WASHINGTON COUNTY
OREGON

September 2, 2022

Brian Creutzburg, Tualatin Basin Coordinator
Oregon Dept. of Environmental Quality; NW Region
700 NE Multnomah, Suite 600
Portland, OR 97232-4100

Dear Mr. Creutzburg,

Washington County is a Designated Management Agencies (DMA) for the rural area Tualatin Sub-basin Nonpoint Sources within our authority and jurisdiction. As required in the DEQ's Compliance Orders for the Tualatin Basin 2001, 2006, 2012 revisions, and the 2021 EPA WQMP for the Willamette Basin TMDL, DMAs are required to develop TMDL implementation plans that describe the management measures they will take to address load allocations for the listed water quality parameters of total phosphorus, dissolved oxygen, bacteria, temperature, and mercury. This submittal addresses the approved 2021 Willamette Basin Mercury TMDL and DEQ Order.

Attached please find the Washington County Water Quality Implementation Plan (WQIP): Mid-Plan Update. It is submitted as required by the due date of September 3, 2022. The approved 5-Year Plan is still in effect and is being implemented as demonstrated in our annual reports. Per our communications with you this year, we are submitting updates primarily to the Mercury Section 3.5, with checks for consistency with relevant updates in the Executive Summary, Introductions, Implementation, and Reporting sections as well. Historical information e.g., in the Appendix, has not been changed. Chapters 5 and 6 include adaptive management descriptions, measurable goals and tracking measures for annual reports, and reasoning for Best Management Practices selection. We believe this also meets the intent of the EPA's required elements for Nonpoint Source Management Plans, and DEQ's required elements for Counties per the "new" Mercury TMDL.

If you have questions regarding this Plan, please do not hesitate to call or e-mail any of the following people: Todd Watkins (Todd_Watkins@co.washington.or.us ;
Tim Sautter (Tim Sautter@co.washington.or.us ; 503-846-7652)
or our consultant Donna Hempstead (enviro-eco17@msn.com ; 503-502-3027).

Thank you.

Sincerely,

Todd Watkins

Todd Watkins, Manager
Operations Division
Washington County Dept. of Land Use & Transportation
1400 S.W. Walnut Street
Hillsboro, OR 97123

Washington County Nonpoint Source Water Quality Implementation Plan Mid-Plan Update

For Addressing Tualatin Basin TMDL Parameters In the Rural Area

September 1, 2022

Table of Contents — Page

Washington County
Water Quality Implementation Plan [Mid-Plan Update]
to Address Tualatin Basin Nonpoint Source TMDLs
in the Rural Area

Executive Summary:

Chapter One: Introduction
Implementing the TMDLs

Chapter Two: Condition Assessment
Water Quality Considerations

Table of Contents Page

Chapter Three: TMDL Parameters: Sources of Loading

Section 3.1
Addressing Sources
Bacteria

Section 3.2
Addressing Sources
Total Phosphorus

Section 3.3
Addressing Sources
Dissolved Oxygen

Table of Contents | Page

Section 3.4 Addressing Sources Temperature

Section 3.5 Addressing Sources Mercury

Chapter Four: Water Quality Monitoring Plan

Table of Contents Page

Chapter Five: Implementing the TMDLs Management Measures

Chapter Six Evaluation and Reporting

Washington County
Water Quality Implementation Plan
to Address Tualatin Basin Nonpoint Source TMDLs

ACRONYMS AND ABBREVIATIONS

Acronym/Abbr.	Meaning
303(d)	Section 303(d) of the federal Clean Water Act
ACOE	U.S. Army Corps of Engineers
ACWA	Association of Clean Water Agencies
ASCE	American Society of Civil Engineers
BES	City of Portland Bureau of Environmental Services
BLM	U.S. Bureau of Land Management
BMPs	Best Management Practice(s)
CBOD	Carbonaceous Biochemical Oxygen Demand
CFR	Code of Federal Regulations
CPS	Capital Project Services Division of Washington County DLUT
CSOs	Combined Sewer Overflow(s)
CWA	Clean Water Act
CWS	Clean Water Services (District) of Washington County
DEQ	Oregon Department of Environmental Quality
DHS	Oregon Department of Human Services
DLUT	Washington County (Oregon) Department of Land Use & Transportation
DMAs	Designated Management Agency(ies)
DO	Dissolved Oxygen
EMCs	Event Mean Concentration(s)
EPA	U.S. Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
ES	Executive Summary; or Environmental Services
ESA	Endangered Species Act (federal)
ESCP	Erosion and Sediment Control Plan
GIS	Geographic Information System
KRIS	Klamath Resource Information System
LA	Load Allocation
LID; LIDA	Low Impact Development; Approach
METRO	Metropolitan Service District
MPN	Most Probably Number
MS4	Municipal Separate Storm Sewer System (Permit/Program)
NBOD	Nitrogenous Biochemical Oxygen Demand
NMFS	National Marine Fisheries Service
NOAA	National Oceanic & Atmospheric Administration (prev. NMFS)
NPDES	National Pollutant Discharge Elimination System (Permit/Program)
NURP	National Urban Runoff Program
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture

Acronym/Abbr.	Meaning
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OGI	Oregon Graduate Institute
ORS	Oregon Revised Statutes
POTWs	Publicly Owned Treatment Works
QRG	Quick Reference Guide
RM	River Mile
RMA	Riparian Management Area (Washington County)
RRM	Routine Road Maintenance
SNTEMP	Stream Network Temperature Model
SOD	Sediment Oxygen Demand
SSOs	Sanitary Sewer Overflow(s)
STPs	Sewage Treatment Plant(s)
SVS	Settleable Volatile Solids
TBPAC	Tualatin Basin Policy Advisory Committee
TBPAC	Tualatin Basin Public Awareness Committee
TDS	Total Dissolved Solids
THPRD	Tualatin Hills Parks & Recreation District
TMDL	Total Maximum Daily Load; or TMDL Program
TP	Total Phosphorus
TSS	Total Suspended Solids
TSWCD	Tualatin Soil and Water Conservation District
TVID	Tualatin Valley Irrigation District
TVS	Total Volatile Solids
UIC	Underground Injection Control
USA	Unified Sewerage Agency (now Clean Water Services)
USGS	United States Geological Survey
UV	Ultra Violet light
VDS	Volatile Dissolved Solids
VS	Volatile Solids
WCSWCD	Washington County Soil and Water Conservation District (now TSWCD)
WLA	Wasteload Allocation
WQF	Water Quality Facility
WQIP/WQMP	Water Quality Implementation Plan/ Water Quality Management Plan
WRB	Willamette River Basin
WWTP; WWTF	Wastewater Treatment Plant; Wastewater Treatment Facility

Executive Summary: Washington County Water Quality Implementation Plan to Address Tualatin Basin Nonpoint Source TMDLs

This Executive Summary (ES) Section includes:

ES - 1.0 Total Maximum Daily Loads (TMDLs)

The Federal Clean Water Act (CWA) requires that States establish a list of impaired or water quality limited waterbodies using water quality standards.[1] In order to meet the water quality standards, the state must establish a Total Maximum Daily Load (TMDL) to address those parameters identified on the "303(d) list".

The TMDL is the total amount of a pollutant a water body can accept without violating the water quality standard.

In August 2001, new Tualatin Basin TMDLs were approved by U.S. EPA for temperature, bacteria and dissolved oxygen, and the existing phosphorus and ammonia TMDLs were revised. All address both point and nonpoint sources. A brief description of each TMDL is listed below:

- Bacteria –Bacterial contamination threatens the beneficial use of recreational water contact. Nonpoint sources in both urban and rural areas have been identified as the primary source of elevated bacteria concentrations.
- Phosphorus – The revised TMDL was set to reflect significant improvements in control of point sources and additional knowledge of nonpoint sources. It is used to control algal blooms and chlorophyll *a*.
- Dissolved Oxygen – The goal of the TMDL is to increase DO levels to support cold-water aquatic life. A number of factors affect DO levels including decomposition of excessive organic matter, elevated temperature, sediment loading, and algal blooms.
- Temperature - The goal of the temperature TMDL is to reduce water temperatures to support cold-water fish, particularly salmon. Temperature is also a factor in algal growth.
- Ammonia – The revised TMDL was set to reflect significant improvements in ammonia discharges from point sources.

[1] Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 et seq.; renamed the Clean Water Act by Congress in 1977 adding provisions for toxic pollutants. Amended in 1987 to strengthen provisions relating to nonpoint source pollution, and to strengthen federal enforcement authority.

- Mercury – The goal of the mercury TMDL is to reduce mercury in fish tissue to a safe level for consumption.

In August 2012 DEQ issued a final Tualatin Subbasin[2] Order and TMDL to provide waste load allocations for total phosphorus and ammonia at 2 new discharge locations, and to allow trading of allocations among three waste water treatment plants for Dissolved Oxygen. The 2012 Order is supplemental to the 2001 TMDL, and did not alter any 303(d) listings.[3]

Update Note re: Mercury: DEQ issued the Revised Willamette Basin Mercury TMDL on Nov 22, 2019. One week later, EPA disapproved the TMDL after determining the load and waste load allocations based on percent reductions would not achieve the TMDL target in all the subbasins addressed by the TMDL (from DEQ website).[4] EPA established a new TMDL on Dec. 30, 2019. After the required 30-day public comment period and another year to address comments, EPA issued the final Revised Willamette Basin Mercury TMDL on Feb. 4, 2021. This Mid-Plan Update addresses those changes, as required.

ES - 2.0 TMDL Allocations

A Load Allocation (LA) is the amount of pollutant that natural plus nonpoint sources can contribute to a receiving water's loading capacity.

Load allocations (LAs) for nonpoint sources and Wasteload allocations (WLAs) for point sources have been set by Oregon DEQ in the Tualatin River Subbasin TMDL document (August, 2001, 2012, 2019 and 2021). Wasteload allocations will not be addressed in this submittal document for Washington County as these are determined by municipal NPDES permit conditions, which are the responsibility of Clean Water Services. Load allocations for the portions of the rural area directly impacted by Washington County activities or operations will be addressed in this document.

ES - 3.0 DMA's and Implementing a TMDL Program

The TMDL water quality standards for phosphorus, total volatile solids (dissolved oxygen), bacteria, temperature and mercury have the effect of a DEQ Order, and are currently in effect for Designated Management Agencies (DMA's) in the Tualatin Basin. DMA's include Clean Water Services, Cities of Portland, Lake Oswego, Rivergrove, and West Linn, Counties of Washington, Multnomah, and Clackamas, METRO regional government agency, the Oregon Department of Agriculture, Oregon Department of Forestry, the U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service. Other entities also play a significant role but are not DMA's. These include the Tualatin Hills Park and Recreation District, the Oregon Department of State Lands, the Oregon Water Resources Department, the Oregon Department of Fish and Wildlife, and others.

According to the statewide OAR (340-042-0080) implementing a TMDL includes:

- Management strategies identified in a Water Quality Management Plan (WQMP) to achieve wasteload and load allocations in a TMDL implemented through water quality permits for those point sources subject to permit requirements [for example, NPDES permits], and through source-specific implementation plans for other nonpoint sources. "Management Strategies" means

[2] The Tualatin is a Subbasin of the Willamette Basin TMDL.
[3] DEQ Memo from WQ Administrator Aldrich, dated August 28, 2012.
[4] https://www.oregon.gov/deq/wq/tmdls/Pages/willhgtmdlac2018.aspx

measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives.[5]

- DMA's other than the OR Department of Forestry or the OR Department of Agriculture, identified as responsible for developing and revising source-specific implementation plans for nonpoint sources [legal interpretation: outside the urban area] must: prepare an implementation plan and submit the plan to the [DEQ] for review and approval according to the schedule specified in the TMDL. This schedule required submittal of a DMA-specific implementation plan by August 7, 2003.

Update Note re: Mercury: Washington County, as a DMA, met the 2003 submittal requirement with approval of a Rural Area Nonpoint Source TMDL Implementation/Management Plan. **This was updated for Mercury as required by DEQ by March 21, 2008.** The DEQ 2012 revisions to the Willamette Basin TMDL (Tualatin Basin is a Sub-Basin) required submittal of updated WQIP's by March 2014. That WQI/MP was approved through March 1, 2019, when this Plan was submitted to DEQ, to cover the next Five-Year Implementation Plan/Program. That Water Quality Implementation Plan was approved by DEQ on February 14, 2020.[6] [Copy of approval letter attached at the end of this section]. **This Mid-Plan Update (September 2022) addresses specific provisions of the Revised Mercury TMDL**.[7]

ES - 4.0 Water Quality Implementation Plan Requirements

Purpose is to Address TMDL Parameters

Due to the inherent limitations in achieving desired load allocations, the purpose of this implementation plan is to address the TMDL parameters and load allocations by reducing pollutants through source control and structural control where applicable, as required in the TMDL approved by EPA.

State Requirements of the Implementation Plans

According to the OAR (340-042-0080) the implementation plan must:

- Identify the management strategies the DMA will use to achieve/address load allocations and reduce pollutant loading;
- Provide a timeline for implementing management strategies and a schedule for completing measurable milestones;
- Provide for performance monitoring with a plan for periodic review and revision of the implementation plan; ["Performance Monitoring" means monitoring implementation of management strategies, including sector-specific and source-specific implementation plans, and resulting water quality changes.][8]

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[5] Oregon Administrative Rules (OAR's) 340-042-0030 and authorized by ORS 468B.020.
[6] Tualatin Basin TMDL Implementation Plan Approval Letter to Washington County DLUT; Wade Peerman, DEQ Tualatin Basin Coordinator; Feb. 14, 2020.
[7] See in particular Chapter 3.5 herein.
[8] Oregon Administrative Rules 340-042-0030(7).

- To the extent required by ORS 197.180 and OAR Chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and

- Provide other analyses or information specified in the Order.

In addition, the DMA must implement and revise the plan as needed.

ES - 5.0 Washington County Water Quality Implementation Plan

The Water Quality Implementation Plan [this document] outlines the management strategies and available technology to address water quality standards, primarily through the application of Best Management Practices, or BMPs. DEQ recognizes that technology for controlling some pollution sources such as nonpoint sources and stormwater is in the development stages and will likely take time to develop effective technologies; and that once those practices are implemented, it will also take time to see a measurable water quality improvement. It is possible that after application of all reasonable best management practices, some TMDLs or their associated surrogates cannot be achieved as originally established.[9]

The WQIP is a programmatic approach, incorporating BMP's, the Monitoring Program, adaptive management, and annual review and reporting into a responsible TMDL compliance management strategy.

The following chapters will satisfy the required submittal by demonstrating how the Washington County Department of Land Use and Transportation (DLUT) will utilize existing and improved best management practices to address TMDLs in the rural area of Washington County. A brief description of each chapter is given below.

Chapter One: Introduction: Implementing the TMDL's

As an introduction, Chapter One explains the history of Tualatin Basin water quality concerns, legal requirements of the original and revised TMDLs, purpose of the Implementation Plan, relationship of NPDES stormwater permits, County responsibilities under the TMDL program, requirements of the Implementation Plan, and related watershed planning efforts by other agencies.

Chapter Two: Condition Assessment

This Chapter describes the Tualatin Basin watershed, provides an overall mapped view, and characterizes the sub-watersheds of Dairy-McKay Creek, Gales Creek, Lower Tualatin River, Rock Creek/Middle Tualatin, and Scoggins Creek. These sub-watersheds differ in topography from steep gradient to low gradient, resulting in major differences in stream morphology and flow.

Chapter Three: Source Identification

Introduces the Tualatin TMDL pollutant parameters of concern: Bacteria, Total Phosphorus, Dissolved Oxygen, Temperature and Mercury. Describes sources of each parameter and how to address sources. Explains available knowledge of each TMDL on source identification, and effectiveness of best management practices for control and treatment. Streams listed as water quality limited within the Basin for each parameter are mapped, and a summary is given for Implementation Plan guidance based on a literature review.

[9] **Tualatin River Subbasin TMDL prepared by Oregon DEQ, Sec. 2.3.2, p. 10, August 2001.**

Chapter Four: Water Quality Monitoring Program

Chapter Four describes goals of the Water Quality Monitoring Plan. Goals include instream monitoring for trends in pollutant concentrations, and for compliance with water quality standards. A history of water quality monitoring in the Basin and in rural Washington County is included. Designated Management Agencies work together with DEQ to develop and implement the monitoring program to address the TMDL parameters. Most of the monitoring in the rural area is accomplished by Clean Water Services. Washington County works with the DMA Monitoring Committee and technical consultants to track representative sites for ambient monitoring and trend analysis.

Chapter Five: Addressing the Load Allocations: Best Management Practices

Chapter Five describes management programs and activities to address the TMDL parameters in the rural portions of Washington County. This follows DEQ guidance on major areas of responsibilities to address the TMDLs, describes Best Management Practices (BMPs), and which pollutants are addressed. The major areas of responsibility include County Roadway Operations, Capital Project Management, County Land Use Planning and Permitting, Septic System Inspection and Permitting, and Riparian Area Management.

Chapter Six: Program Evaluation, Adaptive Management, and Reporting

This Chapter explains how to evaluate progress in addressing the TMDL load allocations for each parameter: Bacteria, Phosphorus, Dissolved Oxygen, Temperature, and Mercury. A baseline for "Reasonable Assurance" is described, including how it relates to Adaptive Management. Some statutory restrictions on County authority to regulate activities on agricultural and forestlands and certain private party activities explain why it is difficult to take responsibility for specific load allocations, and why narrative standards work as well. An outline for reporting progress to DEQ is given.

ES - 6.0 Related Important Efforts in the Watershed

ES-6.0.0 Goal 5; Tualatin Basin Partners for Natural Places

Tualatin Basin Partners for Natural Places: Goal 5/ Natural Resources Program is an alliance of local governments in Washington County working together with Metro to meet federal and state requirements for protecting natural resources in the Tualatin Basin. Goal 5 of Oregon's statewide land use planning program requires cities and counties to inventory and protect natural resources and conserve scenic and historic areas and open space. Metro developed a regional natural resources program concentrating on stream corridors and wildlife habitat.

The Partners analyze important streamside and upland wildlife habitats in the Tualatin Basin watershed, based on a regional inventory, then determine if and how to protect these habitats while balancing economic, social and energy needs. Programs will work to conserve and protect sensitive habitat in significant natural resource areas.

ES-6.0.1 NOAA Fisheries' Approved Limit 10

The Operations Division of the Washington County DLUT developed a comprehensive procedural document: Best Management Practices for Routine Road Maintenance[10], (BMPs/RRM) building on previous BMP programs and documents. The BMPs/RRM is modeled after the NOAA Fisheries-approved Oregon Department of Transportation (ODOT) program for routine road maintenance. The Washington County program satisfies the 4(d) Rule for Pacific Northwest Salmon protection through a "Limit 10" specifically for Washington County, first approved by NOAA Fisheries in 2005, with modifications including the last update in 2017. This TMDL Water Quality Implementation Plan utilizes these best management practices to address the TMDL parameters of concern.

ES-6.0.2 Co-Implementation of NPDES Permit

Washington County DLUT is a formalized Co-Implementer of the NPDES Watershed Permit held by primary Permittee Clean Water Services of Washington County, along with member Cities of Washington County. Stormwater Management is the primary concern, and applies in the urban and urbanizing area of the County. Washington County's Best Management Practices are utilized in both the urban and rural areas and are the basis for the NPDES co-implementation, along with required permit conditions on specific projects where a permit is required.

ES-6.0.3 Tualatin River Watershed Council

Washington County DLUT has been an active member of the Tualatin River Watershed Council since its inception in 1993. The Council is a forum to bring local, state, and federal land management agencies together with local residents, giving a voice in natural resource management that can significantly influence watershed management decisions.[11] The Watershed Council manages partnership projects contributing to water quality improvement, habitat restoration, and overall watershed health across the Basin.

[10] The complete document can be viewed at: https://www.co.washington.or.us/LUT/Divisions/Operations/upload/2017-BMPs-RoutineRdMaint.pdf
[11] https://trwc.org/about-us

Oregon
Kate Brown, Governor

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February 14, 2020

Todd Watkins, P.E. Operations Division Manager
Washington County Department of Land Use & Transportation
155 N First Avenue, Suite 350
Hillsboro, OR 97124-3072

RE: Tualatin Basin TMDL Implementation Plan Approval

Dear Mr. Watkins:

The Oregon Department of Environmental Quality (DEQ) has reviewed the *Water Quality Implementation Plan for Addressing Tualatin Basin Nonpoint Source TMDL Parameters in the Rural Area March 1 2019* received on March 1, 2019. DEQ applauds Washington County's long history of TMDL implementation for the protection and restoration of water quality and appreciates the amount of work that went into preparing this Plan.

The Plan meets the basic requirements for the development of TMDL implementation plans as specified in Oregon Administrative Rule 340-042-0080 (4), and DEQ approves this Plan. DEQ appreciates the dialogue during the development of this update to your plan and that changes were made as requested by DEQ to improve the plan especially as the plan and matrix relate to measurable goals and objectives.

DEQ affirms that we are available to you as a resource as you move forward with TMDL implementation. Annual reports continue to be due March 1 of each year, with a five year review and plan update anticipated in 2023. Please contact DEQ if it is more efficient for you to submit annual reports in a different month of the year. We encourage you to manage your reporting schedule to maximize your reporting efforts by combining this with other reports. Your matrix is designed with the annual reporting requirement in mind and we believe that it is well-suited for tracking and reporting progress overtime. We anticipate that the annual review process will facilitate adaptive management as well as subsequent five year implementation reviews.

We look forward to your continued involvement in TMDL implementation efforts in the Tualatin Basin and to your ongoing commitment to improving water quality conditions. Should you have questions about TMDL implementation or this letter, please call or email me at 503- 229-5046 or peerman.wade@deq.state.or.us.

Sincerely,

Wade R Peerman

Wade Peerman
Tualatin Basin Coordinator
503-229-5046
peerman.wade@deq.state.or.us

electronic cc:

Donna Hempstead, Environmental and Land Use Economics
Tim Sautter, Sr. Environmental Resource Specialist, Washington County DLUT
Stephen Cruise, Project Manager, Washington County DLUT
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Steve Mrazik, Watersheds Manager, Northwest Region, DEQ

Chapter One
Introduction
Implementing the TMDLs

This TMDL Water Quality Implementation Plan (WQIP/WQMP)[1] describes the actions that Washington County carries out to reduce pollution in order to help restore and protect water quality in the rural area of the Tualatin Subbasin, subject to limits of County authority. These efforts are required to meet pollutant load allocations (LA's) as defined in the updated Tualatin Subbasin Total Maximum Daily Load (TMDL) approved by the U.S. Environmental Protection Agency (EPA) originally in 2001, revised in 2012, 2019 and 2021, and administered by the Oregon Department of Environmental Quality (DEQ). The matrix in Chapter 5 summarizes current actions that the County is taking to protect water quality and address the TMDL's.

This Chapter includes Introduction to or Summaries of:

1.0 History of TMDLs in the Tualatin Basin

1.0.0 Listing of Tualatin River on 303(d) List of Impaired Waterbodies

The Federal Clean Water Act (CWA) requires that states establish a list of impaired or water quality limited waterbodies using water quality standards.[2] Once identified, these waterbodies are put on the 303(d) list, named after that section of the CWA. In Oregon, the Department of Environmental Quality (DEQ) was delegated the authority to manage this list. In order to meet the water quality standards, the state must establish a Total Maximum Daily Load (TMDL) to address those parameters identified on the 303(d) list. The TMDL is the total amount of a pollutant a water body can accept without violating the water quality standard.

During the mid to late 1970's Washington County experienced a rapid population growth. As the urban areas grew, small wastewater treatment facilities were combined into larger facilities, operated by the Unified Sewerage Agency (USA). The increase of human activity led to a decrease in water quality. In the mid 1980's, the Tualatin River and 29 of its tributaries were identified as water quality limited due to excessive algal blooms, high pH levels and low dissolved oxygen levels. Elevated phosphorus and ammonia levels from wastewater treatment plants (WWTP) were the primary sources. In 1984, the Tualatin River and its tributaries were listed on the 303(d) list and thus required the development of TMDLs to address the parameters of concern.

[1] Washington County Water Quality Implementation Plan = Washington County Water Quality Management Plan.
[2] Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 et seq.; renamed the Clean Water Act by Congress in 1977 adding provisions for toxic pollutants. Amended in 1987 to strengthen provisions relating to nonpoint source pollution, and to strengthen federal enforcement authority.

1.0.1 TMDL Development in the Tualatin Basin

Ammonia and Phosphorus

In 1988 TMDLs were set for ammonia and phosphorus. The goal of the ammonia TMDL was to increase Dissolved Oxygen (DO) levels necessary for healthy aquatic life in the basin. The focus of the ammonia TMDL was on point sources from the WWTPs in the basin. Waste loads and Load allocations were set forth in the TMDL. The phosphorus TMDL addressed both point and nonpoint sources. Its goal was to reduce algal growth and elevated pH levels to help support the beneficial uses of aquatic life and aesthetics. Wastewater treatment plants were identified as the primary point source of phosphorus in the mainstem of the Tualatin. In 1994, state of the art phosphorus removal was implemented at the Rock Creek and Durham Wastewater Treatment Plants resulting in an immediate 90% reduction in effluent phosphorus concentrations.[3] The success with phosphorus and continuing 303(d) list implementation led to new TMDLs. Nonpoint sources were identified as the primary source of phosphorus in tributaries.

Recommendations for TMDLs

In 1997 the Tualatin Basin Policy Advisory Committee (TBPAC) was formed to review the existing monitoring data and phosphorus and ammonia TMDLs. Data obtained via the monitoring program indicated significant improvements in phosphorus and ammonia levels within the Tualatin basin. Studies also revealed information on background levels of phosphorus. The TBPAC recommended to DEQ that the existing TMDLs for phosphorus and ammonia be revised to reflect this improvement.

In accordance with EPA guidelines, DEQ updated the 303(d) list in 1998. Several new parameters were listed for tributaries of the Tualatin River at that time: temperature, bacteria, low pH, biological criteria, arsenic, iron and manganese. To address these new pollutants of concern, the development of TMDLs was recommended for temperature, bacteria and volatile solids. Elevated levels of arsenic, iron and manganese were identified as naturally occurring and therefore TMDLs were not established. Biological criteria violations were linked to habitat and flow modifications. Because they are not pollutants, no TMDLs were established for these parameters.

Approval of TMDLs

In August 2001, Tualatin Basin TMDLs were approved by U.S. EPA for temperature, bacteria and dissolved oxygen, and the phosphorus and ammonia TMDLs were revised. All address both point and nonpoint sources. In September 2006 DEQ published new Willamette Basin TMDLs for Bacteria, Temperature, and Mercury. As required in the DEQ's Willamette Basin TMDL: Water Quality Management Plan, Designated Management Agencies (DMAs) are required to develop TMDL implementation plans that describe the management measures they will take to achieve load allocations. The DMAs are listed in Chapter 14, with a special footnote regarding Washington County. "Washington County already has a TMDL implementation plan in place that addresses temperature and bacteria because of earlier TMDLs. The County is only responsible for updating this plan to address mercury".[4] Later notices required this update to be submitted by March 31, 2008. Washington County submitted the updated WQMP document in March 2008. Washington County has submitted 5-Year WQIP's in 2009, 2014, and again in 2019.

[3] Public Awareness Document, "Phosphorus Levels Declining and Water Quality Improving in Tualatin River Basin", B. Bonn, Clean Water Services, May 2002.
[4] Willamette Basin TMDL, DEQ Water Quality Management Plan, September 2006, page 14-8.

In August 2012 DEQ issued a final Tualatin Subbasin[5] Order and TMDL to provide waste load allocations for total phosphorus and ammonia at 2 new discharge locations, and to allow trading of allocations among three wastewater treatment plants for Dissolved Oxygen. The 2012 Order is supplemental to the 2001 TMDL, and did not alter any 303(d) listings.[6] The new Order did not change rural area load allocations relative to the Washington County WQIP. The 2019 Washington County TMDL WQ Implementation Plan for Nonpoint Source TMDL Parameters was approved by Oregon DEQ on February 14, 2020. Although the next 5-Year Plan is not expected until 2024, Oregon DEQ requested this Mid-Plan Update to address Mercury revisions approved by U.S. EPA in 2021.

A brief description of each TMDL is listed below:

- Temperature - The goal of the temperature TMDL is to reduce water temperatures to support cold-water fish, particularly salmon. Temperature is also a factor in algal growth.

- Bacteria –Bacterial contamination threatens the beneficial use of recreational water contact. Nonpoint sources in both urban and rural areas have been identified as the primary source of elevated bacteria concentrations.

- Dissolved Oxygen – The goal of the TMDL is to increase DO levels to support cold-water aquatic life. A number of factors affect DO levels including decomposition of excessive organic matter, elevated temperature and algal blooms. Ammonia and volatile solids have been identified as accelerators of oxygen depletion in the water column.

- Ammonia – The revised TMDL was set to reflect significant improvements in ammonia discharges from point sources.

- Phosphorus – The revised TMDL was set to reflect significant improvements in control of point sources and additional knowledge of nonpoint sources.

- Mercury – The goal of the mercury TMDL is to reduce mercury in fish tissue to a safe level for consumption.

1.1 Legal Implications of TMDLs

Background: The federal National Pollutant Discharge Elimination System (NPDES) program was expanded in 1987 requiring municipal and industrial dischargers to limit the amount of pollutants discharged to waterbodies from point sources. In addition, provisions were established to address nonpoint sources of pollutants through other than NPDES permits, generally via TMDL Management Plans. In the development of the Tualatin Basin TMDLs, DEQ launched studies and monitoring plans to assess the sources of pollution and water quality within the basin. Initial studies indicated that elevated levels of ammonia and phosphorus from the WWTP discharges (point sources) were the primary causes of the decline in water quality.

To help facilitate the TMDL process, the first Tualatin Basin TMDL Compliance Order and Schedule was set by DEQ in 1989. The original Tualatin Basin TMDL order required cities and counties to implement programs and achieve identified concentrations by June 30, 1993. This order was extended by the Oregon Environmental

[5] The Tualatin is now a Subbasin of the Willamette Basin TMDL.
[6] DEQ Memo from WQ Administrator Aldrich, dated August 28, 2012.

Quality Commission (EQC) several times, and was finally repealed in November 2000. It was replaced by a new TMDL program finalized by Oregon DEQ in 2001, and approved by U.S. Environmental Protection Agency (EPA) in August 2001, and amended the Phosphorus TMDL in 2012. DEQ revised the Willamette Basin TMDL for Mercury in 2019, with ultimate revisions and approval by EPA in 2021.

1.1.0 Compliance Order and Schedule

The current Tualatin Subbasin TMDL Compliance Order for the parameters other than Mercury was issued August 28, 2012. Designated Management Agencies (DMA's) had 18 months from that date to develop or update their Water Quality Implementation Plan (WQIP). Washington County is a DMA, along with any other local government with jurisdiction in the Tualatin Subbasin. Washington County submitted it's updated WQIP in March 2014, and received DEQ approval of the Plan June 3, 2014. The new Order required new agents, such as ODOT, Oregon Department of State Lands, Tualatin Valley Irrigation District, and even federal agencies such as BLM and U.S. Fish and Wildlife, to develop new Water Quality Management Plans. If a DMA complies with its [approved] Implementation Plan, it will be considered in compliance with the TMDLs.[7]

Update Note re: Mercury: DEQ issued the Revised Willamette Basin Mercury TMDL on Nov 22, 2019, with EPA establishing a new TMDL on Dec. 30, 2019. EPA issued the final Revised Willamette Basin Mercury TMDL on Feb. 4, 2021. This Mid-Plan Update addresses those changes, as required. The new revisions have the effect of a Compliance Order, which will be updated in 2022.

