UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101-3188

WATER DIVISION

Total Maximum Daily Load (TMDL) for Mercury in the Willamette Basin, Oregon

In compliance with the provisions of the Clean Water Act, 33 U.S.C. 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 1004, the Environmental Protection Agency is hereby establishing a TMDL to address discharges of mercury to the waters of the Willamette Basin, Oregon.

The Regional Administrator will promptly issue a public notice seeking comment on this TMDL; prompt issuance of public notice will occur on January 6, 2020. After considering public comment and making any revisions deemed appropriate, the Regional Administrator intends to transmit this TMDL to the State of Oregon for incorporation into its current water quality management plan.

12/20/19
Daniel D. Opalski, Director

Willamette Basin Mercury Total Maximum Daily Load

December 30, 2019

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 10

1200 Sixth Avenue, Suite 155

Seattle, WA 98101- 3188

Contents

Acronyms and Abbreviations v
1 Introduction 1
2 Background 1
2.1 TMDL Components 1
2.2 TMDL Scope 2
3 Applicable Water Quality Standards & Numeric Targets 2
3.1 Beneficial Uses 2
3.2 Applicable Criteria 2
4 Source Analysis 2
4.1 Air Emissions 2
4.2 Nonpoint Sources 3
4.3 Background and Unquantified Anthropogenic Sources 3
4.4 Point Sources 3
4.4.1 Municipal wastewater dischargers 4
4.4.2 Industrial dischargers 4
4.4.3 General Permits 4
4.4.4 Suction Dredge Mining 4
4.4.5 Stormwater 4
5 Analytical Framework 4
6 Loading Capacity 5
7 Allocations 7
7.1 Nonpoint Source Load Allocations 7
7.1.1 Atmospheric Deposition 7
7.1.2 General Nonpoint Sources 8
7.1.3 Legacy Metals Mines 9
7.2 Point Source Wasteload Allocations 10
7.2.1 Wastewater and Industrial Dischargers 10
7.2.2 Minor wastewater POTWs 10
7.2.3 Stormwater facilities 11
7.2.4 Suction dredge facilities 11
7.3 Reserve Capacity 11
7.4 Allocation summary 12
8 Seasonal Variation and Critical Conditions 14

9 Margin of Safety 14
10 Reasonable Assurances.... 15
11 References 16
Appendix A: Final Revised Willamette Basin Mercury Total Maximum Daily Load.... 18
Appendix B: Technical Support Document 19
Appendix C: Allocation Summary.... 20

List of Tables

Table 1. Total Mercury Percent Reductions and Estimated Loading Capacity 6
Table 2. Total Mercury Allocations for the Willamette River Basin and Subbasins.... 12
Table 3. Percent Reductions for Land Managers in the Willamette River Basin and Subbasins 13

Acronyms and Abbreviations

BMP	Best Management Practice
CFR	Code of Federal Regulations
CWA	Clean Water Act
DMA	Designated Management Agency
GEM	Gaseous Elemental Mercury
g	Gram
g/Day	Grams per day
HSPF	Hydrologic Simulation Program – FORTRAN
HUC	Hydrologic Unit Code
LA	Load Allocation
LC	Loading Capacity
Lbs	Pounds
mg	Milligram
mg/kg	Milligrams Per Kilogram
mg/l	Milligrams Per Liter
MOS	Margin of Safety
Hg	Mercury
kg	Kilogram
MeHg	Methylmercury
MS4	Municipal Separate Storm Sewer System
ng/l	nanogram per liter
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
OAR	Oregon Administrative Rule
POTW	Publicly Owned Treatment Works
RC	Reserve Capacity
ROS	Regression on Order Statistics
THg	Total Mercury
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
TSS	Total Suspended Solids
µg	Micrograms
EPA	U.S. Environmental Protection Agency
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan
WQS	Water Quality Standards
WRB	Willamette River Basin
Yr	Year

Willamette Basin Mercury TMDL

1 Introduction

On November 22, 2019, the Oregon Department of Environmental Quality (ODEQ) submitted to the U.S Environmental Protection Agency, Region 10 (EPA), its *Final Revised Willamette Basin Mercury TMDL and WQMP* (ODEQ's 2019 TMDL)[1]. ODEQ's 2019 TMDL, which addressed waterbody impairments for mercury in the Willamette Basin, was an update to the original mercury TMDL approved by EPA in 2006. Litigation resulted in a voluntary remand of the 2006 TMDL, and the Court ordered EPA to take action on a new TMDL by November 29, 2019[2]. In response to the remand, ODEQ developed and submitted to EPA ODEQ's 2019 TMDL. EPA disapproved ODEQ's 2019 TMDL on November 29, 2019 after determining that the load and waste load allocations based on percent reductions would not achieve the TMDL target in all the subbasins addressed by the TMDL. Section 303(d)(2) of the Clean Water Act (CWA) requires EPA to establish a replacement TMDL for the state within 30 days following an action of disapproval. EPA is establishing the TMDL described in this document to satisfy that statutory requirement.

EPA's Willamette Basin Mercury TMDL (EPA's 2019 TMDL) incorporates by reference those sections of ODEQ's 2019 TMDL that EPA found to be consistent with the CWA's and EPA's regulatory requirements. EPA's 2019 TMDL also contains new material prepared by EPA to ensure that the TMDL satisfies those requirements throughout. ODEQ's 2019 TMDL is included in Appendix A of this document.

2 Background

2.1 TMDL Components

A TMDL is a planning tool designed to restore and maintain the quality of waters that have been identified as not meeting applicable water quality standards (USEPA, 1991). A TMDL is typically expressed as:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS \leq LC$$

where:

WLA = Waste Load Allocation – the portion of the loading to the water body assigned to each permitted point source of the pollutant;

LA = Load Allocation – the portion of the pollutant loading assigned to nonpoint sources of the pollutant;

Σ = Summation across multiple items;

MOS = Margin of Safety – an accounting of the uncertainty of the pollutant load and the quality of the water body; and

LC = Loading Capacity.

[1] Final Revised Willamette Basin Mercury Total Maximum Daily Load. Oregon Department of Environmental Quality. November 22, 2019.

[2] *Northwest Environmental Advocates v United States Environmental Protection Agency*, No. 3:12-cv-01751-HZ (D. Or., Oct. 4, 2019).

Section 1.2 of ODEQ's 2019 TMDL defines "TMDL" and describes the TMDL process for addressing waters not meeting water quality standards. EPA has reviewed Section 1.2 and finds it technically reasonable and legally sufficient and incorporates it into EPA's 2019 TMDL.

2.2 TMDL Scope

Section 1.4 of ODEQ's 2019 TMDL describes the geography and physical characteristics of the Willamette River Basin (WRB) while Table 4-1 in Section 4 of ODEQ's 2019 TMDL identifies the basin's mercury-impaired waterbodies that are addressed in EPA's 2019 TMDL. EPA has reviewed the geographic scope and the water quality limited waters identified in ODEQ's 2019 TMDL and finds it technically reasonable and legally sufficient. EPA therefore relies on Section 1.4 and all of Section 4 of ODEQ's 2019 TMDL and incorporates them into EPA's 2019 TMDL.

3 Applicable Water Quality Standards & Numeric Targets

3.1 Beneficial Uses

Water quality standards are adopted to protect the beneficial uses of waters of the state. Beneficial uses are presented for each impaired waterbody in Table 4-1 and discussed in Section 2 of ODEQ's 2019 TMDL. EPA has reviewed Section 2 of ODEQ's 2019 TMDL and finds it technically reasonable and legally sufficient. EPA therefore relies on Section 2 of ODEQ's 2019 TMDL and incorporates it into EPA's 2019 TMDL.

