CHAPTER 1: OVERVIEW

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PURPOSE

Assessing Water Quality

Periodically rivers and streams in the Willamette Basin are listed by Oregon Department of Environmental Quality (ODEQ) as having impaired water quality. The listing process sets in motion the Total Maximum Daily Load or TMDL process. A TMDL is a pollution analysis conducted with the primary purpose of determining how much a pollutant must be reduced in order to meet State water quality criteria. The focus of the Willamette TMDLs is on the most commonly 303(d) listed pollutants in the basin, which are bacteria, mercury, and temperature, although there are listings for other pollutants as well.

ODEQ has been delegated responsibility for conducting this analysis through the federal Clean Water Act (CWA) of 1972. The CWA authorized states to assess water quality and develop a list of rivers and streams that do not meet water quality criteria (the 303(d) listing process), and then determine pollution reductions that will meet water quality criteria (the TMDL process). While ODEQ conducts the TMDL, the US Environmental Protection Agency (USEPA) has approval authority for all TMDLs.

The Willamette Basin is the largest geographical TMDL undertaken by ODEQ to date. While a TMDL must be conducted for every 303(d) listed waterbody, it is important to note that a waterbody can be listed for more than one pollutant not meeting water quality criteria. As a result, TMDLs are actually many TMDLs assembled into one document because they are conducted parameter by parameter or pollutant by pollutant. Additionally, the scale of the TMDL may include more waterbodies than just the listed waterbody. For example, stream temperature is affected by upstream tributaries as well as from more localized impacts. Therefore a temperature TMDL would consider all streams that affect the listed waterbody.

The expected audience for this TMDL document will include local jurisdictions, state and federal agencies, and National Pollutant Discharge Elimination System (NPDES) permit holders with responsibility for implementing TMDL pollutant reductions. The structure of this document reflects the approach taken to accommodate such a large geographical area, the many TMDLs, and the affected industrial, municipal, and other management entities. The document is divided into chapters as follows:

- **Mainstem River Bacteria, Chapter 2** – This chapter includes a review of historical bacterial contamination in the mainstem Willamette River, assessment of current loads and loading capacity, and land use, sector-based allocations that will result in basin wide compliance with bacteria standards. A summary of bacterial allocations developed for tributaries to the Willamette River is also included.
- **Basin Wide Mercury, Chapter 3** – This chapter includes a discussion of mercury in the environment, a summary of the mercury TMDL approach, mercury reductions, and additional data collection.
- **Mainstem Temperature, Chapter 4** – This chapter includes an overview of stream temperature issues throughout the Willamette Basin. There is a discussion of the new temperature criteria and beneficial uses, including threatened salmon and steelhead populations, and the geographic distribution of impaired waters. Analytical approaches for the mainstem Willamette TMDL and TMDLs developed for nine subbasins are described. The chapter discusses how heat loads are allocated among sectors in the mainstem TMDL and provides a summary of allocations for the subbasin TMDLs.
- **Subbasin Chapters 5-13 (**with TMDLs specific to each subbasin) – These chapters include general water quality information pertaining to the subbasin, geographic descriptions, pollutant specific identification of pollution sources, analytical methods, pollutant waste load allocations for point sources and load allocations nonpoint sources, and other TMDL information. *(Note: The Tualatin Subbasin TMDL was completed in 2001 and the Molalla/Pudding and Yamhill Subbasin TMDLs will be completed in 2007.)*
- **Basin Wide Water Quality Management Plan, Chapter 14** – This chapter includes identification of who is responsible for implementing TMDL allocations, suggested management strategies for reducing pollutants, and timelines for when water quality criteria will be met.

BACKGROUND

Clean Water Act

The CWA authorizes the USEPA to "*restore and maintain the physical, chemical, and biological integrity of all waters of the nation*". USEPA does this, in part, by delegating authority to individual states and tribes and through approval of water quality standards.

Water quality standards are important to water quality improvement because they define the goals of a waterbody or stream and are one tool states use for improving water quality. A standard is comprised of three components; beneficial uses to protect, an antidegradation policy, and numeric or narrative criteria. In Oregon, the Oregon Administrative Rules (OARs) specify beneficial uses for each of the 19 river basins. The antidegradation policy is applied so no more pollutants (or increased pollutant loads) can be added to a stream without an economic and social review, and both numeric and narrative criteria are used to protect beneficial uses. Oregon has hundreds of criteria for pollutants or parameters such as bacteria, pH, mercury, dissolved oxygen, and temperature.

Water Quality Improvement Process

In Oregon, the process of going from a water quality goal (standard) to restoring and maintaining water quality proceeds as follows:

- ODEQ develops new and updates current water quality criteria with input from technical & policy advisory committees and public comment. This is a multiple year process.
- ODEQ then develops a rule (OAR) adding new or updating current criteria.
- ODEQ proposes the rule to ODEQ's governing board, the Environmental Quality Commission (EQC).
- If the EQC adopts the proposed rule, the criteria become implementable through Oregon Administrative Rule (OAR).
- After adoption by the EQC, ODEQ then submits the criteria changes to USEPA for approval.

As part of Section 303 of the CWA:

- States are required to assess data that meet quality assurance (QA)/quality control (QC) procedures.
- The data assessment process identifies waterbodies (river, lake or stream reaches) that are exceeding water quality criteria.
- If data show that criteria are exceeded, then the waterbody is placed on the 303(d) list and the term 'water quality limited' is applied to that stream. For example, if the criterion for pH is exceeded for a specific stream, then the stream is not only listed on the 303(d) list, but termed "water quality limited" for pH. A stream can be listed and water quality limited for more than one pollutant.
- Placement of a waterbody on the 303(d) list triggers the TMDL process.

Total Maximum Daily Loads

A TMDL can be thought of as a tool for implementing water quality criteria and is based on the relationship between pollution sources and in-stream water quality conditions. OAR 340-042-0025 through 0080, commonly known as the TMDL rule, references how TMDLs will be established, issued, and implemented in Oregon.

The TMDL process in Oregon (see Figure 1.1):

- A TMDL is the total amount of a pollutant that can enter a waterbody without exceeding the criterion for that pollutant. This is known as the loading capacity.
- Often a basin will have multiple waterbodies with the same water quality problem identified by the 303(d) listing process.
- ODEQ endeavors to use all available valid data in developing TMDLs.
- ODEQ designs a water quality monitoring and data collection study that determines current pollutant conditions and identifies sources of pollution for a whole basin. The analysis may also include collecting stream flow data.

- Data are analyzed and modeled so waste load allocations for point sources and load allocations for nonpoint sources can be calculated.
- TMDLs are expressed as numeric loadings or percent pollutant reductions that are set to limit pollutant levels such that in-stream water quality criteria are met.
- Depending on the pollutant, a percent reduction may be assigned rather than a specific waste load number.
- When load allocations or percent reductions are determined, a Water Quality Management Plan (WQMP) is developed by ODEQ that identifies Designated Management Agencies (DMAs) and describes how DMAs will implement TMDL load allocations. A DMA is any entity with legal authority over a sector or source of water quality pollutants.
- The draft TMDL and WQMP are released for a 60 day (75 day for the Willamette TMDL) public comment period. Comments are addressed and incorporated as appropriate.
- ODEQ's Director signs the final TMDL as an Order and notification letters are sent to DMAs to officially begin the Implementation Plan development timeline. A request for reconsideration or appeal of the TMDL may be made as per OAR 340-042-0070.
- The TMDL and WQMP are submitted to USEPA for approval of just the TMDL per OAR 340-042-0060(3) and 40 CFR 130.7(d). USEPA has 30 days to approve or disapprove the TMDLs.
- DMAs submit Implementation Plans to ODEQ for review and approval within 18 months after receiving notification letters that ODEQ's Director has signed the TMDL as an Order. The Implementation Plans describe in detail how DMAs will implement TMDL load allocations or percent reductions.
- ODEQ recognizes that it may take some period of time – from several years to several decades – before management practices identified in the WQMP and Implementation Plans become fully effective. This is especially true for reducing heat loads (stream temperature) by growing riparian vegetation.
- The TMDL process is iterative. As part of the adaptive management strategy, ODEQ will review and modify TMDLs if new scientific information becomes available that indicate significant changes are needed. At a minimum, TMDLs will be reviewed and revised, if appropriate, on the normal 5 year TMDL cycle.

TMDL Elements

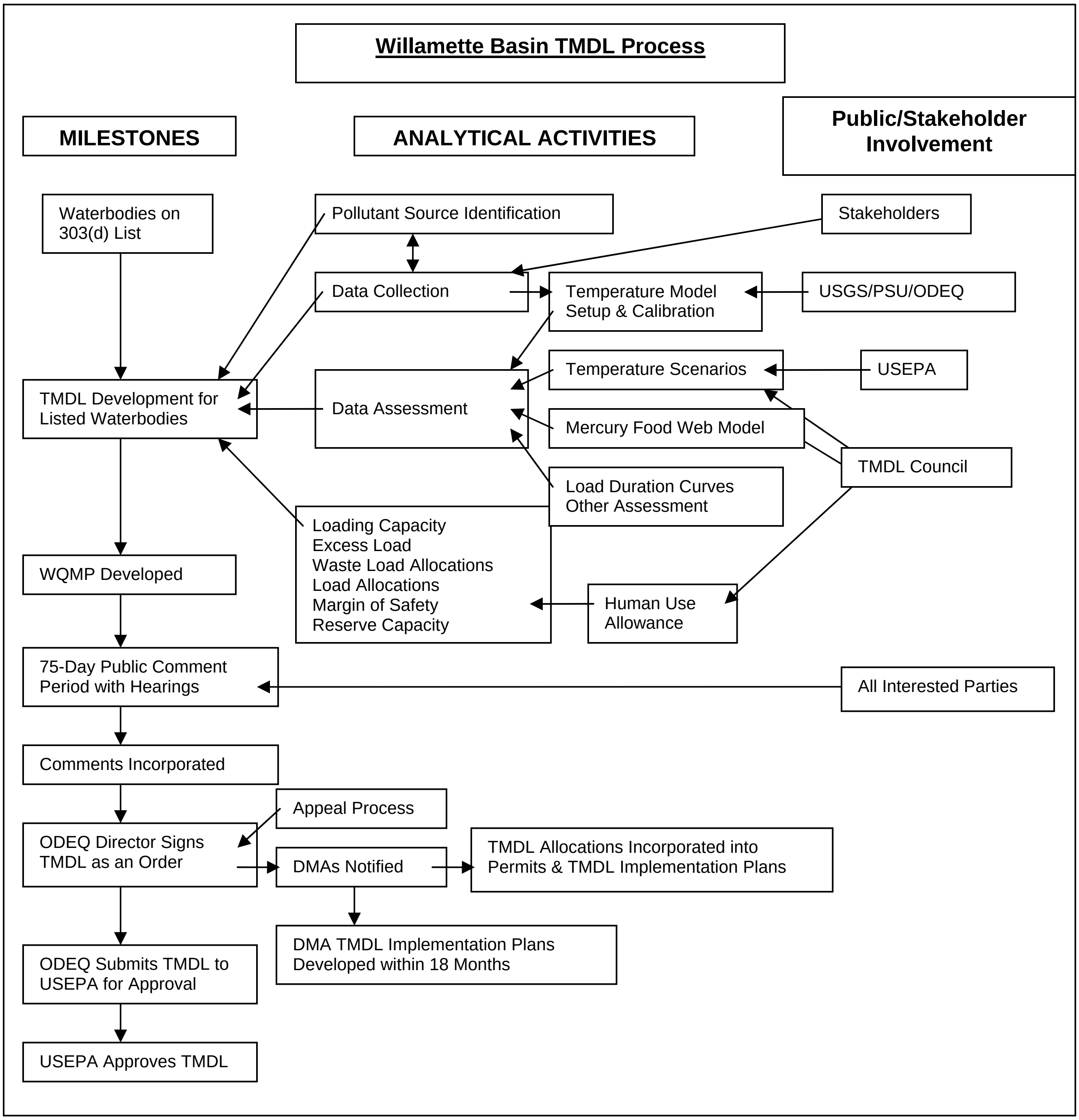
ODEQ must address the elements of a TMDL as described in OAR 340-042-0040 (4) (a – l) in order to meet the rule as well as to attain approval from USEPA. The elements are listed below:

- Name and location – describes the geographic area for which the TMDL is developed and includes maps as appropriate.
- Pollutant identification – identifies the pollutant(s) causing impairment to water quality being addressed by the TMDL.
- Water quality standards and beneficial use identification – identifies the relevant water quality standard and the most sensitive beneficial use(s) affected by the pollutant being addressed in the TMDL.
- Loading capacity – specifies the amount of a pollutant that a waterbody can receive and still meet water quality criteria.
- Excess load – evaluates, data allowing, the difference between the actual pollutant load in a waterbody and the loading capacity of the waterbody.
- Sources or source categories – identifies the pollutant sources and estimates, to the extent that data allow, the amount of actual pollutant loading from these sources.
- Wasteload allocations – determines the portions of the receiving water's loading capacity to be allocated to existing point sources of pollution.
- Load Allocations – determines the portions of the receiving water's loading capacity to be allocated to existing non-point sources of pollution or to background sources.
- Margin of safety – accounts for uncertainty related to the TMDL and quantifies uncertainties associated with estimating pollutant loads, monitoring, and modeling water quality.
- Seasonal variation – accounts for seasonal variation and critical conditions in stream flow, sensitive beneficial uses, pollutant loading and water quality parameters so that water quality criteria will be attained and maintained during all seasons of the year.
- Reserve capacity – an allocation for increasing pollutant loads for future growth and new or expanded sources.