1.2 TMDL Allocations

Load allocations (LAs) for nonpoint sources and Wasteload allocations (WLAs) for point sources have been set by Oregon DEQ in the Tualatin River Subbasin TMDL documents (August, 2001 and August, 2012, and December, 2019). Wasteload allocations are not addressed in this submittal document for Washington County because municipal NPDES permit conditions are determined by DEQ and are the responsibility of the Clean Water Services for urban areas. Load allocations for the portions of the rural area directly impacted by Washington County activities or operations will be addressed in this document.

1.2.0 TMDL's and NPDES

The total permissible pollutant load of a TMDL is allocated to point, nonpoint, background, and future sources of pollution. Wasteload Allocations (WLAs) are portions of the total load that are allotted to point sources, such as wastewater from Sewage Treatment Plants (STPs) or industrial sources, or urban stormwater runoff conveyed to receiving waters from a specific outfall. Most of these point sources are regulated and tracked by conditions in NPDES permits. Load Allocations (LAs) are portions of the TMDL that are attributed to either natural background sources, such as soils, or from nonpoint sources such as agriculture or forestry activities. The TMDL program is the integration of these WLAs and LAs.

Section 402(p) of the Clean Water Act requires controls for certain storm water discharges under the National Pollutant Discharge Elimination System (NPDES) program, deemed point sources.[8] Efforts to address pollutant reductions for point source discharges are addressed in industrial NPDES permits, and in Municipal

[7] Tualatin Subbasin TMDL, Chapter 4, Water Quality Management Plan, August, 2012, p. 83.
[8] U.S. Code Title 33, Chapter 26, Subchapter I, Sec. 1251 et seq.

Separate Storm Sewer System (MS4) permits for urban areas. In the Tualatin Basin, Oregon DEQ permits industrial-level discharges through individual and/or general NPDES permits. Likewise, Clean Water Services (CWS) is the MS4 permit holder for stormwater discharges from its municipal storm sewer system in the urban area of the Basin. Point source stormwater discharges within the urban area are managed by CWS under the renewed MS4 permits.[9]

> Point source stormwater discharges within the urban area are managed by CWS under MS4 NPDES permits.

Nonpoint source stormwater discharges in the rural area are managed through the TMDL program, in part by Washington County practices and activities, as explained in this document. Other Designated Management Agencies in the Tualatin Basin including Clean Water Services, the Oregon Department of Agriculture, the Oregon Department of Forestry and the Oregon Department of Transportation play a significant role in addressing both TMDLs and stormwater discharges. Other entities also play a significant role and have been newly designated MA's. These include the Tualatin Hills Park and Recreation District, the Oregon Division of State Lands, the Oregon Water Resources Department, the Oregon Department of Fish and Wildlife, and others.

1.3 County Responsibilities under the TMDLs

1.3.0 Designated Management Agency

Washington County, as a Designated Management Agency (DMA), is responsible for addressing the Tualatin Basin TMDLs for rural and urban land areas under their authority[10], including[11]:

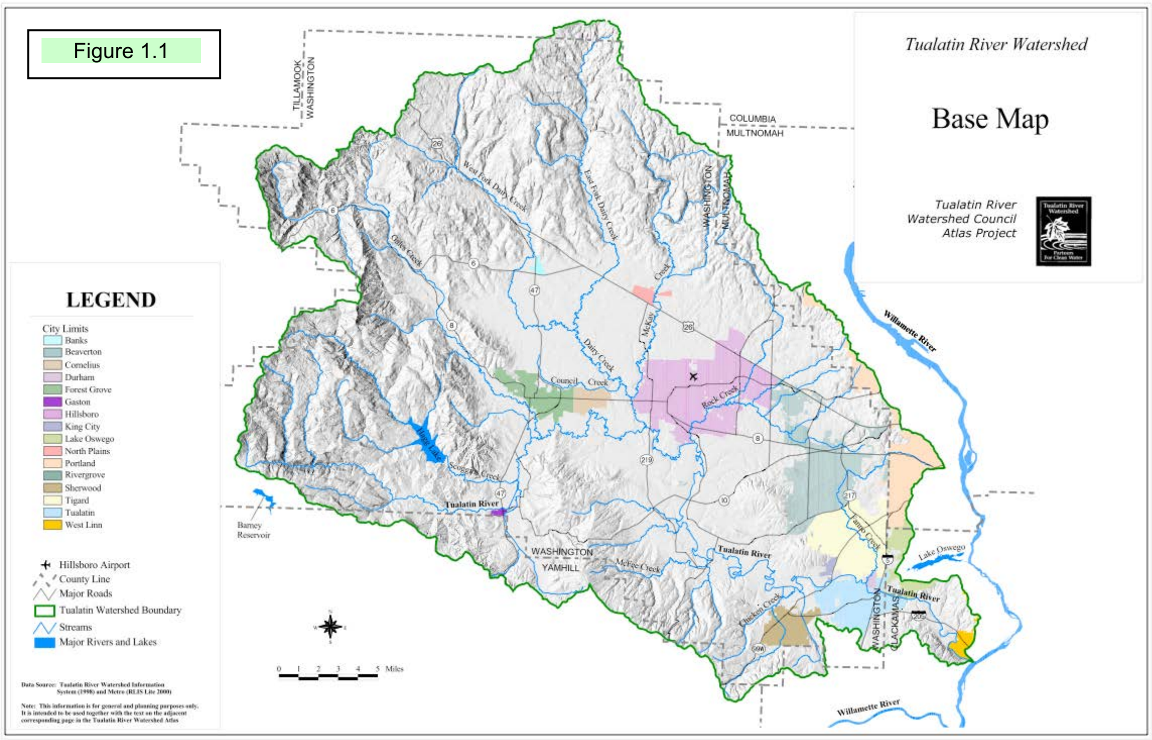
- Zoning and permitting;
- Urban runoff and drainage systems;
- Streets and roads;
- Riparian protection;
- Road, Bridge, and Ditch maintenance and construction practices;
- Sewer and septic systems permitting and enforcement;
- Parks;
- Land Use planning and permitting;
- Maintenance and operation of County-owned Parks or Facilities;
- Riparian Area Management.

The TMDLs for phosphorus, total volatile solids (dissolved oxygen), bacteria, temperature and mercury have the effect of a DEQ Order, and are currently in effect for in the Tualatin Basin.

[9] Clean Water Services combined their MS4 permit and STP's permits into one permit document in 2005. The last renewal permit was approved in 2016.
[10] The implementation activities expected of the County will only extend to the limits of County authority.
[11] Oregon DEQ, Tualatin Subbasin TMDL, WQMP; Chapter 4, p. 101, dated August 2012.

The jurisdictional authority of the County for the Tualatin TMDL program is generally outside Clean Water Services District boundaries (urban services boundary), and within the basin. This is roughly depicted in Figure 1.1 by the gray area and within Washington County boundary lines.

Figure 1.1



1.3.1 Oregon Administrative Rules and the WQIP/WQMP

According to the statewide OAR (340-042-0080) implementing a TMDL includes:

- Management strategies identified in a WQMP to achieve wasteload and load allocations in a TMDL implemented through water quality permits for those point sources subject to permit requirements [for example, NPDES permits], and through source-specific implementation plans for other nonpoint sources. "Management Strategies" means measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives.[12]

- DMA's (other than the OR Department of Forestry or the OR Department of Agriculture) identified as responsible for developing and revising source-specific implementation plans for nonpoint sources (legal interpretation: outside the urban area) must: prepare an implementation plan and submit the plan to the [DEQ] for review and approval according to the schedule specified in the TMDL.

> "Management Strategies" are measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives.

[12] **Oregon Administrative Rules (OAR's) 340-042-0030 and authorized by ORS 468B.020.**

1.4 Implementing the TMDLs

1.4.0 Purpose of Implementation Plan

Oregon DEQ recognizes that it may take some period of time – from several years to several decades – after full implementation before management practices identified in a Water Quality Implementation Plan become fully effective in reducing and controlling certain forms of pollution.

Implementation of a TMDL program is critical to the attainment of water quality standards. The goal of the Clean Water Act and associated Oregon Administrative Rules (OAR's) is that water quality standards shall be met or that all feasible steps will be taken towards achieving the highest quality water attainable.[13] This is a long-term goal in many watersheds, particularly where nonpoint sources are a main concern.

By naming specific TMDL parameters, there is an expectation that specific pollutants will be addressed and achieve the allocated levels of pollutant loading to the receiving stream and river. In theory, the DMA's implementation plan would demonstrate exactly how the management practices within the DMA's jurisdiction would reduce loadings to the DEQ's allocated levels. In practice, the state of the technology is not developed to demonstrate that specific management practices will reduce pollutant loadings to desired levels. This is further complicated for Washington County's responsibilities in the rural area, where Nonpoint diffuse sources are less identifiable.

DEQ recognizes that technology for controlling some pollution sources such as nonpoint sources and stormwater will likely take time to develop effective technologies. It is possible that after application of all reasonable best management practices, some TMDLs or their associated surrogates cannot be achieved as originally established.[14]

Due to these inherent limitations in achieving desired load allocations, the purpose of this implementation plan is to address the TMDL parameters and load allocations by reducing pollutants through source control and structural control where applicable, as required in the TMDL approved by EPA. As better technical information and methodology become available over time, best management practices will continue to improve.

[13] Tualatin River Subbasin TMDL document prepared by Oregon DEQ, Section 2.3.2, page 10; August 2001.
[14] Id.

1.4.1 Requirements of the Implementation Plan

According to OAR (340-042-0080) the implementation plan must:

- Identify the management strategies the DMA will use to achieve/address load allocations and reduce pollutant loading;
- Provide a timeline for implementing management strategies and a schedule for completing measurable milestones;
- Provide for performance monitoring with a plan for periodic review and revision of the implementation plan; ["Performance Monitoring" means monitoring implementation of management strategies, including sector-specific and source-specific implementation plans, and resulting water quality changes.][15]
- To the extent required by ORS 197.180 and OAR Chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and
- Provide other analyses or information specified in the Order.

In addition, the DMA must implement and revise the plan as needed.

According to a DEQ Tualatin Basin Coordinator, the implementation plan framework may contain the following elements[16]:

Framework of Implementation Plans	
1 Goals and Objectives 2 Condition Assessment and Problem Description 3 Proposed Management Measures 4 Reasonable Assurance 5 Identification of Responsible Participants	6 Timeline for Implementation 7 Monitoring and Evaluation 8 Public Involvement 9 Costs and Funding 10 Citation to Legal Authorities

The Washington County Water Quality Implementation Plan for the Nonpoint Source TMDL's in the Tualatin Basin are a combination of the above approaches, that fully meet the intent of the OAR's.

Designing an implementation program generates several of the basic components needed for effective watershed plans. Many of these components are also key elements[17] listed in the Section 319 funding grant guidelines for developing these plans. EPA guidance encourages the development of watershed-based plans with nine key elements. The framework of this Implementation Plan (this Document), along with the actual on-the-ground implementation by the County, as described in various Annual Reports, essentially covers each of the key elements.

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[15] Oregon Administrative Rules 340-042-0030(7).
[16] DEQ Memo to Tualatin Basin DMA's; "Development Issues Related to Tualatin Subbasin TMDL Implementation Plans"; Dec. 3, 2002.
[17] U.S. EPA; Watershed Academy Web: Introduction to Watershed Planning; and "Handbook for Developing Watershed Plans to Restore and Protect our Waters"; EPA Office of Water, Nonpoint Source Control Branch, EPA 841-B-08-002, March 2008.

1.5 Washington County's Implementation Plan

This document is a Management Plan, and is submitted as the Washington County Water Quality Implementation Plan for Rural Nonpoint Source Management in the Tualatin Basin. It addresses the TMDLs by incorporating a combination of the above required and recommended elements. It is submitted to describe how management measures will address the pollutant parameters of bacteria, phosphorus, temperature, mercury and total volatile solids (via surrogate dissolved oxygen).

The document includes the following chapters and will satisfy the required submittal by demonstrating how the Washington County Department of Land Use and Transportation (DLUT) utilizes existing and improved best management practices to address TMDLs in the rural area of Washington County.

Chapter One:	Introduction: Implementing the TMDL's
Chapter Two:	Watershed Characterization/Condition Assessment
Chapter Three:	Identifying and Addressing Sources
Chapter Four:	Water Quality Monitoring
Chapter Five:	Water Quality Management Measures
Chapter Six:	Program Evaluation, Adaptive Management, and Reporting

1.6 Land Use Compatibility

This Washington County Water Quality Implementation Plan is not subject to a permit issued by DEQ. A formal LUCs is not required. The Implementation Plan and activities are consistent with the goals and policies for environmental considerations as stated in the approved Comprehensive Land Use Plan, including Statewide Planning Goals.

1.6.0 Other Land Use Management Measures: Goal 5; Tualatin Basin Partners

Tualatin Basin Partners for Natural Places: Goal 5/ Natural Resources Project is an alliance of local governments in Washington County working together with Metro to meet federal and state requirements for protecting natural resources in the Tualatin Basin. Goal 5 of Oregon's statewide land use planning program requires cities and counties to inventory and protect natural resources and conserve scenic and historic areas and open space. Metro developed a regional natural resources program concentrating on stream corridors and wildlife habitat.

The Partners analyzed, primarily through their land use departments, important streamside and upland wildlife habitats in the Tualatin Basin watershed, based on a regional inventory, then determined if and how to protect these habitats while balancing economic, social and energy needs. The results of the analysis can be found on the web at:
https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8535/Washington_County_Tualatin_Basin_Goal_5.pdf?sequence=1

1.7 Adaptive Management

The goal of the Clean Water Act and associated Oregon Administrative rules is to meet water quality standards. When this is not immediately possible, steps must be taken toward achieving the highest quality water attainable. WQIP's are plans designed to reduce pollutant loads to meet TMDLs. This is a long-term goal in many watersheds, particularly where Nonpoint sources are the main concern, such as the Tualatin Subbasin. Adaptive Management is a desirable and appropriate strategy to use for TMDL implementation.[18]

Current examples of Adaptive Management utilized by Washington County include activities for routine road maintenance, which were significantly revised in 2005 and 2010, and again updated in 2017, to meet federal standards for water quality and fish habitat protection, formally approved by National Marine Fisheries Service to comply with the 4(d) Rule for Pacific NW Salmon. Similarly, new Erosion Control Inspection Forms were introduced to Capital Projects' Inspectors, resulting in better compliance by contractors and project managers in the reduction of sediment loading. Best Management Practices are reviewed annually by the Environmental Resources staff of the Operations Division for needed improvements, which are incorporated as Adaptive Management. TMDL Annual Reports submitted to DEQ each March 1st identify improvements or changes to the TMDL Management Strategies.

More detail regarding the Adaptive Management process can be found in Chapters Five (5) and Six (6) of this document.

[18] **Oregon DEQ, Tualatin Subbasin WQMP, Section 4.1.1 Adaptive Management; August 2012.**

Chapter Two
Condition Assessment
Water Quality Considerations

This Watershed Characterization Chapter is included for historical perspective, at the request of the DEQ Tualatin Basin Coordinator.[19]

This Chapter includes:

2.0 Watershed Characterization

2.0.0 Tualatin River Basin

The Tualatin River Basin occupies approximately 712 square miles in the northwest corner of Oregon. The River runs approximately 80 miles from its headwaters in the Coast Range to its mouth where it converges with the Willamette River. The mainstem and lower reaches of the basin are primarily developed urban areas, while the upper reaches support forest and agricultural activities. Clean Water Services (CWS) serves the urban areas with four wastewater treatment plants. Primarily situated in Washington County, small portions of the basin lie within Multnomah, Clackamas and Yamhill counties.

The hydrologic unit code for the Tualatin River is 17090010 (USGS). This unit is further broken down into fifth field watersheds or subbasins: Dairy-McKay Creek, Gales Creek, Lower Tualatin, Rock Creek/Middle Tualatin River, Scoggins Creek, of which 18 are located within rural Washington County. Table 2.1 lists the reaches and subbasins in which the rural Washington County streams are located. Figure 2.1 shows the Watershed with subbasin boundaries.

2.0.1 Willamette River Basin

The Willamette River Basin (WRB) occupies an area of approximately 32,000 km2 in northwestern Oregon, USA. The Willamette River is the 13th largest river in the coterminous United States in terms of stream flow and produces more runoff per square mile than any of the larger rivers. Oregon's three largest urban areas, the cities of Portland, Salem, and Eugene, border the river. In the WRB, consumption of fish that have accumulated levels of mercury, particularly methyl mercury (MeHg), is a significant mercury health risk for humans. A mercury advisory warning of health risks from consumption of fish has been in effect at Cottage Grove Reservoir (located on the Coast Fork Willamette River in the southern WRB) since 1979.[20] In February 1997, the Oregon Department of Human Services issued a mercury advisory for consumption of largemouth

[19] **Meeting, Nov. 13 2013, with Avis Newell, DEQ Tualatin Basin Coordinator, at Wash. County, Oregon.**
[20] **https://www.oregon.gov/deq/FilterDocs/appxbmercury.pdf , page B-7.**

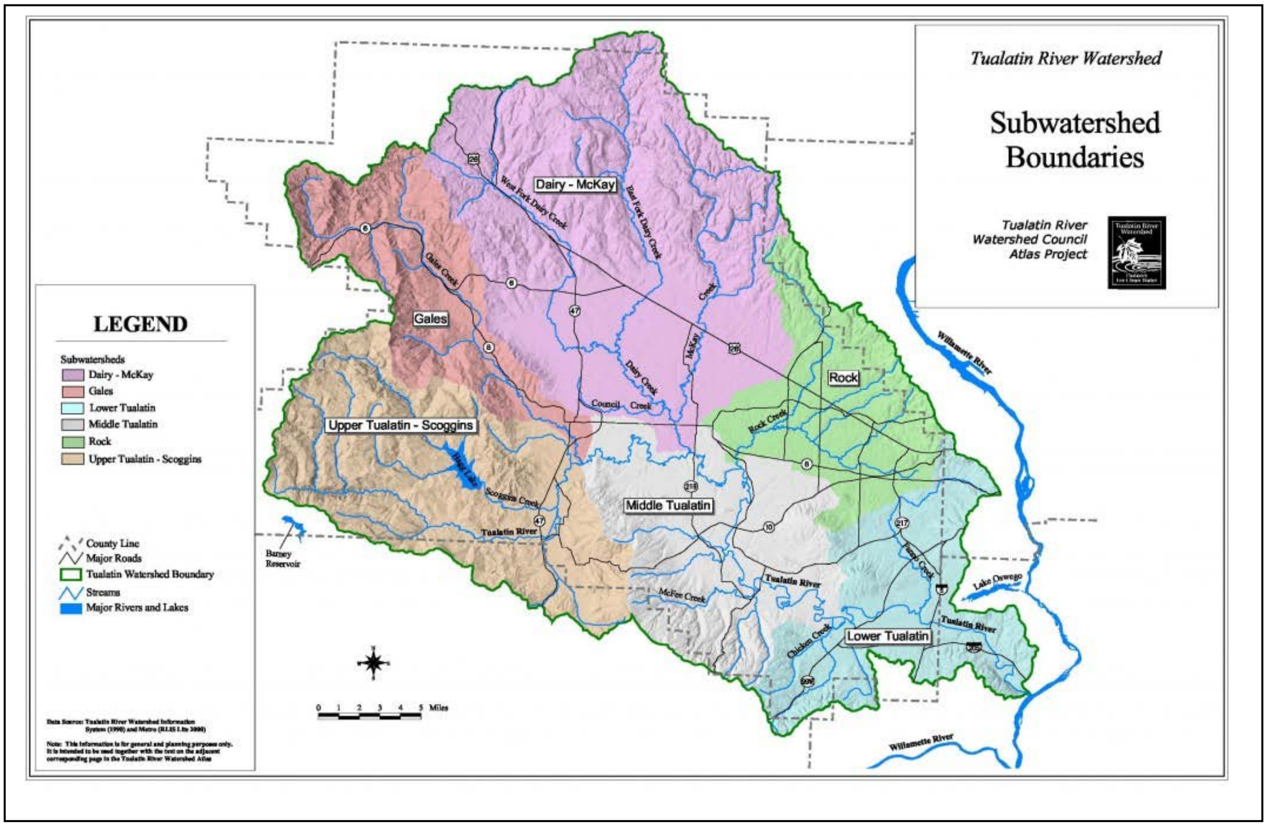
bass, smallmouth bass, and northern pike minnow for the entire mainstem Willamette River, including the Coast Fork to Cottage Grove Reservoir; a separate advisory was issued for Dorena Reservoir, also located on the Coast Fork.[21] The Oregon Department of Human Services issued a consolidated (all species) fish consumption advisory for the entire WRB in 2001. These advisories create, per Clean Water Act Section 303(d), the legal requirement for a mercury TMDL for the WRB.

In the next Chapter: Addressing Sources, Figures 3.1 through 3.4 show the condition assessment from the DEQ Tualatin Basin TMDL document and the DEQ Willamette Basin TMDL for each TMDL parameter other than mercury. Since Mercury is not stream-specific, it is assumed all waterways are subject to the Mercury TMDL, and the map is relative to the entire Willamette Basin in Figure 3.5.

Table 2.1
Tualatin River Basin TMDL Listed Creeks in Rural Washington County by Subbasin[22]

Subbasin	Stream	TMDL Parameters
Dairy Creek-McKay	Council Creek	DO
Dairy Creek- McKay	Dairy Creek	Bacteria, Temperature
Dairy Creek- McKay	E. Fork Dairy Creek	pH (summer), Temperature
Dairy Creek- McKay	W. Fork Dairy Creek	Bacteria (summer), DO, Temperature
Dairy Creek- McKay	McKay Creek	Bacteria, Temperature
Gales Creek	Gales Creek	Bacteria (summer), DO, Temperature
Lower Tualatin River	Cedar Creek	Bacteria, DO, Chlorophyll a
Lower Tualatin River	Chicken Creek	Bacteria, DO
Lower Tualatin River	Summer Creek	Bacteria, Biological Criteria, DO, Temperature
Rock Creek/ Middle Tualatin River	Burris Creek	Bacteria, Biological Criteria, DO, Temperature
Rock Creek/ Middle Tualatin River	Butternut Creek	Bacteria, Biological Criteria, DO, Temperature
Rock Creek/ Middle Tualatin River	Heaton Creek	Bacteria
Rock Creek/ Middle Tualatin River	McFee Creek	Bacteria, DO
Rock Creek/ Middle Tualatin River	Rock Creek	Bacteria, Biological Criteria, DO, Temperature, chlorophyll a
Rock Creek/ Middle Tualatin River	Rock Creek – South	Biological Criteria
Rock Creek/ Middle Tualatin River	Christenson Creek	Bacteria, DO
Scoggins	Carpenter Creek	Bacteria, Biological Criteria, DO, Temperature, Chlorophyll a
Scoggins	Scoggins Creek	DO (Nov-Apr)
Tualatin River	Tualatin River	DO, Chlorophyll a, Bacteria, Temperature

[21] Id.
[22] See Chapter 3 for mapped stream segments.



2.1 Subbasin Characterization

2.1.0 Subbasin Studies

For each subbasin a brief characterization is provided below.[23] Information for each subbasin was taken from Watershed Analysis Reports prepared in cooperation with the Tualatin Soil and Water Conservation District (TSWCD), Tualatin River Watershed Council, and/or the Bureau of Land Management (BLM). The Tualatin Basin has been extensively studied for decades. Many of these reports, including recent ones can be found at the U.S. Geological Survey website at:
https://www.usgs.gov/centers/or-water/science/tualatin-river-basin-water-quality-assessment/

The reports for subbasin characterization were prepared as planning reference tools and relate to geology, hydrogeology, and soil characteristics. Thus, ***although the reports are not recent they are still valid***. They include:

- Tualatin River Watershed Council. 1998. Gales Creek Watershed Assessment Project. September 1998.
- USGS (United States Geological Survey). 1989. Hydrologic map of Tualatin River

[23] **Since geological and geomorphological characteristics have not changed, the Subbasins descriptions are repeated here (by DEQ request, Nov. 2013) from the previous Washington County WQIP.**

- WCSWCD (Washington County Soil and Water Conservation District). 2001. Lower Tualatin Watershed Analysis. August 14, 2001.
- WCSWCD (Washington County Soil and Water Conservation District). 2000. Upper Tualatin-Scoggins Watershed Analysis. February 2000.
- WCSWCD (Washington County Soil and Water Conservation District). 2001. Middle Tualatin-Rock Creek Watershed Analysis. February 14, 2001.
- WCSWCD (Washington County Soil and Water Conservation District). 2001. Dairy Creek Tualatin Watershed Analysis.

2.1.1 Healthy Streams Plan

The study areas for *Watersheds 2000* were focused on urbanized and surrounding areas, while this Implementation Plan concentrates on rural Washington County.

Additional significant historical data for watershed characterization can be found in the Clean Water Services' *Watersheds 2000* and "Healthy Streams Plan" project. However, aside from the upper half of Rock Creek, the 114-square mile East County study area lies almost entirely within the Urban Growth Boundary and includes Beaverton and Tigard. The Central County study area covers approximately 52 square miles in the center of the Tualatin Basin. The cities of Hillsboro, Forest Grove, Banks, and North Plains are included in the study area, but the majority of this portion is outside of the Urban Growth Boundary. The South County study area is the smallest of the three (33 square miles) and lies almost entirely outside of the Urban Growth Boundary, except where it intersects portions of Tualatin and Sherwood. Study data collected on macro-invertebrates, invasive species, stream habitat, and riparian vegetation are accessible from the website www.cleanwaterservices.org in map form.

2.1.2 Dairy-McKay Creek

The Dairy-McKay Creek subbasin is situated in the northern most part of the Tualatin basin and is also the largest subbasin. The hydrologic unit code for Dairy-Mckay Creek is 1709001001 (USGS).

The Dairy-McKay watershed comprises approximately one third of the total area of the larger Tualatin watershed.

The majority of this area lies outside of the Urban Growth Boundary. Land in the northern part of this watershed (Tualatin Mountains) generally has greater slope than the southern part and is subject to mass wasting. Most streams in this watershed originate from the north and flow to the south.

Approximately 69 miles of stream are on the 303(d) list (2001) as impaired in the Dairy-McKay watershed. Parameters of concern include temperature, dissolved oxygen, *E. coli*, phosphorus, and pH. Three inactive Superfund sites are located in this watershed.[24] Dairy Creek is considered essential fish habitat for salmonids and supports cutthroat, steelhead, and Coho, as well as other important cold-water non-salmonids. Steelhead trout have limited distribution, but are known to use the East and West Forks of Dairy Creek, Burgholzer Creek, McKay Creek, and Jackson Creek.

[24] All 3 sites are located in North Plains. Two of these sites, The Dant and Russell Burlington Northern site, and the Vadis pole yard, were found to have hazardous wastes needing removal. Following hazardous waste removal, the EPA removed these sites from the CERCLA list. For the third site, FERAD, Inc., emergency waste removal was not considered necessary and this site was also removed from the list. See http://trwc.org/wp-content/uploads/2013/03/Dairy-McKay-Watershed-Analysis-1999.pdf Section 3.1.4.6

Comparison of existing conditions to reference conditions resulted in a number of report recommendations. These include minimizing erosion, protecting and restoring existing floodplains and wetlands, introduction of large woody debris to stream channels, reducing stream sedimentation, improving water quality, and controlling the spread of noxious weeds.

Topography

The subbasin is divided into three branches: East and West Fork of Dairy Creek and McKay Creek.

Dairy Creek flows from its headwaters in the Tualatin Mountains and flows south toward the City of Hillsboro, where it meets the Tualatin River. Elevations range from more than 2250 feet in the headwater reaches to 1500 feet. As the streams flow south, elevations decrease in the lower Tualatin Plain.

Geology

The geology of the subbasin is characterized by tectonic folding in the Tualatin Mountains. In the headwater reaches, most of the East and West Forks of Dairy Creek are underlain by Tertiary Marine sedimentary formations. The McKay Creek geology is underlain by Columbia River basalt. In the lower parts of the mountain the forks of the creek are also underlain by basalt. The creeks develop into alluvial floodplains starting at the foothills and extending into the plains. Widths of the floodplains average between 2,900 feet and 3,900 feet in the East and West forks, while the McKay Creek averages about 1900 feet in width. Historic floods during the Pleistocene era resulted in deposits of gravel, sand, silt and clay in the valley.

Soils

The parent material within the watershed largely influences its soil types. The sedimentary formations in the upper reaches produce Alfisols and Inceptisols. These erodable soils are fine grained with a large silt component and occur in a wide variety of loams. Soils in the McKay creek area produce Andisols and Utisols. Due to the moist climate, the Columbia River basalt decomposes easily into lateritic, unstable soil. In the plains and alluvial areas, soils are in the silt and clay classes and drain poorly. Phosphorus levels in the valley soils are high indicating accumulation from agricultural practices over the years.

Vegetation

Vegetation within the subbasin includes a variety of native and non-native plant species. In the upper reaches of the Tualatin Mountains, conifers are the dominant vegetation including Douglas-fir, red cedar and western hemlock. Deciduous trees include big-leaf maple, red alder and white oak. Land use in the lower portion of the subbasin is predominantly agriculture and includes wheat, row crops and orchards. Oregon ash and red-osier dogwood typically dominate riparian zones. Non-native species, Himalayan blackberry, reed canary grass and Scotchbroom are present in many disturbed areas. A number of sensitive species have been identified within the subbasin.

Climate

The climate within the Dairy-McKay Creek subbasin is moderate with warm and dry summers, while winters are cool and wet. The moist climate produces precipitation primarily in the winter months. Approximately 72% of the rain falls during the winter months. Precipitation is generally greatest in the upper reaches of the basin in the more mountainous areas. Annual precipitation ranges from 67 inches in the headwaters to 38 inches in the floodplain areas.

Watercourses

Most streams in the Dairy-McKay subbasin are perennial. Flows are seasonal and influenced by precipitation. Winter flows are much higher than those experienced in the summer. Due to its location in the lower portion of the mountains and extension into the alluvial plains, streams within the subbasin do not contribute much to flood peaks within the mainstem of the Tualatin. Flooding within the subbasin does occur mainly in the alluvial plains. The poorly drained soils in this area create standing water.