3.2 Applicable Criteria

A discussion of the applicable water quality criteria is included in Section 3 of ODEQ's 2019 TMDL. Consistent with the Clean Water Act's Section 303(d)(1)(C) and EPA's regulations at 130.7(c)(1), a TMDL is to be established at a level necessary to attain and maintain the applicable narrative and numeric water quality standards. Section 3 of ODEQ's 2019 TMDL includes the state's rationale for the fish tissue criterion being protective of aquatic life and wildlife dependent species and cites EPA's approval action of a California prey fish objective for protection of wildlife at 0.05 mg/kg of mercury in fish tissue. EPA has reviewed the applicable criteria in ODEQ's 2019 TMDL and finds it technically reasonable and legally sufficient. EPA therefore relies on Section 3 of ODEQ's 2019 TMDL and incorporates it into EPA's 2019 TMDL.

4 Source Analysis

Section 9 of ODEQ's 2019 TMDL discusses mercury source assessment. Oregon regulations define a source as a process, practice, activity, or resulting condition that causes or may cause pollution or the introduction of pollutants to a waterbody (OAR 340-042-0040(4)(f) and OAR 340-042-030(12)). EPA finds the systematic manner in which ODEQ has characterized the types of point and nonpoint sources of mercury as presented in Section 9 of ODEQ's 2019 TMDL to be technically reasonable and legally sufficient. EPA therefore relies on Section 9 of ODEQ's 2019 TMDL and incorporates it into this document. The following sections provide a brief overview of the sources identified by ODEQ.

4.1 Air Emissions

Section 9.1 of ODEQ's 2019 TMDL identifies atmospheric deposition of mercury from global sources as the dominant source of mercury in the WRB. ODEQ's 2019 TMDL did not model air sources that originate within the Willamette Basin or the state, or assign allocations to them, because ODEQ did not have current analytical tools to determine loads of mercury that could be deposited from these facilities and then carried to waterways. Although it is possible to make assumptions of the speciation of mercury from these facilities based on comparisons to other similar facilities and then use that information to estimate deposition, EPA believes this would require a relatively large level of effort and would likely indicate that local deposition is quite small in comparison to global pool deposition[3]. This is because the majority of mercury emitted from sources within the Willamette Basin is in the gaseous elemental form, and is therefore not likely to deposit locally (Lin et al., 2012; Schroeder and Munthe, 1998; Zhang et al., 2016). These estimates also would have a high degree of uncertainty associated with them. To address facilities within the Basin, ODEQ targeted mercury air emission reductions as a key strategy in the Water Quality Management Plan (WQMP) in ODEQ's 2019 TMDL, rather than attempting to address them through the TMDL's Waste Load Allocations and Load Allocations. However, because atmospheric deposition is the primary source of mercury in the WRB, limiting the surface runoff and erosion of mercury deposited from the atmosphere is addressed in ODEQ's 2019 TMDL and is in EPA's 2019 TMDL as well.

4.2 Nonpoint Sources

Section 9.2 of ODEQ's 2019 TMDL identifies land management practices that result in runoff or sediment erosion that can transport mercury to the stream network, including forestry and agriculture, water impoundments and conveyances, non-permitted urban stormwater runoff, groundwater, mines, and atmospheric deposition direct to waterbodies or to land.

4.3 Background and Unquantified Anthropogenic Sources

Section 9.3 of ODEQ's 2019 TMDL discusses background[4] or natural sources, and currently unquantified anthropogenic sources of mercury in the basin. Background sources in ODEQ's 2019 TMDL include atmospheric deposition of mercury from emissions outside Oregon, mercury in groundwater due to local geologic formations, and naturally occurring sediment-bound mercury that is eroded and transported to streams in the basin.

4.4 Point Sources

Section 9.4 of ODEQ's 2019 TMDL discusses point sources of mercury in the Willamette Basin. Point sources are generally regulated by National Pollutant Discharge Elimination System (NPDES) permits and are required to receive a waste load allocation in TMDLs if they discharge a pollutant to a waterbody that is impaired for that pollutant. Point sources include municipal wastewater (domestic sewage) dischargers, industrial dischargers, stormwater dischargers, and suction dredge mining.

---

[3] USEPA Region 10. 2019. Memo to File: Air Emission Hg Allocations for Revised Willamette Mercury Total Maximum Daily Load (TMDL). Chris Eckley.

[4] Oregon regulation OAR 340-042-0030(1) defines background sources to include pollutants not originating from human activities and anthropogenic sources of a pollutant that ODEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands or sources otherwise beyond the jurisdiction of the state.

4.4.1 Municipal wastewater dischargers

Major and minor municipal wastewater dischargers are discussed in Section 9.4 of ODEQ's 2019 TMDL and in Section 5.3 of *Mercury TMDL Development for the WRB (Oregon) – Technical Support Document, December 16, 2019* (TSD), Appendix B of this document.

4.4.2 Industrial dischargers

Table 9-4 in Section 9.4.1.2 of ODEQ's 2019 TMDL lists the categories of industrial facilities with NPDES permits that are potential sources of mercury. ODEQ identified 7 major and 15 minor industrial wastewater facilities in these categories that are permitted to discharge wastewater as potential sources of mercury. ODEQ identified an additional 13 active minor industrial permits with identified activities in these categories, but none discharge process wastewater and were therefore excluded.

4.4.3 General Permits

NPDES general permit holders participate in activities not anticipated to be sources of mercury (such as cooling water releases, filter backwash, fish hatcheries, boilers, wash water, and pesticide applications).

4.4.4 Suction Dredge Mining

Registrants for suction dredging were evaluated and found not to be a significant source of mercury in ODEQ's 2019 TMDL (Section 9.4.1.2). However, in areas with sediment data showing mercury contamination, disturbance by suction dredging has a high potential to release long-stored mercury in historic mining areas and is a potential direct, but unquantified source of mercury.

4.4.5 Stormwater

Municipal Separate Storm Sewer System (MS4) permits and associated mercury loads are discussed in Section 9.4.2 of ODEQ's 2019 TMDL. MS4 permits for Phase I (large cities, counties, and the highway system) and Phase II (less urbanized cities and counties) jurisdictions in the Willamette Basin are listed in Table 9-5 of ODEQ's 2019 TMDL. During the development of ODEQ's 2019 TMDL, 47 entities regulated under MS4 permits were identified and included. Several permits combine multiple smaller jurisdictions.

General industrial stormwater and construction stormwater permits are discussed in Sections 9.4.2.2 and 9.4.2.3 of ODEQ's 2019 TMDL.

5 Analytical Framework

The analytical approach for calculating the load capacity required to achieve water quality standards is summarized in Sections 5 and 6 of ODEQ's 2019 TMDL and presented in Sections 3 through 5 in the TSD. Mercury sources are linked to water column concentrations and fish tissue methylmercury concentrations with three linked models – a food web model, a mercury translator model, and a mass balance model. The mass balance model was first used to estimate mercury loads for each source category at the point where they originate ("At Source Loads"). Transport of the source load to the stream network was modeled subsequently. Loads delivered to the stream ("Delivered Loads") are less than "At Source" loads due to transport losses (e.g. storage, volatilization, etc.). In ODEQ's 2019 TMDL, allocations are based on "At Source" loads, and that convention is retained in EPA's 2019 TMDL.

EPA's 2008 Mercury guidance[5] includes linkage analyses as a recommended approach to determine the percent reductions of loading needed to meet fish tissue targets in watersheds dominated by air deposition. The three models used in the development of the 2006 TMDL were updated for the development of ODEQ's 2019 TMDL to incorporate new data as described briefly in ODEQ's 2019 TMDL and in depth in Sections 3 through 5 of the TSD.