- Water Quality Management Plan – provides the framework of management strategies to attain and maintain water quality standards, working in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans.

The following flow chart shows the Willamette Basin TMDL development process.

Figure 1.1 The Willamette Basin TMDL Development Process.



Temperature Standard Change

As defined by USEPA, there are three components included in a water quality standard: 1) beneficial uses, 2) a narrative or numeric criterion to protect those uses, and 3) an anti-degradation policy that protects waters of the state against unnecessary degradation. ODEQ is responsible for updating or adding new standards based on the most recent technical and scientific information available. In December 2003, the EQC adopted a new stream temperature standard (OAR 340-041-0028). The new temperature standard was approved by USEPA in March, 2004. In order to comply with the newly adopted criteria, the temperature TMDLs for the Willamette mainstem and nine subbasins were re-analyzed and adjustments were made where needed. See Appendix C for the new temperature rule.

Criteria vs. Target

Every effort has been made to use language that accurately describes technical information and processes in this document. However, sometimes different words are used interchangeably, as is the case with criteria and target. It should be noted that in this document, criteria most often refers to specific water quality numeric criteria (i.e. a specific number), while target most often refers to a surrogate measure such as a percent reduction target.

INTRODUCTION

Reason for Action

The reason a TMDL is developed is because numeric or narrative criteria have been exceeded, causing harm or impairment to beneficial uses that are designated for a waterbody. The Willamette Basin beneficial uses are listed in Table 1.1.

Table 1. 1 Designated Beneficial Uses in the Willamette Basin. (OAR 340-041-0340, Table 340A)

	Willamette River Tributaries						Main Stem Willamette River			
	Clackamas River	**Molalla River**	**Santiam River**	**McKenzie River**	**Tualatin River**	**All Other Streams & Tributaries**	**Mouth to Willamette Falls, Including Multnomah Channel**	**Willamette Falls to Newberg**	**Newberg to Salem**	**Salem to Coast Fork**
Public Domestic Water Supply1	X	X	X	X	X	X	X	X	X	X
Private Domestic Water Supply1	X	X	X	X	X	X	X	X	X	X
Industrial Water Supply	X	X	X	X	X	X	X	X	X	X
Irrigation	X	X	X	X	X	X	X	X	X	X
Livestock Watering	X	X	X	X	X	X	X	X	X	X
Fish & Aquatic Life2	X	X	X	X	X	X	X	X	X	X
Wildlife & Hunting	X	X	X	X	X	X	X	X	X	X
Fishing	X	X	X	X	X	X	X	X	X	X
Boating	X	X	X	X	X	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X	X	X	X3	X	X
Aesthetic Quality	X	X	X	X	X	X	X	X	X	X
Hydro Power	X	X	X	X	X	X	X	X		
Commercial Navigation & Transportation							X	X	X	

1 With adequate pretreatment and natural quality that meets drinking water standards.
2 See also Figures 340A and 340B for fish use designations for this basin.
3 Not to conflict with commercial activities in Portland Harbor.
Table produced November, 2003

In the Willamette Basin, the most widespread pollutants addressed by this TMDL are bacteria, mercury, and temperature. Bacteria can carry pathogens and cause gastrointestinal problems in humans, causing impairment or harm to human health. In the Willamette Basin, the beneficial uses impaired by bacteria pollution are water contact recreation, fishing, and boating. In other words, human recreational activity that involves contact with water is protected from bacteria contamination. See Chapter 2 and specific subbasin chapters for information pertaining to the Bacteria TMDL.

Mercury and other toxics can increase health risks or even cause outright harm to human health. A Public Health Advisory for fish consumption of largemouth bass, smallmouth bass, and northern pike minnow, caused by elevated mercury levels, was issued by the Oregon Department of Health in 1997. The areas under advisory are the Willamette mainstem from the mouth upstream to the city of Eugene at river mile (RM) 182, the Coast Fork Willamette River from the mouth upstream to and including Cottage Grove reservoir, and Dorena Lake on the Row River. The Health Advisory recommended that children under the age of six eat no more than 4 ounces of fish once in seven weeks. See Chapter 3 for the Mercury TMDL.

Increased stream temperature impairs aquatic life, especially steelhead, cutthroat trout, bull trout, and other salmonids, which are considered to be the most sensitive temperature-related beneficial use in Oregon. Elevated stream temperatures, in the 23°C - 26°C (73°F - 79° F) range, are routinely observed in the Upper Willamette Subbasin. In comparison, Oregon's temperature criteria range from 12°C (53.6°F) for bull trout habitat to 18°C (64.4°F) for salmonid rearing and migration. The elevated temperatures cause death of cold-water fish species during exposure times lasting a few hours to one day. The exact temperature at which a cold-water fish succumbs to such thermal stress depends on the temperature that the fish is acclimated to and on particular life-stage development. This cause of mortality, termed the 'incipient lethal limit', results from breakdown of physiological regulation of vital processes such as respiration and circulation (Heath and Hughes, 1973).

The most common and widespread cause of thermally induced fish mortality is attributed to interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior, increased exposure to pathogens (viruses, bacteria and fungus), decreased food supply (impaired macroinvertebrate populations) and increased competition from warm water tolerant species. This mode of thermally induced mortality, termed 'indirect' or 'sub-lethal', is more delayed, and occurs weeks to months after the onset of elevated temperatures (18°C to 23°C or mid-60°F to low-70°F). See Chapter 4 and specific subbasin chapters for information pertaining to the Temperature TMDL.

Prior to TMDL Approval

There are a number of actions that have to occur before a TMDL is adopted by ODEQ and submitted to USEPA for approval.

TMDL Development

In order to address criteria exceedances for 303(d) listed waterbodies, a TMDL must be developed. A TMDL is the total amount of a pollutant, from all sources, that can enter a specific waterbody without exceeding numeric or narrative water quality criteria. A TMDL can be expressed as:

$$TMDL = LA_{BG} + LA_{NPS} + WLA_{PS} + MOS + RC$$

Where TMDL = Total Maximum Daily Load

LA_{BG} = Load Allocation for Background

LA_{NPS} = Load Allocation for Nonpoint Sources

WLA_{PS} = Waste Load Allocation for Industrial and Municipal Point Sources

MOS = Margin of Safety

RC = Reserve Capacity

The purpose of a TMDL is to identify sources of a pollutant, determine how much the criteria is being exceeded currently or 'current conditions', determine how much pollutant the waterbody can assimilate before criteria are exceeded, determine pollutant load allocations for all sources, and then assign pollutant loads or percent reductions to sources. Meeting waste load and load allocations will ensure water quality standards attainment.

Willamette Basin Pollutants

Each pollutant exceeding water quality criteria and listed on the 303(d) list requires a TMDL. The following specifies which pollutants will be addressed by a TMDL in this document and which will not. See specific chapters for mainstem and subbasin TMDL details. The list of 303(d) listed waterbodies addressed by a TMDL is in Appendix 1.A.

Pollutants being addressed by a TMDL:

- Bacteria (Four subbasins and mainstem Willamette River; planning targets for four subbasins)
- DDT (Johnson Creek; Lower Willamette Subbasin)
- Dieldrin (Johnson Creek; Lower Willamette Subbasin)
- Dissolved Oxygen (Upper Willamette Subbasin)
- Mercury (All 12 Willamette Subbasins)
- Temperature (Nine subbasins and mainstem Willamette River)
- Turbidity (Upper Willamette Subbasin)

Pollutants not being addressed by a TMDL:

- Aldrin
- Aquatic Weeds or Algae
- Arsenic
- Biological Criteria
- Copper
- DDT and DDT Metabolite
- Dichloroethylene
- Dieldrin (except in Johnson Creek)
- Dissolved Oxygen (except in Upper Willamette Subbasin)
- Iron
- Lead
- Manganese
- PCBs and PAHs
- Pentachlorophenol
- pH
- Tetrachloroethylene
- Zinc

The original scope of TMDL work is based on the 1998 303(d) list of impaired waterbodies. The primary reason that many pollutant listings were not addressed is because the pollutants were not listed until the release of the 2002 303(d) list. A secondary, but important, reason certain pollutants are not addressed for this Willamette Basin TMDL iteration is because not enough data were available at the time of TMDL development. See subbasin chapters for details.

Data for TMDL Development

Analysis for a TMDL is dependent on data. However, only data that meet quality assurance (QA) and quality control (QC) standards are used for TMDL analysis. If possible, ODEQ works with others to collect, review, and analyze additional data. Data sources are identified in each TMDL or subbasin specific chapter.

Rarely are there enough readily available data for ODEQ to complete a thorough analysis without the need for gathering additional data. As a result, there are four courses of action that ODEQ can pursue; **1.** ODEQ can design a monitoring plan (Quality Assurance Project Plan or QAPP) and implement water quality sampling that meets the geographic and pollutant specific needs of the TMDL, **2.** work with the data that are currently available, **3.** delay developing a TMDL until more data are collected and then complete during the next basin TMDL cycle or, **4.** develop a TMDL on little or no data.

Analytical Methods

TMDL load allocations are calculated from mathematical models and other analytical methods designed to simulate and/or predict very complex physical, chemical, and biological processes. Models and other analytical methods are simplifications of these complex processes and are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures. It is for this reason that TMDLs include a margin of safety.

The data analysis tool or method utilized is dependent on the pollutant, quantity and quality of the data, the scale or resolution of the data available, and how well the complex and geographic-specific hydrologic processes are understood. In essence, the more data available, the more complex the analytical method can be.

Analytical tools or methods are discussed in each pollutant specific and subbasin chapter explaining how data were analyzed. For additional information on analytical methods see the Technical Appendices.

Surrogate Measures

USEPA regulation 40 CFR 130.2(i) allows TMDLs to be expressed in terms of mass per time, toxicity or 'other appropriate measure'. The term 'appropriate measure' has been defined by ODEQ as 'surrogate measure'. As per OAR 340-042-0030(14) *"Surrogate Measures" means substitute methods or parameters used in a TMDL to represent pollutants.*

The Willamette Basin TMDL has several pollutants that have surrogate measures. They are bacteria, DDT, dieldrin, mercury, and temperature.

Bacteria: Because *E. coli* bacteria organism load allocations have limited value expressed as number of organisms (e.g. 1.E + 11), the surrogate measure of percent reduction is used. Percent reduction, as used in these TMDLs, is the percent reduction of in-stream bacteria organisms needed to achieve both numeric criteria; the numeric criterion of a 30-day log mean of 126 *E. coli* organisms per 100mL, based on a minimum of five samples and no single sample exceeding 406 *E. coli* organisms per 100mL. Percent reduction is normally applied to entire land use sectors such as agriculture or urban. See Chapter 2.

DDT and Dieldrin: Both DDT and dieldrin are highly hydrophobic, which means that they tend to bind to soil particles and fatty tissues rather than dissolve into water. During TMDL development ODEQ found that instream Total Suspended Solids (TSS) concentrations are appropriate to use as a surrogate measure for DDT and dieldrin due to the reliable relationship between the two parameters, the relative ease of measuring TSS, and in order to express allocations in a way that is consistent with applicable measures of performance (BMP effectiveness, etc.). It should be noted that similar evaluation of stormwater data did not produce a good relationship between TSS and toxics, so ODEQ chose not to assign a TSS surrogate for urban stormwater at this time. Wasteload allocations for urban stormwater are expressed as a percent reduction of DDT. See Chapter 5 for details.