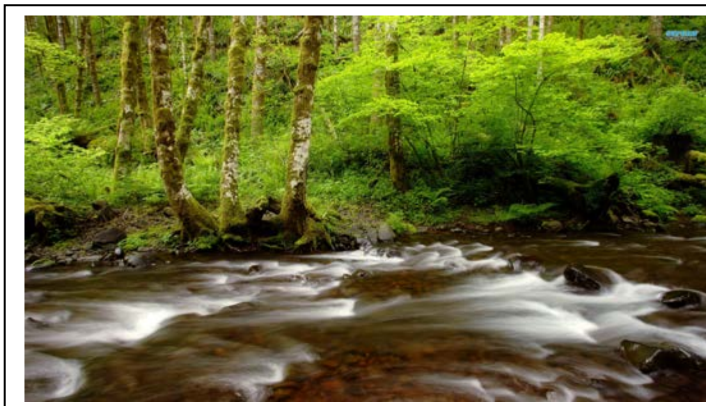
Land Use

Land use within the subbasin consists of forestry, agriculture, urban development and recreation. The primary use is forestry, which occurs in the northern part of the subbasin. Private industry and non-industrial groups own the majority of the land, with less than 12% owned by public agencies. In the lower region of the subbasin, agriculture is the predominant land use. Urban development is primarily centered around Council Creek and lower McKay and Dairy creeks. These areas continue to experience rapid growth. Recreation within the subbasin occurs throughout, but mostly occurs in the upper reaches. These areas provide fishing, hiking, hunting, biking opportunities, while the lower reaches provide space for golf and model airplaning.

2.1.3 Gales Creek

The Gales Creek subbasin is situated in the northwestern most part of the Tualatin basin and is also the smallest subbasin. The hydrologic unit code for Gales Creek is 1709001002 (USGS).

The Gales Creek Watershed Assessment prepared for the Tualatin River Watershed Council contains technical information about past and present conditions in the watershed, identified data gaps, and recommends restoration activities. This includes aerial studies, maps, and field surveys. Looking at the water quality aspects of the assessment, the following information summarizes the findings.



Topography

Gales Creek flows from the east side of the Coast Range Mountains in the northwestern edge of Washington County and flows southeasterly toward Forest Grove, where it meets the Middle Tualatin River. The subbasin is divided into nine subwatersheds. Elevations range from 3,154 feet at the headwaters to 159 feet at the confluence with the Tualatin River. Much of the upper watershed is located in the steep mountain slopes or hillsides. As the mainstem flows toward Forest Grove, gradients level off to fluvial terraces.

Geology

The geology of the subbasin is characterized by volcanic and sedimentary rocks of the Tertiary period. In the upper reaches, basaltic lavas and tuffs, overlain by sedimentary rocks underlie most of the watershed. The historic Missoula Floods of the Pleistocene age resulted in deposition of shale, sandstone, siltstone and claystone in the foothills and valley.

Soils

The parent material within the watershed largely influences its soil types. The volcanic and sedimentary formations in the upper reaches produce silty loam and silty clay loams. In the lower floodplains and wetland areas, alluvium, silt and clay deposits dominate. The entire watershed is underlain by sandstone 400 feet thick.

Vegetation

> Douglas-fir dominates the steeper slopes of the upper watershed, which were replanted as part of logging or the Tillamook burn. Land use in the floodplains is almost exclusively agriculture.

Vegetation within the subbasin includes a variety of native and non-native plant species. Douglas-fir dominates the steeper slopes of the upper watershed, which were replanted as part of logging or the Tillamook burn. Deciduous species along riparian areas in the upper reaches include Black cottonwood, Oregon ash, vine maple, bigleaf maple and elderberry. Lower reaches in the foothills are composed of a mixture of woodlands, pastureland, vineyards, orchards and Christmas tree farms. Land use in the floodplains is almost exclusively agriculture. Species along riparian areas in the lower reaches include both native and non-native vegetation, including red osier dogwood, Himalayan blackberry, snowberry, ninebark, oceanspray, cascara, horsetail, canary reed grass and sedges. A number of sensitive species have been identified within the subbasin.

Climate

Due to its location in the upper Coast Range mountains and close vicinity to the ocean, the climate is largely marine-influenced. Summers are typically hot and dry, while winters are cool and wet. Upper elevations receive some snow and most of the precipitation within the watershed. Precipitation averages 110 inches per year in the upper reaches, while lower reaches receive about 45 inches per year.

Watercourses

> Streams exhibit 'flashy' characteristics where stream levels rise and fall quickly as storms pass.

Most of the streams within the watershed are perennial. Flows are seasonal and influenced by precipitation. Flashy behavior is typical, especially in the upper reaches. Higher gradients in the upper reaches produce fast moving streams and transition into windy streams in the hillsides and rolling hills. In the floodplains, streams tend to meander and are more sluggish.

Land Use

The subbasin is located almost entirely in rural Washington County. Forestry is the dominant land use, followed by agriculture. Agriculture crops consist of vegetables, berries, orchards, Christmas trees, grains and vineyards. Other uses include rural residential, rural commercial and land extensive industrial. Industry is limited to those activities associated with forestry or agricultural activities. Population growth is limited within the watershed due to its rural designation.

2.1.4 Rock Creek / Middle Tualatin River

The Rock Creek/Middle Tualatin River subbasin is situated in the lower southeastern part of the Tualatin basin. The hydrologic unit code for Rock Creek is 1709001004 (USGS).

Topography

Rock Creek flows from its headwaters in the Tualatin Mountains and flows southwest toward Hillsboro toward the confluence with the mainstem of the River. Elevations in the upper reaches range from 1,633 feet to less than 250 feet in the lower alluvial plains. Approximately 60% of the watershed is located in these plains.

Geology

Geology in the subbasin is characterized by tectonic folding in the Tualatin Mountains. Columbia River basalt and sedimentary rock are dominant in the upper reaches, while streams develop into alluvial floodplains in the lower reaches. Floodplains average 2,500 feet in width and are wider in the Tualatin Plain. The Missoula floods during the Pleistocene age resulted in deposits of gravel, sand, silt and clay throughout the valley.

Soils

Soils are largely influenced by the parent rock in the subbasin. In the valley foothills, soils are predominantly Alfisols and Inceptisols, characteristic of the basalt and sandstone. Alfisols, Mollisols and Inceptisols are found in the lower floodplains. Soils are highly erodable in the upper reaches due to the moist climate. Soil erosion is common in all areas of the watershed due to the type of soils and stream morphology.

Vegetation

> Stands in the higher elevations typically consist of red alder, bigleaf maple and Oregon white oak.

Vegetation within the subbasin includes a variety of native and non-native plant species. Coniferous/deciduous forests are dominant in the mountainous and foothill areas with agricultural crops in the lower floodplains. Land use in the floodplains is predominantly agriculture and urban development. Riparian vegetation includes Oregon ash, bigleaf maple, black poplar, red osier dogwood and Himalayan blackberry. Non-native species tend to dominate disturbed areas. A number of sensitive species have been identified within the subbasin.

Climate

A moderate climate characterizes the Rock Creek/Middle Tualatin River subbasin. Summers are hot and dry, and winters are cool and wet. Most of the precipitation falls during the winter months, about 72%, and is mostly rain with some snow in the upper reaches. Precipitation is greatest in the upper reaches in the more mountainous areas. Annual precipitation ranges from 55 inches at the headwaters to 38 inches at Hillsboro.

Watercourses

Streams within the subbasin are mostly perennial with seasonal variations. Flows are typically higher in the winter when precipitation is greater and lower during the summer months. Both confined and unconfined aquifers contribute groundwater to the streams. Flooding in the alluvial plains is somewhat controlled by a number of facilities along the mainstem. However, flooding does occur and is further attenuated by ponding in the floodplains and wetlands.

Land Use

Land use within the subbasin includes urban and rural residential, agriculture, forestry and recreation. The primary use is agriculture (48%) followed by urban residential (38%) in the lower region of the subbasin. Agriculture includes field crops. Urban development is primarily centered in the areas of Cooper Mountain and Bethany Creek. These areas continue to experience rapid growth. Forestry, a minor land use (5%), is concentrated in the northern portion of the watershed. Recreation within the subbasin occurs throughout, but mostly occurs in the southwestern portion. These areas provide hiking, biking, jogging and birding opportunities.

2.1.5 Scoggins Creek

The Scoggins Creek subbasin is situated in the western most part of the Tualatin basin. The hydrologic unit code for Scoggins Creek is 1709001003 (USGS). The Coast Range occurs in the western part of this watershed, where most streams originate and flow from west to east.

> The Upper Tualatin-Scoggins watershed is located in the southwest part and comprises approximately one fifth of the total area of the larger Tualatin watershed. This area lies outside of the Urban Growth Boundary.

Approximately 11 miles of stream are impaired according to 303(d) water quality standards including Carpenter Creek and Scoggins Creek. Parameters of concern include dissolved oxygen and bacteria. Comparison of existing conditions to reference conditions resulted in a number of report recommendations. These include many of the same recommendations made for the Dairy-McKay watershed, such as minimizing erosion, protecting and restoring existing floodplains and wetlands, introduction of large woody debris to stream channels, improving water quality, and controlling the spread of noxious weeds.

Topography

The two main branches of the subbasin, Scoggins Creek and Wapato Creek, flow easterly from the headwaters in the Coast Range Mountains toward the confluence of the Tualatin River near Gaston. Elevations range from 3,525 feet at Saddle Mountain to less than 250 feet in the alluvial valley. Approximately 80% of the subbasin is located in the mountainous areas and is characterized by rugged dissected topography.

Geology

The geology of the subbasin is characterized by volcanic accretion and tectonic folding of the Coast Range Mountains. Volcanic and sedimentary rock were intruded by igneous rocks in the upper reaches. Sandstones are more common in the valleys. The bedrock in the headwaters area is fairly resistant to erosion due to underlying volcanic strata but can be susceptible to landslides where canyon walls are undercut by streams. At lower elevations, slumping and weathering is more likely to occur. Streams develop into alluvial floodplains as elevations fall in the foothills. Floodplain widths average 2,200 feet and 6,693 feet in the Scoggins and Wapato valleys. The alluvium is generally much thinner than elsewhere in the Tualatin River basin.

Soils

The parent material within the watershed largely influences its soil types. In the steep sloping areas, soils include Inceptisols and Ultisols, typical of basalt and volcanic rock. The foothill areas also produce Alfisols and Mollisols. Due to the moist climate, the basaltic and sedimentary formations produce highly erodable and unstable soils. In areas where volcanic bedrock is exposed, soils are more stable.

Vegetation

The majority of land area in this watershed is forested and undergoing active logging activities. Vegetation within the subbasin includes a variety of native and non-native plant species. The steeper slopes of the upper watershed are dominated by Douglas-fir, which were replanted as part of logging or the Tillamook burn. Deciduous species along riparian areas in the upper reaches include Black cottonwood, Oregon ash, vine maple, bigleaf maple and elderberry. The foothills and valley floors are dominated by agriculture, but also include oak woodlands that naturally grade into conifer forest. Species in the narrow riparian zones in the valleys consist of Oregon ash, black poplar, red osier dogwood, Himalayan blackberry and willows. A number of sensitive species have been identified within the subbasin.

Climate

The climate within the Coast Range Mountains is moderate with warm and dry summers, and cool and wet winters. The moist climate produces the majority of precipitation during the winter months. Precipitation, mainly in the form of rain, is greatest in the upper reaches of the subbasin in the more mountainous areas. Annual precipitation ranges from 110 inches at Windy Point to 46 inches in the valley.

Watercourses

Most of the streams within the subbasin are perennial. Flows vary by elevation and seasonally, with 84% of all flows occurring from November to March. Streams at higher elevations experience high flood peaks, but are mitigated by forested lands and flood control at Scoggins Dam (Haag Lake). Lower reaches also experience flooding but are attenuated on the valley floor. Ponding occurs in the Wapato valley during winter months.

Land Use

Land use within the subbasin includes forestry, agriculture, urban and rural residential, and recreation. Forestry is the predominant use occurring over two-thirds of the subbasin. Agriculture is dominant in the foothills and Wapato valley and urban use is restricted to an area surrounding Gaston. Approximately 87%

of the subbasin is privately owned. Recreation within the watershed includes hiking, camping, hunting, fishing, birding, cycling and touring. Haag Lake also offers boating, water skiing and fishing opportunities.

2.1.6 Lower Tualatin River

The Lower Tualatin River subbasin is situated in the southern most part of the Tualatin basin. Thy hydrologic unit code for Lower Tualatin River is 1709001005 (USGS).

Topography

Approximately 63% of the Lower Tualatin subbasin is situated in the plains. The lower portion of the river meanders through relatively flat terrain.

The lower Tualatin River flows from the foothills of the Tualatin Mountains through the Tualatin Plain. Ultimately the River flows east into the Willamette River. Elevations range from 1,000 feet in the hills to less than 60 feet in the plains.

Geology

Tectonic folding and subsequent alluvial depositions characterize the geology of the subbasin. The folding of volcanic and sedimentary rocks became the foothills and a synclinal trough became the plain. Localized lava flows are a result of the folding in the foothills. Columbia River basalt interspersed with sedimentary formations is also typical in these areas. The Tualatin Plain is composed primarily of alluvial fill. The Missoula floods during the Pleistocene age resulted in deposits of gravel, sand, silt and clay in the valley and plains.

Soils

Soils are largely influenced by their parent material. In the foothill areas, soils include Alfisols and Inceptisols, typical of basalt rock. Due to the moist climate, the basaltic and sedimentary formations produce highly erodable and unstable soils. In areas where volcanic bedrock is exposed, soils are more stable. Fluvial action in the plains area erodes soft alluvial fill along streambanks.

Vegetation

Vegetation within the subbasin includes a variety of native and non-native plant species. Forest type vegetation is found in the foothills area, consisting of Douglas fir and bigleaf maple. Land use in the plains is either agriculture or urbanized. Species along riparian areas in the lower reaches include both native and non-native vegetation, including Oregon ash, black poplar, willows, bigleaf maple, red osier dogwood and Himalayan blackberry. A number of sensitive species have been identified within the subbasin.

Climate

Climate within the subbasin is moderate with warm and dry summer months, and cool and wet winters. The moist climate produces precipitation primarily in the winter months (67%). The greatest amount of precipitation falls at higher elevations in the form of rain, with some snow. Annual precipitation ranges from 55 inches at the Chicken Creek to 39 inches at Beaverton.

Watercourses

Most streams are perennial and vary seasonally with precipitation and discharges from upstream dams.

Flows typically peak in the winter and are quite low in the summer months. Flooding can occur in the lower reaches despite flood control efforts. Adjacent floodplains and wetlands attenuate those floods that do occur downstream of the flood control structures.

Land Use

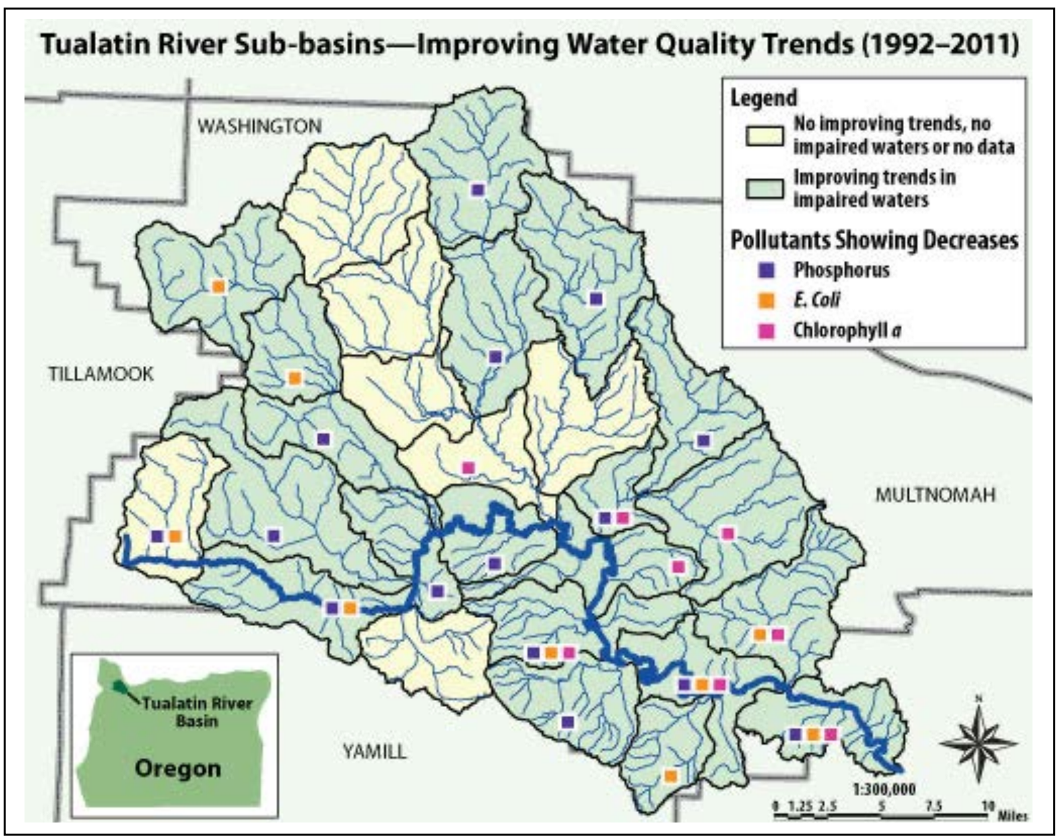
Urban development and agriculture are the primary land uses in the subbasin. The Lower Tualatin subbasin is one of the most developed in the Tualatin basin. Urban and rural residential growth continues in the eastern two-thirds of the watershed. Recreation opportunities include biking, jogging, birding and touring. A number of developed park sites also offer space for organized sports.

Lower Tualatin River

Chapter Three
TMDL Parameters
Identifying and Addressing Sources

In 2012, the U.S. EPA website published a case study "Nonpoint Source Success Stories" about water quality improvements in the Tualatin Basin.[25] It says:

"Thanks to a basin-wide restoration effort, water quality in the Tualatin River watershed has significantly improved since the first TMDLs were adopted in 1988. The incidence of algae blooms in the lower river has decreased, as demonstrated by lower chlorophyll *a* concentrations, no pH violations and higher minimum dissolved oxygen levels. These improvements coincide with lower total phosphorus concentrations, which now meet the 2001 TMDL phosphorus targets in the mainstem Tualatin River. In 2011 CWS performed trend analyses on total phosphorus, bacteria and chlorophyll *a* data collected from 1992 through 2011. A seasonal Kendall trend test showed significantly improving trends (at a 90 percent confidence level or greater) in one or more pollutants contributing to impairments in 20 of 27 Tualatin River sub-basins [Figure 3, below]. Data show that some segments listed as impaired now meet TMDL targets or water quality standards for one or more parameters. Oregon will begin investigating whether these parameters may be removed as sources of impairment from listed segments in an upcoming assessment cycle." It concludes: "Data show that levels of many pollutants have declined significantly."



[25]See: http://water.epa.gov/polwaste/nps/success319/or_tualatin.cfm

This Chapter includes:
3.0 Overview of TMDL Pollutant Sources
Introductions to:
3.1 Bacteria
3.2 Total Phosphorus
3.3 Dissolved Oxygen (DO)
3.4 Temperature
3.5 Mercury

3.0 TMDL Pollutant Sources in the Tualatin Basin: Overview

DEQ's Tualatin River Subbasin TMDL document[26] describes pollutant sources for the following four TMDLs:

- Bacteria
- Total Phosphorus
- Dissolved Oxygen
- Temperature

DEQ's Willamette Basin TMDL document[27] describes pollutant sources for the following three TMDLs:

- Bacteria
- Temperature
- Mercury

Each section below provides a summary of the DEQ description of the TMDL and a discussion of sources, particularly in rural and agricultural areas. The subsections following this overview section go into more detail for each TMDL parameter regarding source identification, current literature reviews, categories of BMPs to control specific pollutants, and results of BMP effectiveness where available.

3.1 Bacteria

The beneficial use occurring within the Tualatin River Basin sensitive to bacteria is: Water Contact Recreation.

The coliform family of bacteria includes total coliforms, fecal coliforms and the group Escherichia coli (E. coli). Coliform bacteria are typically found in warm-blooded animals or humans, but can also be found in soil and plant material. Their presence can indicate fecal contamination. Since E. Coli is specific to digestive tracts of warm-blooded animals, its presence is used to determine fecal contamination. E. Coli is directly related to river flow and turbidity. As river flow and turbidity increase, coliform counts increase also. This occurs as sediments from soils are washed into the stream during rain events.

[26] **1. Tualatin Subbasin Total Maximum Daily Load (TMDL), *Oregon Department of Environmental Quality, August 2001,* and 2012 Amendment for Phosphorus.**
[27] **See http://www.deq.state.or.us/wq/tmdls/willamette.htm#w**

3.1.0 Point Sources

Point sources of bacteria include wastewater discharges and sanitary sewer system overflows. Discharges are primarily from the four wastewater treatment plants located in the urbanized areas of the basin, but also include other permitted discharges from industrial users.

3.1.1 Nonpoint Sources

Non-point sources include urban, agricultural, rural runoff and forested wildlife areas. Pet waste, cross connection of storm and sewer systems and failing septic systems are the primary contributors of urban runoff. Agriculture, rural and forested wildlife area runoff is predominantly from both domestic and wild animal waste and failing septic systems. Densely populated hobby farms within the County contribute to runoff of animal waste. In addition, cattle grazing and trampling in or near riparian zones can contribute to bacteria loads in the streams. Other agricultural activities associated contributing to erosion and runoff include the use of heavy farming equipment in or near riparian zones and removal of riparian vegetation for crop establishment. The discharge of or use of manure for application to fields also increases the potential for increased bacteria loads in streams.

Studies conducted by DEQ indicate that runoff in rural and agricultural areas in the summer months is quite low and contributes little to the overall bacteria loading to the Tualatin River basin.

Bacteria loads to the basin vary seasonally. During the summer, the soils are usually dry and do not contribute much runoff. However, during the wet months, soils are typically saturated and runoff is much greater. A large storm exceeding 4 days of rainfall would create saturated soil conditions.

3.2 pH and Chlorophyll a (Total Phosphorus)

Phosphorus is a limiting factor in algal growth. Increases in phosphorus often result in undesirable algal blooms and thus impact dissolved oxygen levels. Beneficial uses to be protected by limiting algal growth in the Tualatin River subbasin include:

- Aesthetic Quality
- Salmonid Fish Spawning (Trout)
- Salmonid Fish Rearing (Trout)
- Resident Fish and Aquatic Life
- Anadromous Fish Passage
- Water Contact Recreation.

Six stream segments within the Tualatin River watershed were on Oregon's original 1998 303(d) list for chlorophyll *a* violations[28]. The mainstem River and Oswego Lake also experience exceedances of the state's chlorophyll *a* action level. These streams were off the 2002 303(d) list because of the development of the TMDL's. Sources of phosphorus include natural groundwater flows, permitted discharges and surface runoff. The DEQ 2012 Tualatin Subbasin TMDL Amendment for pH and Chlorophyll a (Total

[28] **See Chapter 2, Condition Assessment, herein.**

Phosphorus) allows discharge from 2 waste water treatment plants owned and operated by Clean Water Services to discharge to the Tualatin River in the summer.

3.2.0 Natural Groundwater Flows

The primary source of phosphorus during non-runoff periods is from groundwater flows. During the summer months, there is not enough rainfall to generate surface runoff. Groundwater flows contribute natural sources of phosphorus and comprise the majority of background levels.

3.2.1 Permitted Discharges

Point sources include wastewater discharges, other permitted discharges that may contain phosphorus and sanitary sewer overflows. These point sources occur in the urban areas of the Basin. As of the 2012 TMDL Amendment (DEQ), treated discharge in the summer from 2 Clean Water Services' Waste Treatment Plants are a permitted discharge.

3.2.2 Surface Runoff

Non-point sources include urban runoff, agricultural runoff, road runoff, forestry runoff and groundwater flows. Fertilizers, animal waste and erosion are the primary contributors of phosphorus in runoff.

Forested lands make up approximately 49% of Washington County and agriculture comprises 39%. Both uses are predominantly located in the upper reaches of the Tualatin River basin. While the land surface area in rural areas is greater than in urbanized areas, the volume of runoff is generally less due to the amount of impervious areas. Fertilizer use is prevalent in both urban and agricultural areas, while animal waste runoff is primarily limited to agricultural areas. Small hobby farms or ranches can contribute to animal waste runoff due to densely animal populations. Septic system density in rural areas is typically high and the potential of failing systems is therefore higher than urban areas. Erosion along riparian zones contributes very little to phosphorus loads.

Runoff is greater in the winter when soils become saturated more quickly and runoff is generated. Phosphorus laden sediments deposited into streams during runoff periods can remain until the summer months when temperature and light conditions exist to support algal blooms.

3.3 Dissolved Oxygen

Dissolved oxygen (DO) is a measure of the available oxygen in the water for aquatic species. It is an important factor of a healthy and balanced system. Lower concentrations of DO limit the available oxygen to aquatic life. Concentrations of DO vary seasonally with lower concentrations observed in the summer months.

Five primary factors have been identified as reasons for low DO concentrations in the Tualatin River: nitrification, carbonaceous biochemical oxygen demand (CBOD) within the water column, algal growth, sediment oxygen demand (SOD) and water temperature increases. Nitrification occurs when ammonia is introduced to streamwater and is converted by nitrifying bacteria into nitrate and nitrite. During this process oxygen is consumed, thus lowering the available DO for aquatic species. CBOD refers to the decomposition process of organic matter in the water column. As more matter is decomposed, more oxygen is consumed. Excessive algal growth can cause large DO concentration fluctuations. Chlorophyll concentrations in excess of 15 *u*g/l are used to indicate when excessive algal growth is problematic. Sediment Oxygen Demand (SOD) refers to the process of oxygen consumption in the aerobic decomposition of sediments. Typically, these sediments settle to the bottom of the stream and create a sink of DO. These sinks tend to persist longer than those associated with CBOD and nitrification. Lastly, temperature increases that cause algal blooms can reduce DO levels.

3.3.0 Ammonia

Two pollutants in particular have been identified as accelerators of the five processes identified above: ammonia and volatile solids. Ammonia is a byproduct of nitrogen fertilizers and wastewater and plays a role in nitrification, CBOD and excessive algal growth. In the Tualatin Basin, the primary sources of ammonia loads are the two summer discharging wastewater plants operated by Clean Water Services (CWS). These wastewater plants are located in the urban areas. Rural and agricultural areas contribute ammonia from fertilizers and animal waste.

3.3.1 Volatile Solids

Settleable organic or volatile solids lead to elevated SOD levels. These solids enter the stream as a result of erosion, runoff or direct discharges primarily during the wet months. Once in the stream, the solids settle to the stream bottom and remain in the sediments until scouring flows and velocities move them into the water column.

Studies indicate that instream and near stream erosion contribute significant loadings of solids. Additional sources of solids include runoff from and erosion associated with impervious areas. Removal of vegetation along riparian areas can also increase erosion and runoff.

3.4 Temperature

Stream temperature is an important factor for cold-water aquatic species such as salmon, trout and some amphibians. An increase in water temperature can affect the spawning and fish passage of some fish. If stream temperatures become too hot, fish die almost instantaneously due to denaturing of critical enzyme systems in their bodies. Such warm temperature extremes are rare in the Tualatin River watershed.[29]

Temperature-sensitive beneficial uses protected by reducing water temperature include:

- Salmonid Fish Spawning (Trout)
- Salmonid Fish Rearing (Trout)
- Resident Fish and Aquatic Life
- Anadromous Fish Passage.

> Sources of heat energy include solar radiation, evaporation and convection. Water temperature changes can be affected by many factors.

A change in water temperature is an expression of heat exchange per unit volume including stream morphology and hydrology, climate, geographic locations and riparian vegetation. Two of these factors cannot be controlled by human influence: climate and geographic

[29] **Tualatin Subbasin Total Maximum Daily Load (TMDL),** ***Oregon Department of Environmental Quality, page 24, August 2001.***

location. However, stream morphology, hydrology and riparian vegetation are affected by anthropogenic activities including agriculture, logging practices and urbanization. Temperature changes vary seasonally also, with summer months being warmer than winter months due to the altitude of the sun.

3.4.0 Point Sources

Sources of temperature change are classified as point source or non-point source pollutants. Point sources refer to NPDES warm water discharges to the stream or withdrawals from the stream for agricultural, municipal or industrial use. Withdrawals from the stream decrease the stream volume and therefore increase the water temperature. The majority of irrigation is derived from Haag Lake and therefore has little effect on the stream volume.

3.4.1 Nonpoint Sources

Non-point sources include increases in solar radiation caused by changes to riparian vegetation or stream morphology. Reduced or loss of vegetation along stream banks can decrease the amount of shade which increases the amount of solar radiation that reaches the stream. Stream morphology changes can occur due to erosion along streambanks or instream and channelization affected by humans. Erosion along riparian zones has historically been associated with cattle grazing and logging practices.

However, in the rural areas of Washington County, the majority of agriculture is row-crops. This type of agricultural maintains a vegetative buffer along riparian areas. Channelization used to locally control flooding can make a stream wider and thus increases its surface area. The increased surface area will increase the amount of heat exchange between the stream and the air. In addition, the vegetation required to shade the stream must be taller and denser for a wider stream.

3.4.2 Temperature Standard and Road System

The DEQ TMDL document says revised Water Quality Management Plans should identify constraints of achieving system potential (e.g., effective shading), and gives an example that an existing road or highway may preclude attainment of system potential. It also suggests consideration should be given of designs that support TMDL load allocations (i.e., shading, etc.) whenever construction or restoration activities occur. There is considerable research that even large open parking lots do not increase instream temperatures due to summer rains: there is potential for increased temperatures on extremely hot days, although there is also evidence that the cooling rains do not significantly increase instream temperature. Section 5.2.5.2 of the 2001 TMDL states “because stormwater is not a significant source of heat to subbasin streams during the TMDL period, temperature impacts are not addressed by the MS4 (urban) permit”. By that measure, rural road runoff is even less likely to cause any changes to instream temperature. Washington County practices include the “Riparian Management Area”, or RMA, which is essentially a 250’ vegetated buffer at any road-stream crossing. We believe that is sufficient to avoid the unlikely event of *rural* road runoff causing instream temperature increase.

3.5 Mercury

The mercury TMDL is not due to the violation of in-stream water quality standards.

The Oregon Health Division has posted fish consumption advisories for the Willamette River, Cottage Grove Reservoir and Dorena Reservoir due to high concentrations of mercury in certain fish species. These advisories discourage the consumption of these fish. The fish consumption advisories have triggered this mercury TMDL. The goal of this TMDL is to determine how to reduce the amount of mercury in the river so that mercury levels in fish will drop to an acceptable level. The ultimate objective is to eliminate the fish consumption advisory for mercury so fish are safe to eat.

Initially, it was thought that most mercury in the Willamette Basin comes from old mercury and gold mines located in the mountains of the Coast Fork Subbasin. That does not appear to be the case based on the analysis and the data considered in this study.

3.5.0 Sources

Mercury comes from many sources in the Willamette:

Mercury naturally occurs in the soils of the Willamette Valley. The excess erosion of these soils from agricultural, forested, and urban lands contribute to mercury in the river. Mercury is deposited onto the land and water from numerous atmospheric pollution sources. These include certain industries in the Willamette Valley; the burning of fossil fuels by cars, trucks, trains, boilers, etc; fires; and sources outside the United States. Small quantities of mercury are discharged into the river by wastewater treatment plants and certain industries. Wastewater treatment plants receive mercury through disposal of consumer products (lights and switches) and from dental amalgams (tooth fillings). Mercury occurs in native trees and is released during processing wood pulp and paper. Abandoned mines represent a small contribution of the mercury problem in the Willamette River though they are a significant source of mercury in the Cottage Grove and Dorena Reservoirs.

