (column 8). These 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 9). As shown in Table 4-1, the amount of reserve capacity available ranges from 0.01 to 0.18°C. In the middle Willamette River and the Coast Fork Willamette, 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. However, a portion of the HUA has been assigned to impacts from the PGE Willamette Falls Project. Therefore, consumptive use available is less than in reaches upstream from Willamette Falls.

Table 4-1. 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 transportation corridors, existing buildings, and existing utility infrastructure	Reserve capacity	Total HUA
Coast Fork Willamette River	30-21	0.20	0.01	0.21	0.00	0.02	0.05	0.02	0.30
Coast Fork Willamette River	21-0	0.06	0.02	0.08	0.00	0.04	0.04	0.14	0.30
Middle Fork Willamette River	17-0	0.02	0.02	0.04	0.00	0.04	0.04	0.18	0.30
South Santiam River	37-0	0.11	0.02	0.13	0.00	0.04	0.05	0.08	0.30
North Santiam River	58-11.5	0.05	0.02	0.07	0.00	0.04	0.05	0.14	0.30
Santiam River	11.5-0	0.02	0.02	0.04	0.00	0.04	0.04	0.18	0.30
Willamette River	187-107.5	0.22	0.01	0.23	0.00	0.03	0.03	0.01	0.30
Willamette River	107.5-84.5	0.15	0.01	0.16	0.00	0.03	0.03	0.08	0.30
Willamette River	84.5-51	0.19	0.01	0.20	0.00	0.03	0.03	0.04	0.30
Willamette River	51-45	0.12	0.01	0.13	0.00	0.02	0.02	0.13	0.30
Willamette River	45-0	0.11	0.01	0.12	0.10	0.02	0.02	0.04	0.30

HUA: WLAs and LAs will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3°C (0.5°F) above the applicable criteria after complete mixing and at the POMI
WLA Scenario: WLA13 scenario minus No Point Source scenario. Values shown are at Point of Maximum Impact for each AU (POMI)
General Pt Sources: 0.01-0.02°C
NPDES Pt Sources: WLA Scenario + General NPDES
Dam and Reservoir Operations: 0.10°C for PGE Willamette Falls project
Consumptive use water management and withdrawals: NPS impacts due to consumptive use withdrawal of water (diversion minus return) and warming of such water before return
Solar Loading: Less in lower Willamette
Reserve Capacity: 0.3 minus sum of NPDES Point Sources and LAs to non-point sources
Total HUA: Sum of NPDES Point Sources plus LAs plus RC = 0.30

5 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 sufficient assimilative capacity remains for load allocations (LAs) for mainstem reaches as well as 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:

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

Where:

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

Upper dam boundary conditions are unchanged for the scenarios, since none of the HUA is assigned to Army Corps of Engineers dams or the PGE River Mill dam on the Clackamas River. 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 5-1).

Plots for points of maximum impact (POMIs) are provided below (Figure 5-1 to Figure 5-5). The attainment scenario plot for Coast Fork Willamette River (Figure 5-1), when compared with the WLA scenario (Figure 3-5), shows that some of the available HUA is reduced by tributary WLAs and LAs downstream from the Row River