Mercury: In the case of mercury, surrogate measures were developed to translate the load and wasteload allocations into terms of the percent reductions needed to achieve the interim water column guidance value. These surrogate measures effectively translate average annual loads of mercury into more applicable measures of performance (see Table 3.1). Targets were developed for total mercury recognizing that it is actually the methylated form of mercury that accumulates in fish tissue and exerts the toxic response. The rationale for this is discussed in detail in Chapter 3 of the TMDL.

Temperature: While stream temperature is the Section 303(d) listed water quality parameter, heat is the pollutant. Calculating heat load allocations in kilocalories or BTUs is appropriate for point source effluent that has a specific, end of pipe or point of discharge. However, nonpoint source stream warming is caused by heat energy from increased solar radiation, often caused by removal or disturbance of riparian vegetation. Calculating heat load allocations in kilocalories or BTUs has limited value for determining how much riparian vegetation needs to be restored to meet temperature criteria. Thus the surrogate measure of effective shade is used to develop nonpoint temperature load allocations.

However, in order to determine effective shade, a determination of the appropriate plant communities or riparian vegetation for a stream or stream system and what the potential height and density of that vegetation might be under normal growing conditions is needed. This determination is termed 'system potential vegetation'. System potential vegetation is integral to the development of effective shade allocations. See Appendix C, "Potential Near-Stream Land Cover" for detailed information.

For the purposes of TMDL development, system potential vegetation is defined as the riparian vegetation that can grow and reproduce on a site given the plant biology, site elevation, soil characteristics, and local climate. While human disturbances are not considered in determining system potential vegetation, natural disturbances such as fire and disease are considered. Another way to view effective shade allocations is as system potential vegetation and 'shade targets' that land managers can achieve over time rather than a fixed or hard number allocation.

Margin of Safety

The Clean Water Act and OAR 340-042-0040(4)(i) require that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or with the analytical assumptions made to calculate pollutant load reductions. A MOS is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g. derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The MOS may be implicit, as in conservative assumptions used in calculating the Loading Capacity, Waste Load Allocations, and Load Allocations. The MOS may also be explicitly stated as an added, separate quantity in the TMDL calculation. In either case, assumptions should be stated and the basis behind the MOS documented. The MOS is not meant to compensate for a failure to consider known pollutant sources.

Reserve Capacity

As defined in OAR 340-042-0042(4)(k) reserve capacity "is an allocation for increases in pollutant loads from future growth and new or expanded sources. The TMDL may allocate no reserve capacity and explain that decision." Reserve capacity will be discussed in each pollutant-specific and subbasin chapter of the Willamette Basin TMDL.

Public Involvement

TMDL Council

In late 2000, ODEQ contracted through the State's alternative dispute resolution service for an independent assessment of stakeholder interests in developing TMDLs for the mainstem Willamette River. Broad stakeholder interviews were conducted by an independent facilitator, and recommendations accepted to convene a representative group of individuals who could bring the perspectives of various stakeholder sectors, point and nonpoint sources, to a common table.

The 20-member Willamette River TMDLs Council met for the first time on March 19, 2001. Members were asked to participate over an approximately 30-month period, providing input on development of TMDLs for mercury and temperature for the mainstem Willamette. The group was facilitated by an independent facilitator, and staffed by ODEQ, as well as invited resources from other agencies, as appropriate to the group's agendas. ODEQ provided basic information and the group explored all elements of Clean Water Act regulations, linkages with Agriculture Water Quality Management Area Plans under the Oregon Department of Agriculture and with forestry best management practices under the Oregon Department of Forestry, requirements of federal agencies (USEPA and the Services), and other supporting background information.

The Council met approximately bi-monthly over the course of the TMDL development. During that time, ODEQ received valuable ideas and input from the group, and asked them to participate in the developmental process as well as the final outcome of the mercury and temperature TMDLs. Council membership at the time of completion of the draft TMDL document is listed in Table 1.2. (More information can be found on ODEQ's website: http://www.deq.state.or.us/wq/willamette/WRBHome.htm .)

The Council was a helpful sounding board for ODEQ, provided much valuable information and reactions, and aided ODEQ in reaching complex technical and policy decisions. The TMDLs for both temperature and mercury reflect significant input from Council members and their constituent groups, and ODEQ is appreciative of the group's participation.

Table 1. 2 Willamette Mainstem TMDL Council members.

Name	Organization	Representing
Greg Aldrich	ODEQ	Government - state
Nina Bell	Northwest Environmental Advocates	Environmental
Dave Cruickshank	Cruickshank Farm	Agriculture - small farm
Bill Dameworth	Pope & Talbot, Inc.	Industry
Steve Downs	Association of Clean Water Agencies (ACWA)	Government - local
Douglas Hunt	Northwest Steelheaders	Fishing - recreation
Chris Jarmer	Oregon Forest Industries Council	Forestry - commercial
Jim Kincaid	Cable Huston Benedict Haagensen & Lloyd, LLP	Industry - Associated Oregon Industries
Doug Krahmer	Blue Horizon Farms	Agriculture - large farm
Jerry Marguth	Nixon Farms, Inc.	Agriculture - grass farm
Ernie Platt	Home Builders Association of Metropolitan Portland	Development
Lori Powers	Eugene Water & Electric Board	Utility
Matthew Rea	US Army Corps of Engineers	Government - federal
Mark Simmons	Oregon Association of Nurserymen, Inc.	Agriculture - nursery
Glen Spain	Pacific Coast Federation of Fishermen's Associations	Fishing - commercial
Mark Steele	Norpac Foods	Industry
Rod Thompson	Confederated Tribes of Grande Ronde	Tribes
Kathryn VanNatta	Northwest Pulp & Paper Association	Industry
Travis Williams	Willamette Riverkeepers	Environmental
Mark Yeager	Association of Clean Water Agencies (ACWA)	Government - local

The Council provided valuable input to ODEQ on key areas such as:

- Input on adequacy of temperature data, and advice on structuring two additional seasons of data collection; funding was provided by Oregon Association of Clean Water Agencies and Northwest Pulp and Paper Association, as well as by the U.S. Army Corps of Engineers (USACE).
- Development of a river temperature model specific to the Willamette River, working in a modeling subgroup advisory to ODEQ and its partners, Portland State University and the U.S. Geological Survey; provision of point source discharge data to validate model.
- Definition of system potential for vegetation in the Willamette Basin, to address effects of nonpoint source allocation scenarios.
- Development of a food-web model specific to the Willamette River for determining mercury targets for fish tissue and water column.
- Determination of river flow scenarios to be used in temperature modeling, taking into account the function of USACE flood control dams and reservoirs on the tributaries to the Willamette.
- Analysis of sources of mercury within the Willamette Basin, and provision of additional data to supplement ODEQ's database for quantifying mercury sources.
- Feedback on which fish species to use in establishing mercury targets.
- Determination of data adequacy for mercury TMDL allocations, and input to the interim path forward to address continued monitoring and model development needs.
- Review of wasteload allocation and load allocation policies relevant to temperature TMDLs, and input on how human use allowance should be shared among source categories, while still maintaining reserve capacity for future growth.
- Input to ODEQ on its water quality management planning process and elements of public involvement related to broader review of the draft TMDL document.

Other organizations assisted ODEQ by funding data collection, collecting data, or information used in TMDL analyses. See specific chapters for details on sources of data or information.

In addition to the Council, ODEQ formed the Modeling Coordination Team (MCT). The MCT provided technical expertise to resolve temperature modeling issues.

Public Outreach

Information/Open House Meetings	**Public Hearings**
November 30, 2004 (Salem)	January 10, 2005 (Eugene, Portland)
December 2, 2004 (Portland)	January 12, 2005 (Albany, Salem)
December 6, 2004 (Eugene)	
December 14, 2004 (Albany)	
Chapter 4: Temperature Revision:	May 4, 2006 (Eugene) May 8, 2006 (Portland) May 9, 2006 (Albany)

Water Quality Management Plan

Implementing TMDL load allocations is critical to water quality improvement. ODEQ is responsible for developing a Water Quality Management Plan (WQMP) that explains how TMDL load allocations will be implemented. The WQMP also identifies Designated Management Agencies (DMAs). DMAs are agencies or entities with legal authority over land use activities affecting water quality and are responsible for implementing TMDL load allocations or reduction strategies. The WQMP also identifies what type of implementation strategies might be used, timelines for implementing load allocations, and requesting additional information from DMAs as necessary. See Chapter 14 for WQMP details.

Reasonable assurance is one of the elements of the WQMP as per OAR 340-042-0040(4)(l)(J), which states "Description of reasonable assurance that management strategies and sector-specific or source-specific implementation plans will be carried out through regulatory or voluntary actions".

Assurance of standards attainment is also an element of the WQMP as per OAR 340-042-0040(4)(l)(E) and (F) which request an "*explanation of how implementing the management strategies will result in attainment of water quality standards*" and *"timelines for attainment of water quality standards*".

TMDL Approval

Division 42 of the Oregon Administrative Rules (OAR) defines signing authority for TMDLs as resting with the ODEQ Director. Therefore, when ODEQ completes development of TMDLs and meets the requirement for public participation, as per OAR 340-042-0050, the Director signs the TMDL as an Order. ODEQ then submits the TMDL to USEPA for approval. USEPA reviews the TMDL for compliance with the Clean Water Act.

Requesting reconsideration or appealing a TMDL is allowed per OAR 340-042-0070 after the TMDL Order has been signed.

After TMDL Approval

There are several actions that have to occur after a TMDL is approved by ODEQ and submitted to USEPA.

Implementation Plans

DMAs are required to submit an Implementation Plan to ODEQ explaining how TMDL load allocations will be implemented. Actual implementation is accomplished by DMAs through their land and/or water resource management mechanisms and strategies. The support of DMAs in implementing TMDLs is essential because water quality will not improve without TMDL implementation.

The Implementation Plans are due 18 months from the date on the Notification Letter that ODEQ sends to notify DMAs, permittees and others, that the TMDLs have been issued as an Order by ODEQ. The Implementation Plan due date is not dependant on USEPA's approval of the TMDL. ODEQ will work with DMAs in developing Implementation Plans that are consistent in meeting the assumptions and requirements of the TMDL load allocations.

Point sources will meet their TMDL waste load allocation through the National Pollutant Discharge Elimination System (NPDES) permitting process. ODEQ expects that nonpoint sources will meet their TMDL load allocations through compliance with Forest Practices Act rules and land management strategies identified in Agricultural Water Quality Management Area Plans, Water Quality Restoration Plans or Implementation Plans.

The implementation of TMDLs and DMA Implementation Plans is enforceable by ODEQ, other state agencies, and local governments. However, it is envisioned that sufficient initiative exists to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that responsible agencies or local governments will work with land managers to overcome impediments to implementation through education and technical support, with enforcement as a last resort.

Adaptive Management

The goal of the Clean Water Act and Oregon Administrative Rules is that water quality standards shall be met or all feasible steps will be taken towards achieving the highest quality water attainable. This is a long-term goal in many watersheds, particularly where it may take from several years to several decades, before management practices identified in an Implementation Plan become fully effective in reducing and controlling certain pollutants. For example, reductions in heat loads will take many years to achieve if restoring appropriate riparian vegetation is identified as the most effective management strategy. In addition, the technology for controlling some nonpoint sources of pollution is still in the development stages and will likely take one or more iterations before effectiveness can be adequately evaluated.

To achieve the highest water quality attainable, implementation of TMDL load allocations must commence as soon as possible. However, ODEQ recognizes that despite the best and most sincere efforts natural events, beyond the control of humans, may interfere with or delay attainment of TMDL load allocations and/or the associated surrogates. Such events could be, but are not limited to floods, fire, insect infestations, and drought. It is possible that after application of all reasonable best management practices or management strategies some load allocations cannot be achieved as originally established.

ODEQ recognizes that if a DMA complies with its Implementation Plan, Agricultural Water Quality Management Area Plan (SB1010 Plans), Forest Practices Act rules, or federal Water Quality Restoration Plans (WQRP), the DMA will be considered in compliance with the TMDL as per OAR 340-042-0080. See Chapter 14 for more information about Water Quality Management Plans and Implementation Plans.

Subject to available resources, ODEQ will review and modify established TMDLs if new scientific information becomes available that indicate significant changes are needed.