This analytical approach is reasonable and practical to establish a total mercury load capacity based on a methylmercury fish tissue criterion. The linkage analysis is appropriate and reasonable for translating the fish tissue criterion to a water column total mercury load and aligns with EPA's mercury guidance. Given the complex, nonlinear transformation of mercury in the environment, EPA finds the linked model approach to be a technically reasonable and legally sufficient way to estimate the load capacity. EPA therefore relies on Sections 5 and 6 of ODEQ's 2019 TMDL found in Appendix A and Sections 3 through 5 of the TSD, and incorporates these sections into EPA's 2019 TMDL

6 Loading Capacity

Loading capacity is the amount of a pollutant or pollutants that a waterbody can receive and still meet water quality standards (40 CRF 130.2(f)). The loading capacity for EPA's 2019 TMDL is calculated by estimating the percent reduction that is required to achieve water quality standards in each HUC8 subbasin of the Willamette Basin and applying this percent reduction to the loads estimated by the mass balance model.

Mercury accumulation through the food chain is a chronic process that occurs over time. As a result, a measure of the central tendency of exposure concentrations over time is most relevant to addressing the impairment. To do this, the median target surface water concentration calculated for the Northern Pikeminnow (Section 6.1.2 of ODEQ's 2019 TMDL) is compared to the median observed surface water total mercury concentration. The median is used instead of the mean because it is more robust against extreme outliers and is minimally affected by the presence of censored data. The required percent reductions for each HUC8 watershed (R_i) are thus

$$R_i = \left[1 - \frac{TL}{EL_i}\right] x\ 100$$

where *TL* is the target median water column concentration of 0.14 ng/l determined from the linkage analysis to achieve the fish tissue target of 0.040 mg/kg for the Northern Pikeminnow, and EL_i is the existing median surface water total mercury concentration.

Water column total mercury samples collected since 2002 by multiple agencies were provided by ODEQ for computing HUC-scale median concentrations. For most HUC8 basins, these data extend through 2011, although the Coast Fork Willamette HUC8 (17090002) has data through 2014. More recent data are available only for the Tualatin (17090010) and Lower Willamette (17090012) HUC8s. ODEQ applied the more recent mainstem data to characterize median concentrations in the Tualatin (2012 to 2019) and Lower Willamette (2013 to 2017) HUC8s in ODEQ's 2019 TMDL (Section 7.2). Censored samples were incorporated using the Regression on Order Statistics (ROS; Bolks et al., 2014) method prior to the

[5] U.S. Environmental Protection Agency. (2008). *TMDLs Where Mercury Loading are Predominantly from Air Deposition*. Office of Water. Washington, DC.

computation of HUC-scale median concentrations. EPA accepts the subbasin data used in ODEQ's analysis of existing concentrations and accepts ODEQ's update of existing concentrations in the Tualatin and Lower Willamette subbasins. ODEQ has indicated that they will continue to assess and monitor the watershed based on discussion in Section 13 of ODEQ's 2019 TMDL and the *Monitoring Strategy to Support Implementation of the Willamette Mercury Total Maximum Daily Load (Draft)* that was included in ODEQ's submittal package.

The ODEQ's 2019 TMDL established the TMDL load capacity by calculating an existing basin-wide median total mercury concentration of 1.2 ng/l and determining that 88% reduction was needed to achieve the TMDL target of 0.14 ng/l. EPA reviewed this approach and determined that the percent reduction allocations in the TMDL would not result in meeting the TMDL target in three subbasins which exceed the basin-wide median concentration of 1.2 ng/l. Upon further review, EPA has determined that the ODEQ's 2019 TMDL would not achieve the TMDL target in two additional subbasins, Upper Willamette and Middle Willamette. The existing median mercury concentration in Middle Willamette (1.23 ng/l) is above the basin-wide median concentration of 1.2 ng/l, and the existing median mercury concentration in the Upper Willamette is below the basin-wide median of 1.2 ng/l. ODEQ set a basin-wide reduction target of 88%, however, ODEQ's 2019 TMDL did not apply an 88% reduction uniformly to all source categories resulting in effective reductions that were less than 88% in these HUCs. For example, a 75% reduction was assigned to MS4 facilities, and a 10% reduction was applied to POTW and industrial dischargers. This resulted in an effective 87% reduction in the Upper Willamette and 78% reduction in the Middle Willamette subbasins, which is not sufficient to reduce existing concentrations to achieve the TMDL target. Revised allocations for these subbasins are established in EPA's 2019 TMDL, while retaining ODEQ's percent reduction allocations in the remaining subbasins.

The median water column concentrations and percent reductions needed to achieve the TMDL target in each subbasin are shown in Table 1. The percent reductions are applied to the at-source total mercury loads to calculate the daily loading capacity for each subbasin and summed to establish the basin-wide load capacity.

Table 1. Total Mercury Percent Reductions and Estimated Loading Capacity

HUC8/ Waterbody	Median THg Concentration (ng/l)	Required Percent Reduction	At source THg Load (g/day)	THg Loading Capacity (g/day)
17090001	0.86	88%	23.47	2.61
17090002	3.39	96%	24.39	0.94
17090003	1.01	88%	71.62	4.72
17090004	1.00	88%	34.81	3.70
17090005	0.92	88%	21.57	2.20
17090006	1.20	88%	38.24	3.50
17090007	1.23	89%	17.32	1.93
17090008	1.13	88%	35.50	3.22
17090009	0.88	88%	30.70	2.91
17090010	1.32	89%	22.93	1.91
17090011	1.00	88%	23.63	2.58
17090012	1.23	89%	6.02	0.68
Multnomah Channel	1.23	89%	7.68	0.70
Columbia Slough	1.23	89%	2.71	0.29
TOTAL			360.58	31.89

Note: The reduction estimates for HUC 17090012 are also applicable to the Multnomah Channel and Columbia Slough, although these are tabulated separately for implementation purposes. Loads for HUC 17090012 are for the mouth of the Willamette River and omit the totals for Multnomah Channel and Columbia Slough.

7 Allocations

7.1 Nonpoint Source Load Allocations

7.1.1 Atmospheric Deposition

In ODEQ's 2019 TMDL, it was assumed that the mercury load to the watershed from atmospheric deposition would decrease by 11% over time. As described in the TSD, mercury deposited over land can be transported to the river network via runoff or it can accumulate in soils and vegetation throughout the basin. Since mercury is tightly bound to organic matter in soils, it has accumulated and continues to accumulate over long periods of time, resulting in legacy concentrations of mercury in soil. Consequently, reductions in current and future deposition are not expected to result in immediate reductions in soil mercury concentrations; only gradual reductions over long period of times would be expected (Harris et al 2007). These reductions would be expected to be on a time frame longer than the TMDL implementation time frame indicated by ODEQ. Mercury concentrations in surface runoff, such as stormwater, represent a mix of newly deposited mercury as well as legacy deposited mercury that becomes more mobile over time as soil organic material is slowly broken down until the mercury is mobilized and bound to dissolved organic carbon. This process results in a time-lag between reductions in deposition and similar levels of reduction in stormwater runoff. In urban catchments with more impervious surface and a lower amount of organic material, this time-lag is shortened. Mercury deposited directly to open surface water bodies would respond immediately to changes in atmospheric deposition. In subbasins with greater surface water area, deposition direct to water can be a significant portion of the overall mercury load, especially once other nonpoint sources of mercury loading are reduced to achieve load allocations. Due to the significance of deposition to water in these subbasins, EPA reviewed relevant literature regarding deposition trends to assess the assumption in ODEQ's 2019 TMDL of an 11% decrease in atmospheric deposition over time.