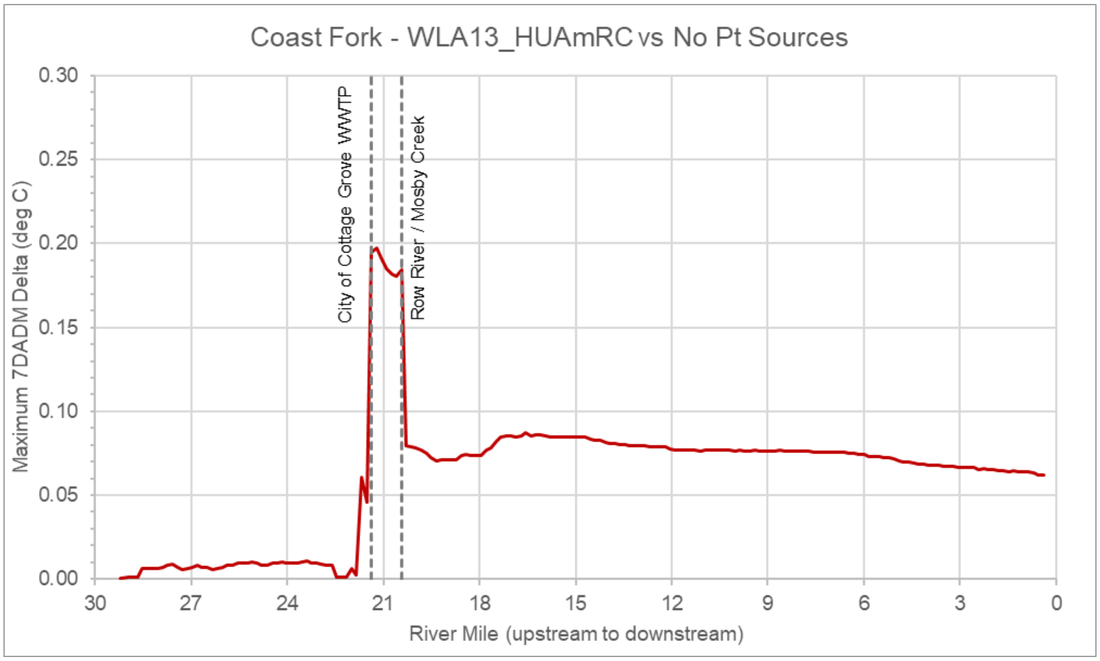

Figure 5-1: Coast Fork Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

Similarly, for other rivers with significant WLA impacts, including the South Santiam River (Figure 5-2 vs. Figure 3-4), upper Willamette River (Figure 5-3 vs. Figure 3-9), middle Willamette River (Figure 5-4 vs. Figure 3-12), and lower Willamette River (Figure 5-5 vs. Figure 3-15), less of the available HUA remains for the attainment scenario than for the WLA scenario.

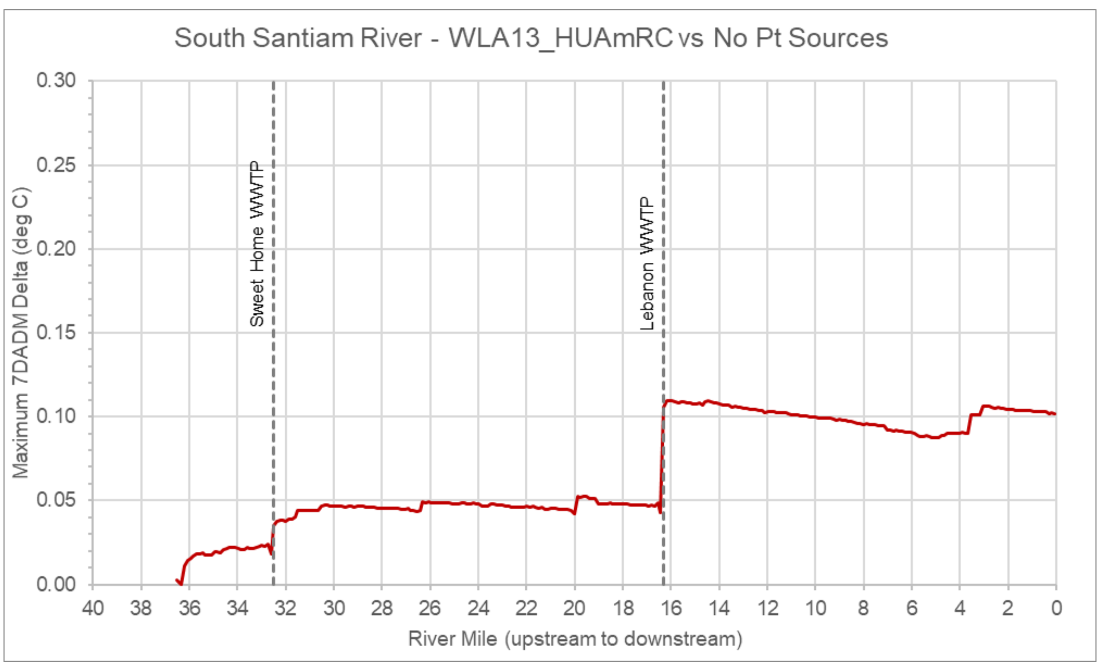

Figure 5-2: South Santiam River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