Water Quality Trading Program / Permits

Sources facing expensive upgrades to comply with their waste load allocations (WLAs) may wish to consider water quality trading. In January of 2003, the USEPA Office of Water issued a Water Quality Trading Policy that describes trading and lists the general elements and provisions that USEPA believes are important for creating credible water quality trading programs.

According to the USEPA policy, trading is an approach that can offer greater efficiency in achieving water quality goals on a watershed basis. It allows one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs.

Some trades result in the creation of water quality trading “markets”. Those that do not have markets can be thought of as mitigation projects or as trades. Either way, trading can be a less expensive or more environmentally beneficial way to achieve compliance with environmental regulations. Trading can also be a better way to protect the resource.

The mechanics of a particular water quality trade will depend in part on the parameter to be traded. For example, a source needing to reduce its temperature impact could pursue water quality trading in lieu of installing expensive refrigeration equipment. By implementing a water quality trade, the source could offset its temperature impact via flow augmentation or by accelerating restoration of riparian vegetation. Flow augmentation and riparian shading are more direct ways to protect the resource than refrigeration, and do not require significant amounts of electricity, and its environmental side effects, to implement.

ODEQ has completed the process of implementing water quality trading in the Tualatin Subbasin of the Willamette Basin. In the Tualatin the sewerage and surface water management agency, Clean Water Services (CWS), has successfully achieved trading for intra- and inter-plant trading of biochemical oxygen demand (BOD) and ammonia, as well as temperature. The permit may be viewed at: http://www.deq.state.or.us/wq/wqpermit/indvpermitdocs.htm

Link to USEPA trading policy: http://www.epa.gov/owow/watershed/trading/tradingpolicy.html

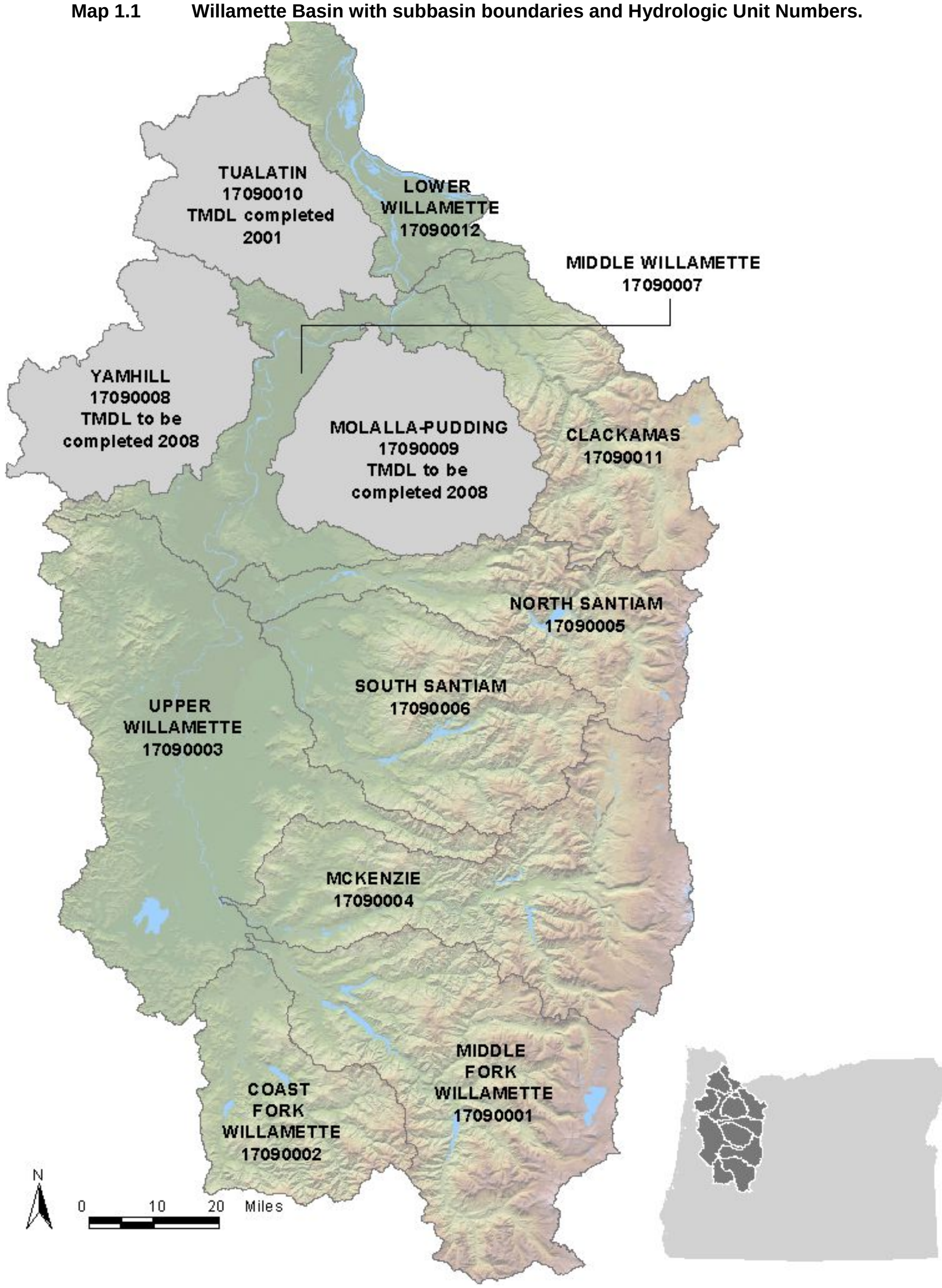
Link to USEPA Region 10 Water Quality Trading Assessment Handbook:
http://yosemite.epa.gov/R10/OI.NSF/Effluent+Trading/ET

WILLAMETTE BASIN DESCRIPTION

Basin Geography

Oregon's Willamette River is just less than 190 miles in length and is the 13th largest river in the lower 48 states in terms of stream flow. The average annual discharge to the Columbia River of 22.73 million acre-feet is nearly 15 % of the total Columbia River flow (Kammerer, 1990). The mainstem Willamette River includes flow from major tributaries which roughly correspond to the 12 subbasins that together make up the whole Willamette Basin (Map 1.1).

Map 1.1 Willamette Basin with subbasin boundaries and Hydrologic Unit Numbers.



The subbasins of the Willamette Basin included in this TMDL are:

- Lower Willamette
- Tualatin (mercury only)
- Molalla-Pudding (mercury only)
- Yamhill (mercury only)
- Clackamas
- South Santiam
- North Santiam
- Middle Willamette
- McKenzie
- Coast Fork Willamette
- Middle Fork Willamette
- Upper Willamette

See specific chapters for mainstem and subbasin TMDL details.

The mainstem river begins where the Coast Fork Willamette River and the Middle Fork Willamette River meet, just south of Eugene and Springfield. The river flows northward, adding major and minor river and stream flows, until it meets the Columbia River north of Portland. Many tributaries to the mainstem originate in the Coast Mountain range to the west and the Cascade Mountain range to the east.

HUCs, Subbasins, and Watersheds

ODEQ uses the United States Geological Survey (USGS) system of hydrologic delineation known as Hydrologic Unit Codes (HUCs) for all TMDL s. OAR 340-042-0030(4) defines Hydrologic Unit Code as "*a multi-scale numeric code used by the U.S. Geological Survey to classify major areas of surface drainage in the United States. The code includes fields for geographic regions, geographic subregions, major river basins and subbasins. The third field of the code generally corresponds to the major river basins named in OAR Chapter 340, Division 41. The fourth field generally corresponds to the subbasins typically addressed in TMDLs."* HUCs often cross political or jurisdictional boundaries such as state, county or city limit boundaries. See Map 1.1 for subbasin HUCs.

Climate

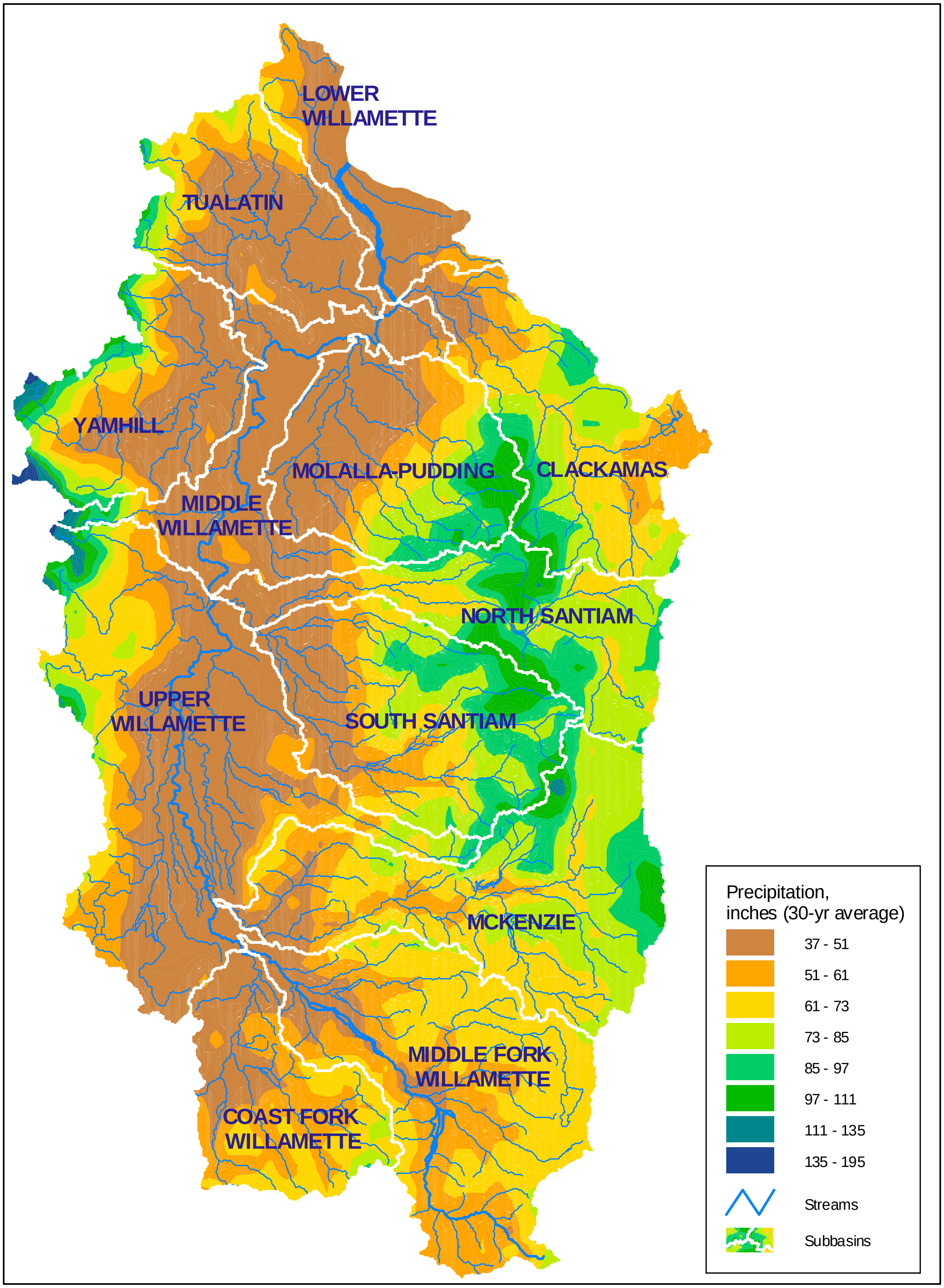
Season and elevation are the biggest drivers of precipitation in the Willamette Basin (Map 1.2). Annual precipitation in the basin is generally greatest between October and March. July and August are typically the driest months with less than 5% of total annual precipitation. Elevation plays an important role in the total amount of precipitation because the higher the elevation the greater the total precipitation. For example, the Willamette valley floor may receive 40 or 50 inches annual precipitation compared to the mountainous regions which may receive nearly 200 inches. The Coast Mountains are wetter with precipitation in the form of rain and some snow pack while the precipitation in Cascades comes primarily from snow pack.

Stream Flow

The most important characteristic to note about stream flow in the Willamette Basin is that it is highly modified by dam and reservoir operations. The US Congress passed 15 flood control acts between 1938 and 1974 that affect the Willamette Basin. The purpose of the USACE dams is to provide flood control, navigation, hydroelectric power, and water in summer for irrigation and recreation.