Several studies have observed declining linear trends in atmospheric gaseous elemental mercury (GEM) concentrations in North America over roughly the last 20 years. For example, a spatially and temporally integrated average decline between 1997 and 2013 across the U.S. and Canada of -1.1%/yr has been observed (Weiss-Penzias et al., 2016). Analysis of monitoring data across Canada between 1995 and 2011 showed a spatially averaged decline of -1.5%/yr in GEM concentrations (Cole et al., 2014). Average decreases in GEM have ranged from -1.2 to -2.1%/yr at northern midlatitudes (Zhang et al., 2016). Across North America GEM was calculated to have declined -1.1±0.3%/yr between 2000 and 2015 (Streets et al., 2019). Mercury concentrations in wet deposition averaged across North America have also been shown to decline by -1.6±0.3%/yr (Zhang et al., 2016).

The Minamata Convention on Mercury (the global treaty to regulate mercury release) was ratified by 50 nations in 2017 at which point the Convention was in force. The treaty has now been ratified by 115 nations, which includes the world's largest emitters of mercury. This treaty is expected to result in additional declines in atmospheric mercury concentrations and deposition over the next few decades (Pacyna et al., 2016).

Given the current range of measured decreases in mercury concentrations across North America (-1.1 to -2.1 %/yr), assuming reductions of atmospheric deposition of 35% over the next 28 years (WQMP) is reasonable. To reach a 35% reduction of atmospheric deposition over 28 years, the annual reduction would need to be -1.25%/yr, which is on the lower end of values reported in some studies. This lower-end value is reasonable because, although the rate of decrease into the future could be lower than trends based on observations from the 1990s to 2010s (Weiss-Penzias et al., 2016), the implementation of the Minamata Convention is expected to further decrease mercury emissions globally. Therefore, it is likely that there will continue to be additional decreases in atmospheric mercury concentrations and deposition over the next few decades and a rate of -1.25%/yr is an appropriate and conservative estimate. For these reasons, EPA assumed that a 35% reduction in atmospheric mercury deposition is a reasonable and appropriate allocation target, as opposed to an 11% reduction as expressed in ODEQ's 2019 TMDL.

7.1.2 General Nonpoint Sources

Surface Runoff

Mercury loads in direct surface runoff are assumed to be primarily attributable to wet and dry atmospheric deposition. Most of the precipitation that falls on impervious surfaces becomes direct runoff, so a large fraction of the wet and dry deposition mercury load is delivered to streams in runoff. In contrast, only a small fraction of precipitation onto pervious surfaces follows direct surface runoff pathways. Table 10-1 in ODEQ's 2019 TMDL proposes an 88% reduction for general nonpoint source loading rates for total mercury, including an 88% reduction in the delivery via runoff of atmospherically deposited mercury from nonpoint source areas. With a reduction of atmospheric deposition, assumed to be 35% in EPA's 2019 TMDL, the effective reduction of mercury loading would be greater than 88%[6].

In revising the TMDL to achieve the in-stream water column concentration target in all subbasins, EPA determined that greater reductions in surface water runoff would be needed. In five subbasins where the TMDL target was not met in ODEQ's 2019 TMDL, EPA's 2019 TMDL specifies a 97% reduction in the delivery of the surface runoff load and assigns this load reduction responsibility to land managers. The effect of this reduction plus reducing atmospheric deposition by 35% results in a combined reduction in mercury loading in surface runoff of 98%. The combined reduction is accounted for in the loading analysis needed to achieve the TMDL target. For the remaining basins where the TMDL target was met, EPA's 2019 TMDL retains the 88% reduction for this source category from ODEQ's 2019 TMDL.

Sediment Erosion

ODEQ's 2019 TMDL assigned an 88% load reduction to mercury in sediment erosion from agriculture, forestry, developed land outside of urban DMAs or MS4s, and "other" nonpoint source load categories such as water impoundments and water conveyance entities. Greater reductions are needed in subbasins that did not achieve ODEQ's 2019 TMDL target. EPA conducted an analysis where the needed reduction from this category was incrementally increased above 88% to the point where, in combination with other allocation adjustments, the TMDL target would be met in each subbasin. These needed changes in sediment erosion varied (89 – 97%) by subbasin due to land use and loading differences between subbasins, and due to the magnitude of departure in meeting the TMDL target in ODEQ's 2019

[6] Note that the percent reductions required for atmospheric deposition and surface runoff of atmospherically deposited mercury are not additive, as presented in ODEQ's 2019 TMDL. That is, a 35% reduction in atmospheric deposition and an 88% reduction in runoff of atmospherically derived mercury does not equal a total reduction of 123%. Reductions in wet and dry deposition over time (35%) will result in lower concentrations on the landscape, such that when reducing these concentrations by 88%, the cumulative reduction will be greater than 88%. The comprehensive percent reduction achieved with this strategy will be 92% [Reduced Load = Existing Load x (1-0.35) x (1-.88) = Existing Load x 0.08, which equates to a comprehensive reduction of 92% (1-0.08=0.92)].

TMDL. Since the differences between subbasins were relatively small, for consistency purposes across land management categories, EPA's 2019 TMDL establishes a 97%[7] reduction in this source category. This matches the needed reduction from surface runoff from these land use categories. Reductions in the rate of atmospheric deposition of mercury will also ultimately result in reductions of mercury concentrations in surface sediment however, this process is slow and is expected to occur over a time frame well beyond the TMDL implementation time frame indicated by ODEQ. Consequently, mercury loading from sediment erosion will continue to be driven by historically deposited mercury and no additional loading reduction for erosion is assumed.

Groundwater Loading

Data on groundwater contributions of mercury load are extremely limited at present. However, based on the limited existing data, mercury concentrations in groundwater are expected to be generally low. In EPA's 2019 TMDL, a reduction of 88% is applied to all groundwater[8]. Reductions in groundwater load are not expected to be achieved quickly, as concentrations of dissolved mercury in groundwater reflect many decades of legacy accumulation from atmospheric deposition and geologic sources. Groundwater concentrations and loads are expected to decrease gradually over time as atmospheric deposition continues to decrease and surface land management practices improve. It may be appropriate to re-evaluate this component as additional data are collected.

7.1.3 Legacy Metals Mines

Section 9.2.3 of ODEQ's 2019 TMDL describes the extent of abandoned mine sites in the WRB and Table 9-2 identifies the 12 mining districts and abandoned mine lands that are currently being assessed and remediated by ODEQ's Clean Up Program or by federal agencies (EPA, the Bureau of Land Management (BLM), and the US Forest Service (USFS)). Although mining activities are no longer occuring at the Black Butte Mine, immediately upstream of the Cottage Grove Reservoir, or the Bohemia gold mining district, tributary to Dorena Reservoir, they are continuing sources of mercury in the basin. ODEQ's 2019 TMDL states that Furnace Creek, which is significantly impacted by historic Black Butte Mine activities and was part of a 2018 Superfund remediation action, was determined to be contributing a substantial percentage of the mercury load to the Coast Fork of the Willamette River. ODEQ's 2019 TMDL also provides that sediment samples from tributaries to the Row River, which empties into the Dorena Reservoir, indicate mercury contamination from historic mining sources is a primary cause of elevated mercury in fish tissue in Dorena Reservoir (Ambers and Hygelund, 2001; Hygelund et al., 2001). The Cottage Grove Reservoir and the Dorena Reservoir are in the Coast Fork Subbasin. ODEQ's 2019 TMDL states that, for other abandoned mine lands in the WRB, sufficient data are not available to indicate whether the lower priority sites are significant sources of mercury. ODEQ's 2019 TMDL further states that the sites will continue to be assessed and remediated as warranted. ODEQ established a 95% reduction allocation for historic mine sites in the Coast Fork and other subbasins. EPA determined that ODEQ's reduction allocation in this subbasin would not achieve the TMDL target. EPA's 2019 TMDL

---

[7] Although this reduction is greater than the 88% reduction applied for sediment erosion in other subbasins, the strategy and type of BMP practices outlined in the ODEQ's 2019 TMDL are expected to be able to achieve the new, higher reduction percentages.