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Section 3.1
Addressing Sources
Bacteria

Section 3.1 includes:

3.1.0 Introduction

Contamination of water by fecal matter can threaten the health of humans that come into contact with the water. The presence of fecal coliform bacteria or of *Esherichia coli* (*E. coli*) is used to identify contamination by fecal matter, which indicates that other potentially disease-causing bacteria may also be present.

To count bacteria levels, individual state standards may employ different sampling methods, indicators, averaging periods, averaging methods, instantaneous maximums and seasonal limits. A term called MPN (Most Probable Number) is used to represent the number of colonies per 100 ml, based on the typical standard in use in that locale.

Streams listed in the Tualatin Basin as not meeting the bacteria TMDL standard are shown in Figure 3.1.

The Oregon Department of Environmental Quality (DEQ) water quality standard for *E. coli* in freshwater where water contact recreation is the most sensitive beneficial use is less than 406 *E. coli* organisms (most probable number – mpn) per 100 milliliters (ml) in any single sample; anda 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples. These standards were established for in-streamconcentrations, not for in-pipe concentrations of stormwater prior to mixing at the discharge point.

To address the water quality standard for bacteria in general and in rural Washington County, a review of sources and control strategies (Best Management Practices) was conducted, resulting in a series of Fact Sheets[31]. For each TMDL parameter, the fact sheets presented source identification, current literature reviews, categories of BMPs to control specific pollutants, and results of BMP effectiveness where available. Results from this and other studies that help identify sources and controls are summarized below.

[31] **A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap) 2003.**

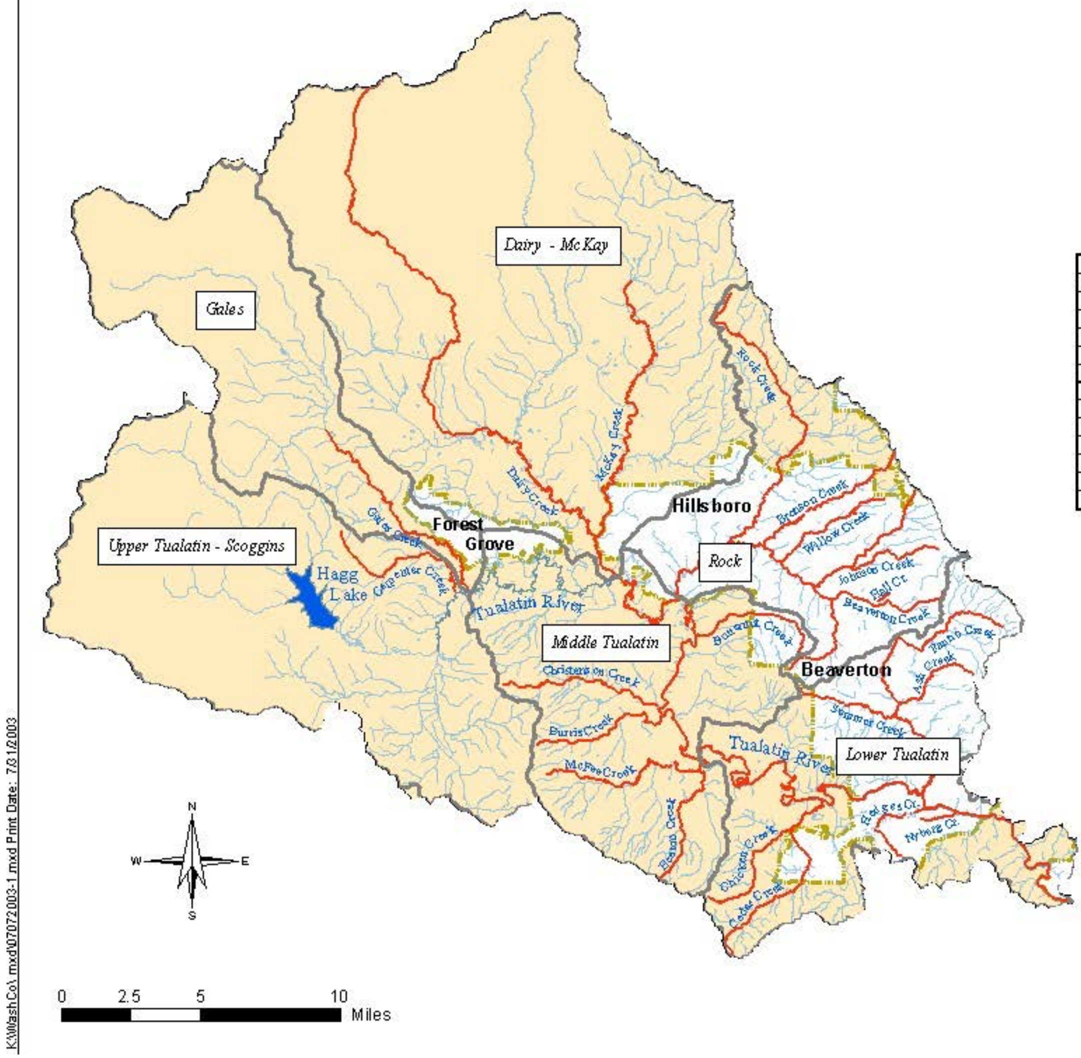

Figure 3.1

Tualatin Basin 2001
Bacteria TMDL Listed Streams

Stream Name	
Ash Creek	Gales Creek
Beaverton Creek	Hall Creek
Bronson Creek	Heaton Creek
Burris Creek	Hedges Creek
Butternut Creek	Johnson Creek, North
Carpenter Creek	Johnson Creek, South
Cedar Creek	McFee Creek
Cedar Mill Creek	McKay Creek
Chicken Creek	Nyberg Creek
Christensen Creek	Rock Creek
Dairy Creek, Mouth	Summer Creek
Dairy Creek, West Fork	Tualatin River
Fanno Creek	Willow Creek

Legend

Urban Growth Boundary
Subbasin Boundaries
Listed Streams

Washington County DLUT
Water Quality NPS
Implementation Plan

URS

Print Date: July 2003

3.1.1 Source Identification

3.1.1-0 Bacterial Contamination

Locating and identifying the sources of fecal bacteria contamination is difficult. Some of the more common sources of bacterial contamination in a water body include livestock, waterfowl and other residentwildlife, pets, sewer overflows, illicit discharges, and septic tank failures.

Sources of anthropogenic bacteria in streams generally include the following (not specific to Tualatin Basin):

- Combined Sewer Overflows (CSOs): Combined sanitary/storm sewers are generally found in older city infrastructures and are likely to overflow during wet weather. The NPDES Municipal program is designed to eventually eliminate CSOs and to address the MS4 (Separate Storm Sewer System).

- Sanitary Sewer Overflows (SSOs): The Association of Metropolitan Sewage Agencies (AMSA) estimates that about 140 overflows occur per one thousand miles of sanitary sewer lines each year (a thousand miles of sewer serves a population of about 250,000). They also found that 15 to 35 percent of all sewer lines were over capacity and could potentially overflow during storms. Clean Water Services developed an extensive program to reduce SSOs to near zero.

- Illicit connections to storm sewers: Illicit connections can come from industrial areas, commercial business, and other sources. Contamination can come from illicit connections of human sewage, washwater, or wastewater. Illicit does not necessarily indicate intentional cross-contamination. The NPDES program and permits require programs to find and eliminate illicit connections.

- Illegal dumping: Illegal dumping of raw sewage into storm drains from septage vacuum trucks, recreational vehicles and portable toilets can all be sources of bacterial contamination.

- Failing septic systems: The design life of most septic systems is up to 30 years, at which point major rehabilitation or replacement may be needed. Soil types are critical with respect to success. A properly functioning septic system treats sewage to prevent ground and surface water pollution.

Non-Human Sources of Bacteria in streams include the following (not specific to Tualatin Basin):

- Domestic and wild animals: Two separate genetic studies that were conducted independently (Alderiso and Trial) concluded that 95% of fecal coliform found in urban stormwater is of non-human origin.[32] Documented sources include dogs, cats, raccoons, rats, beavers, gulls, geese, pigeons and even insects. Dogs and cats in particular appear to be major sources (a single gram of dog feces contains 23 million fecal coliform bacteria (van der Wel)[33]). Geese, gulls and ducks are also speculated to be a major source in urban

[32] See https://www.nps.gov/goga/learn/management/upload/-1570-http www-stormwatercenter.pdf
[33] Id.

areas, particularly at lakes and stormwater ponds where large resident populations become established. Livestock can be major sources in unsewered urban watersheds particularly those areas of the urban fringe that have horse pastures, hobby farms and ranchettes.

- Cats: A study conducted in King County, Washington showed cat feces as the primary source of bacterial contamination in urban streams (King County Stormwater Annual Report).

- Ducks: Noticeably high bacteria concentrations were observed from samples collected at the confluence of Pendleton Creek and Fanno Creek where there is a duck pond. (Stormwater Annual Report).

- Moist Soils and Sediments: The urban drainage system itself is considered to be a source of elevated bacteria concentrations as bacteria can survive and even multiply in sediments. Fecal coliform levels in stream and lake sediments are routinely three to four orders of magnitude higher than those in the overlying water column (Van Donsel and Geldreich).[34] Coliform bacteria have been found to survive and grow in moist soils and leaf piles (Oliveri).[35] This may explain why grass swales and ditches frequently have high bacteria levels. Sediments in the drainage system can become a major sink and/or source during storm events if sediments are flushed or resuspended. In several source identification studies in urban areas, end-of-pipe bacteria concentrations were at least an order of magnitude higher than any other source area in the contributing watershed.

3.1.1-1 Original Literature Review[36] re: Source Identification

Studies summarized for bacteria source identification included an exhaustive summary by the Center for Watershed Protection based on 53 references, and actual data from the Tualatin Basin:

- Watershed Protection Techniques, Special Issue: Bacteria, Concentrations, Sources and Pathways, (Tom Schueler) April 1999[37]; and

- Stormwater Annual Reports, USA (now Clean Water Services), Washington County, ODOT (included in the annotated bibliography under research regarding BMP effectiveness).

The compilation from The Center for Watershed Protection included 34 more urban stormwater monitoring studies. Nearly every individual stormwater runoff sample in the database exceeded bacteria standards, usually by a factor of 75 to 100. Additionally, there is enormous storm to storm variability in fecal coliform bacteria, with concentrations often spanning five orders of magnitude at the same sampling station.

[34] Seasonal variation in survival of indictor bacteria in soil and their contribution to storm water pollution, Von Donsel, Geldreich, Clarke, *Applied Microbiology,* 15(6), 1362-1370.

[35] Lim, Olivieri, *Sources of Microorganisms in Urban Runoff;* John Hopkins Scool of Public Health and Hygiene, Maryland.

[36] This literature review was conducted for the Washington County Water Quality Implementation Plan in 2003. It is included here for 2 reasons: 1) At the request of a Tualatin Basin Coordinator (2013) for historical perspective, and 2) bacterial sources have not changed in that time.

[37] From Watershed Protection Techniques, Special Topic: Microbes, Center for Watershed Protection, April 1999, Vol. 3, No. 1. Note: This study is not available in a web search (2019).

3.1.1-2 Important Results/Conclusions from the Studies[38] re: Source Identification

Indicators of Anthropogenic Sources

If levels are extreme and on the order of $10^5 – 10^6$, they are likely to be associated with an inappropriate human discharge (e.g., failing septic system, sanitary sewer overflows or illicit connections). As a general rule, human sources of sewage should be suspected when fecal coliform concentrations are consistently above 10^5 (Pitt)[39].

Bacteria in Stormwater Runoff

The National Urban Runoff Program (NURP) reported a mean fecal coliform concentration in stormwater runoff of about 20,000 colonies per 100 ml based on 1,600 storm runoff samples largely collected during the NURP study.

Fecal coliform levels are about 90% lower in runoff that occurs in winter than during the summer months.

Bacteria levels coincide with large rain events and typically are highest after first flush events (i.e., first events of the season after a long dry period).

Dry weather Instream Bacteria Levels

Fecal coliform levels in streams in dry weather (baseflow conditions) are generally much lower than during storms, unless an illicit sewage discharge is present upstream.

Relation to Impervious Cover

Fecal coliforms do not appear to be directly related to subwatershed impervious cover (Hydroqual). Developed watersheds nearly always have greater fecal coliform concentrations than undeveloped watersheds. However, more impervious cover in a developed watershed was not observed to increase fecal coliform concentrations.

Septic vs. Sanitary Sewer Systems

Bacteria data collected in Fanno and Bronson Creeks within Washington County showed equally high bacteria concentrations in areas served by septic systems and sanitary sewer systems. Background levels ranged from <100 CFU/100ml to several thousand CFU/100 ml (CFU = colony forming units).

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[38] **The previous water quality standard for bacteria was based on fecal coliform as opposed to E. coli. Therefore, most of the historic stormwater data (i.e., prior to 1998) were analyzed for fecal coliform. The DEQ water quality standard for fecal coliform in freshwater was 200 colonies per 100 ml. Since a large portion of the stormwater data include fecal coliform as opposed to E. coli, the following information in this fact sheet includes research related to both E. coli and fecal coliform. The presence of elevated fecal coliform concentrations does not directly indicate the presence of elevated E. coli concentrations. However, BMP mechanisms that are effective at reducing fecal coliform levels are also likely to be effective at reducing E. coli levels.**

[39] **Pitt, R. 1998 Epidemiology and Stormwater Management. *Stormwater Quality Management.***

Bacteria and Other Parameters

There appears to be no correlation between bacteria levels and other parameters, except rainfall and turbidity. Elevated bacteria counts are also sometimes associated with high turbidity levels.

3.1.2 Selecting BMPs to Address Bacteria

3.1.2-0 Target Known Sources

For urban areas, based on study results described above, non-human sources are considered to be the most significant. Therefore, the focus of BMPs should be on pet, livestock, and wildlife waste and minimizing urban drainage sinks (i.e., reducing sediment/debris accumulation in the system).

If existing bacteria levels are significantly high (>10^5) then BMPs that target sewage sources should be high priority (sanitary leaks, septic tanks, illicit discharges).

If septic systems are suspect, investigation of these systems should focus on those that are > 15 years old.

BMPs in the urban area are not a part of this Implementation Plan for Washington County DLUT. The urban area is managed by Clean Water Services, and is addressed in their Management Plan underconditions of the municipal NPDES permit.

3.1.2-1 Research BMP Categories

Categories of BMP’s reviewed[40] for effectiveness in addressing or controlling bacterial contamination included the following:

- Detention Ponds
- Retention Ponds
- Sand filters
- Swales
- Grass filter strips
- Vortechnics Settling Chamber
- Source controls
- Public Education/Information.

3.1.2-2 Schedule BMP Activities

If BMPs are non-structural (i.e., maintenance, and public education), scheduled activities should occur when temperatures are the warmest. Reasons for this include:

[40] **A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap) 2003.**

- The potential for human exposure to bacteria through water recreation activities is higher during periods of warmer temperatures.
- When streamflow is low there is less dilution of bacteria that may be entering the stream from illicit discharges or failing septic systems.
- Warm temperatures are conducive to bacterial growth.

3.1.3 BMP Effectiveness

It is unfortunate but important to note that effluent data from the studied BMPs were so variable with respect to bacteria that it can't be stated whether one is more effective than another or whether any of them are very effective at all. Nonetheless, the literature review and national studies of current technology to control bacteria levels provided valuable information as outlined below.

3.1.3-0 Literature Review of BMP Effectiveness Data

Studies summarized for bacteria BMP effectiveness included an exhaustive summary by the Center for Watershed Protection based on 53 references, a national BMP Database, and actual data from the Tualatin Basin:

- Watershed Protection Techniques; Special Issue Bacteria, Concentrations, Sources and Pathways, Tom Schueler (April, 1999)[41];
- National Stormwater Best Management Practices (BMP) Database, Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE),http://www.bmpdatabase.org/ . Only the data reported in the National BMP Database that was collected as Event Mean Concentrations (EMCs) was examined. Data reported in the National BMP Database that was collected as grab samples was not examined.
- Stormwater Annual Reports, Clean Water Services, Washington County and Oregon Department of Transportation. In accordance with their NPDES permit requirements, a stormwater monitoring program was implemented. The annual reports summarize the results of the monitoring program and provide a status for BMPs.
- Brochures - Portland Water Quality Swales, and Portland Water Quality Ponds, City of Portland.

[41] **From Watershed Protection Techniques, Special Topic: Microbes, Center for Watershed Protection, April 1999, Vol. 3, No. 1. Note: This study is not available in a web search (as of 2019).**

3.1.3-1 Important Results/Conclusions from the Studies re: BMP Effectiveness

Current Practices and Technology: Limited Success

Current known stormwater practices, stream buffers and source controls have a modest potential to reduce bacteria levels, but cannot reduce them far enough to meet water quality standards in most urban settings. Bacteria is prevalent and very difficult to control.

Reducing overall stormwater volumes through infiltration (i.e., low impact development techniques) can help to reduce bacteria loads to surface waters. However, it is not known whether this could reduce bacteria loads sufficient to meet water quality standards.

There are upper limits on what stormwater treatment systems that rely on sedimentation can achieve with respect to bacteria removal. Even an advanced secondary wastewater treatment that filters its effluent still discharges fecal coliform at the 10^3 to 10^5 levels before final chemical disinfection (ASCE). This suggests that it may not be possible or practical to meet bacterial standards in urban stormwater runoff. The bacteria removal reported for stormwater management practices falls well short of the removal needed to meet standards.

Although there are significant limits with respect to bacteria removal through the use of structural BMPs, there are some factors that promote increases in bacteria die-off.[42] These include:

- Sunlight - Maximum die-off requires clear water, however, the turbidity and organic matter found in urban runoff can greatly interfere with the sunlight effect (Bank and Schemhel)[43]. Substantial treatment would be needed to remove suspended solids before UV light could be effective. In addition, exposing water bodies to increased UV light is in direct conflict with the temperature TMDL.

- Sedimentation - One study indicated that 15 – 30 percent of fecal coliform cells present instormwater are adsorbed to larger suspended particles, most of which are greater than 30 micronsin diameter (Schillinger and Gannon)[44]. The bacteria that do adsorb to these larger particles can settle rapidly out of the water column. Fifty percent of fecal coliform bacteria were not attached. These bacteria have slower settling velocities and may remain in suspension for days or weeks. Approximately 90 percent of bacteria are expected to settle out from a typical stormwater pond in about two days under ideal conditions.

- Sand Filtration - Most field studies of sand filters show removal of 50 to 65 percent of bacteria.

- Soil Filtration - Similar to sand filtration although more effective since the higher organic matter and clay content of most soils increases potential bacteria adsorption (Robertson and Edberg).

[42] **See also Microbes and Urban Watersheds: Ways to Kill 'Em; Feature Article #3 from Watershed Protection Techniques. 3(1): 566-574. At http://www.northinlet.sc.edu/training/media/resources/Microbes&Watersheds%20Ways%20to%20Kill%20Em.pdf**

[43] **Bank and Schmehl. "Bactericidal Effectiveness of Modulated UV Light".** ***Applications of Environmental Microbiology*** **56(12): 3888-3889. At https://www.ncbi.nlm.nih.gov/pmc/articles/PMC185087/**

[44] **Schillinger and Gannon, Coliform Attachment to Suspended Particles in Stormwater; U.S. Environmental Protection Agency. NTIS PB 83-108324. 106 pp.**

- Chemical Disinfection - Although effective for treatment of drinking water and wastewater, chlorine dosing of stormwater is difficult due to the variable flows and turbidity levels. Therefore, it has only been used for this purpose in rare cases.

- Growth Inhibitors - Cooler temperatures, low nutrient levels, low carbon supplies, low pH levels and moisture loss are all factors that inhibit the growth of bacteria.

Structural and Source Controls: BMP Effectiveness

Detention Ponds - Outflow concentrations of fecal coliform averaged 5,144 colonies/100 ml based on 9 events. *E. coli* averaged 869 colonies/100 ml based on two events (Schueler). *E. coli* data collected as part of the BMP Effectiveness Study by Clean Water Services ranged from 600 mpn/100 ml to 250,000 mpn/100 ml in effluent samples. Data indicates effluent bacteria levels were actually higher than influent levels in many of the samples. The average effluent concentration of *E. coli* from the Portland ponds was 1,209 CFU/100 ml.

Retention Ponds - Outflow concentrations of *E. coli* from a retention pond in a residential neighborhood averaged 1,625 mpn/100 ml based on 10 events (ASCE Database). The average effluent concentration from the Portland retention pond was 1,084 CFU/100 ml.

Sand Filters - Outflow concentrations of fecal coliform averaged 5,899 colonies/100 ml. based on 9 events.

Swales - Outflow concentrations of fecal coliform averaged 2,506 colonies/100 ml based on 3 events (Schueler). Average *E. Coli* concentration in affluent from Portland swales ranged from 5,500 to 12,000 colonies/100 ml. As a group, the grass swales were found to have no ability to reduce fecal coliform levels, with zero or negative changes in concentration reported in four out of five studies. Pet droppings, in-situ multiplication and short travel times were all cited as reasons for the poor performance of swales.

Grass Filter Strips - Studies suggest only a modest capability to remove fecal coliforms from runoff.

Vortechnics Settling Chamber - Samples collected in the CWS BMP Effectiveness study revealed often higher bacteria levels in effluent samples than influent samples. Concentrations ranged from 7 mpn/100 ml to 28,300 mp/100 ml.

Source Control - As demonstrated in the Source Identification section above, bacteria comes from a vast variety of sources and is extremely prevalent in our environment. Little monitoring has been conducted to determine if source control can actually reduce watershed bacteria levels (i.e., on a widespread basis).

Pet Waste - An example of one source that can be controlled by human intervention is pet waste. A previous study on controlling pet waste in the Chesapeake Bay watershed showed that approximately 41% of dog walkers do not pick up the waste. Eighty percent of that 41% indicated that several factors (i.e., complaints, simpler collection methods, more convenient disposal methods and/or fines) would still not induce them to change their behavior. However, urban areas within Washington County likely have a better response rate due to emphasis on dog parks, pet waste stations, and public education efforts.

Source Control: Public Education/ Information

Public education and information efforts are tracked annually in the Tualatin Basin by the Tualatin Basin Public Awareness Committee. Efforts focus on educating the public on the use and disposal of hazardous household chemicals, pesticides and fertilizers, effects of illicit dumping on water quality and the significance of pet waste in urban runoff. Though difficult to measure quantitatively, these efforts appear to be successful in educating the public.

3.1.3-2 Conclusion re: BMP Effectiveness

Once human sources are addressed, studies do not indicate that there are best management practices that will be effective at reducing widespread bacteria concentrations to levels low enough to meet standards. Insome cases, structural BMPs may actually be causing increases in bacteria concentrations. Therefore, in developing water quality management plans for bacteria, guidance from the above studies, EPA Fact Sheets, and/or DEQ Guidance, along with best professional judgment should be used to reduce bacteria levels to the extent practicable.

3.1.4 Implementation Plan Guidance for Reducing Bacteria Concentrations

- If bacteria levels are at concentrations that indicate human sources (i.e., > 10^5), the focus of efforts should be on reducing illicit discharges, CSOs, SSOs, and failing septic systems. This would likely reduce bacteria levels to concentrations that are more typical of urban runoff that does not contain anthropogenic sources.

- Minimize runoff by slowing down flow, or by recharge (such as collection and deposition).

- Pre-treatment sediment chambers should be kept dry where possible.

- Limit emphasis on structural BMPs (for bacteria) as they have not proven effective at reducing bacteria levels. If structural BMPs are proposed to address other parameters, consider design issues that address bacteria as described below:

  Detention Ponds - If detention is used as a BMP, significant settling times would be needed (i.e., a minimum of 2 days). Turf and open water areas around stormwater ponds should be reduced to eliminate attractiveness to waterfowl. Shallow benches and wetland areas should be added to stormwater ponds to enhance the plankton community and therefore increase bacterial predation.

  Filtration - The use of soil filtration should be maximized where possible. Fine grained materials should be used for filter media when filtering practices are employed.

  Grass Swales - Grass swales should not be proposed as a method of reducing levels of bacteria.

- Emphasis should be placed on designing and maintaining the storm system to prevent bacteria-laden bottom sediments from accumulating and being resuspended and exported.

Section 3.2
Addressing Sources
Total Phosphorus

Section 3.2 includes:

3.2.0 Introduction

The Oregon Department of Environmental Quality (DEQ) water quality standard for Total Phosphorus translated load and wasteload allocations into concentrations for the Tualatin Basin TMDLs. These concentrations for load allocations range from 0.04 mg/L in the more rural areas to 0.19 mg/L at the mouth of Rock Creek.[45] Load allocations for runoff have the same value as the background concentrations. However, daily load equivalents for the monthly (summer) values included in the 2001 TMDL have been added in the 2012 Amendment. The Phosphorus TMDL listed streams are shown below in Figure 3.2.[46]

Phosphorus occurs in natural waters and wastewaters almost entirely as phosphates. As its name suggests, total phosphorus is a measure of all phosphorus in a sample including phosphorus contained in organic and inorganic particles. The measurement is a test performed on an unfiltered sample. Total phosphorus content only provides a crude indication of the potential to cause algal growth because it includes phosphorus that is unavailable to aquatic life (phosphorus bound up in sediment or plant material).

Total suspended phosphorus is a measure of the amount of phosphorus contained in suspended material in a water sample. It does not have much significance with respect to algal growth. **Total dissolved phosphorus** is a measure of the phosphorus contained in a water sample after suspended material has been removed. It provides a good indication of the potential for algal growth because dissolved phosphorus is readily available to plants. **Orthophosphate** is a measure of certain forms of phosphates. It does not include polyphosphates or organic phosphates. It also serves as an indicator of the potential for algal growth.

To address the water quality standard for total phosphorus, a review of sources and control strategies (Best Management Practices) was conducted[47]. The review evaluated monitoring data collected in Oregon from 1990 to 1996. The purpose of the monitoring in the early years of the Municipal NPDES Program was to compare data across land use types, and determine if there were statistical differences. (The study did not include an analysis of runoff data from rural land uses.) BMP effectiveness studies were also summarized in the Total Phosphorus review. The purpose of the analysis was to determine if any categories of BMPs were

[45] Tualatin Basin TMDL Ch. 2 pH and Chlorophyll a (Toal Phosphorus) TMDL Amendment, Aug. 2012. See: https://www.oregon.gov/deq/FilterDocs/tualatinCh2Phosphorus.pdf
[46] Id. Figure in original document was Figure 2-1.
[47] A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap) June 2003.

more effective than another. Results from this and other studies to identify sources and controls are summarized below.

3.2.1 Source Identification

3.2.1-0 Anthropogenic Sources of Total Phosphorus

The primary anthropogenic sources of total phosphorus in the Tualatin River Subbasin are the following:[48]

1. **Wastewater Treatment Plants and Sanitary Sewer Systems**: Two of the four wastewater treatment plants (WWTPs) in the subbasin, Durham and Rock Creek discharge during the phosphorus TMDL period.[49] Wasteload allocations have been assigned to both of these plants. Sanitary sewer system overflows during this season are typically minimal during the TMDL period.

2. **Cross Connections:** Cross connections between sanitary and storm sewer systems are common and can be a significant source of pollutants.

3. **Permitted Sites other than POTWs:** Discharges from permitted sites (industrial, etc.) may contain phosphorus either in stormwater runoff or in direct discharges.

4. **Urban Runoff:** Urban runoff can be quite high in total phosphorus concentrations. The ultimate sources could include fertilizers, erosion, cross- connections.

5. **Rural Runoff:** Rural runoff may contain phosphorus from the same source as urban runoff, with the possible exception of sanitary sewers. Additional potential sources are “hobby” farms, horse pastures, and ranchettes. These sites are often stocked very densely and may have poor management. The density of septic systems is usually relatively high in rural areas and therefore the possibility of failing systems is also quite high.

6. **Agricultural Runoff:** Some of the potential sources of phosphorus in agricultural runoff are fertilizers, animal wastes, and erosion.

7. **Forestry Runoff:** Since surface runoff in forested areas during the TMDL season is expected to be minimal, phosphorus loads from forestry operations are most likely associated with forest industry roads and culverts.

8. **Failing Septic Systems:** Effluent from failing septic systems can contain phosphorus, along with bacteria, BOD and other pollutants.

9. **Instream and Near-stream Erosion:** Phosphorus contained in soils may be transported to the critical segments of the Tualatin River through instream and near-stream erosion. While a certain amount of this erosion is natural, some erosion (especially during the summer), is from human activity.

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[48] **Tualatin River Subbasin TMDL, Appendix I, Water Quality Management Plan, Oregon DEQ, August, 2001.**
[49] **Id., p. I-7.**

Figure 2-1. 2004/2006 303(d) List for Phosphorus, pH or Chlorophyll *a* (Bolded Green Lines) in the Tualatin and Oswego Lake Subbasins

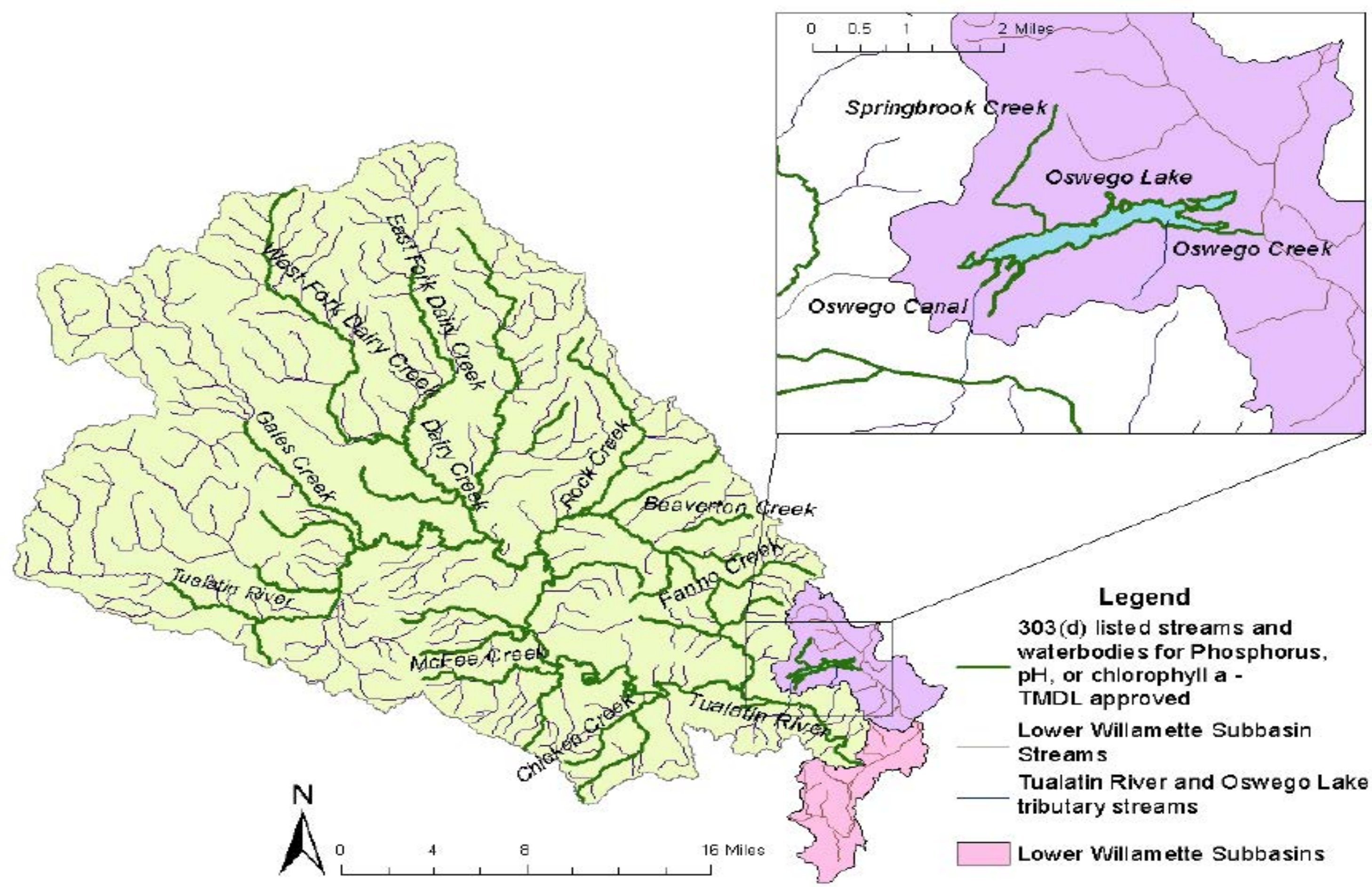

Figure 3.2: Phosphorus TMDL Listed Streams

3.2.1-1 Point Sources

There are point and nonpoint sources of phosphorus in the Tualatin River basin. Point sources include municipal wastewater discharges, urban stormwater discharges, and sanitary sewer overflows. Point source discharges are entirely within the urban area, by definition of stormwater point source, and thus are managed by Clean Water Services.