However, dam operations have dramatically changed the natural flow patterns of the Willamette River by reducing peak flows in winter and artificially augmenting summer low flows. While these changes are beneficial for flood control, navigation, recreation, and irrigation, there have been unintended consequences for aquatic life. Not only are stream temperatures affected by reservoir stratification and bottom release of stored water, but also the timing of when high and low stream temperatures occur has been shifted. High stream temperatures that normally occur in July and August have been shifted to September and October. In addition, low stream temperatures that occur in January and February can be lowered further from bottom reservoir releases and lower temperatures, in some areas, have been shifted well into June. These prolonged shifts affect fall and spring salmonid spawning, incubation, and fry emergence timing.

Map 1.2 Precipitation in the Willamette Basin.



Dam and Reservoir Operations

The USACE constructed a series of 11 dams with reservoirs and 2 re-regulating dams on major tributaries in the basin between 1941 and 1969, known as the Willamette Project (Table 1.3). USACE operates the Willamette Project based on the purposes authorized by Congress, beginning sixty years ago, with the Flood Control Act of 1938. Flood control is the highest priority of the Willamette Project, but other purposes include flow augmentation for navigation, irrigation, hydroelectric power production, fisheries, recreation, and water quality. The project provides the capacity of seasonal storage of nearly 1.6 million acre feet of water and a production capacity of 2,100 megawatts (MW) of electric power.

Over 350 other dams have also been installed in the basin for irrigation purposes primarily. Nevertheless, the most notable dams and reservoirs in the Willamette Basin and with the largest influence on water quality within the basin are the large federal facilities of the USACE Willamette Project.

Table 1. 3 Summary of USACE dams in the Willamette Basin.

Dam & Reservoir	Tributary Location	Year Complete	Total Storage in acre-feet	Summer Storage	# of Rec Areas	Power Generators	Draw-down Priority
Fern Ridge	Long Tom	1941	116,800	93,900	5	None	Last
Cottage Grove	Coast Fork	1942	32,900	28,700	5	None	5th
Big Cliff	North Santiam	1953	NA, Re-regulating	NA	None	1	NA
Detroit	North Santiam	1953	455,100	281,000	7	2	Last
Dorena	Row	1949	77,600	65,000	5	None	5th
Hills Creek	MF Willamette	1961	355,500	194,000	5	2	4th
Foster	South Santiam	1968	60,700	24,800	6	2	Last
Green Peter	Middle Santiam	1968	428,100	249,900	3	2	5th
Lookout Point	MF Willamette	1954	455,800	324,200	6	3	1st
Dexter	MF Willamette	1954	NA, Re-regulating	NA	2	1	NA
Blue River	Blue	1969	89,500	78,800	3	None	3rd
Cougar	SF McKenzie	1964	219,000	143,900	6	2	2nd
Fall Creek	MF Willamette	1966	125,000	108,200	5	None	5th

(Source: www.wrd.state.or.us/programs/will_res/index.html)

Willamette Project reservoirs attenuate flood flows and hold spring runoff from the Coast Range and Cascade Mountains. Stored water is released when reservoir capacity is met or to augment stream flows during the dry months of summer and early fall. As currently constructed and operated the release of water from Willamette Project reservoirs modifies natural temperature patterns downstream during late summer and early fall, but also during spring and early summer as well. The temperature seasonal shifts occur because stored water in reservoirs stratifies and the reservoirs were constructed with regulating outlets near the bottom of each structure. (The only exception to bottom released water outlets is Cougar reservoir which has been structurally modified to allow “selective withdrawal” of stratified waters.)

Seasonal pattern shifts are of concern because water temperature triggers aquatic life activities such as spawning, length of time needed for incubation and fry emergence. The food supplies (macroinvertabrates) salmonids rely on are also affected by seasonal temperature shifts. In late summer and into autumn, the reservoirs are drawn down to provide flood storage capacity for the coming winter precipitation. During this time, thermal stratification in the reservoirs breaks down but reservoir water temperatures remain warmer than inflowing upstream tributary temperatures. This is also the season when fall spawning fish have moved into reaches below the reservoirs to wait for spawning. Salmon and trout will hold in the coldest water they can find to wait for stream temperatures to cool enough to trigger their spawning migration.

Alternately, colder, winter waters are released during spring and into early summer when inflowing upstream tributary temperatures are warmer than stored reservoir waters. This is the season when fall spawned fry should be emerging but the colder water shifts their emergence timing. Spring spawning is also delayed until winter water temperatures warm enough to trigger spawning. Late spring spawning can mean that fry emergence occurs when summer water temperatures are too warm for emerging fry.

USACE entered into formal consultation with NOAA Fisheries (also known as National Marine Fisheries Service) and US Fish and Wildlife Service as a result of the listing of steelhead, spring Chinook and bull trout and other species as threatened under the Endangered Species Act (ESA). The USACE's biological assessment concluded that the Willamette Reservoirs are likely to adversely affect all threatened aquatic species above Willamette Falls. The two federal fisheries services are scheduled to release a biological opinion with recommendations for reasonable and prudent actions USACE should undertake to ensure the survival and recovery of these species. One of the recommended actions is a series of minimum flow regimes downstream of each Willamette Project Reservoir. These came to be known as BiOp (Biological Opinion) flows among staff and stakeholders during the development of the TMDL.

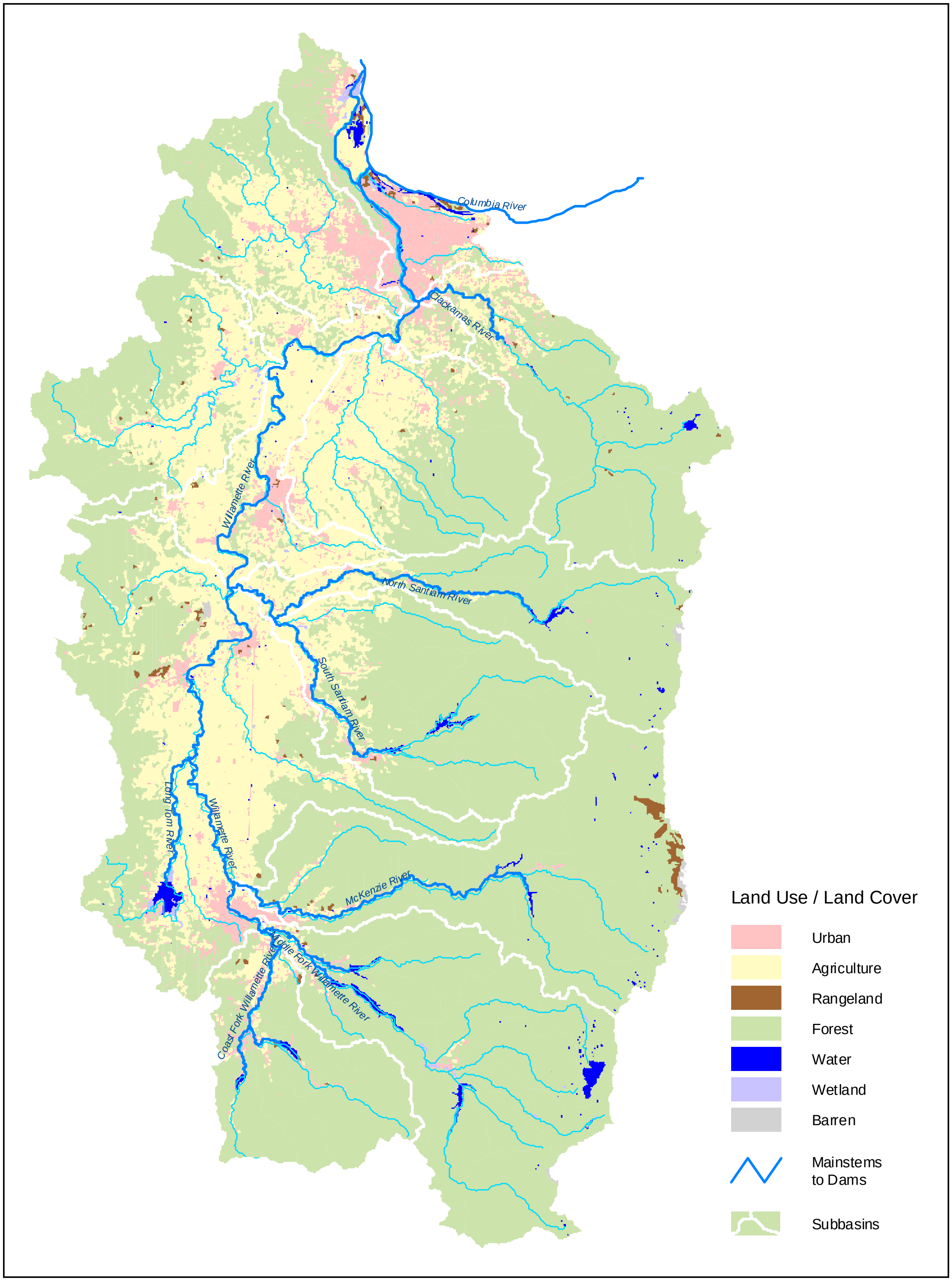
USACE has long recognized the adverse effects the Willamette Project can have on cold water fish use of river reaches below the dams. In recent years, USACE has begun to modify Cougar Reservoir on the South Fork McKenzie to allow for selective withdrawal of water from various depths in the thermally stratified reservoir. This will allow USACE to better match outflow temperatures to inflowing tributary temperatures and restore much of the natural seasonal temperature pattern of the South Fork McKenzie River. However, until selective control structures or their equivalent are in place at several other large Willamette reservoirs, project operations will continue to affect downstream water temperatures and fisheries.

Navigation is also an authorized purpose for the Willamette Project. Original legislation addressing USACE responsibilities to maintain navigation in the Willamette extends back to the River and Harbors Act of 1871, which along with subsequent legislation called for maintenance in the upper river of a navigable channel and operation of locks at Willamette Falls and the Yamhill River, (Willamette Project Biological Assessment 2-14). Original authorization of the Willamette Project in 1938 called for minimum flows of 5,000 cubic feet per second (cfs) between Albany and the Santiam River and 6,500 cfs downstream to Salem. This authorization occurred when much of the middle and lower Willamette River and its tributaries carried large volumes of untreated sewage and industrial waste. The expected benefits to water quality and fisheries of these higher summer stream flows were also noted in the legislative documentation and are still applicable today.