[8] In ODEQ's 2019 TMDL the percent reduction applied to groundwater is discussed in varying manners. EPA utilized an 88% reduction for the groundwater source category, as listed in ODEQ's 2019 TMDL Table 10-1.

increases this reduction to 98%[9]. See additional discussion of the rationale for this decision in Appendix C.

7.2 Point Source Wasteload Allocations

Point sources of mercury loading in the WRB include municipal POTWs, industrial dischargers, suction dredging, and regulated stormwater discharge. As discussed in Section 4, municipal POTWs and industrial point sources account for less than 1% of the mercury load, and regulated stormwater accounts for approximately 3% of the load. Given the small contributions of point source loading relative to the nonpoint source load in the WRB, ODEQ's 2019 TMDL established aggregate wasteload allocations for wastewater and stormwater point sources as percent reductions from current loading.

As discussed in Section 9 of ODEQ's 2019 TMDL, mercury loading in the WRB is largely the result of atmospheric deposition of mercury originating outside the WRB. The use of aggregate WLAs for point sources is generally consistent with EPA guidance regarding mercury TMDLs in which mercury impairments are predominantly the result of atmospheric deposition (EPA, 2008). ODEQ has discretion to determine how to apportion these subbasin-specific aggregate wasteload allocations to individual facilities.

7.2.1 Wastewater and Industrial Dischargers

The ODEQ aggregate WLA of 10% reduction from current loading for wastewater, and industrial dischargers determined to be sources of mercury loading, is retained in all but two subbasins. Permit categories covered by this aggregate WLA include the following:

Major and minor domestic Sewage Treatment Plant wastewater permits (POTWs)
Major and minor Industrial wastewater permits
Wastewater discharges covered under general permits

EPA has determined that wastewater and industrial discharger reductions greater than 10% are needed in the Middle Willamette and Lower Willamette subbasins to achieve the TMDL target. Current effluent data provided by ODEQ for TMDL development indicate that some major POTW and industrial facilities have effluent concentrations that are higher than other major facilities and contribute greater loading in their respective subbasins. Reductions in current concentration and loading from these facilities, in combination with greater reductions from the general nonpoint source category, are needed to achieve the TMDL target in each subbasin. Additional explanation of required reductions for each of these subbasins is provided in Appendix C.

7.2.2 Minor wastewater POTWs

Minor POTW dischargers are included within the aggregate 10% reduction WLA for POTW and industrial facilities. However, the intent of the ODEQ's 2019 TMDL was to impose no further reduction in load from Minor POTWs (p. 118, Appendix A). This approach is reasonable given the very small contribution of these sources to the overall load cumulatively (0.07%; p. 48, Appendix A). To achieve this objective, an allocation of 0% reduction is established in EPA's 2019 TMDL for Minor POTW and industrial dischargers. No reductions in current load are required for Minor facilities, and additional future loads

[9] In Section 7.2.4 a separate wasteload allocation is established for suction dredging in the Coast Fork subbasin, due to mining-related mercury contamination in stream sediments.

are not accounted for in this TMDL. However, if Minor facilities in the WRB increase in size to become Major facilities, the permit requirements would be expected to change to include TMDL implementation and mercury monitoring requirements as provided in ODEQ's 2019 TMDL. In addition, ODEQ's Reasonable Potential Analysis Internal Management Directive (DEQ 11-WQ-020-IMD) and 40 CFR 122.21(j) also require mercury monitoring for Major facilities.

7.2.3 Stormwater facilities

In ODEQ's 2019 TMDL (p. 60, Appendix A), ODEQ established a 75% aggregate reduction WLA for regulated stormwater dischargers, including the following permit categories:

Municipal Separate Storm Sewer System (MS4) Phase I and II facilities
Industrial Stormwater (1200-A and 1200-Z permits)
Construction Stormwater (1200-C/CN/CA general permits)

EPA retains the 75% aggregate reduction WLA for these facilities, except in the Middle Willamette and Lower Willamette subbasins. To achieve the TMDL target in these subbasins, EPA established a 97% reduction WLA for regulated stormwater in the Middle Willamette and Lower Willamette subbasins. In combination with other changes to point source loading, these further load reductions will achieve the TMDL target in these subbasins.

7.2.4 Suction dredge facilities

EPA agrees with ODEQ's conclusion (p. 62, Appendix A) that suction dredging can be a significant source of mercury loading in areas where stream sediments are contaminated with mercury. Therefore, EPA retains ODEQ's intent to prohibit suction dredge mining at locations described in the ODEQ's 2019 TMDL (p. 62, Appendix A) by establishing a zero WLA for the suction dredge industry in these locations. No WLA for mercury or restriction upon suction dredging is established in other locations in the WRB, since it is not anticipated to be a source of mercury loading elsewhere.

7.3 Reserve Capacity

ODEQ's 2019 TMDL includes a reserve capacity equivalent to 1% of LC which is an allowance for increases in pollutant loads from future growth and new or expanded sources. Reserve capacity may be granted by ODEQ to NPDES permitted point sources. Although not required by the CWA or implementing regulations, reserving an allocation for future growth or expansions is considered good practice and EPA agrees with the value of setting aside a reserve capacity, and retains the 1% allocation for Reserve Capacity, portions of which may be granted to dischargers by ODEQ at its discretion.

7.4 Allocation summary

Table 2. Total Mercury Allocations for the Willamette River Basin and Subbasins

Allocated At-source Loads (g/day)															
Category	**17090001**	**17090002**	**17090003**	**17090004**	**17090005**	**17090006**	**17090007**	**17090008**	**17090009**	**17090010**	**17090011**	**17090012**	**Multnomah**	**Columbia**	**Total**
Agriculture, forest, shrub, developed, other[1] (runoff and sediment)	1.22	0.38	1.47	1.75	1.21	2.62	0.25	2.44	2.01	0.44	1.17	0.07	0.53	0.17	15.73
Groundwater (agriculture, forest, shrub, developed, other[1])	0.89	0.23	0.88	1.44	0.71	0.59	0.22	0.49	0.53	0.23	0.95	0.02	0.09	0.01	7.28
Atmospheric deposition direct to water	0.45	0.12	0.75	0.21	0.18	0.17	1.04	0.12	0.12	0.15	0.14	0.31	0.03	0.03	3.81
NPDES Permitted Stormwater Point Source Discharges	0.01	0.03	0.52	0.04	<0.01	0.01	0.04	0.01	0.05	0.46	0.09	0.03	<0.01	0.08	1.38
Non-Permitted Urban Stormwater	<0.01	<0.01	0.04	<0.01	0.02	0.02	0.01	0.09	0.08	<0.01	0.01	<0.01	0.03	<0.01	0.32
Legacy Metals Mines	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.08
NPDES Permitted POTW Wastewater Discharges	0.05	0.01	0.56	<0.01	0.07	0.08	0.14	0.06	0.11	0.64	0.21	0.23	0.01	<0.01	2.17
NPDES Permitted Industrial Wastewater Discharges	<0.01	0.07	0.50	0.25	0.01	<0.01	0.24	0.01	<0.01	0.01	<0.01	0.02	<0.01	<0.01	1.11
Total	2.61	0.94	4.72	3.70	2.20	3.50	1.93	3.22	2.91	1.91	2.58	0.68	0.70	0.29	31.89

[1] "Other" includes water impoundments and water conveyance entities as listed in ODEQ Table 10-1

These allocations represent the mass loading that results from the specified reductions from current total mercury loading for each source category.