The study of stormwater quality data for point sources compared urban land uses and found the mean TP concentration was highest for in-pipe industrial stations (0.633 mg/L), followed by instream industrial (0.509 mg/L), commercial (0.391 mg/L), transportation (0.376 mg/L), residential (0.365 mg/L), and open space (0.166 mg/L). However, an evaluation did not show statistical significance of the results.

An Oregon ACWA Committee looked at pollutant data by land use types.[50] When pooling station data in the ACWA study, total phosphorus was initially included as one of the pollutants for evaluation. However, total phosphorus (TP) was dropped from the evaluation as concentrations were not found to be consistent among stations with similar land uses. It was suggested that for total phosphorus, concentrations may be more affected by soil types than by land use.

> For total phosphorus, concentrations may be more affected by soil types than by land use.

3.2.1-2 Nonpoint Sources

Non-point sources include runoff from roads, runoff from agricultural and forested areas, and groundwater flows.

Potential pathways of phosphorus to surface waters outside the urban area and potential responsible parties include:

- Road runoff (County, ODOT and private parties),
- Sediment and fertilizer runoff (County ditches, ODA and THPRD),
- Construction site runoff (County and private parties),
- Runoff from agricultural areas (ODA),
- Runoff from forested areas (ODF),
- Sewer overflow or leaks, (County) and
  Groundwater flows (natural background).

Soil types no doubt play the most significant role in identifying sources of phosphorus. Nonpoint Source water quality management plans should focus on reducing activities that accelerate instream erosion and those that increase bank stability. This Washington County Nonpoint Source Implementation Plan addresses only rural area management.

[50] **Year unknown: in late 1990's.**

3.2.2 BMP Effectiveness

3.2.2-0 Literature Review[51] of BMP Effectiveness Data

Studies summarized

Studies summarized for phosphorus BMP effectiveness included a national Stormwater BMP Database, NPDES Stormwater Annual Compliance Reports, and actual data from the Tualatin Basin:

- National Stormwater Best Management Practices (BMP) Database, Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE), http://www.bmpdatabase.org/ (2003).

- International Stormwater BMP Database, Water Environment & Reuse Foundation, 2016 Summary Statistics: The BMP performance analyses provided in this report are based on the BMP performance data in the BMP Database as of November 2016. The analyses are based upon the distributions of influent and effluent water quality sample data for individual events by BMP category, thereby providing greater weight to those BMPs for which there are a larger number of data points reported. In other words, the performance analysis presented in this technical summary is "storm-weighted," as opposed to "BMP weighted." http://www.bmpdatabase.org/Docs/03-SW-1COh%20BMP%20Database%202016%20Summary%20Stats.pdf (2017).

- NPDES Stormwater Annual Compliance Reports, Clean Water Services (CWS), Washington County.

BMP Categories Reviewed

Categories of BMP's reviewed[52] for effectiveness in reducing total phosphorus levels included the following:

- Porous Pavement
- Swales (i.e., mowed grass swales)
- Detention Ponds
- Retention Ponds
- Media Filter
- Wetland Basins
- Wetland Channels (i.e., swales planted with wetland plants)
- Public Education/Information – technical assistance program supported by USA [now CWS] and SWCD to assist small farm owners in reducing identified pollution from agricultural practices
- Vortechnics Settling Chamber
- Extended dry detention pond.

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[51] The original literature review was conducted for the Washington County Water Quality Implementation Plan in 2003. It is summarized herein (see Appendix) for historical perspective, and because it was analyzed with regard to the Tualatin TMDL. Newer data and summary conclusions from similar sources (i.e., the ASCE National Stormwater Database) have been added.

[52] A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap) June, 2003.

The compilation of effectiveness data in the 2017 analysis for Total Phosphorus also included porous pavement and bio-retention treatment.[53]

3.2.2-1 Results of BMP Effectiveness: Structural Controls

The results from recent studies summarized from the National Stormwater BMP Database are shown below in Table 3.1.[54] Conclusions from the original 2003 analysis and the 2016 (publ. 2017) analysis are summarized below.

Table 3.1 (From WERF Stormwater Database)

Table 2-21. Influent/Effluent Summary Statistics for Total Phosphorus (mg/L)

	BMP Category	BMPs		EMCs		25th		Median			75th	
		In	Out	In	Out	In	Out	In	Out	Difference	In	Out
Phosphorus as P, Total (mg/L)	Bioretention	30	30	583	505	0.07	0.08	0.13 (0.12, 0.15)	0.24 (0.18, 0.28)	◆◆◆	0.26	0.59
	Composite	10	10	184	166	0.17	0.09	0.35 (0.28, 0.40)	0.13 (0.12, 0.14)	◆◆◆	0.65	0.22
	Detention Basin	31	31	397	412	0.14	0.11	0.23 (0.21, 0.26)	0.19 (0.17, 0.20)	◆◆◆	0.38	0.30
	Grass Strip	19	19	360	276	0.08	0.10	0.14 (0.12, 0.15)	0.17 (0.15, 0.20)	◇◆◆	0.25	0.34
	Grass Swale	23	23	436	445	0.07	0.11	0.12 (0.11, 0.14)	0.20 (0.18, 0.21)	◆◆◆	0.25	0.29
	Media Filter	23	22	372	349	0.07	0.04	0.15 (0.13, 0.15)	0.09 (0.07, 0.10)	◆◆◆	0.28	0.16
	Porous Pavement	8	8	373	219	0.12	0.07	0.19 (0.16, 0.21)	0.11 (0.10, 0.11)	◆◆◆	0.36	0.20
	Retention Pond	55	55	891	873	0.09	0.04	0.20 (0.18, 0.22)	0.09 (0.08, 0.10)	◆◆◆	0.42	0.20
	Wetland Basin	20	20	595	574	0.10	0.07	0.16 (0.14, 0.17)	0.12 (0.11, 0.13)	◆◆◆	0.27	0.22
	Wetland Basin/ Retention Pond	75	75	1486	1447	0.09	0.05	0.18 (0.17, 0.19)	0.10 (0.10, 0.11)	◆◆◆	0.36	0.21
	Wetland Channel	12	12	193	172	0.11	0.10	0.17 (0.15, 0.19)	0.15 (0.13, 0.17)	◇◇◆	0.28	0.24

Relation to Tualatin TMDL

As shown in the original review and Appendix Table A-1, of the 35 BMPs that were monitored for TP, only 13 BMPs (i.e., 35%) had mean outflow concentrations of TP that were below the maximum Tualatin basin TMDL concentration of 0.19 mg/L. Mean inflow concentrations of TP for the BMPs ranged from 0.1 to 2.9 mg/L. Mean outflow concentrations of TP ranged from 0.05 to 1.35 mg/L.

Limited Applicability in Rural Area

As shown in Appendix Table A-1, none of the BMPs had TP effluent concentrations of 0.04 mg/L or less which is the TMDL concentration specified for rural areas.

Total Phosphorus Removal in General

In both the 2003 analysis and the 2017 analysis, swales consistently showed poor performance for TP removal, and in fact tended to export phosphorus. For each swale type studied, the average TP outflow concentration was greater than the average TP inflow concentration. For the rest of the BMP types that were monitored the results were somewhat variable. For the most part the BMPs showed limited positive

[53] International Stormwater BMP Database, Water Environment & Reuse Foundation, 2016 Summary Statistics, http://www.bmpdatabase.org/Docs/03-SW-1COh%20BMP%20Database%202016%20Summary%20Stats.pdf (2017).
[54] Id.

performance. However, for each BMP type (except for wetland channels and detention types) there was one BMP where average outflow was greater than average inflow.

In both the 2003 and the 2017 analyses, it was concluded that results are likely to be highly dependent upon specific BMP design, influent concentrations of TP, and storm event characteristics.

3.2.2-2 Specific results for each BMP type (original study and 2017 compilation)

Swales had effluent concentrations ranging from 0.19 to 1.0 mg/L in the original study. None of the 7 ASCE 2003 database swales showed positive results with respect to treating TP. For the three Portland swales that were monitored, average TP effluent concentrations ranged from 0.05 mg/L to 2.9 mg/L. Results were varied with some storms showing positive removals and others showing negative removals. In the 2017 analysis, grass strips and grass swales had higher effluent concentrations than influent.

Detention basins in the ASCE 2003 database had mean TP reductions that ranged from –0.11 to 0.44 mg/L. For the 4 basins, mean inflow concentrations of TP ranged from 0.32 to 0.74 mg/L, and mean outflow concentrations of TP ranged from 0.23 to 0.49 mg/L. For the Portland ponds, the average TP effluent concentration was 0.27 mg/L. The 2017 analysis showed some reduction in Total Phosphorus as a result of detention.

Media filters in the new 2016 study (publ. 2017) showed significant reductions in Total Phosphrous effluent. The ASCE 2003 database demonstrated mean TP reductions that ranged from –0.41 to 0.22 mg/L. For the 6 filters, mean inflow concentrations of TP ranged from 0.15 to 0.49 mg/L, and mean outflow concentrations of TP ranged from 0.12 to 0.90 mg/L.

Retention ponds in the 2003 database had mean TP reductions that ranged from –0.19 to 1.04 mg/L. For the 11 ponds, mean inflow concentrations of TP ranged from 0.10 to 0.52 mg/L, and mean outflow concentrations of TP ranged from 0.06 to 1.3 mg/L. For the Portland pond, the average TP effluent concentration was 0.16 mg/L. The 2016 (publ. 2017) study and analysis showed better results, with Total Phosphorus effluent significantly lower than the influent.

Wetland basins provided reduction in TP as demonstrated in the 2016 database and analysis. In the ASCE 2003 database, mean TP reductions ranged from –0.05 to 1.89 mg/L. For the 5 wetland basins, mean inflow concentrations of TP ranged from 0.10 to 2.91 mg/L, and mean outflow concentrations of TP ranged from 0.05 to 1.02 mg/L.

Wetland Basin/Retention Pond [Treatment Train] in the 2016 database and analysis showed a more significant reduction in Total Phosphorus, indicating multiple treatment types at the same location are much more effective.

Wetland channels in the 2003 database analysis had mean TP reductions that ranged from 0.02 to 0.13 mg/L. For the 3 wetland channels, mean inflow concentrations of TP ranged from 0.12 to 0.47 mg/L, and mean outflow concentrations of TP ranged from 0.09 to 0.34 mg/L. In the 2016 study, wetland channels showed limited effectiveness.

Vortechnics settling chamber effluent concentrations ranged from 0.055 mg/L to 0.382 mg/L. (2003 study).

Dry extended detention pond effluent concentrations ranged from 0.054 mg/L to 0.203 mg/L. These concentrations were similar to inflow concentrations and in many cases greater. (2003 study).

Public Education and Technical Assistance to small farms in rural Washington County is offered through brochures (public education), and through the Tualatin Soil & Water Conservation District (technical and/or financial assistance). The District provides assistance to landowners to implement conservation measures to protect natural resources in the Tualatin River Watershed. There is a renewed effort to include localized cooperation (with the County) as a BMP.

3.2.2-4 Conclusions re: BMP Effectiveness

Even though many of the BMPs showed positive performance, for the most part, the studies indicate that structural best management practices (i.e., those BMP types that were included in the ASCE database) will not be sufficient for meeting Tualatin basin TMDL concentrations for Total Phosphorus. As mentioned above for the 2003 analysis, out of the 37 BMPs that were monitored for TP in the ASCE database, only 13 BMPs (i.e., 35%) had mean outflow concentrations of TP that were below the maximum Tualatin basin TMDL concentration of 0.19 mg/L. None of the BMPs had TP effluent concentrations of 0.04 mg/L or less which is the TMDL concentration specified for rural areas. Mean outflow concentrations of TP ranged from 0.05 to 1.35 mg/L.

The 2016 (publ. 2017) WERF study did not provide as many details, but conclusions were similar, with the exception of multiple structural controls on the same site (treatment trains), which provided significantly more reduction. Again, this is not sufficient to attain given TMDL concentrations for Total Phosphorus.

The data show that it will be difficult to provide reasonable assurance that TP concentrations are met using only the BMP types analyzed in the ASCE database studies. Other BMPs such as maintenance practices (source control) and education are needed.

The County uses a combination of structural controls and source controls (such as BMPs, maintenance practices, training) to provide reasonable assurance that TP concentrations are targeted and addressed. The County's TMDL responsibility is limited to the rural area, and actions within their authority. The vast majority of this responsibility therefore lies in road construction and maintenance practices, which are reviewed and reported annually. Continual improvements to BMP's within these areas are part of Adaptive Management.

3.2.3 Implementation Plan Guidance for Reducing Phosphorus Concentrations

1. The data clearly show that swales are not effective for phosphorus removal and should not be part of a management plan to reduce phosphorus loads unless the specific cause for poor performance is identified and eliminated. It is possible that grassy swales have been fertilized (those in the study). Local information shows swales are sometimes effective.

2. The structural controls reviewed in the study were ineffective in reducing phosphorus levels to required concentrations. These are not applicable in the rural area of Washington County, however, indicating a different method is necessary.

The implementation plan concentrates on:

- Maintenance practices on rural County roadways under the operational jurisdiction of the County,
- Septic system permitting, and
- Land use and natural resource management, utilizing source control methodology.

See Chapter Five, herein, for Best Management Practices to reduce phosphorus loading.

3. Research should continue to look at soils, seasonal loadings, and rainfall patterns for identification of phosphorus loading.

The Implementation Plan guidance for Reducing Phosphorus Concentrations has been reviewed and renewed as valid management strategy for the near term. Adaptive Management is always applied (at least annually) to continually improve the controls.

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Section 3.3
Addressing Sources
Dissolved Oxygen

Section 3.3 includes:

3.3.0 Introduction to Dissolved Oxygen (DO)

The Oregon DEQ water quality standard for waterbodies identified by the Department as providing cold-water aquatic life states that dissolved oxygen shall not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen shall not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen shall not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and shall not fall below 6.0 mg/l as an absolute minimum. Most major tributary streams in the Tualatin Basin fall within the cold-water criteria. These are shown graphically in Figure 3.3. The seasonal compliance period is generally May 1 – October 31.

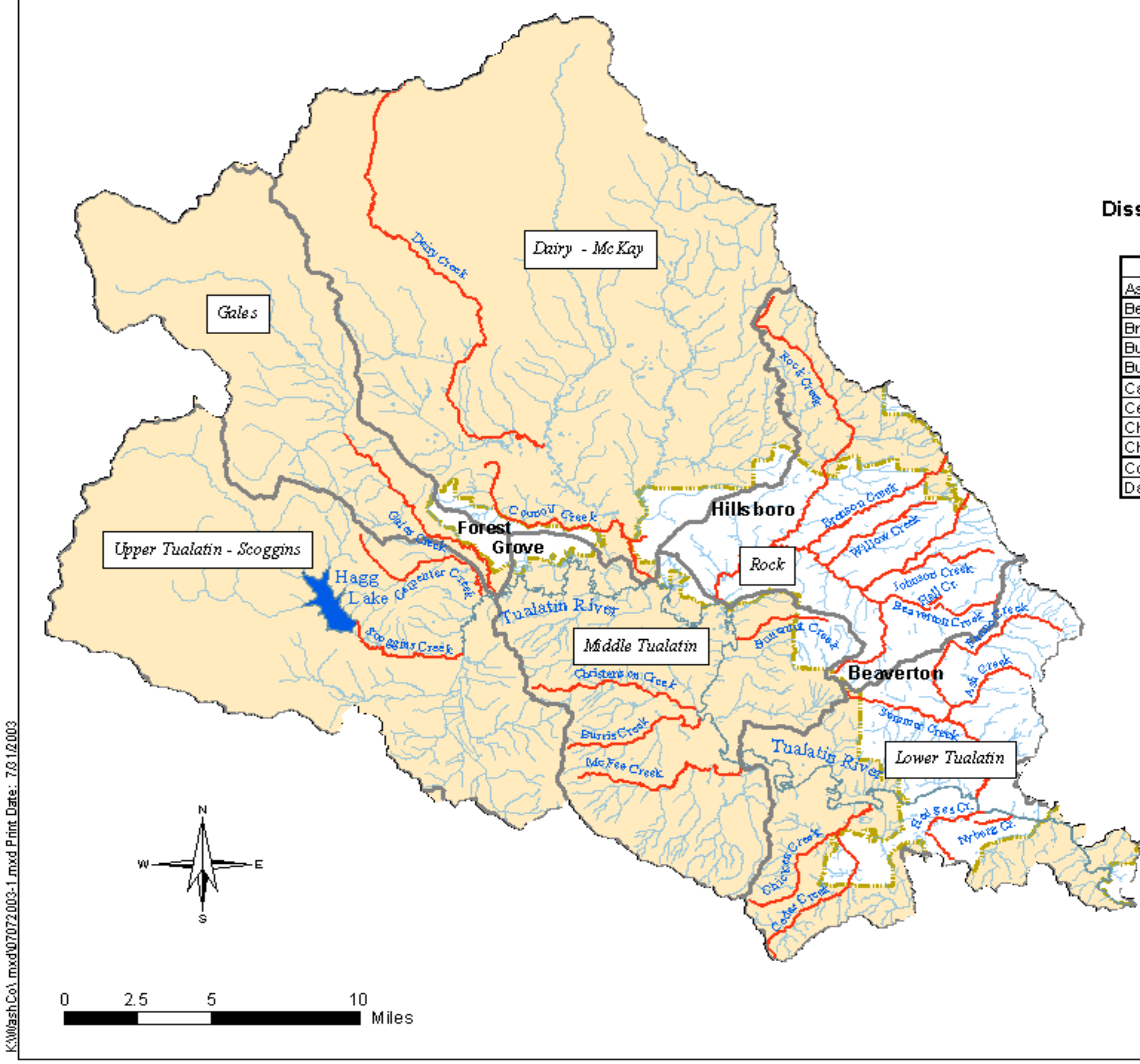
When organic matter enters streams or rivers, it is decomposed by bacteria. The process of decomposition removes dissolved oxygen from the water. Under most natural conditions in cold water streams, oxygen depletion caused by bacterial decomposition of organic matter is offset by reoxygenation through the water surface. In the Tualatin watershed, the rate of oxygen depletion caused by bacterial decomposition of organic matter exceeds that of reoxygenation and therefore, oxygen concentrations are depleted.

Oxygen demand in the Tualatin watershed consists of carbonaceous and nitrogenous oxygen demand in the water column and in sediments. The Tualatin watershed TMDLs are focused on reducing the loads of sediment oxygen demanding (SOD) substances (ranging from 20-50% reductions) for both the mainstem and tributaries. The TMDL includes load allocations (LAs) and waste load allocations (WLAs) for reducing the SOD. The TMDL is expressed in terms of settleable volatile solids. However, as there is currently no agreed upon method for measuring settleable volatile solids, the TMDL focuses on Total Suspended Solids (TSS).

Although an instream water quality standard does not exist for TSS, the industrial NPDES permits include a TSS effluent limit benchmark of 100 mg/L. To provide an indication of the relative quality of discharges, TSS concentrations reported in the literature review fact sheets are sometimes compared to the original benchmark of 130 mg/L. Results from this and other studies that help identify sources and controls are summarized below.

Figure 3.3

Tualatin Basin 2001
Dissolved Oxygen TMDL Listed Streams



Stream Name	
Ash Creek	Fanno Creek
Beaverton Creek	Gales Creek
Bronson Creek	Hall Creek
Burris Creek	Hedges Creek
Butternut Creek	Johnson Creek, South
Carpenter Creek	McFee Creek
Cedar Creek	Nyberg Creek
Chicken Creek	Rock Creek
Christenson Creek	Scoggins Creek
Council Creek	Summer Creek
Dairy Creek, West Fork	Willow Creek

Legend

Urban Growth Boundary

Subbasin Boundaries

Listed Streams

Washington County DLUT
Water Quality NPS
Implementation Plan

URS

Print Date: July 2003

3.3.1 Source Identification

As explained above, there are several factors that may contribute to the deficit of dissolved oxygen on the tributary streams in the Tualatin River Basin. These include nitrification, carbonaceous biochemical oxygen demand (CBOD) with the water column, algal growth, sediment oxygen demand (SOD), and temperature.[55] These factors are briefly explained below.

3.3.1-0 Contributing Factors to Deficit of DO

Nitrification

When nitrogen in the form of ammonia is introduced to natural waters, the ammonia may "consume" dissolved oxygen as nitrifying bacteria convert the ammonia into nitrite and nitrate (nitrification). The consumption of oxygen during this process is called nitrogenous biochemical oxygen demand (NBOD). How much oxygen is consumed is related to several factors: residence time, water temperature, ammonia concentration in the water, and the presence of nitrifying bacteria.

CBOD

Water column carbonaceous biochemical oxygen demand (CBOD) is the oxygen consumed by the decomposition of organic matter in water. The sources of the organic matter can be varied, either resulting from natural sources such as direct deposition of leaf litter or from anthropogenic sources such as polluted runoff.

Algal Growth

In many waterbodies, dissolved oxygen concentrations may be excessive due to algae. Excessive algae concentrations can cause large diel fluctuations in DO. Such streams generally exhibit supersaturated dissolved oxygen concentrations during the day and low DO concentrations at night. The DEQ has designated an action level of 15 *u*g/L concentration of chlorophyll *a* to indicate when algal growth may be a problem.

Sediment Oxygen Demand (SOD)

When solids that contain organics settle to the bottom of a stream they may decompose anaerobically or aerobically, depending on conditions. The oxygen consumed in aerobic decomposition of these sediments is called SOD and represents another dissolved oxygen sink for a stream. The SOD may differ from CBOD and nitrification because organic-containing sediment deposited as a result of stormwater runoff may remain a problem long after the storm event has passed.

3.3.1-1 Literature Review[56] of Sources

NOTE: This original Literature Review of TSS Source Identification is included here for historical perspective.

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[55] Tualatin River Subbasin TMDL document prepared by Oregon DEQ, Section 4.3.4.2, page 91; August 2001.

[56] This literature review was conducted for the Washington County Water Quality Implementation Plan in 2003. It is included here for 2 reasons: 1) At the request of a Tualatin Basin Coordinator (2013) for historical perspective, and 2) We believe the expense of an additional literature review would not yield useful results in terms of changing implementation strategy.

To address source identification and BMP effectiveness for dissolved oxygen in general, a review of sources and control strategies (Best Management Practices) was conducted.[57] Because total suspended solids are a valid indicator of dissolved oxygen depletion, and since the Oregon Department of Environmental Quality (DEQ) does not have an instream water quality standard for total suspended solids (TSS) in receiving waters, TSS fact sheets have been prepared to indirectly address dissolved oxygen problems in the Tualatin River watershed.

Studies summarized

Studies summarized for TSS source identification included Oregon stormwater studies and actual data from the Tualatin Basin:

- Analysis of Oregon Urban Runoff Water Quality Monitoring Data Collected by the Association of Clean Water Agencies (ACWA).[58] Characteristics of this study:
  - ➢ The study includes information from 40 municipal land use monitoring stations in western Oregon with up to 15 sampling events per station totaling approximately 334 data points.
  - ➢ The study includes 10 residential stations representing approximately 71 data points, 9 commercial stations representing approximately 77 data points, 7 industrial stations representing approximately 55 data points, 3 transportation stations representing approximately 23 data points, 10 mixed use stations representing approximately 100 data points, and 1 open space station representing approximately 8 data points.
  - ➢ The data points for each land use were grouped and evaluated to determine whether the data were statistically comparable and could be combined. Mixed land use stations were excluded from this evaluation. Four stations were excluded from the analysis based on this evaluation (one residential, two commercial and one industrial station). In addition, the industrial land use stations were divided into two groups; in-pipe stations versus in-stream stations.
  - ➢ The pooled data for each land use were compared to see if land use data were significantly different from each other. A statistical evaluation was conducted to determine whether more data points would significantly reduce the confidence intervals of the land use mean concentrations (e.g., improve the estimates of land use runoff average concentrations).

- Stormwater Annual Reports[59], Clean Water Services, Washington County, Oregon Department of Transportation (ODOT).
  - ➢ This included water quality monitoring data collected from 1993-1999 at nine sites in Washington County, each representing a specific land use type (Stormwater Annual Report, 1999). Up to five storm events were sampled each year (note: not each site was sampled each year). Sample averages were calculated from the 1993-1999 data and used for a comparative analysis of land uses.

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[57] **A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap); June, 2003.**
[58] **Id.**
[59] **Stormwater Annual Reports submitted to Oregon DEQ, Co-Permittees Clean Water Services (prev. USA), Washington County, and ODOT; 1996 et seq.**

- Stormwater Effects Handbook: A Toolbox for Watershed Managers, Scientists, and Engineers, Burton and Pitt, Lewis Publishers, 2002.[60]

3.3.1-2 Important Results/Conclusions from the Studies re: Source Identification

Land Use Types not Statistically Different

When pooled land use data were compared to each other in the ACWA study, the following land uses could not be shown to be statistically different from each other. The mean TSS concentration was highest for in-pipe industrial stations (194 mg/L) followed by transportation (169 mg/L), instream industrial (102 mg/L), commercial (92 mg/L), residential (64 mg/L), and finally open space (58 mg/L).

Although statistical analyses were not conducted, data from the CWS 1999 Annual Stormwater Report indicate that average TSS concentrations are greatest at industrial sites (80.8 mg/L) followed by residential and commercial.

Data Points Needed for Certainty

Results from the ACWA study indicated that continuing with monitoring by sampling three more storm events annually for each station would not dramatically decrease the uncertainties in the estimation of mean concentrations for these land uses. The degree of change in the confidence limit would be low compared to the percent increase in additional data points needed. For example, to see a 5% reduction in TSS at the Fanno Creek monitoring site would require approximately 202 additional samples.

Sedimentation Greatest during Construction Periods

Erosion losses and downstream sedimentation are greatest during construction periods, when soil exposure is greatest, and decline after construction is completed. The typically high erosion rates mean that even a small construction project may have a significant detrimental effect on local water bodies (Burton and Pitt, 2002).

The construction site monitoring data collected for the NPDES Compliance Report for the City of Portland (1998) indicated that construction sites contribute large TSS loads to receiving waters, even when sedimentation ponds are used. TSS concentrations in runoff from construction sites ranged from 846 to 6,200 mg/L at manholes, and from 563 to 4,500 mg/L at sedimentation pond outlets. TSS concentrations in runoff from developed urban land that was not undergoing active construction was much lower. At in-stream NPDES sampling sites in developed urban drainage areas (Fanno Creek, Johnson Creek), TSS concentrations ranged from 62 to 280 mg/L.

Runoff Data for Rural Areas

While cropland has been implicated as the most major source of erosion, runoff data were not gathered and analyzed from rural lands uses for the ACWA study reviewed here.

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[60] **See: http://rpitt.eng.ua.edu/Publications/BooksandReports/Stormwater%20Effects%20Handbook%20by%20%20Burton%20and%20Pitt%20book/toc.pdf**

Land Use Monitoring not Necessary

Monitoring programs to collect new land use data in order to better refine land use mean concentrations are not cost effective. Continued land use monitoring should only be proposed in WQMPs to evaluate long term trends.

3.3.2 Selecting BMPs to Address Dissolved Oxygen

3.3.2-0 Research BMP Categories

Categories of BMP's reviewed[61] for effectiveness in addressing or controlling sediment included the following:

- Porous Pavement
- Bio-Retention
- Vortechnics settling chamber (historical data)
- Detention basins/ponds
- LID
- Retention ponds
- Swales (i.e., mowed grass swales)
- Media filters
- Wetland basins
- Wetland channels (i.e., swales planted with wetland plants).

3.3.2-1 Literature Review[62] of BMP Effectiveness Data

Studies summarized for sediment BMP effectiveness included a national BMP Database, and data from the Tualatin Basin:

- National Stormwater Best Management Practices (BMP) Database[63], Urban Water Resources Research Council of the American Society of Civil Engineers (ASCE), http://www.bmpdatabase.org/ accessed May 5, 2003. It is important to note that only the data reported in the National BMP Database that was collected as Event Mean Concentrations (EMCs) was examined for this fact sheet. Data reported in the National BMP Database that was collected as grab samples was not examined. Data were only examined from studies containing10 or more samples.

- International Stormwater BMP Database, Water Environment & Reuse Foundation, 2016 Summary Statistics: The BMP performance analyses provided in this report are based on the BMP performance

[61] A Compilation of Historical Stormwater Quality Data for Use in Providing Reasonable Assurance, URS Corporation (K. Reininga and J. Belknap); June, 2003; and International Stormwater BMP Database, Water Environment & Reuse Foundation, 2016 Summary Statistics.

[62] The original literature review was conducted for the Washington County Water Quality Implementation Plan in 2003. It is summarized herein for historical perspective, and because it was analyzed with regard to the Tualatin TMDL. Newer data and summary conclusions from similar sources (i.e., the ASCE National Stormwater Database) have been added.
[63] The data analysis includes calculation of the arithmetic mean of the inflow and outflow concentration data based on a lognormal distribution of the data, and the comparison of mean inflow and outflow concentrations to determine if the results are statistically different.

data in the BMP Database as of November 2016. The analyses are based upon the distributions of influent and effluent water quality sample data for individual events by BMP category, thereby providing greater weight to those BMPs for which there are a larger number of data points reported. In other words, the performance analysis presented in this technical summary is "storm-weighted," as opposed to "BMP weighted." http://www.bmpdatabase.org/Docs/03-SW-1COh%20BMP%20Database%202016%20Summary%20Stats.pdf (2017).

- Brochures - Portland Water Quality Swales and Portland Water Quality Ponds, City of Portland Bureau of Environmental Services (BES).