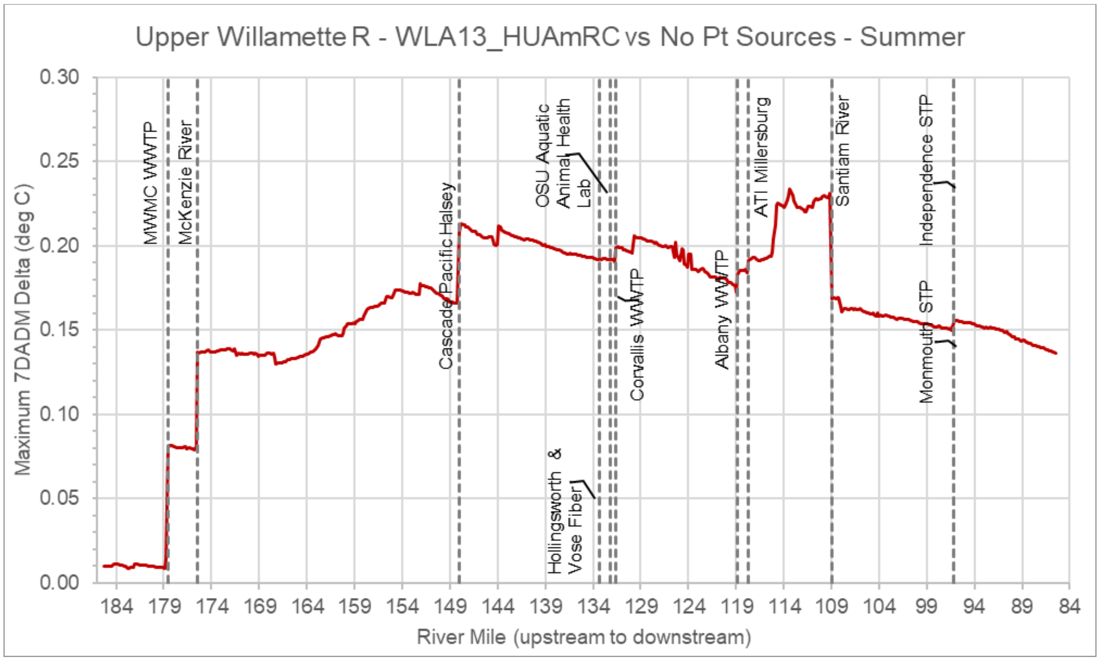

Figure 5-3: Upper Willamette R - Impacts of tributary WLAs and LAs plus mainstem WLAs.