Table 3. Percent Reductions for Land Managers in the Willamette River Basin and Subbasins

Percent Reductions in At-source Loads for Land Managers														
Category	**17090001**	**17090002**	**17090003**	**17090004**	**17090005**	**17090006**	**17090007**	**17090008**	**17090009**	**17090010**	**17090011**	**17090012**	**Multnomah**	**Columbia**
Agriculture, forest, shrub, developed, other[1] (runoff and sediment)	88%	97%	97%	88%	88%	88%	97%	88%	88%	97%	88%	97%	88%	88%
Groundwater (agriculture, forest, shrub, developed, other[1])	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%
Atmospheric deposition direct to water	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
NPDES Permitted Stormwater Point Source Discharges	75%	75%	75%	75%	75%	75%	97%	75%	75%	75%	75%	97%	75%	75%
Non-Permitted Urban Stormwater	75%	75%	75%	NA	75%	75%	97%	75%	75%	75%	75%	75%	75%	75%
Legacy Metals Mines	95%	98%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
NPDES Permitted POTW Wastewater Discharges	10%	10%	10%	10%	10%	10%	74%	10%	10%	10%	10%	65%	10%	10%
NPDES Permitted Industrial Wastewater Discharges	10%	10%	10%	10%	10%	10%	17%	10%	10%	10%	10%	10%	10%	10%

[1] "Other" includes water impoundments and water conveyance entities as listed in ODEQ Table 10-1

8 Seasonal Variation and Critical Conditions

Section 8 of ODEQ's 2019 TMDL presents the seasonal variation and critical condition analysis for the Willamette Basin. EPA has reviewed ODEQ's approach for seasonal variations and critical conditions and finds the approach technically reasonable and legally sufficient. ODEQ adequately integrated seasonal dynamics and critical conditions that affect mercury transport within the Willamette Basin throughout the model analyses. EPA therefore incorporates Section 8 of ODEQ's 2019 TMDL into EPA's 2019 TMDL.

9 Margin of Safety

TMDLs are required to include a margin of safety (MOS) to account for any lack of knowledge or uncertainty concerning the relationship between pollutant loading and receiving water quality (CWA 303(d)(1)(C) and 40 CFR 130.7(c)(1)). The MOS can be either explicit, through allocation of a load from the loading capacity, or implicit, through use of conservative assumptions in the TMDL analysis or in developing a TMDL target, or both. Section 11 of ODEQ's 2019 TMDL describes three specific components of the implicit MOS applied by ODEQ in the analyses and in the selection of the target for ODEQ's 2019 TMDL. EPA accepts and incorporates two of three components (#1 and #2 below) of the implicit MOS described in ODEQ's 2019 TMDL. EPA added an additional (#3 below) component to the implicit MOS.

1. The target for ODEQ's 2019 TMDL for water column concentration of 0.14 ng/l total mercury is established to achieve the fish tissue mercury criterion (0.04 mg/kg) for the most sensitive or conservative species, the Northern Pikeminnow. The selection of the Northern Pikeminnow provides an implicit margin of safety because it is the most efficient mercury bioaccumulator among the species considered due to its high trophic level. This results in the most conservative mercury concentration target.

2. ODEQ used total mercury concentration in fish tissue rather than the methylmercury concentration as the target in ODEQ's 2019 TMDL. The total mercury in fish is composed of 95% or greater methylmercury in higher trophic level piscivores (USEPA, 2000). By using the total mercury concentration in fish tissue rather than lower methylmercury concentration, a higher fish tissue methylmercury reduction target is established. Doing so helps ensure the methylmercury criteria will be achieved.

3. Needed reductions in loads are based on comparing water column mercury targets to ambient monitoring data. Those monitoring data are available through 2011 in only 9 of the 12 HUC8 watersheds and thus do not incorporate any reductions in mercury loading that have occurred since 2011. Data presented in ODEQ's 2019 TMDL (p. 37) indicate that mercury concentrations have been declining in more recent years (2012 – 2019) in the Tualatin and Lower Willamette subbasins.

EPA finds that the components of the implicit margin of safety discussed above account for any lack of knowledge or uncertainties concerning the relationship between pollutant loading and receiving water quality.

10 Reasonable Assurances

Section 303(d) of the Clean Water Act (CWA) requires that a TMDL be "established at a level necessary to implement the applicable water quality standard." According to 40 C.F.R. §130.2(i), "[i]f best management practices or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent." Providing reasonable assurance that nonpoint source control measures will achieve expected load reductions increases the probability that the pollution reduction levels specified in the TMDL will be achieved and, therefore, applicable WQS will be attained.

ODEQ's 2019 TMDL describes both the potential actions for achieving the wasteload and load allocations and the foreseeable mechanisms for accomplishing them in Section 13 (Water Quality Management Plan or WQMP) and Section 14 (Reasonable Assurance), as well as in the draft *Monitoring Strategy to Support Implementation of the Willamette Mercury Total Maximum Daily Load (Draft)* that was included in ODEQ's submittal package. Section 14 of ODEQ's 2019 TMDL provides examples of required measures for the Designated Management Agencies (DMAs) to address mercury loading from nonpoint sources of pollution. For example, within 18 months after issuance of the TMDL, DMAs must develop and submit to ODEQ, TMDL implementation plans to address mercury loading through controlling erosion and runoff from their respective sector activities. ODEQ's typical water quality management approach with DMAs entails review and approval of these plans and periodic reviews to ensure plan implementation and effectiveness. ODEQ, in cooperation with the Oregon Department of Agriculture, reviews Agricultural Water Quality Management Plans established throughout the WRB to address agricultural nonpoint sources of pollution. ODEQ's review focuses on water quality trends in TSS loading which ODEQ intends to associate with mercury loading. Based on water quality trends, ODEQ recommends improvements to the Agricultural Water Quality Management Plans. ODEQ applies a similar approach in working with federal and non-federal forest land managers.

Section 14 of ODEQ's 2019 TMDL also provides examples of proven techniques for point sources, such as required mercury monitoring for major NPDES dischargers, the implementation of mercury minimization plans for major dischargers, the application of advanced wastewater treatment for greater biosolids removal, and outreach and education programs, that have been implemented as part of the 2006 Willamette TMDL.

Monitoring by ODEQ shows that a combination of point and nonpoint source control activities have reduced mercury concentrations. For example, ODEQ conducted additional analysis of monitoring data that showed progress in reducing median total mercury concentrations in the Tualatin and Lower Willamette subbasins by approximately 51% and 43% respectively since 2011. This information provides additional confidence that continued implementation of ODEQ's WQMP will lead to achieving allocations in EPA's 2019 TMDL. EPA expects ODEQ will use these mechanisms and tools when implementing EPA's 2019 TMDL.

EPA has reviewed ODEQ's approach for addressing reasonable assurance in ODEQ's 2019 TMDL and finds the approach technically reasonable and legally sufficient. EPA relies on these documents for reasonable assurance and incorporates them into this TMDL.

11 References

The references contained in Section 15 (References) of Oregon's Final Revised Willamette Basin Mercury TMDL are incorporated into EPA's 2019 TMDL. Additional references are listed below.

Bolks A, DeWire A, and Harcum JB. (2014). Baseline Assessment of Left-Censored Environmental Data Using R. Tech Notes 10. National Nonpoint Source Monitoring Program, U.S. Environmental Protection Agency.