- Stormwater Annual Reports, Clean Water Services (CWS), Washington County and Oregon Department of Transportation (ODOT).

3.3.2-2 Results of BMP Effectiveness for TSS: Structural Controls

The results from recent studies[64] summarized from the National Stormwater BMP Database (ASCE) are shown in Table 3.3. The results from the 2003 review of local data can be found in Appendix A, Table A-3. Conclusions from the original 2003 analysis and the 2016 (publ. 2017) analysis are summarized below.

Table 3.3: Influent/Effluent Summary Statistics for TSS (mg/L)

BMP Category	BMPs		EMCs		25th		Median			75th	
	In	Out	In	Out	In	Out	In	Out	Difference	In	Out
Bioretention	25	25	520	463	18.0	4.0	40.6 (36.0, 46.0)	10.0 (8.0, 10.0)	◆◆◆	99.2	18.5
Composite	10	10	202	174	42.4	8.0	85.7 (75.0, 101.3)	18.0 (12.8, 19.2)	◆◆◆	178.8	36.5
Detention Basin	32	33	411	436	24.1	10.5	68.0 (57.4, 76.2)	24.3 (21.8, 27.0)	◆◆◆	129.0	49.6
Grass Strip	19	19	361	282	20.0	10.0	44.0 (39.0, 48.0)	19.0 (15.5, 21.0)	◆◆◆	90.0	35.0
Grass Swale	24	24	442	418	9.2	11.0	28.6 (23.0, 35.0)	24.0 (19.0, 26.0)	◇◇◆	67.5	46.7
LID	3	3	131	62	25.5	13.0	51.0 (32.0, 54.0)	29.5 (15.0, 49.3)	◇◇◇	87.5	82.0
Media Filter	25	25	400	377	22.0	3.9	56.4 (46.0, 61.9)	9.0 (6.4, 10.0)	◆◆◆	120.0	22.8
Porous Pavement	9	9	404	248	36.8	15.0	93.7 (75.0, 126.0)	26.0 (20.6, 27.0)	◆◆◆	243.0	53.2
Retention Pond	56	56	923	933	15.0	4.3	47.2 (40.0, 54.0)	11.7 (10.0, 12.3)	◆◆◆	139.8	28.0
Wetland Basin	22	22	492	486	13.1	4.7	31.0 (26.4, 35.5)	14.1 (11.6, 15.2)	◆◆◆	75.9	31.0
Wetland Basin/ Retention Pond	78	78	1415	1419	14.0	4.5	38.9 (35.6, 43.6)	12.0 (11.1, 13.0)	◆◆◆	110.3	29.6
Wetland Channel	12	12	199	178	13.0	8.0	22.0 (18.0, 24.0)	17.0 (13.0, 19.0)	◇◆◆	98.4	40.5

Total Suspended Solids (TSS) Removal in General

In both the 2003 (national and local) and the 2017 (international) analyses, it was concluded that all of the BMP types demonstrated significant reduction in TSS, with the exception of LID sites. None of the BMP categories examined from the 2003 National Stormwater BMP Database showed significantly better performance for TSS removal than the others. The 2016 Summary (publ. 2017) report added data for Bioretention. The lowest effluent

[64] International Stormwater BMP Database, WERF Study, 2016 Summary (publ. 2017). At: http://www.bmpdatabase.org/Docs/03-SW-1COh%20BMP%20Database%202016%20Summary%20Stats.pdf

concentrations observed for TSS include bioretention, media filters, retention basins, and wetland basins. These BMPs enable sedimentation and filtration, which are effective treatment processes for sediment removal.

In general, the data from both analyses indicate that all of the types of BMPs monitored are capable of removing TSS to meet the NPDES benchmark of 100 mg/L. The performance is likely dependent upon BMP design, influent concentrations of TSS, and factors related to TSS sources such as particle size and settling time. The 2017 analysis concluded all of the BMP types evaluated discharged median effluent concentrations below 30 mg/L, which it says is a common benchmark for TSS performance.

As shown by the 2003 analysis and Table A-3, of the 37 BMPs that were monitored for TSS, all but 3 BMPs had mean outflow concentrations of TSS that were below the NPDES benchmark of 130 mg/L. One media filter, one retention pond, and one wetland channel had mean outflow concentrations of TSS that exceeded the benchmark. However, even these concentrations were relatively low (133.8 mg/L-166.4 mg/L). Mean inflow concentrations of TSS for the BMPs ranged from 5 to 330 mg/L. Mean outflow concentrations of TSS ranged from 1 to 166 mg/L.

See Appendix A for 2003 analysis and findings by BMP type. The 2017 analysis did not include a similar narrative.

Total Dissolved Solids (TDS) Removal

Table A-4 in the Appendix displays the monitoring results of 9 BMPs that were monitored for removal of total dissolved solids (National BMP Database, 2003). Although mean reductions for 6 of the BMPs ranged from 3 to 28 mg/L, none of the BMPs showed mean outflow concentrations that were statistically less than the mean inflow concentrations based on the number of samples and the range of data points. In the 2003 review it was found that two of the BMPs, a biofilter swale and a retention pond, performed poorly for removal of dissolved solids and showed mean outflow concentrations that were statistically greater than the mean inflow concentrations. Although the results were not statistically different, the wetland basin showed the greatest mean reduction of dissolved solids and had the lowest mean outflow concentration of 28 mg/L. The 2017 analysis only looked at results of TSS removal, not TDS.

Total Volatile Solids (TVS) Removal

Table A-4 in the Appendix also displays the monitoring results of 7 BMPs that were monitored for the removal of total volatile solids (National BMP Database, 2003). Two retention ponds studied showed the greatest mean reductions of total volatile solids, ranging from 57 to 140 mg/L. Two wetland channels studies also showed mean reductions of volatile solids of 25 mg/L and had the lowest mean outflows of 8 to 10 mg/L, but mean influent concentrations for these BMPs were lower than for the retention ponds. Although the results were not statistically different between the mean concentrations in the inflow and the outflow, the detention basin showed a mean reduction of total volatile solids of 18 mg/L. The biofilter swale showed a statistically greater mean concentration of total volatile solids in the outflow than in the inflow, although the increase was only 7 mg/L. The media filter also showed an increase of 7 mg/L in the mean outflow concentration, but the results were not statistically different. The 2017 analysis only looked at results of TSS removal, not TVS.

Volatile Solids (VS) Removal

The results of monitoring for two BMPs that were monitored for the removal of volatile solids are also displayed in Table A-4 (National BMP Database, 2003). The detention basin had a mean outflow concentration of volatile solids of 5 mg/L, a statistically significant decrease in mean concentration from the inflow of 12 mg/L. The media filter had a mean outflow concentration of volatile solids of 8 mg/L. Although the outflow results for the media filter show an increase of 2 mg/L over the mean inflow, the results were not statistically different. The 2017 analysis only looked at results of TSS removal, not VS.

Volatile Dissolved Solids (VDS) Removal

The results of monitoring for two BMPs that were monitored for the removal of volatile dissolved solids are also displayed in Table A-4 (National BMP Database, 2003). The detention basin had a mean outflow concentration of volatile dissolved solids of 26 mg/L, and the media filter had a mean outflow concentration of volatile dissolved solids of 29 mg/L, but neither of the results was statistically different. The 2017 analysis only looked at results of TSS removal, not VDS.

3.3.2-3 Remaining Questions/ Data Gaps re: BMP Effectiveness

The BMPs summarized in the ASCE database were focused on treatment of runoff from new development. It would be helpful to have additional data on the effectiveness of these BMPs at treating runoff from construction sites with significantly higher influent TSS concentrations. [See 2019 Update Note, below].

The relationship between settleable volatile solids (SVS) and TSS is not well understood. If the goal is to reduce SOD through the reduction of settleable volatile solids, then this relationship should be determined.

2019 Update: For public transportation projects, Washington County will continue to follow Clean Water Services' Design & Construction standards for the urban area as they are updated. The County does not have urban stormwater runoff standards for private new development, as this is done by Clean Water Services, thus will not be doing an additional literature review or technical review.

3.3.3 Conclusions re: BMP Effectiveness

In general, the data indicates that all of the types of structural BMPs monitored are capable of removing TSS to meet the NPDES benchmark of 130 mg/L but the performance is likely dependent upon BMP design, influent concentrations of TSS, and factors related to TSS sources such as particle size and settling time. For example, the treatment pond used for the Forest Heights construction site (see the TSS Sources Fact Sheet) had one effluent concentration that was as high as 4,500 mg/L. This high concentration was thought to be due to the clayey nature of the soil (i.e., very small particle sizes), the very high TSS influent concentration, and the short settling time in the pond due to the fact that the pond had filled with sediments from previous storms.

None of the structural types of BMPs examined from the National Stormwater BMP Database showed significantly better performance for TSS removal than the others. The study did not reveal a BMP category that out-performed any other BMP category – thus no guidance regarding which BMP to use is available through this national database.

With respect to the effectiveness of structural BMPs at reducing TDS, TVS, VS, and VDS, the results are highly variable. Therefore, these types of BMPs should not be utilized if these parameters are considered to be critical.

The literature review demonstrated little confidence in addressing specific TDS, TVS, although all types of structural controls are capable of removing TSS. If TSS is the surrogate for Dissolved Oxygen, the current structural controls, with standards to be updated (by CWS), will be sufficient to address D.O.

3.3.4 Implementation Plan Guidance for Reducing Sediments

3.3.4-0 Urban Areas (Clean Water Services' authority)

Due to the relatively high loads of TSS contributed by construction sites in urban areas, active promotion of best management practices to developers and builders along with increased construction site inspection by erosion control specialists should be of highest priority with respect to controlling TSS.

For built-out urban areas not undergoing construction, sediment controls should focus on land uses that contribute the highest average TSS loads. Sediment controls in traffic corridors and other highly used transportation areas should be a high priority.

Sediment controls in built-out industrial, commercial and residential land should be the next priority unless site specific data or observations indicate the need for higher priority attention, such as at an industrial site where heavy vehicle traffic creates high TSS loads.

Structural BMPs in the categories reviewed are capable of removing TSS to meet the NPDES benchmark of 130 mg/L but efficiency results are dependent upon specific design. Structural BMPs are generally not used outside the urban area, and are not expected to be a method of achieving load allocations for dissolved oxygen.

3.3.4-1 Rural Area (within Washington County authority)

Conclusion for Nonpoint Source Management: Water quality management plans addressing TSS (surrogate for D.O.) should focus on reducing activities that accelerate instream erosion (i.e., reducing quantities of runoff generated, increasing channel roughness, slowing flows) and increasing activities that stabilize streambanks. Washington County activities and programs meet these instream protective standards that prevent and minimize erosion during construction and post-construction, provide stabilization of streambanks, and protect channel geomorphology. Some of the standards are met through other regulations from Army Corps of Engineers (404 permits), OR Dept. of Fish & Wildlife, NOAA Fisheries, and Division of State Lands.

Section 3.4
Addressing Sources
Temperature

Section 3.4 includes:

3.4.0 Introduction

The Oregon Department of Environmental Quality (DEQ) protects water quality by establishing standards to protect beneficial uses such as aquatic life, fisheries, irrigation, etc. While there may be competing beneficial uses in a river or stream, federal law requires DEQ to protect the *most sensitive* of these beneficial uses. The temperature standard is designed to protect cold water fish such as salmon and trout. Streams listed for the Temperature TMDL in the Tualatin Basin are shown in Figure 3.4.

Water temperature has a profound effect on organisms that live or reproduce in the water. This is particularly true of Oregon's native "cold-water" fish such as salmon, bulltrout, steelhead trout, and some amphibians (frogs and salamanders). When water temperature becomes too high, salmon and trout suffer a variety of effects ranging from decreased spawning success to death.[65]

As the basis for the 2001 TMDL, nineteen stream segments in the Tualatin River Subbasin were listed on the 1998 303(d) list for water temperature violations. All segments were listed based upon the 64°F water temperature criteria. Peak temperatures in the Tualatin basin occur from June through October and the Tualatin River below river mile 38.4 is commonly above the 64°F numeric criterion throughout the summer and early fall. No measurable surface water temperature increase resulting from anthropogenic activities is allowed in the Tualatin River Subbasin due to the existing water temperature violations.

The temperature standard for the Tualatin Sub-basin was not amended in the 2012 TMDL Update due to legal challenges. In August 2013, EPA disapproved the natural conditions criterion contained in Oregon's water quality standard for temperature (State rules). When the temperature standard is amended, a re-evaluation will occur, but is unlikely to change Washington County's implementation plan for the rural area.

In the Tualatin River Subbasin, surface water temperatures are heavily influenced by human activities. These activities can have detrimental or beneficial impact. Direct impacts include, for example, cool water releases from reservoirs. Indirect impacts include, for example, loss of riparian vegetation (shading reduces the rate of heating), changes to stream morphology, and water withdrawal.

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[65] **Fact Sheets and Information on the 1998 Listing of Water Quality Limited Waterbodies, Oregon DEQ, February 1998.**

3.4.1 Source Identification

3.4.1-0 Factors that Affect Stream Temperature

Elevated summertime stream temperatures attributed to anthropogenic sources may result from the following conditions within the Tualatin River Subbasin:[66]

Riparian Vegetation Disturbance: Shade is very important as a means of intercepting sunlight and reducing energy that is transferred to the surface of a stream. This shade can come in the form of tall grass (effective in shading a small narrow stream), shrubs, brush, and taller trees farther from the stream. Canopy density and height are important factors in determining how much sunlight is intercepted. The thicker and taller the canopy, the less direct solar energy reaches the water surface over the course of a day.[67]

Channel Widening: The surface area of a stream is very important in the transfer of energy. The width of a stream determines the surface area exposed to the atmosphere. A wide, shallow stream receives more energy (and therefore increases in temperature faster) than a stream of the same volume that is narrow and deep. Natural events or land use activity that knocks down stream banks also makes the stream wider for the same volume of water. This increase in surface area increases the water temperature when the stream is exposed to heating by solar radiation.[68]

Stream Volume: Reduced flow volumes from irrigation, industrial and municipal withdrawals can cause stream volume to change. Streams with smaller volumes of water change temperature faster than streams or rivers with larger volumes of water.

Water Inflow and Outflow: In some sections of a stream or river, water moves from the stream into the surrounding soil, causing significant losses of flow volume. In other sections of the same stream, water may flow from the soil into the stream, adding to the flow volume. During much of the summer, water flowing into the stream from the soil is cooler than the water already in the stream. The temperature of that part of the stream can decrease.[69] Inflow and outflow are very difficult to measure. Oregon DEQ identified disconnected floodplains as a factor in maintaining stream temperature.

Air Temperature: When air temperatures are high, some heat is added to the stream directly from the air (convection). Simultaneously, this warmer air causes more evaporation. Because energy (heat) is used to evaporate water, heat energy is lost from the stream when evaporation occurs, thus cooling the stream. Since we have no control over air temperature, it offers a limited management opportunity to achieve desired stream temperatures.

Seasonal Variability: Headwater stream temperatures (in forested western Oregon) showed great stream temperature variability

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[66] **Tualatin River Subbasin TMDL, Appendix I, Water Quality Management Plan, Oregon DEQ, August, 2001.**
[67] **From Stream Temperatures: Some Basic Considerations; Moore and miner, OSU Extension Service, May 1997.**
[68] **Id.**
[69] **Id.**

3.4.2 Temperature Loading

3.4.2-0 Literature Review of Temperature "Sources"

Studies summarized

Studies summarized for processes that affect temperature loading on streams included NMFS publications, Oregon DEQ TMDL documents, studies from the Klamath Resource Information System, and actual data from the Tualatin Basin:

- *An ecosystem approach to salmonid conservation*. Spence, B.C, G.A. Lomnicky, R.M. Hughes and R.P. Novitski. TR-4501-96-6057. ManTech Corp, Corvalis, OR. Funded by National Marine Fisheries Service, U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency. http://www.calwater.ca.gov/Admin_Record/D-051874.pdf .

> This document synthesizes over 50 years of reported scientific research in order to describe physical, chemical, and biological processes operating across the landscape, within riparian areas, and in aquatic ecosystems; as well as the effects of human activities on these processes. Original references to research that is synthesized in this document are included in this fact sheet.

- Tualatin Subbasin Total Maximum Daily Load (TMDL). 2001. Oregon Department of Environmental Quality (DEQ).

- Guidelines for Rating Selected Level 2 Environmental Attributes for the Ecosystem Diagnosis and Treatment Model (EDT). January 2003. Mobrand Biometrics, Inc.

- "Stream Conditions: Temperature"; and "Hypothesis #5: Alteration of riparian stands has increased stream warming in some reaches of the Ten Mile River, even where direct shade has been retained." The Klamath Resource Information System (KRIS).

  www.krisweb.com/krisnoyo/krisdb/html/krisweb/analysis/hypoth5.htm

- "Increase Stream Shading for Stream Temperature Reduction", U.S. Dept. of Agriculture, Conservation Enhancement Activity, Publ. E291127Z; 2017.

- "Spatial and Seasonal Variability of Forested Headwater Stream Temperatures in Western Oregon", Leach, Olson, Anderon; Aquatic Species, Vol. 79, Issue 2, pp. 291-307; April 2017.

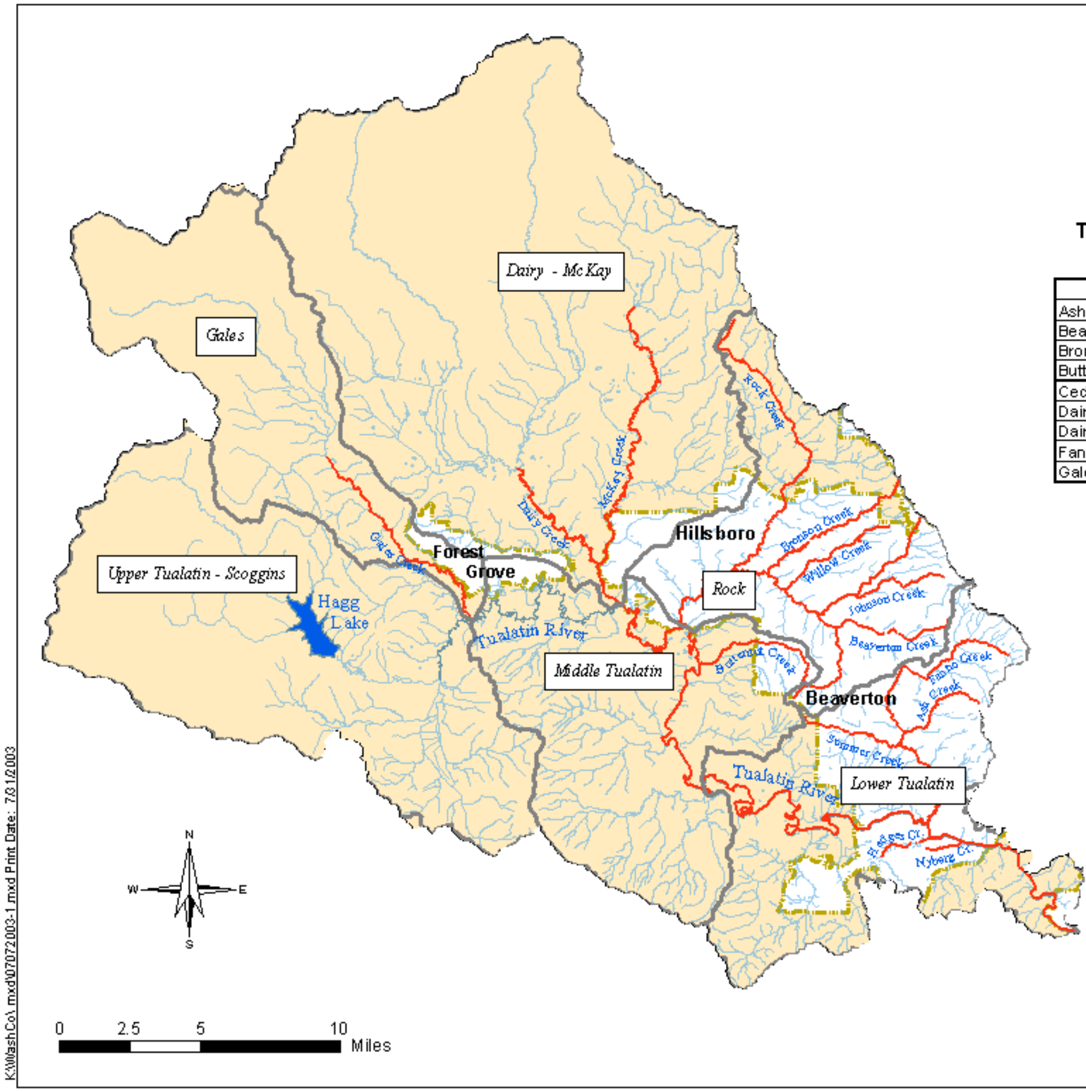

Figure 3.4

Tualatin Basin 2001
Temperature TMDL Listed Streams

Stream Name	
Ash Creek	Hedges Creek
Beaverton Creek	Johnson Creek, North
Bronson Creek	Johnson Creek, South
Butternut Creek	McKay Creek
Cedar Mill Creek	Nyberg Creek
Dairy Creek, East Fork	Rock Creek
Dairy Creek, West Fork	Summer Creek
Fanno Creek	Tualatin River
Gales Creek	Willow Creek

Legend

Urban Growth Boundary
Subbasin Boundaries
Listed Streams

Washington County DLUT
Water Quality NPS
Implementation Plan

URS

Print Date: July 2003

3.4.2-1 Important Results from the Studies re: Temperature "Sources"

Heat Transfer: Varying Scientific Opinions re: Instream Temperature Increases

Heat energy is transferred to and from streams and rivers by six processes: short-wave radiation (primarily direct solar), long-wave radiation (thermal radiation emitted from the Earth's surface), convective mixing with the air, evaporation, conduction with the stream bed, and advective mixing with inflow from groundwater or tributary streams (Spence et al, 1996).[70]

There are varying scientific opinions about the relative importance of the above listed process as a source for temperature increases in streams. While it is known that all of the above processes interact to produce the temperature regimes observed in streams and rivers and it is also known that the relative importance of each process differs among locations, there is disagreement as to what are the dominant processes.

Spence et al. (1996) sites several sources (Brown, 1980; Beschta et al., 1987; Sullivan et al., 1990) that indicate that in small- to intermediate-sized streams of forested regions, incoming solar radiation represents the dominant form of energy input to streams during summer, with convection, conduction, evaporation, and advection playing relatively minor roles. Spence et al. (1996) also notes that groundwater inputs may be important in small streams where they constitute a large percentage of the overall discharge, particularly during periods of the year when flows are low.

Spence et al. (1996) sites several sources (Brown, 1980; Beschta et al., 1987; Sullivan et al., 1990) that indicate that downstream, where flow increases, the effects of riparian shading and advective mixing generally diminish, and the importance of evaporative heat-loss increases (Spence et al., 1996).

Effect of Alteration of Riparian Stands

In contrast to the research results cited by Spence et al. (1996), KRIS (2003)[71] proposes a hypothesis that: "Alteration of riparian stands has increased stream warming in some reaches of the Ten Mile River, even where direct shade has been retained."

KRIS supports this hypothesis by noting that while many previous works considered direct solar radiation to be the dominant mechanism for warming streams (Brown, 1980 as cited in Spence et al., 1998), most of the recent scientific literature considers air temperature over the stream to be the most influential factor. Poole and Berman (2000)[72] also recognize the relationship between increasing air flow over the stream and water temperature elevation. Brosofske et al (1997)[73] found that upslope soil temperatures were also a predictor of water temperature (KRIS, 2003).[74]

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[70] **"An Ecosystem Approach to Salmonid Conservation", Spence, Lomnicky, Hughes, Novitzki, Dec. 1996. See: http://www.calwater.ca.gov/Admin_Record/D-051874.pdf**

[71] KRIS; See: www.krisweb.com/krisnoyo/krisdb/html/krisweb/analysis/hypoth5.htm

[72] **"Pathways of Human Influence on Water Temperature Dynamics in Stream Channels. U.S. EPA, Region 10, Seattle, WA; Poole, G.C., and Berman, C. H.; 2000. See: http://www.krisweb.com/biblio/gen_usepa_pooleetal_2000_pathways.pdf**

[73] **"Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. Ecological Applications Vol. 7(4): 1188-1200; Brosofske, Chen, Naiman, and Franklin (1997).**

[74] **KRIS, Id.**

Most Sensitive Variables

KRIS (2003) notes that Bartholow (1989)[75] found that air temperature above the stream surface was the greatest factor in increasing water temperatures followed in importance by relative humidity and shade, respectively. Bartholow's (1989) work was based on field data from hundreds of locations throughout the West used to develop the SNTEMP stream temperature model (KRIS, 2003). Bartholow found that when predicting *mean* daily water temperature, air temperature is the most sensitive input variable. Relative humidity is the next most sensitive input variable, accounting for less than half as much change in stream temperature. Percent shade follows a close third to relative humidity. When predicting *maximum* daily water temperature, air temperature is just as important, but percent shade, which affects diurnal range, overtakes relative humidity as the second most sensitive variable. For both measures, stream flow is the fourth most sensitive variable and water temperature is very sensitive to changes in air temperature when stream flow is low (KRIS, 2003 cited Essig, 1998).

Amount and Type of Riparian Vegetation

There is agreement, however, that the amount and type of riparian vegetation play dominant roles in regulating incoming solar radiation in smaller streams (Spence et al.,1996 cited Brown, 1980; Beschta et al., 1987; Caldwell et al., 1991). The percentage of total solar radiation that reaches the stream surfaces in undisturbed forested reaches can be less than 16% under dense coniferous canopies found in old-growth stands of the Coast Range and western Cascades (Spence et al., 1996 cited Summers, 1983). As streams become larger and wider, riparian vegetation shades a progressively smaller proportion of the water surface, diminishing the influence of riparian vegetation on water temperature.

Increased exposure of streams to solar radiation due to the removal of streamside vegetation has altered the natural temperature regime of streams throughout the Pacific Northwest. Studies in the Coast Range and the Cascade Mountains of Oregon have shown increases in mean monthly maximum temperatures of about 3 to 8°C following clearcut logging (Mobrand Biometrics 2003 cited Beschta et al. 1987).

Long-Wave Radiation

Long-wave radiation back into the atmosphere plays a relatively minor role in the overall energy budget of a stream. Long-wave radiation loss is determined primarily by the temperature differential between water and air, with greater exchange occurring when the difference between the air and water temperatures is greatest. Riparian vegetation reduces long-wave radiation through its effect on microclimate within the riparian zone. Temperatures in the riparian zone tend to be cooler during the day and warmer at night than those above the forest canopy; this dampening of diel temperature fluctuations moderates long-wave radiative gains and losses.

Effects of Groundwater Inputs

The role of advection depends on the volume of groundwater or tributary inputs relative to the total stream discharge; consequently, the importance of advection tends to diminish in a downstream direction. Nevertheless, even when groundwater inputs to streams are small, they may provide thermal heterogeneity that is biologically important. Groundwater inputs can significantly moderate streamflow and temperature regimes in both summer and winter.

[75] **"Stream temperature investigations: field and analytic methods. Instream flow information paper No. 13. Biological Report 89(17); Bartholow, J.M., U.S. Fish and Wildlife Service, Ft. Collins, CO, 1989**

The temperature of water that enters streams from groundwater flow depends on ambient conditions in the soil environment. Seasonal groundwater temperature fluctuations are greatest at the surface and decrease with depth down to the "neutral zone," generally about 52-59 ft (16-18 m) below the surface, where temperatures remain constant throughout the year. If the groundwater flow originates below the neutral zone, then groundwater temperatures will remain constant; if it originates above the neutral zone, then groundwater temperatures will exhibit seasonal variation (Spence et al.1996 cited Meisner 1990).

Channel Characteristics

Channel characteristics may also significantly affect heat-exchange processes in streams. Wide, shallow streams exhibit greater radiative, convective, and evaporative exchange due to greater water surface area, thus heating and cooling more rapidly than deep, narrow streams. Similarly, the rate of energy exchange is affected by seasonal changes in stream discharge, which alter surface-to-volume ratios and determine the relative importance of groundwater inputs. In most streams in the Pacific Northwest, groundwater inputs are critical to cool streams during warm summer months (Spence et al.1996).

High Turbidity and Sedimentation

Wetzel (1983, as cited in Spence et al., 1996) and Hagans et al. (1986, as cited in Spence et al., 1996) reported that high turbidity and sedimentation caused stream temperatures to increase, as dark-colored fine sediment replaced lighter- colored coarse gravels. The darker sediment stored more solar radiation. Fine sediment may also block exchange between surface waters and intragravel flows, contributing to warming.

Land Use Practices

Land-use practices can significantly change seasonal and diel temperature regimes in streams, primarily through the alteration of forest and riparian canopy but also through irrigation, impoundments, heated industrial effluents, and thermal power plants (Spence et al.,1996). Stream temperatures can be altered by the following conditions or actions:

- Removal of streambank vegetation;
- Filling and drying of wetlands;
- Interception and rerouting of groundwater inputs;
- Withdrawal and return of water for agricultural irrigation;
- Release of water from reservoirs (warm water from a surface release and cold water from a deep release);
- Changes in channel or water body size;
- Suspended sediment/turbidity in streams;
- Stormwater runoff from warmed surfaces;
- Point sources such as wastewater treatment plants, thermal power plants, and food processing plants; and
- Low streamflow.

Simplified Analysis

Although the scientific studies summarized above indicate that water temperature is affected by a variety of processes, DEQ’s analysis of temperature sources in the Tualatin TMDL contains a simplified assessment of nonpoint temperature sources. The TMDL report states that elevated summertime stream temperatures attributed to nonpoint sources result from increased solar radiation heat loading. The TMDL attributes nonpoint source temperature increases in the Tualatin to the disturbance/removal of near stream vegetation that has reduced levels of stream shading and exposed streams to higher levels of solar radiation (i.e. reduction in stream surface shading via decreased riparian vegetation height, width and/or density increases the amount of solar radiation reaching the stream surface) (DEQ, 2001).

Discharges from Permitted Facilities

NPDES permitted facilities discharge surface water to the Tualatin River and tributaries during the critical summertime temperature period. For 2017, the District (i.e., Clean Water Services) offset the excess thermal loads from the Rock Creek WWTF, Durham WWTF and Forest Grove WWTF and NTS using credits generated from flow enhancement and riparian shade planting activities as demonstrated by a zero net thermal load to the Tualatin River.[76]

3.4.2-2 Summary of "Sources" of Instream Temperature

There are varying scientific opinions about the dominant processes that affect stream temperature.

Spence et al. cites several sources that indicate that in small- to intermediate-sized streams of forested regions, incoming solar radiation represents the dominant form of energy input to streams during summer.

As streams become larger and wider, riparian vegetation shades a progressively smaller proportion of the water surface, diminishing the effects of riparian shading on water temperature.

Groundwater inputs may be important in small streams where they constitute a large percentage of the overall discharge, particularly during periods of the year when flows are low. As streams become larger and wider, riparian vegetation shades a progressively smaller proportion of the water surface, diminishing the effects of riparian shading and advective mixing on water temperature and increasing the importance of evaporative heat-loss.

In contrast to the research results cited by Spence et al. (1996), KRIS (2003) notes that while many previous works considered direct solar radiation to be the dominant mechanism for warming streams most of the recent scientific literature considers air temperature over the stream to be the most influential factor.