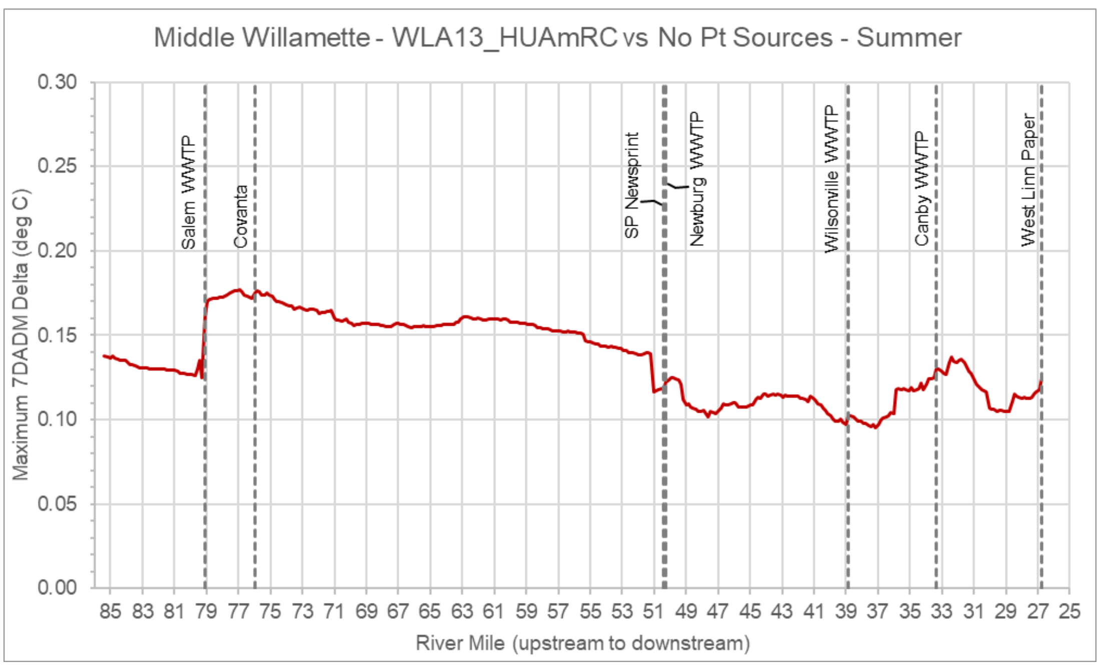

Figure 5-4: Middle Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

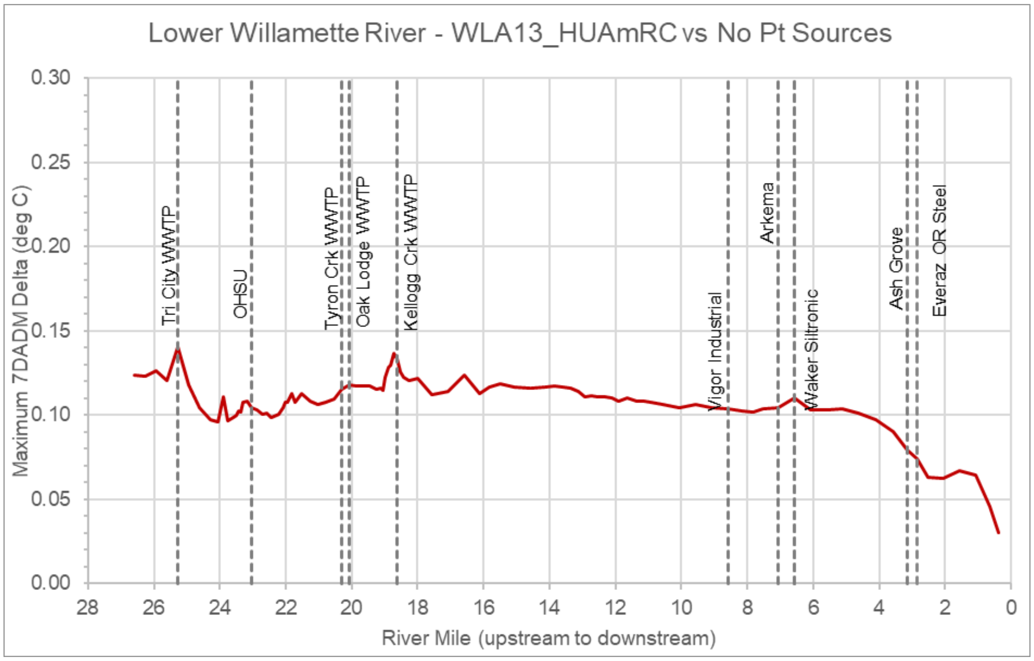

Figure 5-5: Lower Willamette River - Impacts of tributary WLAs and LAs plus mainstem WLAs.

The attainment scenario shows that less of the HUA may be available for reserve capacity. Table 5-1 shows the reserve capacity provided by the TMDL (column 3). Table 5-1 column 4 shows the Attainment Scenario model calculated maximum ΔT due to WLAs (mainstem + tributary) plus tributary LAs (maximum 7DADM changes in Figure 5-1 to Figure 5-5) . 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 5-1 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^{o}C. This impact could reduce the amount of reserve capacity available in some reaches.

Column 8 of Table 5-1 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^{o}C.

Column 9 of Table 5-1 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 5-1 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 5-1 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 5-1 columns 10 and 11, then it is considered to be a reasonable value. This is the case for all reserve capacity values, which indicates that it is reasonable to specify the amounts in column 3 as reserve capacity.

Table 5-1: Attainment scenario influence on HUA assignments and reserve capacity.