Chen CY, Driscoll CT, Eagles-Smith CA, Eckley CS, Gay DA, Hsu-Kim H, et al. (2018). A Critical Time for Mercury Science to Inform Global Policy. Environmental Science & Technology 52: 9556-9561.

Cole AS, Steffen A, Eckley CS, Narayan J, Pilote M, Tordon R, et al. (2014). A Survey of Mercury in Air and Precipitation across Canada: Patterns and Trends. Atmosphere; 5: 635-668.

Eckley, CS. (2019). *Future predictions of mercury deposition, runoff, and soil/sediment concentrations in the Willamette River Basin*. U.S. Environmental Protection Agency, Region 10, December 12, 2019.

Harris RC, Rudd JWM, Amyot M, Babiarz CL, Beaty KG, Blanchfield PJ, et al. (2007). Whole-ecosystem study shows rapid fish-mercury response to changes in mercury deposition. Proceedings of the National Academy of Sciences; 104: 16586-16591.

Lin, et. al., 2012. Lin CJ, Shetty SK, Pan L, Pongprueksa P, Jang CR, Chu HW. Source attribution for mercury deposition in the contiguous United States: Regional difference and seasonal variation (vol 62, pg 52, 2012). Journal of the Air & Waste Management Association 2012; 62: 604-604

Zhang L, Wang SX, Wu QR, Wang FY, Lin CJ, Zhang LM, et al. Mercury transformation and speciation in flue gases from anthropogenic emission sources: a critical review. Atmospheric Chemistry and Physics 2016; 16: 2417-2433.

Northwest Environmental Advocates v United States Environmental Protection Agency, No. 3:12-cv-01751-HZ (D. Or., Feb. 25, 2019).

Oregon Department of Environmental Quality. (2019). *Revised Final Willamette Basin Mercury TMDL and Water Quality Management Plan* (including appendices C. Variance justification excerpts, D. Stormwater references and resources, E. List of designated management agencies and responsible persons, F. Oregon permitted mercury air emissions and H. Watershed-Based Plan Crosswalk). Retrieved from https://www.oregon.gov/deq/wq/Documents/willHgtmdlwqmpF.pdf

Oregon Department of Environmental Quality. (2019). *Revised Willamette Basin Mercury TMDL and Water Quality Management Plan: Response to Public Comments.* Retrieved from https://www.oregon.gov/deq/wq/Documents/willHgRTCreport.pdf.

Oregon Department of Environmental Quality. (2019). *Monitoring Strategy to Support Implementation of the Willamette Mercury Total Maximum Daily Load* (Draft). Retrieved from https://www.oregon.gov/deq/wq/Documents/WillHgMonStrategyD.pdf

Oregon Department of Environmental Quality. (2019). *Submittal (to EPA) of Willamette Basin Mercury TMDL and WQMP)*. Retrieved from https://www.oregon.gov/deq/wq/Documents/willHgSubmittal.pdf

Oregon Department of Environmental Quality. (2019). Willamette Basin Mercury TMDL Order. Retrieved from https://www.oregon.gov/deq/wq/Documents/willHgOrder.pdf

Pacyna JM, Travnikov O, De Simone F, Hedgecock IM, Sundseth K, Pacyna EG, et al. (2016). Current and future levels of mercury atmospheric pollution on a global scale. Atmospheric Chemistry and Physics 16: 12495-12511.

Schroeder WH, Munthe J. Atmospheric mercury - An overview. Atmospheric Environment 1998; 32: 809-822.

Streets DG, Horowitz HM, Lu ZF, Levin L, Thackray CP, Sunderland EM. Global and regional trends in mercury emissions and concentrations, 2010-2015. (2019). Atmospheric Environment 201: 417-427.

Tetra Tech. (2019). *Mercury TMDL Development for the Willamette River Basin (Oregon) – Technical Support Document*, Prepared for U.S. Environmental Protection Agency and Oregon Department of Environmental Quality. December 16, 2019.

U.S. Environmental Protection Agency, Region 10. (2019*). Letter and Decision Rationale for Final Revised Willamette Basin Mercury Total Maximum Daily Load*. November 29, 2019.

U.S. Environmental Protection Agency. (2008). *TMDLs Where Mercury Loading are Predominantly from Air Deposition*. Office of Water. Washington, DC.

U.S. Environmental Protection Agency. (2006). *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No.05-5015, (April 25, 2006) and Implications for NPDES Permits*. Office of Water, Washington, DC.

U.S. Environmental Protection Agency. (2002). *Guidelines for Reviewing TMDLs Under Existing Regulations Issued in 1992.* Office of Water. Washington, DC.

U.S. Environmental Protection Agency. (1991). *Guidance for Water Quality-Based Decision: The TMDL Process*, US EPA. April 1991.

Weiss-Penzias PS, Gay DA, Brigham ME, Parsons MT, Gustin MS, ter Schure A. (2016). Trends in mercury wet deposition and mercury air concentrations across the US and Canada. Science of the Total Environment 568: 546-556.

Zhang YX, Jacob DJ, Horowitz HM, Chen L, Amos HM, Krabbenhoft DP, et al. (2016). Observed decrease in atmospheric mercury explained by global decline in anthropogenic emissions. Proceedings of the National Academy of Sciences of the United States of America 113: 526-531.

Appendix A: Final Revised Willamette Basin Mercury Total Maximum Daily Load

(including appendices C. Variance justification excerpts, D. Stormwater references and resources, E. List of designated management agencies and responsible persons, F. Oregon permitted mercury air emissions and H. Watershed-Based Plan Crosswalk) (https://www.oregon.gov/deq/wq/Documents/willHgtmdlwqmpF.pdf

Appendix B: Technical Support Document

https://www.epa.gov/sites/production/files/2019-12/documents/tmdl-willamette-mercury-technical-support-document.pdf

Appendix C: Allocation Summary

In general, EPA has retained the ODEQ aggregate allocations where they will achieve the TMDL target. EPA has increased the load allocation for atmospheric deposition to 35% in all subbasins, as discussed in Section 7.1.1. In subbasins for which greater reductions are needed to achieve the TMDL target, EPA has provided greater reduction for the General NPS, permitted and unpermitted stormwater, legacy metals mines and POTW and industrial dischargers.

In the Middle Willamette and Lower Willamette subbasins EPA determined that retaining a 10% reduction for point sources would not achieve the TMDL target. Consequently, greater aggregate reductions from wastewater, industrial, and stormwater point sources are specified for these subbasins, in addition to greater nonpoint source reductions. As with aggregated wasteload allocations applied in other subbasins, ODEQ has discretion to determine how to apportion these subbasin specific aggregate wasteload allocations to individual facilities through TMDL implementation.

A series of tables summarizing load and wasteload allocation revisions within each subbasin, and rationale for specific allocations revisions, is provided in this Appendix. All allocations are aggregate allocations for each source type.

Coast Fork - 17090002			
Category	**% contribution***	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	74%	88%	**97%**
Groundwater (agriculture, forest, shrub, developed, other)	8%	88%	88%
Atmospheric deposition direct to water	<1%	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	<1%	75%	75%
Non-Permitted Urban Stormwater	<1%	75%	75%
Legacy Metals Mines	16%	95%	**98%**
Suction dredge mining (Dorena Reservoir tributaries including Row River, Brice Creek, Sharps Creek, and Champion Creek)	unknown	prohibited	**0 WLA**
NPDES Permitted Major Wastewater Discharges	<1%	10%	10%
NPDES Permitted Industrial Discharges	<1%	10%	10%

* - relative percent contribution of subbasin total mercury load.