Substantial scientific literature suggests that alteration of the riparian canopy, even well back from the stream, can open air flow and change the microclimate over the stream. Increasing airflow, particularly in areas with high summer air temperatures, can increase heat exchange with the stream and thereby elevate water temperatures (KRIS, 2003). Thus, even where direct shade is retained over streams, alteration of riparian stands and adjacent upland areas may result in increased stream warming due to changes in the microclimate over the stream. The findings that shading provides great benefit are verified in current approaches (2017).[77]

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[76] **See: Water Quality Credit Trading 2017 Annual Report; Clean Water Services; https://www.cleanwaterservices.org/media/2299/2017-cws-water-quality-credit-trading-annual-report.pdf**

[77] **"Increase Stream Shading for Stream Temperature Reduction", U.S. Dept. of Agriculture, Conservation Enhancement Activity, Publ. E291127Z; 2017.**

3.4.3 BMP Effectiveness

3.4.3-0 Literature Review of Management Practices or Scenarios to Affect Instream Temperature

Studies summarized

Studies summarized for management activities that may affect temperature loading on streams included USGS publications, Oregon DEQ TMDL documents, NPDES Stormwater Annual Compliance Reports, and data from the Tualatin Basin and other Basins:

- Effects of Hypothetical Management Scenarios on Simulated Water Temperatures in the Tualatin River, Oregon, 2000. John C. Risley. USGS Water-Resources Investigations Report 00-4071. See: https://pubs.usgs.gov/wri/2000/4071/report.pdf

- An Ecosystem Approach to Salmonid Conservation. Spence, B.C, G.A. Lomnicky, R.M. Hughes and R.P. Novitski. TR-4501-96-6057. 1996. ManTech Corp, Corvallis, OR. Funded by National Marine Fisheries Service, U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency. Available from NMFS, Portland, OR. http://www.calwater.ca.gov/Admin_Record/D-051874.pdf .

- "Stream Conditions: Temperature"; and "Hypothesis #5: Alteration of riparian stands has increased stream warming in some reaches of the Ten Mile River, even where direct shade has been retained." The Klamath Resource Information System (KRIS). Accessed June 17, 2003.
  www.krisweb.com/krisnoyo/krisdb/html/krisweb/analysis/hypoth5.htm

> The "Stream Conditions: Temperature" page is designed to supply basic information about fish, water quality and watershed dynamics to aid in understanding the contents of the KRIS Mendocino projects (Noyo River, Big River and Ten Mile River). The KRIS Mendocino project supports the California Resources Agency's North Coast Watershed Assessment Program.

- Tualatin Subbasin Total Maximum Daily Load (TMDL). 2001, 2012 revisions. Oregon Department of Environmental Quality (DEQ).

- Factors Influencing Stream Temperatures in Small Streams: Substrate Effects and a Shading Experiment; S.L. Johnson; U.S. Forest Service, Pacific NW Research Station, Corvallis, OR; 2004. http://forestry.oregonstate.edu/cof/fe/watershd/fe538/StreamTemperature/johnson_factors_effecting_stream_temp_CJOF04.pdf

- Spatial and Seasonal Variability of Forested Headwater Stream Temperatures in Western Oregon, USA; Aquatic Sciences, Vol. 79, Issue 2, pp. 291-307; April 2017. https://link.springer.com/article/10.1007%2Fs00027-016-0497-9

3.4.3-1 Results of Studies re: Effectiveness of Management Practices on Instream Temperature

Effects of Buffer Strips

The effect of buffer strips left along streams following logging or land clearing depends on a range of factors, such as vegetation species composition, age of stand, and density of vegetation (Spence et al., 1996). Buffer width should be increased to 60 feet and up to 180 feet to increase stream shading for stream temperature reduction. (U.S. Dept. Ag., 2017).

Several studies have indicated that a 100 foot (30 meter) minimum buffer width on each streamside would be required to ameliorate upslope influences and maintain uniform humidity and air temperatures within the riparian area (Ledwith, 1996 as cited in KRIS, 2003; and Beschta et al., 1987 as cited in Mobrand Biometrics, 2003). Beschta et al. (1987, as cited in Mobrand Biometrics, 2003) finds that in forested areas within the Coast Range and Cascade Mountains of Oregon, buffer strips with widths of 30 m or more generally provide the same level of shading as that of an old-growth stand.

However, other studies have recommended wider riparian buffers. Brosofske et al. (1997, cited in KRIS, 2003) recommends a 150 foot (45 meter) buffer width on each streamside. Spence et al. (1996) recommends a buffer width of one site potential tree height (approximately 200 feet or 60 meters) on each streamside when a stream's temperature is higher than its normal range variability. (Spence et al., 1996).

Effect of Wood Jams

Poole and Berman (1999, cited in KRIS, 2003) noted that large wood jams can contribute to stream cooling by forcing more stream flow into shallow ground water, which is called the hyporheaic zone. The water drops slightly in temperature before emerging downstream.

Alteration of the Riparian Canopy outside Stream Area

Substantial current scientific literature suggests that alteration of the riparian canopy, even well back from the stream, can open air flow and change the microclimate over the stream (Brosofske et al., 1999, cited in KRIS, 2003). Increasing airflow, particularly in areas with high summer air temperatures, can increase heat exchange with the stream and thereby elevate water temperatures (Bartholow, 1989; Poole and Berman, 1999; as cited in KRIS, 2003).

Simulated Water Management Scenarios

In a heat-transport modeling study of the Tualatin River, 16 scenarios simulated various hypothetical water-management scenarios for the 1994 and 1995 conditions in the river. In all of the scenarios, the Oregon temperature standard of 64ºF (17.8ºC) was exceeded in much of the lower reaches of the Tualatin River during the warmer months in both years (USGS, 1998).

In one scenario, a cooler water-temperature data set, representing more shaded "natural" background conditions, was used as input to the model upper boundary at Gaston (RM 63.9). Water temperatures decreased substantially between RM 63.9 and the confluence with Scoggins Creek (RM 60.0) by as much as 4.0ºC (USGS, 1998). This modeling scenario indicates that increasing the riparian shading in the upper reaches of the Tualatin River to pre-disturbed conditions may substantially reduce upper reach water temperatures.

In a follow-up scenario, the same model upper boundary condition was used in conjunction with the "natural" background conditions scenario from an earlier study. Water temperatures again decreased substantially between RM 63.9 and the confluence with Scoggins Creek (RM 60.0). However, between Scoggins Creek and the Dairy Creek confluence (RM 44.8), water temperatures gradually increased because the unnaturally cool water released from Henry Hagg Lake was not present. However, almost all of the reach above Rood Bridge (RM 38.4) was still in compliance with the water-quality standard. Below RM 38.4 temperatures increased (1.0°C or less) for July and August and decreased for other months (USGS, 1998). This modeling scenario indicates that increasing the riparian shading in the upper reaches of the Tualatin River to pre-disturbed conditions may not substantially reduce lower reach water temperatures (below RM 38) without the additional release of cool water from Henry Hagg Lake (USGS, 1998).

This modeling scenario indicates that increasing the riparian shading in the upper reaches of the Tualatin River to pre-disturbed conditions may not substantially reduce lower reach water temperatures (below RM 38) without the additional release of cool water from Henry Hagg Lake.

Derivation of Loading Capacity

The Tualatin River Subbasin Temperature TMDL incorporates measures other than "daily loads" to fulfill requirements of the 303(d) rule. Although a loading capacity for heat energy is derived, it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat energy loads, the TMDL allocates "other appropriate measures" (or surrogates measures) as provided under EPA regulations [40 CFR 130.2(i)] (DEQ, 2001).

Solar Radiation is the Identified Target

Although a loading capacity for heat energy is derived, it is of limited value in guiding management activities needed to solve identified water quality problems.

The Tualatin TMDL identifies incoming solar radiation as the dominant process that increases water temperatures and therefore uses a loading capacity for radiant heat energy (i.e., incoming solar radiation) to define a reduction target. The solar radiation reduction target forms the basis for identifying a surrogate measure to regulate water temperature from nonpoint sources.

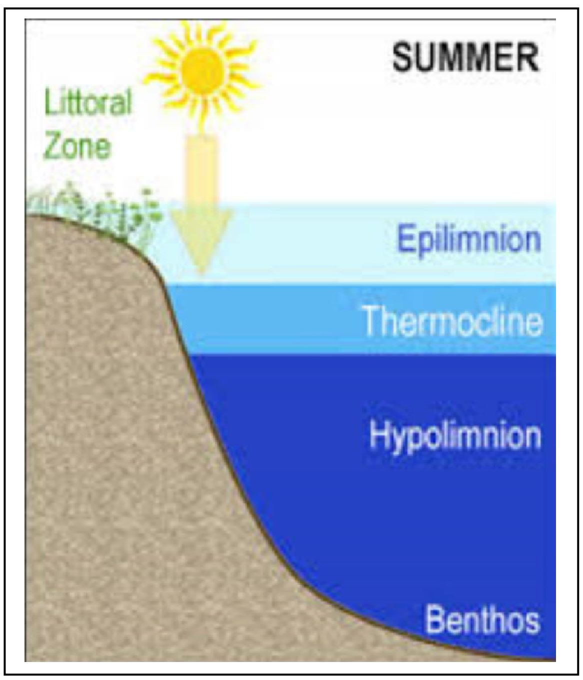
The specific surrogate used in the Tualatin TMDL is percent effective shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The solar radiation loading capacity is translated directly (linearly) by effective solar loading. The definition of effective shade allows direct measurement of the solar radiation loading capacity. For purposes of this TMDL, shade is defined as the percent reduction of potential solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities.

Percent Effective Shade

Because factors that affect water temperature are interrelated, the Tualatin TMDL surrogate measure (percent effective shade) relies on restoring/protecting riparian vegetation to increase stream surface shade levels, reducing stream bank erosion, stabilizing channels, reducing the near-stream disturbance zone width and reducing the surface area of the stream exposed to radiant processes. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Brown 1969, Beschta et al. 1987, Holaday 1992, Li et al. 1994, as cited in DEQ, 2001).

Importance of Hagg Lake Release on River Temperature

The flow in the Tualatin River downstream of the Scoggins Creek confluence (River Mile 60.0) is augmented by releases from Hagg Lake reservoir. During the summer of 1998 (June to August), the Hagg Lake augmentation water was significantly cooler than the Tualatin River mainstem. In contrast, the Hagg Lake augmentation water was warmer than the Tualatin River mainstem during the late summer and early fall months (August to October). This phenomenon can be explained by the fact that reservoirs are thermally stratified. Hagg Lake is a bottom release reservoir and draws from the deeper hypolimnion cool water, until the reservoir is drawn down to the point where the deeper hypolimnion has been fully released and the warmer epilimnion begin to influence discharge waters. A secondary change in reservoir release waters temperature can occur when the reservoir turns over. Hagg Lake thermal stratification ends in fall when surface epilimnion waters cool, become more dense and mix with deeper and cooler strata by wind and convective currents (DEQ, 2001).



3.4.3-2 Conclusions re: Managing Temperature Effects

1. In a heat-transport modeling study of the Tualatin River, 16 scenarios simulated various hypothetical water-management scenarios, including increased riparian shading and altered wastewater treatment plant discharges. In all of the scenarios, the Oregon temperature standard of 64ºF (17.8ºC) was exceeded in much of the lower reaches of the Tualatin River during the warmer months in both years (USGS, 1998).

2. Several modeling scenarios indicated that increasing the riparian shading in the upper reaches of the Tualatin River to pre-disturbed conditions may substantially reduce upper reach water temperatures but may not substantially reduce lower reach water temperatures (below RM 38) without the release of cool water from Henry Hagg Lake.

3. Recommended buffer widths required to ameliorate upslope influences and maintain uniform humidity and air temperatures within the riparian vary among scientific studies from 100 feet (30 meters) on each streamside to one potential tree height (approximately 200 feet or 60 meters) on each streamside.

4. Substantial scientific literature suggests that alteration of the riparian canopy, even well back from the stream, can open air flow and change the microclimate over the stream. Increasing airflow, particularly in areas with high summer air temperatures, can increase heat exchange with the stream and thereby elevate water temperatures (KRIS, 2003).

5. Several modeling scenarios indicated that altering the point source contributions of heated water from wastewater treatment plants to the Tualatin River could result in changes in the river water temperature. Various scenarios showed a range of decrease in water temperature from 0.05 to 2.2ºC with input of cooler water. Clean Water Services is permitted to utilize trading of wasteload allocations and load allocations, with the goal of reducing overall thermal loading to the river.[78]

3.4.4 Implementation Plan Guidance Addressing Temperature

Results of temperature modeling that minimized human sources of heat found that 98% of the stream network would be below a 64°F (17.8°C) for maximum daily temperature threshold.

Percent effective shade is used as a surrogate measure for nonpoint source pollutant loading since it offers a straightforward parameter to monitor and measure. It is also easily translated into quantifiable water management objectives. Site-specific effective shade surrogates can be used to assess TMDL nonpoint source allocation attainment. Attainment of surrogate measures ensures attainment of the nonpoint source allocations.[79]

The upland rural area of Washington County has a high level of streamside tree cover (forested). Previous monitoring of the rural area shows few summer exceedences of the temperature standard, when looking at median temperatures. A recent summary of water quality data for TMDL parameters showed exceedences of the Temperature standard,[80] with a higher number of exceedences as the monitoring stations are lower in

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[78] See: Water Quality Credit Trading 2017 Annual Report; Clean Water Services; https://www.cleanwaterservices.org/media/2299/2017-cws-water-quality-credit-trading-annual-report.pdf
[79] Tualatin Subbasin TMDL, Oregon DEQ, 2001, p. 2.
[80] For this study and analysis, "Exceeds" at any one station was noted where one or more samples exceeded the water quality standard within the last two years of data. DEQ's Water Quality Status and Trends Analysis for the Oregon Dept. of

the Basin. This is not surprising, as the river flattens out and flows through more developed area. The Washington County implementation plan for Temperature should concentrate on lowland enhancements to address the surrogate measure of effective shade.

The U.S. Dept. of Agriculture Conservation Stewardship Program lists criteria[81] to address stream temperature reduction through increased stream shading. Some of the practices are listed below:

- Existing buffer width (no tree removal) should be at least 35 feet or the minimum State or local buffer-width requirement, whichever is greater.
- Use tree and shrub species that are native and non-invasive.
- Necessary site preparation and planting shall be done at a time and manner to insure survival and growth of selected species.
- If disturbed, riparian vegetation will be protected until the plant replacements are well established.

Agriculture's Biennial Review of the Agricultural Area Rules and Plans, Nov. 2017. See: https://www.oregon.gov/deq/FilterDocs/strTualatinreport.pdf

[81] "Increase Stream Shading for Stream Temperature Reduction", U.S. Dept. of Agriculture, Conservation Enhancement Activity, Publ. E291127Z; 2017.

Section 3.5
Addressing Sources
Mercury (Willamette Basin: Tualatin Sub-Basin)

Section 3.5 includes:

3.5.0 Introduction[82]

Mercury is a naturally occurring element found in soils throughout the Willamette Basin. Mercury is also found in trees and fossil fuels such as coal, natural gas, diesel and heating oil. The mercury present in these fuels is released into the atmosphere upon combustion. This mercury can be transported great distances and can later be deposited on the land where storm water runoff can carry it into rivers and lakes. Mercury was mined commercially in Oregon and used in many products including fluorescent lights, thermometers, automobile switches and dental fillings.

The accumulation of mercury in fish is a well-recognized environmental problem throughout the United States. Mercury is a potent toxin that can cause damage to the brain and nervous system. Small children and the developing fetus are most sensitive to mercury's toxic effects. The primary way that humans are exposed to mercury is through the consumption of fish or seafood containing elevated levels of mercury, in the form of methylmercury. In Oregon, the state's Department of Human Services (DHS) issued fish consumption advisories for mercury for the Willamette River and the Dorena and Cottage Grove Reservoirs. In the Willamette, it differs depending on what section of the Willamette.[83]

The Oregon Department of Environmental Quality (DEQ) water quality standard for Mercury was established by EPA in 2019. Challenges were made to the technical document and public comments were received. After a U.S. District Court issued a ruling to revise it and with further technical work, EPA approved the final TMDL February 2021.[84] The current goal is to reduce mercury levels in the Willamette Basin to a point where fish are no longer unsafe to eat. DEQ has utilized an incremental approach for the

[82] Information for this introduction is from Oregon DEQ's Fact Sheets: Willamette River Basin Mercury TMDL, 2017; Willamette Basin Mercury Variance, dated 6/21/2018; and Mercury in Oregon Waters, dated 2/15/2017.
[83] Oregon Health Authority: Fish and Shellfish Consumption, Fish Advisories and Consumption Guidelines; See: https://www.oregon.gov/OHA/PH/HealthyEnvironments/Recreation/FishConsumption/Pages/fishadvisories.aspx#fish
[84] TMDL targets and allocations in Willamette Basin Mercury Total Maximum Daily Load, December 30, 2019, as revised on February 4, 2021; U.S. EPA, Region 10; February 4, 2021.

mercury TMDL with the establishment of interim targets and allocations.

To address the reduction of mercury DEQ is requiring certain municipal and industrial participants to implement Best Management Practices to reduce soil erosion. Washington County (rural) is one of the Designated Management Agencies (DMAs). The current Washington County 5-Year TMDL program was approved by Oregon DEQ Feb. 14, 2020.[85] The County is not an urban or industrial manager. Unincorporated urban areas of Washington County are implemented with Clean Water Services, as a co-implementer, along with cities in Washington County. Clean Water Services submits a separate report for those areas. Other efforts (such as through METRO) are to actively promote efforts to recycle products containing mercury such as fluorescent lights, thermometers, automobile switches, and dental amalgam.

3.5.1 Source Identification

3.5.1-0 Anthropogenic Sources of Mercury

The primary anthropogenic sources of mercury in the Willamette River Basin are the following:[86]

Discharges of mercury pollution to the air, water or land from sources within Oregon include both "point" (regulated or permitted) sources and "nonpoint" sources. **Point sources** in Oregon include the following:

- Power generation and transmission;
- Cement kiln;
- Manufacturing facilities;
- Combustion of fuels in boilers;
- Crematoria;
- Municipal waste incinerators;
- Municipal wastewater treatment plants (effluent and biosolids);
- Urban stormwater runoff.

The largest single point source in Oregon is a cement kiln located in the northeastern region of the state. Two municipal solid waste incinerators are operating in Oregon that serve surrounding local communities, but most solid waste generated in Oregon that is not recycled is disposed in landfills. In addition, there are numerous municipal wastewater treatment plants, fuel boilers, and crematoria throughout the state, each of which is likely to discharge small quantities of mercury.

The possible **nonpoint** mercury pollution sources in Oregon include the following[87]:

- Erosion of, and runoff from, native soils;
- Abandoned mercury mines;

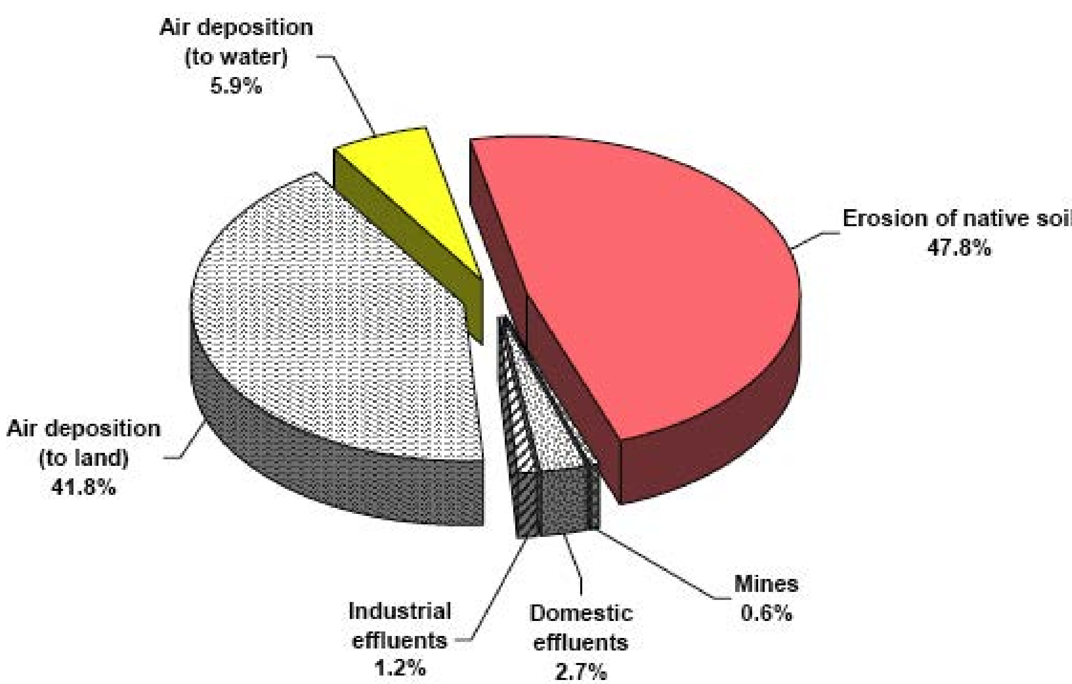
[85] Oregon DEQ, NW Region/Water Quality letter from Tualatin Basin Coordinator (Wade Peerman) to DLUT; 2-14-2020.
[86] 2007-2011 Mercury Reduction Strategy, March 28, 2007, Oregon DEQ; and DEQ Fact Sheet: Mercury in Oregon Waters, Feb. 15, 2017, Oregon DEQ.
[87] Id.

- Abandoned gold mines;
- Air emissions from motor vehicles;
- Volcanic eruptions;
- Forest fires;
- Environmental cleanup sites (not associated with mining);
- Improper disposal of mercury-containing consumer and industrial products.

This TMDL implementation plan for Washington County addresses Nonpoint Sources of pollutants. Point source discharges are entirely within the urban area, by definition of stormwater point source, and thus are managed by Clean Water Services. For point sources in Washington County, refer to Clean Water Services' Surface Water Management Plans, Municipal NPDES Permits, and TMDL Management Plans.

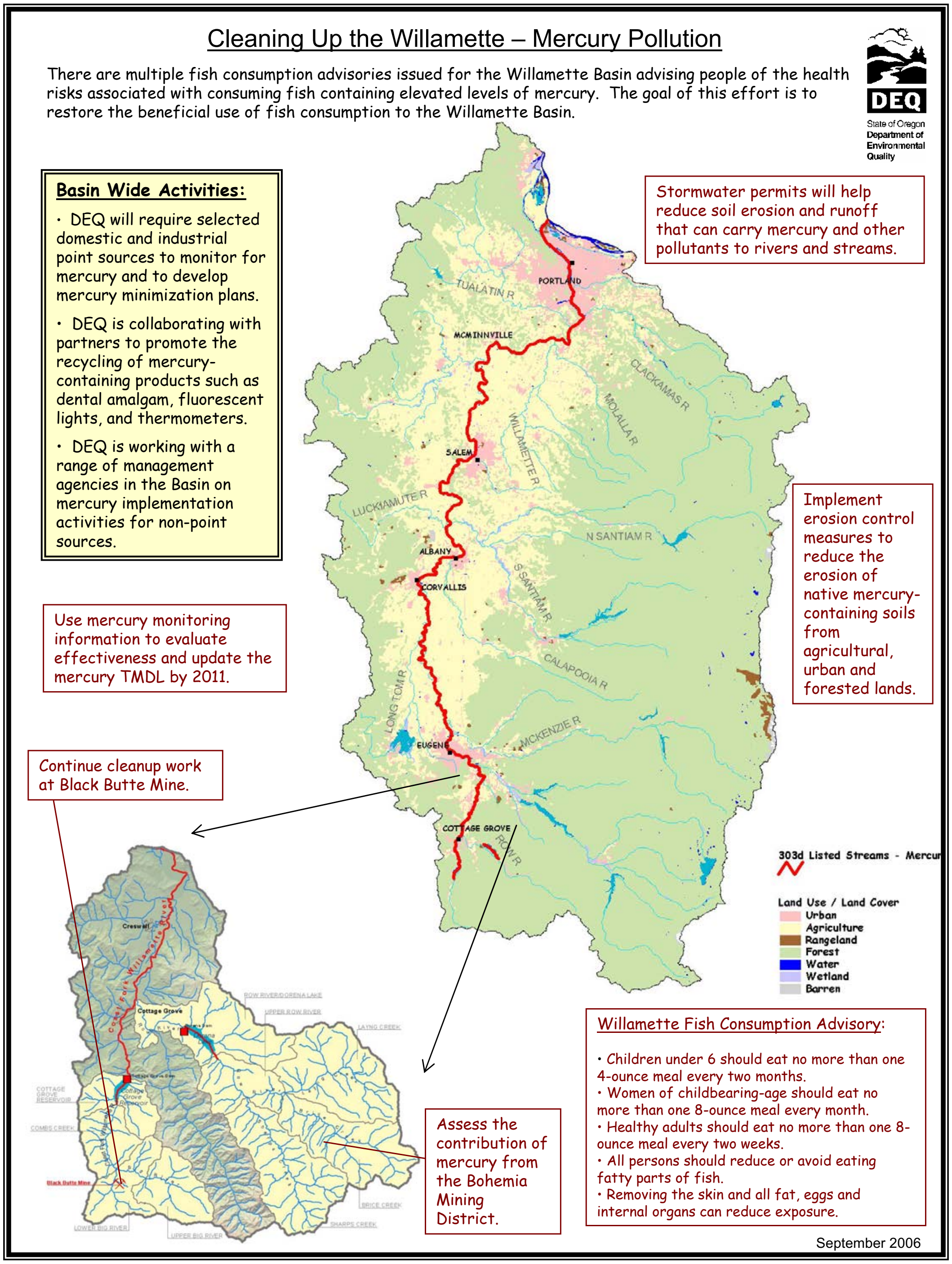
SOURCES OF MERCURY IN THE WILLAMETTE BASIN

Relative Load Contributions for the Mainstem Willamette River by Source Category[88]



As DEQ, EPA, and Stakeholders work to update the Mercury TMDL for the State and for the Willamette Basin, these load contributions' percentages may change. The figure above is shown for general purposes. As shown in the Map below, the Tualatin Basin is one of multiple Sub-Basins in the Willamette Basin addressing Mercury.

[88] Source: Department of Environmental Quality, Willamette Basin Total Maximum Daily Load (TMDL).


Cleaning Up the Willamette – Mercury Pollution
There are multiple fish consumption advisories issued for the Willamette Basin advising people of the health risks associated with consuming fish containing elevated levels of mercury. The goal of this effort is to restore the beneficial use of fish consumption to the Willamette Basin.
DEQ
State of Oregon Department of Environmental Quality
Basin Wide Activities:
• DEQ will require selected domestic and industrial point sources to monitor for mercury and to develop mercury minimization plans.
• DEQ is collaborating with partners to promote the recycling of mercury-containing products such as dental amalgam, fluorescent lights, and thermometers.
• DEQ is working with a range of management agencies in the Basin on mercury implementation activities for non-point sources.
Stormwater permits will help reduce soil erosion and runoff that can carry mercury and other pollutants to rivers and streams.
Implement erosion control measures to reduce the erosion of native mercury-containing soils from agricultural, urban and forested lands.
Use mercury monitoring information to evaluate effectiveness and update the mercury TMDL by 2011.
Continue cleanup work at Black Butte Mine.
Assess the contribution of mercury from the Bohemia Mining District.
PORTLAND
TUALATIN R
MCMINNVILLE
CLACKAMAS R
MOLALLA R
WILLAMETTE R
SALEM
LUCKIAMUTE R
N SANTIAM R
ALBANY
CORVALLIS
S SANTIAM R
CALAPOOIA R
LONG TOM R
MCKENZIE R
EUGENE
COTTAGE GROVE
ROW R
303d Listed Streams - Mercury
Land Use / Land Cover
Urban
Agriculture
Rangeland
Forest
Water
Wetland
Barren
Creswell
Cottage Grove
Black Butte Mine
Willamette Fish Consumption Advisory:
• Children under 6 should eat no more than one 4-ounce meal every two months.
• Women of childbearing-age should eat no more than one 8-ounce meal every month.
• Healthy adults should eat no more than one 8-ounce meal every two weeks.
• All persons should reduce or avoid eating fatty parts of fish.
• Removing the skin and all fat, eggs and internal organs can reduce exposure.
September 2006

3.5.1-1 Nonpoint Sources

Non-point sources of mercury include atmospheric deposition, runoff from roads, runoff from agricultural and forested areas, and runoff from waste disposal sites (improper disposal).

Potential pathways of mercury to surface waters outside the urban area and potential responsible parties include:

- Road runoff (County, ODOT and private parties);
- Sediment and runoff (County ditches, ODA and THPRD);
- Construction site runoff (County and private parties);
- Runoff from agricultural areas (ODA);
- Runoff from forested areas (ODF); and
- Air deposition (natural and unnatural background).

Nonpoint Source water quality management plans should focus on reducing activities that accelerate instream erosion and increase bank stability. [Note: This Washington County Nonpoint Source Implementation Plan addresses only rural area management.]

3.5.2 Implementation Plan Guidance for Reducing Mercury Concentrations

Washington County is a Designated Management Agency (DMA) under the federal Clean Water Act for implementation of the Tualatin Basin TMDL for Phosphorus, Bacteria, Temperature, and Dissolved Oxygen, and the newer Willamette Basin Mercury TMDL. Washington County has implemented a TMDL Nonpoint Source (rural) program for phosphorus since 1988. In 2001 and 2006 new TMDLs were approved by EPA for temperature, bacteria and D.O. The approved Water Quality Management Plan (WQMP) has been implemented for all parameters since then. As some counties are consider a Clean Water Act "Phase 2" and are not familiar with source controls, those communities are expected to implement specific "Minimum Management Measures".

The Washington County TMDL program, including Mercury, has been approved by DEQ every five years. This updated Chapter demonstrates ongoing compliance beyond the required "Minimum Management Measures" for the new Willamette Basin TMDL.

3.5.2-0 BMP Implementation Strategies

1. Monitoring - Air Deposition: DEQ has ambient air quality monitoring stations in Portland, Eugene, Medford and LaGrande that routinely collect samples for mercury and other metals. Washington County will not be conducting duplicate mercury monitoring.

2. Best Management Practices Designed to Reduce Sediment: The implementation plan intends to concentrate on 1) maintenance practices on rural County roadways under the operational jurisdiction of the

County, 2) erosion and sediment control, and 3) land use and natural resource management, utilizing source control methodology. See Chapter Five, herein, for Best Management Practices to reduce mercury loading through reductions in sediment loading.

3. Public Education: Educational materials are available from Oregon DEQ to prevent and reduce the introduction of mercury into the environment through the proper management of mercury-containing products and wastes, including cleaning up mercury spills.