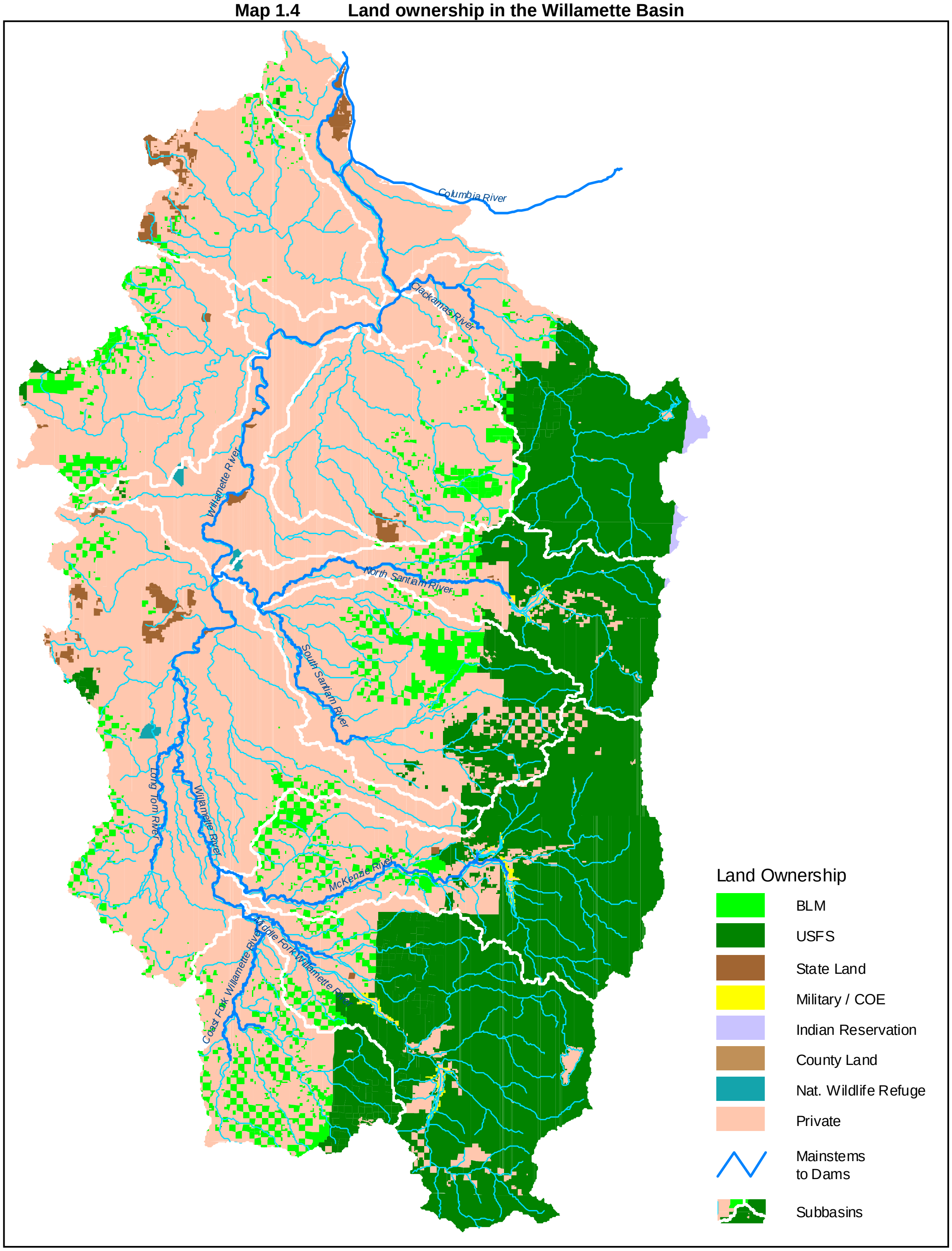
Land Use and Ownership

Forestry, agriculture and urban uses dominate land use in the Willamette Basin (Maps 1.3 and 1.4). There are three US National Forests, Bureau of Land Management (BLM) lands and Oregon State forest lands that are managed in the basin. While forestry use is active from the higher elevations to the foothills of the Coast and Cascade mountain ranges, agricultural lands are the largest land uses in the lowlands. The combination of a long growing season, mild winters, warm summers, and fertile soils means the basin is one of the most diverse and economically valuable agricultural areas in the state. Additionally, urban areas include 92 incorporated cities and towns of a statewide total of 211. The three largest cities in the state, Portland, Salem, and Eugene are in the basin. Approximately 70% of Oregon's total population, over two million people, live in the Willamette Basin, which is the fastest growing area of the state.

Map 1.3 Land use in the Willamette Basin.



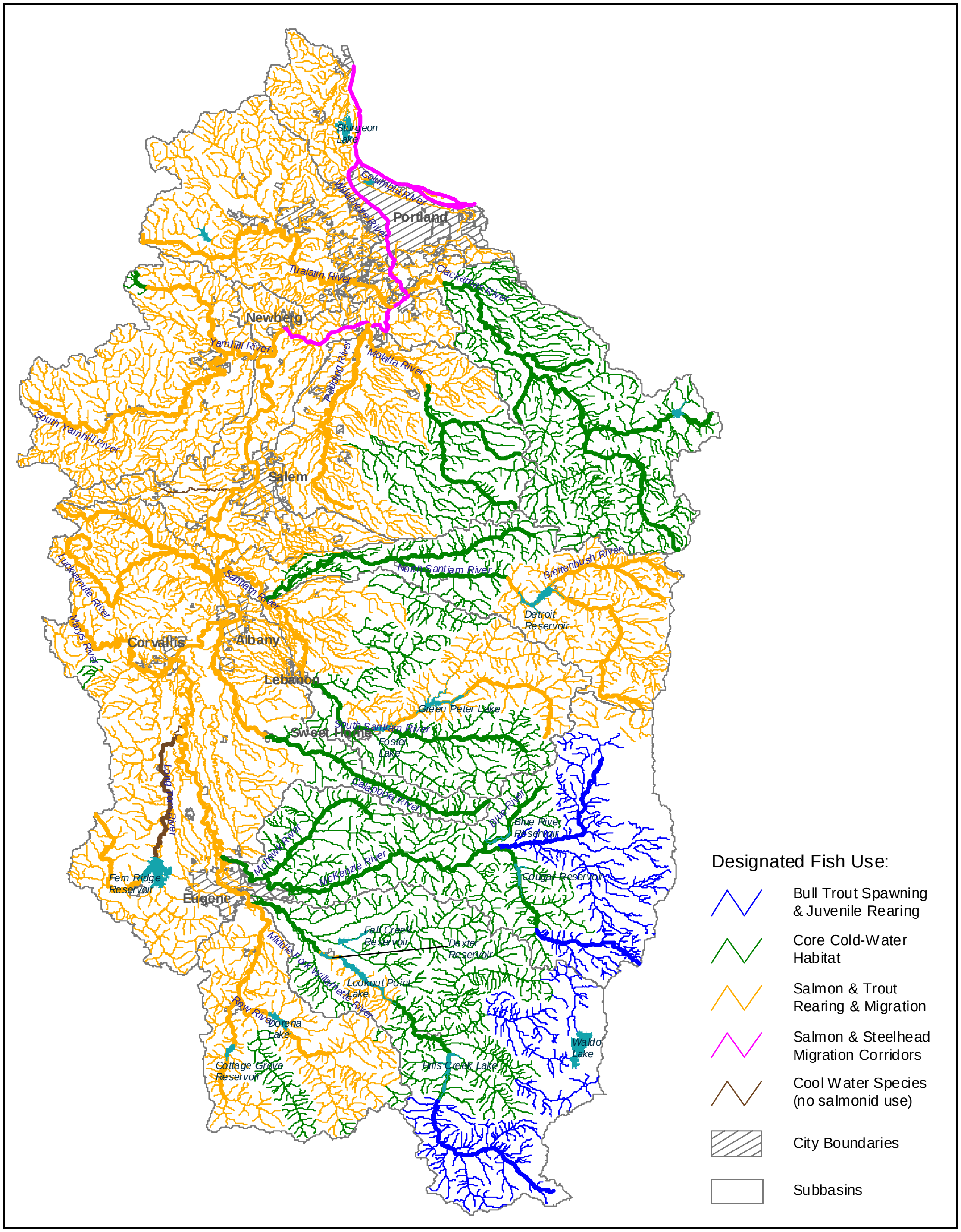
Map 1.4 Land ownership in the Willamette Basin



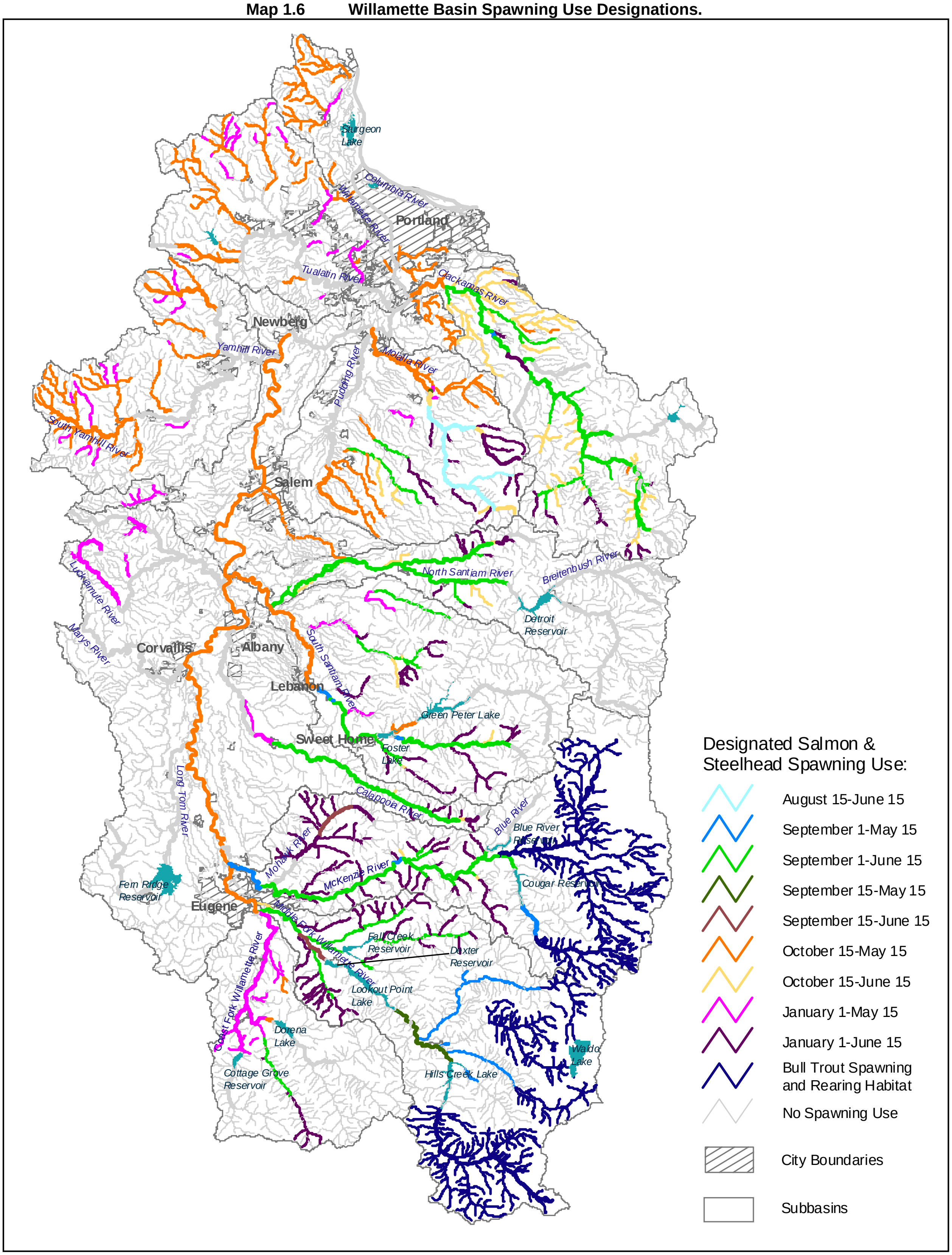
Fisheries

The Willamette Basin provides habitat for many aquatic species, including native and non-native fish species. It should be noted that Oregon's water quality standards apply to all fish species whether they are native or non-native.

Map 1.5 Willamette Basin Fish Use Designations.



Map 1.6 Willamette Basin Spawning Use Designations.



Native Fish

Native fish species present in the Willamette Basin include the following:

Table 1. 4 Native Fish Species in the Willamette Basin.

Bull trout (*Salvelinus confluentus*)	Peamouth (*Mylocheilus caurinus*)
Chinook salmon (*Oncorhynchus tshawytscha*)	Prickly sculpin (*Cottus asper*)
Chiselmouth (*Acrocheilus alutaceus*)	Rainbow trout (resident) (*Oncorhynchus mykiss*)
Coastal cutthroat trout (*Oncorhynchus clarki clarki*)	Redside shiner (*Richardsonius balteatus*)
Coho salmon (*Oncorhynchus kisutch*)	Reticulate sculpin (*Cottus perplexus*)
Eulachon (*Thaleichthys pacificus*)	Riffle sculpin (*Cottus gulosus*)
Largescale sucker (*Catostomus macrocheilus*)	River lamprey (*Lampetra ayresi*)
Leopard dace (*Rhinichthys falcatus*)	Sand roller (*Percopsis transmontana*)
Longnose dace (*Rhinichthys cataractae*)	Shorthead sculpin (*Cottus confuscus*)
Mottled sculpin (*Cottus bairdi*)	Speckled dace (*Rhinichthys osculus*)
Mountain sucker (*Catostomus platyrhynchus*)	Starry flounder (*Platichthys stellatus*)
Mountain whitefish (*Prosopium williamsoni*)	Steelhead (sea run rainbow) (*Oncorhynchus mykiss*)
Northern pike minnow (*Ptychocheilus oregonensis*)	Threespine stickleback (*Gasterosteus aculeatus*)
Oregon chub (*Oregonichthys crameri*)	Torrent sculpin (*Cottus rhotheus*)
Pacific lamprey (*Lampetra tridentata*)	Western brook lamprey (*Lampetra richardsoni*)
Paiute sculpin (*Cottus beldingi*)	White sturgeon (*Acipenser transmontanus*)

Non-native Fish

In addition to native species in the Willamette many fish species have been introduced intentionally or unintentionally for various reasons. The non-native fish species identified in the Willamette Basin are as follows:

Table 1. 5 Non-native Fish Species in the Willamette Basin.