Rationale for revised allocations:

General NPS - Nonpoint source loading accounts for 74% of mercury loading in the subbasin. An increase in reductions to 97% is needed to achieve the TMDL target, in combination with small increases in needed reduction from legacy mining sources.

Legacy Metals Mines - Contamination resulting from legacy metal mining accounts for 16% of mercury loading in the subbasin. A significant portion of this originates from the Black Butte Superfund facility. Due to the relatively large contribution of mercury loading from this source and the fact that it is relatively controllable (significant remediation has already occurred), ODEQ assigned a 95% reduction WLA to this category. EPA determined that an increase in reduction in the legacy mining source category from 95% to 98% is necessary, in combination with increased nonpoint source reductions, to achieve the TMDL target in this subbasin.

Atmospheric deposition - This allocation is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.

Upper Willamette - 17090003			
Category	**% contribution***	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	82%	88%	**97%**
Groundwater (agriculture, forest, shrub, developed, other)	10%	88%	88%
Atmospheric deposition direct to water	2%	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	5%	75%	75%
Non-Permitted Urban Stormwater	<1%	75%	75%
Legacy Metals Mines	<1%	95%	95%
NPDES Permitted Major Wastewater Discharges	<1%	10%	10%
NPDES Permitted Industrial Discharges	<1%	10%	10%

* - relative percent contribution of subbasin total mercury load.

Rationale for revised allocations:

General NPS - Nonpoint source loading accounts for 82% of mercury loading in the subbasin. An increase in reductions to 97% is needed to achieve the TMDL target. Other mercury source categories are very small by comparison. Therefore, the percent reduction allocations from ODEQ's 2019 TMDL for those other categories other than atmospheric deposition are adopted without change.

Atmospheric deposition - This allocation is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.

Middle Willamette - 17090007			
Category	**% contribution***	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	62%	88%	**97%**
Groundwater (agriculture, forest, shrub, developed, other)	11%	88%	88%
Atmospheric deposition direct to water	9%	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	10%	75%	**97%**
Non-Permitted Urban Stormwater	4%	75%	**97%**
Legacy Metals Mines	0%	95%	95%
NPDES Major Permitted Wastewater Discharges	3%	10%	**74%**
NPDES Permitted Industrial Discharges	2%	10%	**17%**

* - relative percent contribution of subbasin total mercury load.

Rationale for revised allocations:

General NPS - Nonpoint source loading accounts for 62% of mercury loading in the subbasin. An increase in reductions to 97% is needed to achieve the TMDL target, when balanced with reductions from other source categories discussed below.

NPDES Permitted Stormwater - Regulated stormwater accounts for 10% of the subbasin mercury load. Increasing reductions from 75% to 97% will result in reductions equivalent to those needed from the General NPS category and non-permitted stormwater (below). In combination with other changes to point source loading, these further load reductions will achieve the TMDL target in this subbasin.

Non-Permitted Urban Stormwater - Non-permitted stormwater accounts for 4% of the subbasin mercury load. An increase in reductions from these sources from 75% to 97% will result in reductions equivalent to those needed from the General NPS and Regulated Stormwater categories and will achieve the TMDL target in this subbasin.

NPDES Permitted Wastewater Discharges - EPA reviewed available effluent concentration and loading data provided by ODEQ to support development of ODEQ's 2019 TMDL, which indicates a significant range in both discharge loading and concentration across these facilities. For certain facilities, current loading information is not readily available. EPA determined that a 74% reduction in the estimated cumulative load from all wastewater dischargers, in combination with greater reductions from nonpoint source and stormwater loading, will achieve the TMDL target.

NPDES Permitted Industrial Discharges - EPA reviewed available effluent concentration and loading data provided by ODEQ to support development of ODEQ's 2019 TMDL, which indicates a significant range in both discharge loading and concentration across these facilities. For certain facilities, consistent estimates of concentration and loads is not readily available. EPA determined that a 17% reduction in the estimated cumulative load from all industrial dischargers, in combination with greater reductions from wastewater, nonpoint source and stormwater loading, will achieve the TMDL target

Atmospheric deposition - This allocation is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.

Tualatin – 17090010			
Category	**% contribution***	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	75%	88%	**97%**
Groundwater (agriculture, forest, shrub, developed, other)	8%	88%	88%
Atmospheric deposition direct to water	1%	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	13%	75%	75%
Non-Permitted Urban Stormwater	<1%	75%	75%
Legacy Metals Mines	0%	95%	95%
NPDES Permitted Major Wastewater Point Source Discharges	3%	10%	10%
NPDES Permitted Industrial Discharges	<1%	10%	10%

* - relative percent contribution of subbasin total mercury load.

Rationale for revised allocations:

General NPS - Nonpoint source loading accounts for 75% of mercury loading in the subbasin. An increase in reductions to 97% is needed to achieve the TMDL target. Other mercury source categories are small by comparison, and the ODEQ percent reduction allocations for those categories other than atmospheric deposition are therefore adopted without change.

Atmospheric deposition - This allocation is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.

Lower Willamette – 17090012			
Category	**% contribution***	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	57%	88%	**97%**
Groundwater (agriculture, forest, shrub, developed, other)	4%	88%	88%
Atmospheric deposition direct to water	8%	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	21%	75%	**97%**
Non-Permitted Urban Stormwater	<1%	75%	75%
Legacy Metals Mines	<1%	95%	95%
NPDES Permitted Major Wastewater Discharges	11%	10%	**65%**
NPDES Permitted Industrial Discharges	<1%	10%	10%

* - relative percent contribution of subbasin total mercury load.

Rationale for revised allocations

General NPS - Nonpoint source loading accounts for the majority (57%) of mercury loading in the subbasin. An increase in reductions to 97%, balanced with increased point source reductions below, will achieve the TMDL target.

NPDES Stormwater (MS4) - Regulated stormwater accounts for 21% of the subbasin total mercury load. Increasing needed reductions to 97%, balanced with other point source and nonpoint source reductions, will achieve the TMDL target. These NPDES stormwater reductions are equivalent to percent reduction allocations for the General NPS category.

NPDES Permitted Wastewater Discharges - EPA reviewed available effluent concentration and loading data provided by ODEQ to support development of ODEQ's 2019 TMDL. Wastewater dischargers account for approximately 11% of the current mercury loading in the subbasin, though for certain facilities, current loading information could only be estimated. EPA determined that a 65% reduction in the estimated cumulative load from all wastewater dischargers, in combination with greater reductions from nonpoint source and stormwater loading, will achieve the TMDL target.

Atmospheric deposition - This allocation is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.

Middle Fork Willamette – 17090001, Mckenzie-17090004, North Santiam-17090005 South Santiam-17090006, Yamhill-17090008, Molalla Pudding-17090009, Clackamas-17090011,		
Category	**ODEQ 2019 allocated reduction**	**EPA 2019 allocated reduction**
General NPS - Agriculture, forest, shrub, developed, other (runoff and sediment)	88%	88%
Groundwater (agriculture, forest, shrub, developed, other)	88%	88%
Atmospheric deposition direct to water	11%	**35%**
NPDES Permitted Stormwater Point Source Discharges	75%	75%
Non-Permitted Urban Stormwater	75%	75%
Legacy Metals Mines	95%	95%
NPDES Permitted Major Wastewater Discharges	10%	10%
NPDES Permitted Industrial Discharges	10%	10%

Rationale for revised allocations

Allocations in the above listed subbasins are the same as in ODEQ's 2019 TMDL except for atmospheric deposition which is increased for all subbasins to 35% based on re-assessment of predicted reductions in atmospheric deposition.