Assessment Unit Name	RM	Reserve capacity	ATTAIN-MENT SCENARIO: Model calculated max ΔT due to WLAs (mainstem + tributary) plus tributary LAs	NPDES General point sources	ATTAIN-MENT SCENARIO plus NPDES General Permits	ATTAIN-MENT SCENARIO minus WLA SCENARIO: Trib WLA + Trib LA	HUA available to allocate	HUA assigned to non-point source LAs	Un-allocated HUA	Unallocated HUA if 50% of the HUA assigned to non-point source LAs is due to trib NPS LAs
Coast Fork Willamette	30-21	0.02	0.20	0.01	0.21	0.00	0.09	0.07	0.02	0.05
Coast Fork Willamette	21-0	0.14	0.09	0.02	0.11	0.03	0.19	0.08	0.11	0.15
Middle Fork Willamette	17-0	0.18	0.02	0.02	0.04	0.00	0.26	0.08	0.18	0.22
South Santiam	37-0	0.08	0.11	0.02	0.13	0.00	0.17	0.09	0.08	0.13
North Santiam	58-11.5	0.14	0.06	0.02	0.08	0.01	0.22	0.09	0.13	0.18
Santiam River	11.5-0	0.18	0.05	0.02	0.07	0.03	0.23	0.08	0.15	0.20
Willamette River	187-107.5	0.01	0.23	0.01	0.24	0.01	0.06	0.06	0.00	0.03
Willamette River	107.5-84.5	0.08	0.17	0.01	0.18	0.02	0.12	0.06	0.06	0.09
Willamette River	84.5-51	0.04	0.20	0.01	0.21	0.01	0.09	0.06	0.03	0.07
Willamette River	51-45	0.13	0.13	0.01	0.14	0.01	0.17	0.04	0.13	0.04
Willamette River	45-0	0.04	0.14	0.01	0.15	0.03	0.15	0.14	0.01	0.04

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

ATTAINMENT SCENARIO plus NPDES General Point Sources WLAs: add 0.01 – 0.02^{o}C

ATTAINMENT SCENARIO minus WLA SCENARIO: Impacts of tributary WLA and LAs

HUA available to allocate: 0.3 minus ATTAINMENT SCENARIO plus NPDES General Point Sources WLAs

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

Unallocated HUA: 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

Reserve Capacity: 0.01 in upper Willamette is reasonable since in range 0 to 0.03
0.04 in middle Willamette is reasonable since in range 0.03 to 0.07

6 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 0.5°C. 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 0.04°C as a daily average (Table 6-1). The impact as a daily average is less than the 0.07°C impact as a 7-day average daily maximum (7DADM) and slightly more than the 0.03°C impact as a 7-day average.

In addition to tributary load and wasteload allocations plus Willamette Mainstem wasteload allocations, 0.09°C of the HUA near the river mouth is assigned to dam and reservoir operations; 0.02°C 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 0.17°C, as follows:

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

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

Table 6-1. 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 6-1 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 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 0.5°C as a daily average. This provides additional assurance that requirements of the for the Willamette River specified by the USEPA Columbia and Lower Snake Rivers Temperature Total Maximum Daily Load will be met.

7 Restored vegetation scenario

The 2006 Willamette Basin TMDL provides information on modeling performed with the shade improved from that for current conditions to that for systemwide site potential vegetation (system potential vegetation).

Figure 7-1 illustrates the difference between current effective shade levels (based on data used for the 2006 TMDL) and system potential shade levels for river mile 187 to river mile 26 at Willamette Falls. Current shade levels were not included in the calibrated model below Willamette Falls.