American shad (*Alosa sapidissima*)	Largemouth bass (*Micropterus salmoides*)
Banded killifish (*Fundulus diaphanus*)	Mosquitofish (*Gambusia affinis*)
Black bullhead (*Ameiurus melas*)	Oriental weatherfish (*Misgurnus anguillicaudatus*)
Black crappie (*Pomoxis nigromaculatus*)	Pumpkinseed (*Lepomis gibbosus*)
Bluegill (*Lepomis macrochirus*)	Redear sunfish (*Lepomis microlophus*)
Brook trout (*Salvelinus fontinalis*)	Smallmouth bass (*Micropterus dolomieui*)
Brown bullhead (*Ameiurus nebulosus*)	Sockeye salmon (*Oncorhynchus nerka nerka*)
Brown trout (*Oncorhynchus trutta*)	Tench (*Tinca tinca*)
Channel catfish (*Ictalurus punctatus*)	Walleye (*Stizostedion vitreum*)
Common carp (*Cyprinus carpio*)	Warmouth (*Lepomis gulosus*)
Fathead minnow (*Pimephales promelas*)	White catfish (*Ameiurus catus*)
Goldfish (*Carassius auratus*)	White crappie (*Pomoxis annularis*)
Green sunfish (*Lepomis cyanellus*)	Yellow bullhead (*Ameiurus natalis*)
Kokanee (*Oncorhynchus nerka kennerlyi*)	Yellow perch (*Perca flavescens*)
Lake trout (*Salvelinus namaycush*)	

(Native and non-native species list taken form Summary of Information on Aquatic Biota and Their Habitats in the Willamette Basin, Oregon, through 1995, U.S. Geological Survey, Water-Resources Investigations Report 97-4023, Portland, Oregon 1997, Table 3, page 22.) http://oregon.usgs.gov/pubs_dir/Pdf/97-4023.pdf

Threatened or Endangered Fish

Of the 32 native species of fish in the basin, 6 are listed as threatened or endangered; Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*Oncorhynchus kisutch*), Steelhead (*Oncorhynchus mykiss*), Chum Salmon (*Oncorhynchus keta*), bull trout (*Salvelinus confluentus)*, and Oregon chub (*Oregonichthys crameri*).

NOAA Fisheries developed evolutionarily significant units (ESU) to delineate genetically unique subgroups within a species. Each salmonid species has a specific ESU, which may overlap with other species.

Spring Chinook

Spring Chinook (*Oncorhynchus tshawytscha*) were listed as threatened under the Endangered Species Act (ESA) in March of 1999. The Willamette Falls create a differentiation within the Willamette spring Chinook necessitating different ESUs. In Willamette River tributaries downstream of Willamette Falls, spring Chinook are classified as belonging to the Lower Columbia River ESU while spring Chinook appearing in the Willamette River and tributaries upstream of Willamette Falls are categorized as Upper Willamette River ESU. Adult spring Chinook enter the Willamette beginning in February with migration to upstream holding areas mostly complete by May. Spawning takes place between August and November (ODFW, 1992). After hatching, juveniles will rear in the freshwater from 3 to 18 months. Sub-yearlings begin emigration in late winter to early spring, a few months after hatching. Yearlings emigrate approximately 12 to 18 months after hatching, spending an extended period in their natal stream.

In addition to wild juvenile emigration, approximately 3 million hatchery juveniles have been released in the Willamette from nine sites located throughout the basin. Release sites and hatcheries are located on mainstem Willamette River, Middle Fork Willamette River, McKenzie River, North and South Fork Santiam Rivers, Clackamas River, and Molalla River. A majority of hatchery sub-yearlings are released in February and March and moderately sized yearlings are released in October and November.

During the 1950's and 1960's, dams constructed by the USACE blocked approximately 400 river miles of spawning habitat on the Santiam, Middle Fork Willamette, and McKenzie rivers historically utilized by native spring Chinook. Currently, most natural production of spring Chinook occurs in the McKenzie, Santiam, and Clackamas rivers, the McKenzie sustaining the majority of the population (Willis et al, 1995).

Winter Steelhead

Just as with Willamette spring Chinook, the Willamette winter steelhead (*Oncorhynchus mykiss*) are broken into two ESUs. Willamette Falls is the division between the Lower Columbia River and Upper Willamette River steelhead ESUs with the Lower Columbia downstream of the falls and the Upper Willamette upstream of the falls.

The upper Willamette steelhead were listed as threatened in March of 1999. The Upper Willamette ESU habitat was designated as the Willamette River and its tributaries up to and including the Calapooia River. Construction of the Big Cliff Dam on the North Santiam River and the Green Peter Dam on the South Santiam River in the 1950's and 1960's prevented passage upstream. The dams have become the upper bounds of steelhead habitat in the Santiam watershed.

There are currently three hatchery runs of steelhead on the Willamette River: They are Big Creek early run winter steelhead, Skamania summer steelhead stock, and Marion Forks Hatchery stock. Marion Forks Hatchery stock on the North Santiam is the only hatchery run included in the Upper Willamette ESU (NMFS Fisheries, 1999). The primary production areas for native late run winter steelhead are located on the east side of the Willamette Basin in the Molalla, Santiam and Calapooia subbasins (Busby et al, 1996). The mainstem Willamette does not sustain a substantial amount of spawning, as most spawning takes place in Willamette tributaries (ODFW, 1990b). The Little North Fork, Rock Creek, and Mad Creek watersheds are the major spawning areas in the North Santiam Basin, while Thomas Creek, Crabtree Creek, Wiley Creek, Canyon Creek, and Moose Creek are the primary spawning areas in the South Santiam watershed (Wevers et al, 1992b). Other principle spawning grounds include North Fork, Table Rock Fork, Milk Creek, and Copper Creek in the Molalla River and Butte, and Abiqua Creeks in the Pudding River. Winter steelhead begin passing through the Willamette Falls fish ladder in February with the greatest counts in March. Migration is typically complete in May. Spawning on the west side of the basin occurs in April while spawning in the Cascade drainage is most frequent in May (ODFW, 1990a; Wevers et al, 1992a). Juvenile steelhead utilize the mainstem Willamette and it's tributaries for rearing, spending approximately 2 years in freshwater before emigration in March to late May (Wevers et al, 1992a, 1992b).

Lower Columbia River steelhead occupy the Willamette and its tributaries below Willamette Falls and were listed as threatened in March of 1998. There are two steelhead runs in the Lower Columbia ESU, a winter run entering freshwater between November and April and a summer run entering between May and October. Steelhead typically move into the Willamette and Clackamas between February and March. Spawning begins in April with peak activity in May and June. Just as with the upper Willamette ESU, lower Columbia steelhead spend approximately 2 years rearing in freshwater before emigration begins.

Bull Trout

Bull trout (*Salvelinus confluentus*) occurring in the Willamette Basin are included in the Lower Columbia River Distinct Population Segment (DPS) which was listed as threatened under the ESA by the USFWS in June of 1998. The DPS represents an isolated population found in the upper reaches of Columbia River tributaries such as the Willamette. Historically bull trout occurred throughout the Willamette Basin but particularly on the west side of the Cascade Range (Buchanan and Hemmingsen, 1995). Historically bull trout populations have been found to occur in the Clackamas River, North Santiam River, South Santiam River, McKenzie River, Middle Fork Willamette River, and Long Tom River subbasins (Goetz, 1994). Bull trout populations are both geologically and reproductively isolated. At present only the McKenzie River is known to contain a viable production of bull trout (Buchanan et al, 1997). The population in the McKenzie contains three sub-populations, the middle McKenzie River basin between Leaburg and Trail Bridge dams, the upper McKenzie River basin above Trail Bridge Dam up to Tamolitch Falls, and the South Fork McKenzie River basin above Cougar Dam (Buchanan et al, 1997). The middle McKenzie population is believed to be stable or increasing in production while the South Fork and upper McKenzie are at high risk of extinction (Buchanan et al, 1997; ODFW 1999). The McKenzie River populations utilize two types of migratory paths: fluvial from natal streams to larger rivers, and adfluvial from natal streams to lakes or reservoirs. Migration from the middle McKenzie to spawning areas located in Anderson and Olallie creeks takes place in July and August. Spawning follows in September through November (Taylor and Reasoner, 1998). In the South McKenzie migration occurs in late June to spawning areas in Roaring River (Buchanan et al, 1997; Unthank 1998). Specific information on upper McKenzie sub-population migration habits was not available. Juvenile bull trout spend from several months to years rearing in natal streams before emigration to larger rivers or lakes begin. In the McKenzie juveniles spend about 2 to 3 years in natal streams. The optimal rearing temperature for bull trout has been determined to be between 7°C and 8°C (Goetz, 1989). Bull trout distribution may be limited by water temperature above 15°C.

Coho Salmon

In 1995 the NOAA Fisheries (formerly known as NMFS) listed the Southern Washington/Lower Columbia River coho salmon ESU as a candidate species under the ESA. Coho salmon (*Oncorhynchus kisutch*) included in this ESU occupy the lower Willamette and its tributaries below Willamette Falls. The Clackamas River above North Fork Dam contains the only native coho salmon population in the basin. This population is identified from other hatchery based populations by the late return of adult that enter the system in October and spawn in February and March. Runs of coho that return in August and spawn in November are considered to be hatchery stock that are sustaining a naturally spawning population. Coho salmon rear in freshwater for slightly longer than a year emigrating to saltwater in April and May. Observations at the North Fork Dam have revealed the juvenile coho are passing over the dam throughout the year with the highest presence recorded in April and May (Cramer and Cramer, 1994).

Oregon Chub

Oregon Chub (*Oregonichthys crameri*) are endemic throughout the entire Willamette Basin upstream of the Willamette Falls to Cottage Grove and Hills Creek reservoirs in the southern valley. Tributaries of the Willamette that historically supported Oregon chub are the Clackamas River, Molalla River, Mill Creek, Luckiamute River, North Santiam River, South Santiam River, Calapooia River, Long Tom River, Muddy Creek, McKenzie River, Coast Fork Willamette River, Middle Fork Willamette River drainages, and the mainstem Willamette River. Presently known populations of chub are located in the following tributaries, Santiam River, Muddy Creek, Camas Creek, and the Middle Fork Willamette River drainages with the Middle Willamette supporting the largest population (Scheerer, 1999). Prime chub habitat is located in off-channel backwaters, flooded marshes and other area of slow velocities. Oregon chub spawn in the summer months from May through August. The eggs are adhesive and usually attached to vegetation located in spawning habitat. Oregon chub were listed as endangered in 1993 after extreme reduction in habitat and restricted distribution.

Chum Salmon

In March of 1999, NOAA Fisheries listed Lower Columbia Chum Salmon (*Oncorhynchus keta*) ESU as threatened under the ESA. Included in the ESU are all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon. As identified in Kostow, 1995, Chum population in Oregon occur in the following tributaries of the Columbia: Youngs Bay, Mill Creek, John Day River, Mary's Creek, Bear Creek, Ferris Creek, Big Creek, Fertile Valley Creek, Gnat Creek, and Hunt Creek . Although historic populations of chum occurred throughout the lower Willamette, current records do not identify any populations in the Lower Willamette and its tributaries, which is the extent of the potential habitat in the Willamette Basin. Chum salmon enter freshwater between June and March with spawning taking place mid-November through January. Chum fry have a low tolerance for freshwater, therefore after emerging they proceed directly to estuaries. There are no current recovery plans underway for chum salmon in the lower Willamette Basin.

Previously Listed as Threatened or Endangered

Coastal Cutthroat

Coastal cutthroat trout (*Oncorhynchus clarki clarki*) are the most complex salmonids of the Willamette Basin utilizing freshwater and saltwater migration and non-migratory strategies within the same populations. Cutthroat trout occur above and below Willamette Falls, however, the anadormous component only exist in areas below the Falls based on an absences of cutthroat trout observations at the falls. The U.S. Fish and Wildlife Service determined in June of 2002 that the Southwest Washington/Lower Columbia Cutthroat Trout ESU did not qualify for listing under the ESA. In August of 1999 the NOAA Fisheries determined that listing under the ESA was not warranted for the upper Willamette ESU.

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APPENDIX 1.A : 303(D) LISTINGS

The following table summarizes the 303(d) listed waterbodies that have TMDLs developed for this Willamette Basin TMDL iteration.

Basin	Waterbody Name	RM	Parameter	Season	Criteria/Text
CLACKAMAS	Bargfeld Creek	0 to 2.3	E. Coli	Summer	126 organisms
CLACKAMAS	Clackamas River	0 to 15	E. Coli	6/1 - 9/30	126 organisms
CLACKAMAS	Clackamas River	0 to 22.9	Temperature	Summer	Rearing: 17.8 C
CLACKAMAS	Cow Creek	0 to 2.6	Temperature	Summer	Rearing: 17.8 C
CLACKAMAS	Cow Creek	0 to 2.6	E. Coli	10/1 - 5/31	126 organisms
CLACKAMAS	Deep Creek	1.9 to 14.1	E. Coli	Summer	126 organisms
CLACKAMAS	Eagle Creek	0 to 20	Temperature	Summer	Rearing: 17.8 C
CLACKAMAS	Fish Creek	0 to 6.8	Temperature	Summer	Rearing: 17.8 C
CLACKAMAS	North Fork Deep Creek	0 to 9	E. Coli	Summer	126 organisms
CLACKAMAS	Rock Creek	0 to 6.1	E. Coli	10/1 - 5/31	126 organisms
CLACKAMAS	Sieben Drainage Ditch	0 to 1	E. Coli	10/1 - 5/31	126 organisms
CLACKAMAS	Sieben Drainage Ditch	1 to 1.8	E. Coli	10/1 - 5/31	126 organisms
CLACKAMAS	Tickle Creek	0 to 2.3	E. Coli	Summer	126 organisms
COAST FORK	Brice Creek	0 to 11.2	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Coast Fork Willamette River	0 to 31.3	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Coast Fork Willamette River	0 to 31.3	Fecal Coliform	W/S/F	Geometric Mean
COAST FORK	Coast Fork Willamette River	0 to 31.3	Fecal Coliform	Summer	Geometric Mean
COAST FORK	Coast Fork Willamette River	0 to 31.3	Mercury	Year Around	public health advisories…
COAST FORK	Cottage Grove Reservoir/Coast Fork Willamette R	28.5 to 31.3	Mercury	Year Around	public health advisories…
COAST FORK	Dorena Lake/Row River	7.4 to 11.3	Mercury	Year Around	public health advisories…
COAST FORK	King Creek	0 to 1.6	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Laying Creek	0 to 7.7	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Martin Creek	0 to 3.4	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Mosby Creek	0 to 21.2	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Row River	0 to 7.4	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Row River	11.3 to 20.8	Temperature	Summer	Rearing: 17.8 C
COAST FORK	Sharps Creek	0 to 12.5	Temperature	Summer	Rearing: 17.8 C
LOWER	Johnson Creek	0 to 23.7	Fecal Coliform	W/S/F	Geometric Mean
LOWER	Johnson Creek	0 to 23.7	Fecal Coliform	Summer	Geometric Mean
LOWER	Johnson Creek	0 to 23.7	Dieldrin	Year Around	Table 20
LOWER	Johnson Creek	0 to 23.7	DDT	Year Around	Table 20
LOWER	Johnson Creek	0 to 23.7	Temperature	Year Around	Administrative list removal; TMDL completed
LOWER	Kellogg Creek	0 to 5	E. Coli	10/1 - 5/31	126 organisms
LOWER	Mount Scott Creek	0 to 6.1	E. Coli	10/1 - 5/31	126 organisms
LOWER	Phillips Creek	0 to 1.2	E.Coli	10/1 - 5/31	126 organisms
LOWER	Smith Lake	1.7 to 3	pH	Summer	pH: 6.5 to 8.5
LOWER	Spring Brook Creek	0 to 2.3	Fecal Coliform	W/S/F	Geometric Mean

Basin	Waterbody Name	RM	Parameter	Season	Criteria/Text
LOWER	Spring Brook Creek	0 to 2.3	Fecal Coliform	Summer	Geometric Mean
LOWER	Tryon Creek	0 to 5	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	Blue River	0 to 1.8	Temperature	S/S/F	Spawning: 12.8 C
MCKENZIE	Blue River	1.8 to 15.5	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	Deer Creek	0 to 8.3	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	French Pete Creek	0 to 12.9	Temperature	Summer	Bull Trout: 10.0 C
MCKENZIE	Horse Creek	0 to 14.2	Temperature	Summer	Bull Trout: 10.0 C
MCKENZIE	McKenzie River	0 to 34.1	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	McKenzie River	34.1 to 54.5	Temperature	S/S/F	Rearing: 17.8 C
MCKENZIE	McKenzie River	54.4 to 83	Temperature	Summer	Bull Trout: 10.0 C
MCKENZIE	Mill Creek	0 to 2.7	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	Mohawk River	0 to 25.4	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	Shotgun Creek	0 to 6.6	Temperature	Summer	Rearing: 17.8 C
MCKENZIE	South Fork McKenzie R	0 to 4.5	Temperature	S/S/F	Spawning: 12.8 C
MCKENZIE	Unnamed Waterbody	0 to 1.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Anthony Creek	0 to 4.3	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Bohemia Creek	0 to 4.4	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Coal Creek	0 to 8.9	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Fall Creek	0 to 7	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Fall Creek	13 to 32.7	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Hills Creek	1.7 to 8.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Little Fall Creek	0 to 20.6	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Lost Creek	0 to 8.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Lost Creek	0 to 8.2	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Lost Creek	8.2 to 13.6	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Lost Creek	13.6 to 14.7	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Middle Fork	0 to 15.6	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Middle Fork	52.5 to 64.1	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Mike Creek	0 to 2.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	N Fk Middle Fk	0 to 14.1	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	N Fk Middle Fk	14.1 to 49.4	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Packard Creek	0 to 5.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Portland Creek	0 to 3	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Salt Creek	0 to 13.6	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	S F Winberry Creek	0 to 3.1	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Unnamed Waterbody	0 to 2.3	Temperature	Summer	Rearing: 17.8 C
MIDDLE FORK	Unnamed Waterbody	0 to 2.3	Temperature	9/15 - 6/30	Spawning: 12.8 C
MIDDLE FORK	Winberry Creek	2.9 to 8	Temperature	Summer	Rearing: 17.8 C
MIDDLE	Abernethy Creek	0 to 15.5	Temperature	Summer	Rearing: 17.8 C
MIDDLE	Bashaw Creek	0 to 4.8	Fecal Coliform	Year Around	Geometric Mean
MIDDLE	Clark Creek	0 to 1.9	E. Coli	Year Around	126 organisms
MIDDLE	Mill Creek	0 to 25.7	Fecal Coliform	Year Around	Geometric Mean
MIDDLE	Patterson Creek	0 to 7.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE	Pringle Creek	0 to 6.2	E. Coli	Year Around	126 organisms
MIDDLE	Pringle Creek	0 to 6.2	Temperature	Summer	Rearing: 17.8 C
MIDDLE	Rickreall Creek	0 to 24.9	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Bear Branch	0 to 9.8	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Blowout Creek	0 to 11.9	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Boulder Creek	0 to 2.4	Temperature	Summer	Rearing: 17.8 C

Basin	Waterbody Name	RM	Parameter	Season	Criteria/Text
N SANTIAM	Chehulpum Creek	0 to 7.1	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Elkhorn Creek	0 to 7.4	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Little North Santiam	0 to 25.1	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Marion Creek	0 to 6.2	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	N SANTIAM River	0 to 10	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	North Santiam River	0 to 10	Temperature	9/1 - 6/30	Spawning: 12.8 C
N SANTIAM	North Santiam River	10 to 26.5	Temperature	9/15 - 6/30	Spawning: 12.8 C
N SANTIAM	Santiam River	0 to 12	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Santiam River	0 to 12	Temperature	9/15 - 6/30	Spawning: 12.8 C
N SANTIAM	Stout Creek	0 to 8.9	Temperature	Summer	Rearing: 17.8 C
N SANTIAM	Unnamed Waterbody	0 to 2.8	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Beaver Creek	0 to 16	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Crabtree Creek	0 to 32.1	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Hamilton Creek	0 to 11.6	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	McDowell Creek	0 to 5.7	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Middle Santiam River	5.3 to 37.1	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Neal Creek	0 to 10	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Quartzville Creek	3.3 to 26.8	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	South Santiam River	0 to 25.9	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	South Santiam River	0 to 25.9	Temperature	9/15 - 6/30	Spawning: 12.8 C
S SANTIAM	South Santiam River	35.7 to 63.4	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	South Santiam River	35.7 to 63.4	Temperature	9/1 - 6/30	Spawning: 12.8 C
S SANTIAM	Sucker Slough	0 to 9.8	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Thomas Creek	0 to 16.2	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Thomas Creek	16.2 to 26.1	Temperature	Summer	Rearing: 17.8 C
S SANTIAM	Wiley Creek	0 to 17.2	Temperature	Summer	Rearing: 17.8 C
UPPER	A-3 Drain	0 to 0	E. Coli	6/1 - 9/30	126 organisms
UPPER	A-3 Drain	0 to 0	E. Coli	10/1 - 5/31	126 organisms
UPPER	Amazon Creek	0 to 22.6	E. Coli	6/1 - 9/30	126 organisms
UPPER	Amazon Creek	0 to 22.6	E. Coli	10/1 - 5/31	126 organisms
UPPER	Amazon Diversion Canal	0 to 1.8	Dissolved Oxygen	S/S/F	Cool water: 6.5 mg/l
UPPER	Amazon Diversion Canal	0 to 1.8	Fecal Coliform	Year Around	Geometric Mean
UPPER	Calapooia River	0 to 42.8	Temperature	Summer	Rearing: 17.8 C
UPPER	Calapooia River	0 to 42.8	Fecal Coliform	W/S/F	Geometric Mean
UPPER	Coyote Creek	0 to 26.2	Dissolved Oxygen	S/S/F	Cool water: 6.5 mg/l
UPPER	Coyote Creek	0 to 26.2	Fecal Coliform	Year Around	Geometric Mean
UPPER	Ferguson Creek	0 to 10	Temperature	Summer	Rearing: 17.8 C
UPPER	Fern Ridge Reservoir/Long Tom	24.2 to 31.8	Fecal Coliform	W/S/F	Geometric Mean
UPPER	Fern Ridge Reservoir/Long Tom	24.2 to 31.8	Turbidity	Year Around	10% increase
UPPER	Long Tom River	0 to 24.2	Temperature	Summer	Rearing: 17.8 C
UPPER	Long Tom River	0 to 24.2	Fecal Coliform	W/S/F	Geometric Mean
UPPER	Luckiamute River	0 to 31.7	Fecal Coliform	W/S/F	Geometric Mean
UPPER	Marys River	0 to 13.9	Temperature	Summer	Rearing: 17.8 C
UPPER	Marys River	0 to 13.9	Fecal Coliform	W/S/F	Geometric Mean
UPPER	Muddy Creek	0 to 33	Temperature	Summer	Rearing: 17.8 C

Basin	Waterbody Name	RM	Parameter	Season	Criteria/Text
UPPER	South Fork Berry Creek	0 to 2.1	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	0 to 24.8	Fecal Coliform	Winter/Spring/ Fall	Geometric Mean of 200, No more than 10%>400
WILLAMETTE	Willamette River	0 to 24.8	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	0 to 24.8	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	24.8 to 54.8	Fecal Coliform	Winter/Spring/ Fall	Geometric Mean of 200, No more than 10%>400
WILLAMETTE	Willamette River	24.8 to 54.8	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	24.8 to 54.8	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	54.8 to 108	Fecal Coliform	Winter/Spring/ Fall	Geometric Mean of 200, No more than 10%>400
WILLAMETTE	Willamette River	54.8 to 108	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	54.8 to 108	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	108 to 119.7	Fecal Coliform	Winter/Spring/ Fall	Geometric Mean of 200, No more than 10%>400
WILLAMETTE	Willamette River	108 to 119.7	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	108 to 119.7	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	119.7 to 148.8	Fecal Coliform	Winter/Spring/ Fall	Geometric Mean of 200, No more than 10%>400
WILLAMETTE	Willamette River	119.7 to 148.8	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	119.7 to 148.8	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	148.8 to 174.5	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	148.8 to 174.5	Temperature	Summer	Rearing: 17.8 C
WILLAMETTE	Willamette River	174.5 to 186.4	Mercury	Year Around	public health advisories…
WILLAMETTE	Willamette River	174.5 to 186.4	Temperature	Summer	Rearing: 17.8 C