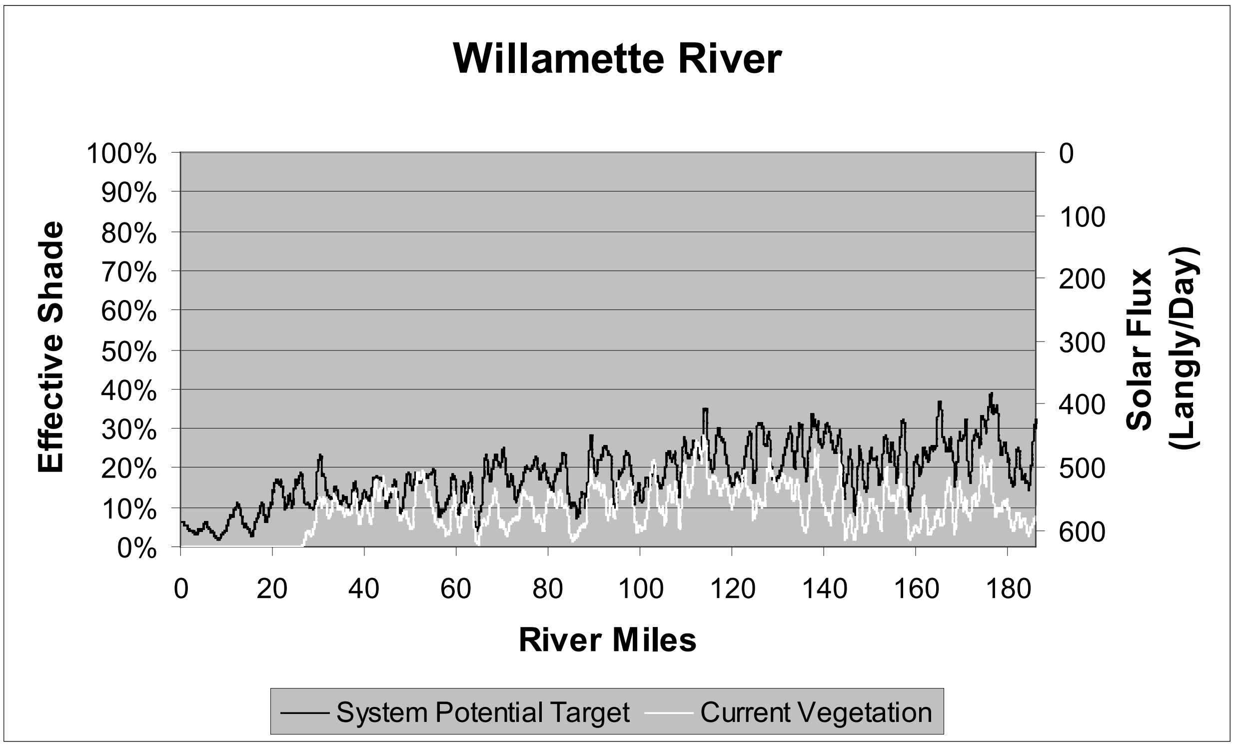

Figure 7-1: Example of current and effective shade relationship for the Willamette River (DEQ 2006).

Nonpoint source heat loads were determined by quantifying differences between solar radiation heat loads for current vegetation conditions and 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 7-1. 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 7-1 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 7-1 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 7-1 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 7-1: Heat load from solar radiation in August (DEQ 2006).

Subbasin	River Mile Reach	August Current Condition Solar Loading (Billion Kcal/day)	August Potential (Background) Solar Loading (Billion Kcal/day)	August Anthropogenic Solar Loading (Billion Kcal/day)	August Portion from Anthropogenic Non-Point Sources
Willamette River	**Willamette River (RM 0-187)**	287.93	265.01	22.92	8.0%
	187-171.8 (Upper Willamette)	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 (Middle Willamette)	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 (Lower Willamette)	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 Subbasin	**Clackamas**	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 Subbasin	**Coast Fork**	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%
	Mosby River	0.32	0.28	0.04	12.1%
	Row River	1.78	1.12	0.66	37.4%
	7.5-0	1.78	1.12	0.66	37.4%
Lower Willamette Subbasin	**Columbia Slough**	3.54	2.66	0.89	25.0%
	Lower Slough	2.12	1.97	0.14	6.8%
	Middle Slough	1.07	0.42	0.65	60.7%
	Upper Slough	0.36	0.27	0.09	25.8%
	Johnson Creek	0.58	0.37	0.21	36.1%
Mckenzie Subbasin	**Blue River**	0.16	0.09	0.07	41.8%
	McKenzie	52.60	44.46	8.14	15.5%
	59.8-41.3	7.70	6.46	1.23	16.0%
	41.3-13.7	17.10	14.17	2.92	17.1%
	13.7-0	27.80	23.82	3.98	14.3%
	Mohawk River	0.77	0.61	0.16	20.7%
	South Fork Mckenzie	0.68	0.44	0.24	35.8%
	Upper McKenzie	1.78	0.96	0.81	45.8%
Middle Fork Willamette Subbasin	**Middle Fork**	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	1.18	0.92	0.26	21.8%
	7.1-0	1.18	0.92	0.26	21.8%
North Santiam Subbasin	**Little North Santiam**	0.68	0.60	0.08	12.4%
	North Santiam	11.19	10.63	0.56	5.0%
	27-0	11.19	10.63	0.56	5.0%
	Santiam	9.19	8.44	0.75	8.2%
	11.7-0	9.19	8.44	0.75	8.2%
South Santiam Subbasin	**Crabtree**	1.58	1.32	0.26	16.7%
	South Santiam	21.51	18.33	3.18	14.8%
	37.7-0	21.51	18.33	3.18	14.8%
	Thomas Creek	1.01	1.01	0.00	0.3%
Upper Willamette Subbasin	**Calapooia River**	2.40	1.94	0.46	19.2%
	Coyote Creek	0.27	0.19	0.09	31.8%
	Lukiamute River	1.32	1.12	0.20	15.2%
	Long Tom	3.80	2.25	1.54	40.6%
	25.7-0	3.80	2.25	1.54	40.6%

Figure 7-2 from the 2006 TMDL 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 more than 0.75°C warming at river mile 140 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), nonpoint solar loads cause warming of river temperatures in excess of the 0.3°C HUA.

For Figure 7-2, the Delta 7DADM temperatures shown are different than those in plots above. For Figure 7-2, 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.

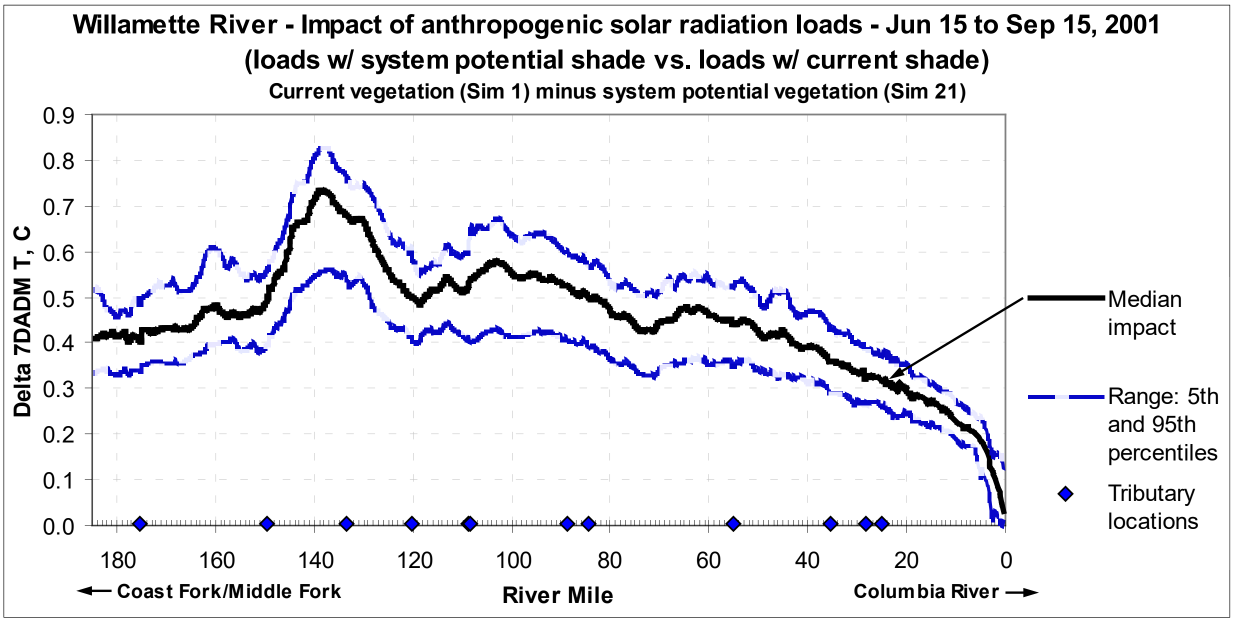

Figure 7-2: Maximum difference in seven day average of the daily maximum temperatures between 2001 calibrated model and 2001 calibrated model with system potential vegetation.

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

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