3.5.2-1 Stormwater Control Measures for Counties

DEQ's primary TMDL strategy is to reduce erosion and runoff to water bodies. Non-permitted stormwater (e.g., rural runoff) accounts for 4% of the entire subbasin mercury load.[89] Although the 2021 EPA Final document does not include the Management strategies (Chapter 13) for specific Nonpoint Source DMA's that is in the 2019 DEQ submittal, the DEQ clarified at the Work Sessions that counties must address "4 Minimum Measures" for Stormwater Control. Implementation Workshops were offered by DEQ in 2021, including a June 2021 work session specifically for County Implementation in addressing the Willamette Basin Mercury TMDL. There are ten counties implementing the Willamette Basin Mercury TMDL. For Counties, the Mercury TMDL requires the implementation of the four stormwater control measures. These are outlined in the Table below:

Stormwater Control Measures	Implementation Deadlines from TMDL Issuance Date Feb. 4 2021
1. Pollution Prevention and Good Housekeeping for Municipal Operations a. Properly operate and maintain lands, properties, facilities, roads, parks, etc. using pollution prevention and good housekeeping measures to reduce sediment runoff b. Must maintain records and report annually including a descriptive summary of their activities in the TMDL annual report (e.g., training records, bridge maintenance, BMPs, snow removal practices, etc.)	Sept. 3, 2022
2. Public Education and Outreach a. Conduct public education and outreach to reduce mercury and mercury-related pollutants, such as sediment, on county lands and property such as property owners adjacent to county roads and ditches. b. Efforts to encourage and facilitate reporting of sediment related issues or concerns from the public. c. Must track implementation of the public education and outreach efforts. d. For example, where a vegetated county roadside ditch has been sprayed with herbicide – consider outreach to farmer.	Sept. 3, 2022
3. Enforcement of Prohibited Pollutants a. Must reduce conveyance of mercury to waterbodies from county lands and properties, including enforcing on other entities that contribute mercury-related pollutants, such as sediment, to county property and assets.	March 3, 2024

[89] **TMDL for Mercury in the Willamette Basin, Oregon; U.S. EPA, Region 10; Feb. 4, 2021.**

b. Must maintain a procedure or system to document all complaints or reports of mercury and mercury-related discharges. c. TMDL annual report must track implementation of the enforcement program and describe all activities.	
4. Construction Site Runoff Control a. 1200-C permit in place for one acre or larger. b. Incorporate erosion control requirements into county building and grading permit applications. Permit language must require erosion, sediment and waste material management controls to be used and maintained at construction sites from initial clearing thru final stabilization. c. Must update language in grading permits, including enforcement, to be effective (where necessary). d. May prioritize where permit requirements apply – for example, areas where increased development is occurring, or density of development, or building sites next to waterways.	Sept. 3, 2025

The approved and current Washington County TMDL Nonpoint Water Quality Implementation Plan implements these "4 Minimum Management Measures" as well as other programs under County control such as Riparian Management and BMPs specific to Routine Road Maintenance. The Best Management Practice (BMP) selection process for addressing Stormwater Runoff can be found in this WQIP in Section 5.1.

3.5.3 Management Measures for Washington County Rural Area: Reducing Mercury Concentrations

Operations and Maintenance; Capital Projects

***TMDL Pollutants Addressed*: Sediments (Mercury); Nutrients (TP); Bacteria; Sediments (DO)**

The current Best Management Practices (BMP) program grew out of the first TMDL for the Tualatin Basin which included a State Rule for water quality treatment to remove 60% phosphorus loadings on any new construction. This originated changes to Washington County Operations, Maintenance, and Construction and Engineering practices as early as 1990. With the addition of Municipal Stormwater NPDES requirements, and continual revisions and improvements, it became the current Best Management Practices Program. Both the Operations & Maintenance, and the Capital Projects Services Divisions of the County Dept. of Land Use & Transportation have comprehensive environmental standards built into nearly every activity, from design to construction to post-construction.

The summaries in this Section, and the BMP Table 5.3 at the end of Chapter 5, are a general overview of these extensive programs. There are many drivers for attention to water quality, including the TMDL program. Washington County will continue to meet and exceed environmental standards. Below is an overview of the Management Measures utilized on a frequent basis.

3.5.3-0 County Roadway Operations and BMPs

Best management practices to ensure that pollutant loadings from roadway operations are minimized are designed to prevent sediment and pollutant loadings that could impair surface waters. In the year 2000, Washington County DLUT developed and the Board of County Commissioners approved new Road Maintenance management measures based on the ODOT routine road maintenance program submitted to National Marine Fisheries Service. The program resulted in a document called "BMPRO 2000".[90] This was improved and revised in 2004, 2011, 2016, and 2017. For example, through the adaptive management process, a new section specifically addressing vegetation management and BMPs was added. The document can be found on the internet at:
https://www.co.washington.or.us/LUT/Divisions/Operations/upload/2017-BMPs-RoutineRdMaint.pdf

Since then, these management measures have been reviewed and revised due to field experience and continuing attention to water quality and habitat concerns (Adaptive Management). The current document is known as "*Best Management Practices for Routine Road Maintenance*"[91], which incorporates the Vegetation Management practices (Series 300) at a consistent level to the other BMP categories of Bridge Operations (Series 100), Roadway Surfaces (Series 200), Drainage Operations (Series 400), Traffic Operations (Series 500), Emergency Response (Series 900), and Environmental Management (Series 1000). This document became the basis for the federally approved program for Washington County DLUT pursuant to Limit 10(i) under the Endangered Species Act 4(d) rule for threatened salmon and steelhead (65 FR 42422, July 10, 2000).

Successful implementation of the program is dependent on the BMPs, which include the following categories:

Series 100	**Bridge Operations**
Series 200	**Roadway Surfaces**
Series 300	**Vegetation Management**
Series 400	**Drainage Operations**
Series 500	**Traffic Operations**
Series 900	**Emergency Response**
Series 1000	**Environmental Management**

The BMP's are implemented in the field by the County Operations and Maintenance Crew. Each crew member has received BMP training provided by the Operations' Environmental Services group. Part of this training involves a Quick Reference Guide, "The QRG", organized by BMP category. A similar document, the Inspector's QRG, a quick reference guide to Environmental BMP's includes Standard Specifications and County-supplied Special Provisions.

Riparian Management Areas are field-marked with RMA signage (about 80% complete) for special attention to RMA-BMPs. An RMA is an area adjacent to natural streams, rivers, wetlands, or other resource waters within which operational limitations may be assigned. DLUT jurisdiction extends no further than the limits

[90] Roadway Operations Best Management Practices: Water Quality & Habitat Guide; (BMPRO 2000); and Id. (2017).
[91] Best Management Practices for Routine Road Maintenance, Washington County, Oregon, DLUT, 2011.

of the public right-of-way. These limits often extend no further than 30 feet either side of the roadway centerline. The RMA is used in the implementation and training of *Best Management Practices for Routine Road Maintenance.*

Table 3.5.1 below is an abbreviated version and example of typical work activities performed by the Operations Division field crews, with notations of TMDL parameters positively affected by BMP implementation. Each of the work activities has associated BMPs (similar to that described above for Series 100), including a training program and field manual to help remind crews of the BMP responsibilities. Crew leaders and supervisors perform the BMPs on a daily basis, with guidance and oversight by the Operations Divisions' full-time environmental resources staff.

Table 3.5.1 (Abbreviated)
Routine Road Maintenance Water Quality Considerations

SERIES 100 DESCRIPTION: BRIDGE MAINTENANCE							
Bridge repair activity may include the repair of bridges and large culverts. In-water bridge repairs may include the installation, repair or replacement of rip-rap, drainage structures and catch basins, and the replacement of structural components.							
WATER QUALITY CONSIDERATIONS							
These practices are focused on the protection of habitat and ensuring that potentially harmful materials are not allowed to enter resource water. This is achieved through the proper use of containment devices, sound work-site practices and minimum removal of vegetation.							
RRM-BMP Activity Code*	Roadway Operations Activity Category	APPLICABLE TMDL PARAMETER					
		Bacteria	Phosph	Temp.	TSS-	DO; Hg	
101	Bridge Construction	✱	✱			✱	
102	Bridge Demolition		✱			✱	
106	Shoulder Erosion Repair		✱			✱	
107	Place Concrete Barriers		✱			✱	
108	Clean Bridge & Bridge Rail	✱	✱			✱	
109	Debris Removal - Stream	✱	✱			✱	
127	Guardrail Installation		✱			✱	

3.5.3-1 *Capital Projects (Construction) and BMPs*

The Capital Project Services Division of Washington County DLUT (previously this Division was called CPM: Capital Project Management) administers major road and bridge projects, as well as other infrastructure such as major culverts, water quality facilities (WQF's), underground storage facilities associated with the WQF's. Runoff treatment and control is the primary protection for sedimentation.

More information on these projects can be found at the following website:
https://www.co.washington.or.us/LUT/TransportationProjects/capitalprojects.cfm

3.5.3-2 Runoff Treatment and Control

Specific criteria followed by the County can be found in the CWS Design and Construction Standards, Chapter 4. When a capital project involves new road-building, road-widening, and other significant projects, water quantity and water quality facilities (WQF's) are usually part of the project. For the urban area, these are subject to review and approval by Clean Water Services and certain cities within Washington County. The standards protect existing WQF's from construction impacts (such as erosive flows into a WQF) and require new or updated WQF's in most cases.

Water quantity and quality control requirements are standardized, to lessen the impact to the existing system. The Runoff Treatment and Controls in CWS Standards include the following categories:

- Erosion Protection of Existing WQF's
- Vegetation – Planting requirements and prohibited species
- Fencing Protection of Existing WQF's
- Access for maintenance of WQF's
- Dedicated easement to CWS or City for maintenance
- Water Quantity Controls – Detention, Improvement, SDC fee
- Hydraulic Design Criteria – No increase in peak runoff rates
- Water Quantity Facility Design Standards
- Water Quality Treatment Design Requirements
- Water Quality Storm, Volume, and Flow Considerations
- Pre-Treatment Required
- Approved Proprietary Treatment Systems
- Water Quality Manhole Design Criteria
- Vegetated Swale Design Criteria
- Extended Dry Basin Design Criteria
- Constructed Wetland for Water Quality
- Low Impact Development Approaches (LIDA)
- Porous Pavement
- Green Roof
- Infiltration Planters
- Flow-thru Planters
- LIDA Swales
- Vegetated Filter Strips

3.5.3-3 Erosion and Sediment Control NPDES 1200-CA Permit

Washington County Capital Projects Services holds an NPDES 1200-CA [**C**onstruction-**A**gency] permit for erosion and sediment control. Sources covered by the permit include clearing, grading, excavation, and stockpiling activities under the authority or jurisdiction of the County that disturb one or more acres.[92] The permit does not authorize in-water or riparian work. It does not authorize direct or indirect discharges to waters of the State, including discharges to an underground injection control (UIC) system. It covers both urban and rural activities for CPS projects.

A copy of the permit can be found at: https://www.oregon.gov/deq/FilterPermitsDocs/1200caPermit.pdf

Erosion Control Measures Followed by Capital Projects Services Division of DLUT:

- A conditional Erosion and Sediment Control Plan (ESCP) must be implemented to *prevent the discharge* of significant amounts of sediment to surface waters. Significant amounts of sediment are described as:
    - Earth slides or mud flows that leave the construction site*;
    - Evidence (such as the presence of rills, rivulets or channels) of concentrated flows* of water causing erosion when such flows are not filtered or settled to remove sediment prior to leaving the construction site;
    - Turbid flows* that are not filtered or settled to remove turbidity prior to leaving the construction site;
    - Deposits of sediment at the construction site in areas that drain to unprotected storm water inlets or catch basins that discharge to surface waters.
    - Deposits of sediment from the construction site on public or private streets outside of the permitted construction activity that are likely to discharge to surface waters;
    - Deposits of sediment from the construction site on any adjacent property outside of the permitted construction activity that are likely to discharge to surface waters.

*Flow to stormwater inlets or catch basins located on the site are considered "leaving the site" if there are no sediment control structures designed for expected construction flows downstream of the inlets or catch basins.

[92] **The original DEQ-issued permit covered construction activities disturbing 5 or more acres. This changed due to case law at the national level, and now covers construction activities disturbing 1 or more acre. See: https://www.oregon.gov/deq/FilterPermitsDocs/1200caPermit.pdf**

- ESCP Preparation, Retention, Implementation:
  - The ESCP must be prepared, retained on project site, and made available to DEQ upon request.
  - The ESCP shall include any procedures necessary to met local ESC requirements or stormwater management requirements.
  - Additional erosion control measures may be required, especially in the wet weather period of October thru May.

- Erosion and Sediment Control Plan must include:
  - Site description (construction activity, proposed timetable, area of the site, nature of the fill material, erosion potential of soils, names of receiving waters);
  - Site Map (see permit for detailed requirements);
  - Required controls and practices:
    - Each site must have graveled, paved, or constructed entrances, exits and parking areas prior to beginning any other work;
    - All unpaved roads located on site must be graveled (or erosion control measures down gradient may be used in place of graveling);
    - Water-tight trucks must be used to haul saturated soils from the site (or loads must be drained until dripping has been reduced);
    - Controls to prevent the discharge of all wash water from concrete trucks;
    - Procedures for correct installation or use of all ESC measures;
    - Procedures for prompt repair and maintenance of ESC measures being used on-site.
  - Required Site-Dependent Additional Controls and Practices – ESCP must describe:
    - Clearing and grading practices, including schedule of phasing;
    - Vegetative erosion control practices, including temporary and permanent seeding, mulching, sod stabilization, buffer strips, and tree protection;

- Protection of exposed areas from stormwater, including mulching, erosion control blankets, and soil tackifiers;

- Practices to divert flows from exposed soil, store flows to allow for settling, filter flows, or reduce soil laden runoff. ESC practices must consider use of silt fences, earth dikes, brush barriers, drainage swales, check dams, sediment traps, and sedimentation basins;

- Stockpiles management, including locating away from construction activity, and stabilization or covering at the end of the work day;

3.5.3-4 401 Water Quality (State) Certification

Section 401 of the Clean Water Act requires that activities permitted under Section 404 meet state water quality standards. Usually, ACOE will determine whether a discharge will take place under the project description, and inform the applicant whether 401 WQ Certification is also needed. If so, the activity must demonstrate to DEQ they are meeting State water quality standards. WQ standards include not only specific effluent or discharge limits and implementation plans, but also TMDL standards and implementation plans – such as those for the Tualatin Basin TMDL.

3.5.4 Management Measures for Washington County Rural Area: Land Use Planning and Permitting

***TMDL Pollutants Addressed*: Sediments (Mercury); Nutrients (TP); Temperature; Sediments (DO)**

3.5.4-0 County Erosion Control, Flood Plain Protection, Natural Resources, Water Resources

Management measures for rural areas to control erosion, protect flood plains, natural resources and water resources are accomplished through application of the Rural/ Natural Resource Plan, County Code requirements for erosion control and flood plain management, and protective policies to implement those standards. These are described below.

Management measures for urban areas to control erosion, protect flood plains, and water resources are intended to accomplish the following: (1) decrease the erosive potential of increased runoff volumes and velocities associated with development-induced changes in hydrology; (2) remove suspended solids and associated pollutants entrained in runoff that result from activities occurring during and after development; (3) retain hydrological conditions to resemble those of the pre-disturbance condition; and (4) preserve natural systems including instream habitat. These measures are the responsibility of Clean Water Services within their service area, i.e., the urban area of the Basin.

3.5.4-1 Rural/ Natural Resource Plan

The Washington County DLUT identified and mapped Significant Natural Resources within the County rural area as part of the Rural/ Natural Resource Plan[93]. The map clearly identifies the following resources:

- **Water Areas and Wetlands:** 100 year flood plain, drainage hazard areas and ponds, except those already developed.
- **Wildlife Habitat:** Sensitive habitats identified by the Oregon Department of Fish and Wildlife, and forested areas coincidental with water areas and wetlands.
- **Water Areas and Wetlands & Fish and Wildlife Habitat:** Water areas and wetlands that are also fish and wildlife habitat.
- **Mineral and Aggregate Overlay:** Regulates resource extraction and processing activities to minimize their impact on adjacent land uses.
- **Significant Natural Areas:** Site of special importance, in their natural condition, for their ecologic, scientific, and educational value.
- **Scenic Resources:** Scenic routes, views, or features. Scenic features includes land forms, vegetation or water courses with aesthetic value to the surrounding area.
- **Historic and Cultural Resources:** Historic buildings and structures are protected by regulations in the County's Historic and Cultural Resource Overlay District.
- **Resource Overlap:** Indicates that more than one significant natural resource is located on a site. The provisions of the Plan and Code for each resource apply.

3.5.4-2 Grading and Erosion Control Activities

Within Clean Water Services' service boundary, all erosion control activities and permits are reviewed and processed by CWS. Outside CWS boundary in Washington County (primarily rural area), the County Land Development Division administers grading and erosion control activities.[94] These include, in general, the following standards and process:

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[93] **Rural/Natural Resource Plan, official maps and texts filed with the Records Division of the Washington County Department of Assessment and Taxation. The Rural/Natural Resource Plan Element is one of a number of planning documents which in total comprise the Washington County Comprehensive Plan. The updated 2017 Plan can be found at: https://www.co.washington.or.us/LUT/Divisions/LongRangePlanning/upload/Rural_NaturalResourcePlan_112417.pdf**

[94] **https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_410GRDR;**

- Property owners proposing a new building or other major improvement requiring development review through the County land use rules are required to meet grading and erosion requirements as part of the Land Development review process.

- Property owners proposing only to grade soil or materials in excess of 150 cubic yards, or within sensitive areas, are required to submit grading and erosion control plans for processing through the County Building Services Section, part of the Land Development Division. Based on slope gradient and/or stability of the proposed development site, Building Services may ask the applicant to have an Engineered Grading Permit proposal.

- Property owners proposing to grade soil or materials of total volume less than 150 cubic yards are required to provide erosion control measures and are processed through the County Building Services Section.

- Sensitive areas include flood areas, riparian areas, wetlands, or steep slopes.

- All erosion control practices are required to conform to the latest CWS Guidance Manual practices.

- Activities in Washington County associated with agricultural practices or forest practices are exempt from County review by state law.

Typically, an erosion and sediment control plan for controlling the adverse impacts of construction and land development will fulfill the intent of this management measure. The plan should include the following elements:

- Description of predominant soil types;
- Details of site grading including existing and proposed contours;
- Design details and locations for structural controls;
- Provisions to preserve topsoil and limit disturbance;
- Details of temporary and permanent stabilization measures; and
- Description of the sequence of construction.

3.5.4-3 Washington County Code (Article IV) Provisions Related to Rural Area Development

The following Code Sections and Policies provide authority/regulatory action related to water quality in the rural areas of Washington County.

Article IV; Development Standards

426 – Erosion Control

Summary of Erosion Control Ordinance[95] – The purpose of the Erosion Control Ordinance is to implement the administrative rules of the Oregon Department of Environmental Quality mandating erosion control measures in the Tualatin River and Oswego Lake sub-basin which are to be applied during construction to control and limit soil erosion. The Ordinance requires that any "development" is required to have an Erosion Control Plan.

421 – Flood Plain and Drainage Hazard Area Development
Summary of Flood Plain and Drainage Hazard Area Ordinance[96] – This Ordinance regulates all development within identified flood plain and drainage hazard areas. These areas are identified in "Flood Plain Series, Washington County, Oregon". It requires that development is "flood proofed" and it also restricts development to that which minimizes the impact of disturbance or alteration of riparian wildlife and vegetated areas.

421-7.6 - All cut and fill shall be structurally sound and designed to minimize erosion. All fill below the flood surface elevation shall be accompanied by an equal amount of cut or storage within the boundary of the development site unless the proposed cut and fill is found to be in compliance with an adopted Drainage Master Plan or certain other provisions.

422 – Significant Natural Resources
Summary of Significant Natural Resources Standards[97] – The purpose of these standards is to permit limited and safe development in areas with significant natural resources, while providing for the identification, protection, enhancement and perpetuation of natural sites, features, objects and organisms within the County, here identified for their uniqueness, psychological or scientific value, fish and wildlife habitat, education opportunities or ecological role. The standards restrict most development with riparian corridors, wildlife areas and wetland and water areas and wetland and fish and wildlife habitat areas. It does allow street crossings, transportation facilities and enhancement of degraded riparian corridors, water areas or water areas and wetlands and fish and wildlife habitat.

3.5.5 Management Measures for Washington County Rural Area: Facilities

TMDL Pollutants Addressed: ***Temperature, Sediments (DO); Sediments (Mercury)***

3.5.5-0 County Owned Facilities

Washington County has no parks in the urban area. These are owned and operated by Tualatin Hills Parks and Recreation District. In the rural area, county parks are maintained by the Facilities Management Division of the Support Services Department. Staff supervise and maintain Scoggins Valley Park at Henry Hagg Lake

[95] **https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_426ERCO**
[96] **https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_421FLPLDRHAARDE**
[97] **https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_422SINARE**

under a cooperative agreement with the federal Bureau of Reclamation, and operate Metzger Park under its Local Improvement District structure. The parks are primarily kept as natural area.

Closed landfills in the rural area (2) are naturalized with vegetative cover. They are monitored for hazardous substances.

A municipal yard including storage facilities and fleet management is located in the City of Hillsboro at the Washington County DLUT Walnut Street facility. This location has an individual NPDES 1200-Z permit for stormwater discharge, including a Stormwater Pollution Prevention Plan.

3.5.6 Management Measures for Washington County Rural Area: Riparian Management

TMDL Pollutants Addressed: ***Sediments (Mercury); Temperature, Nutrients (TP); Sediments (DO); Bacteria***

3.5.6-0 Riparian Area Function

> Riparian areas are defined as: A vegetated ecosystem along a water body through which energy, materials and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body.

Riparian areas occur next to the banks of streams, lakes, and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Streamside vegetation protects water quality and provides a "green zone" of vegetation that stabilizes streambanks, regulates stream temperatures, and provides a continual source of woody debris to the stream channel. The majority of fish food organisms come from overhanging vegetation and bordering trees while leaves and twigs that fall into streams are the primary nutrient source that drives aquatic ecosystems.

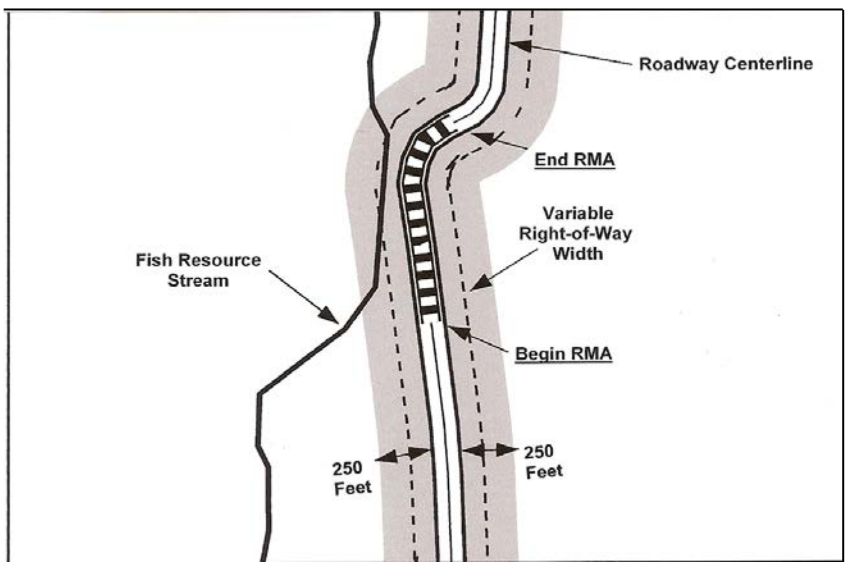
Riparian areas frequently contain the highest number of plant and animals species found in forests, and provide critical habitats, home ranges, and travel corridors for wildlife. Biologically diverse, these areas maintain ecological linkages, connecting hillsides to streams and upper headwaters to lower valley bottoms.

The typical Riparian Management Area (RMA) consists of a riparian management zone and, where required by regulation, a reserve zone. The width of these zones is determined by attributes of streams, wetlands or lakes, and adjacent terrestrial ecosystems.

3.5.6-1 Riparian Area Management; Washington County Rural Road Operations, BMPs and RMAs

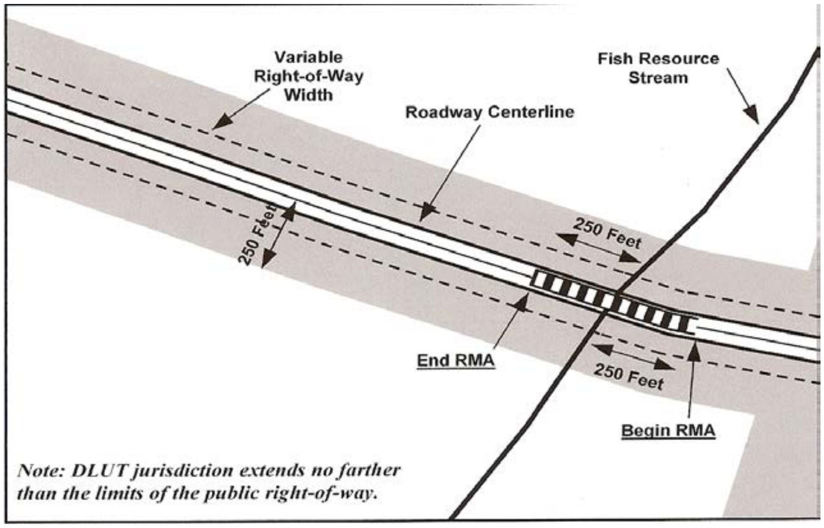
Recognizing the function and support of a properly operating riparian management area, in part due to NOAA Fisheries' guidance, Washington County DLUT incorporated Riparian Management Areas (RMA's) into their original Best Management Practices for Roadway Operations 2003 manual[98]. Updates in 2004 2011, and 2017, including RMA's, became the *"Best Management Practices for Routine Road Maintenance"*[99] This document demonstrates typical applications for roadway maintenance and operations, and roadside vegetation management which will protect significant natural resources and sensitive areas. The RMA incorporates a 250-foot margin of no chemical spray harmful to a riparian area, special brush clearing and ditch maintenance methods, considerations for road construction handling, and other minimization and avoidance methods to protect the riparian area. RMA's are marked with a sign for crew awareness.

1) Operational limitations may be assigned to areas up to 250 feet from a resource water. Best Management Practices (BMPs) are followed to reduce the potential impacts roadway operations may have on the quality of RMAs.



Riparian Management Area – Road Adjacent to a Water Resource

[98] Original Best Management Practices for Roadway Operations; (BMPRO 2003); approved by Washington County Board of Commissioners about August 2003.
[99] See: https://www.co.washington.or.us/LUT/Divisions/Operations/upload/2017-BMPs-RoutineRdMaint.pdf



Riparian Management Area – Road Crossing a Water Resource

2) The RMA is measured from the outer edge of an intersecting stream or the centerline of an adjacent roadway. 250 feet is the objective; however, roadway design or other limiting factors may cause this standard to be adjusted.

3.5.6-2 Riparian Area: Natural Resource Management; County Land Use Planning

The Washington County Code restricts most development within riparian corridors, wildlife areas, wetland and water areas, and wetland and fish and wildlife habitat areas. Allowable development includes street crossings, transportation facilities and enhancement of degraded riparian corridors.

All proposed projects are screened by Washington County DLUT for flood hazard and habitat considerations. Habitat area screening is dependent on the mapped Natural Resource (NR) area. The reviewer checks the applicant's location for flood hazard areas and Significant Natural Resource zone (mapped for entire County: digitized and hard copy). The mapped area includes a "pink line" of 250' added to either side of an identified NR zone (total 500' error rate). This NR area can be in or out of the flood plain. Filling outside the flood plain and greater than 150 cubic feet material displacement will trigger the same review, and the need for a grading (erosion control) permit. About 10% of development applications will trigger attention to erosion and sediment control, i.e., have some encroachment on resource area/ flood or drainage hazard area.

Riparian management is accomplished through the Floodplain and Drainage Hazard areas and Code Sections 421 and 422. A Section 421 Type I procedure allows certain development to be approved in a flood area, including restoration and stabilization of a river or other waters for erosion control purposes, within certain provisions. If this occurs, vegetative cover for bank stabilization is required. Section 421 Type II or Type

III procedures allow development in a flood area subject to specific restrictions.[100]

Section 422 permits limited and safe development in areas with significant natural resources, while providing for the identification, protection, enhancement and perpetuation of certain valuable resources, including fish and wildlife habitat. Land subject to this section includes water areas, wetland, fish and wildlife habitat, sensitive habitats, certain forested areas, and other significant natural areas.

3.5.7 Management Measures for Washington County Rural Area: Inventory of Water Quality Facilities

TMDL Pollutants Addressed: ***Sediments (Mercury); Temperature, Nutrients (TP); Sediments (DO); Bacteria***

The Washington County Operations Division maintains an inventory and mapping of the County road systems, and associated facilities. The maps show the geographic locations of drainage facilities, Water Quality Facilities, Catch Basins, and Downstream Defenders.[101] These systems are primarily maintained by the Operations Division, although certain catch basins and non-proprietary WQF's are maintained by CWS within their urban services boundaries. For this and other reasons, the County maintains an extensive GIS that includes online map access.

3.5.8 Management Measures for Washington County Rural Area: BMP Implementation Matrix and Annual Reporting

TMDL Pollutants Addressed: ***Sediments (Mercury); Temperature, Nutrients (TP); Sediments (DO); Bacteria***

Management Measures to address and target TMDL Parameters are an important part of the big picture and comprehensive approach utilized by Washington County to address water quality, water quantity, habitat, and other environmental programs. The Table 5.3 in Chapter 5 summarizes Washington County's Best Management Practices and general Implementation strategies that collectively meet the County's TMDL Compliance standards for the Nonpoint Source Rural Area Management component of the Tualatin Basin. Where noted, BMP documents, 1200-CA permit, field manuals, etc. are available separately and not included herein.

Best Management Practices (BMP's) are the foundation of the Operations Divisions' actions to meet environmental standards. In the NPDES permit, TMDL program, and ESA 4(d) Rule mandates, BMP's are the techniques used to minimize or prevent adverse impacts to water quality or habitat. These techniques are

[100] For more detail refer to Washington County Code Section 421-5 and 6. At: https://www.co.washington.or.us/LUT/Divisions/LongRangePlanning/Publications/upload/421-422.pdf
[101] A Downstream Defender is an advanced hydrodynamic vortex separator designed to provide high removal efficiencies of settleable solids and floatables over a wide range of flow rates.

used to control stormwater runoff, sediment control, soil stabilization, pollution prevention, vegetation management, fish preservation, and emergency response to spills. Management decisions are also BMP's, as are reports, plans, and programs.

Table 5.3 is the basis for the TMDL Annual Report to DEQ each March 1st. Schedules, timelines, and measurable milestones are incorporated into Adaptive Management and Annual Reporting. BMP's listed in Table 5.3 are available in more detail in separate documents. The BMP Matrix is an outline of the extensive Washington County BMP Program, which meets not only the TMDL Nonpoint Source Program requirements, but also regulatory requirements through NOAA Fisheries, Army Corps Permits, ODF&W rules, and NPDES permits.

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Chapter Four

Water Quality Monitoring Plan

Chapter 4 includes:

4.0 Coordinated Basin–Wide Water Quality Monitoring Program

Program Design and Purpose

As part of the original Compliance Order and Schedule for the Tualatin Basin TMDL Program, DEQ required the Designated Management Agencies (DMA's) to prepare a coordinated water quality monitoring program. After years of work, the water quality monitoring program was designed to monitor and characterize existing water quality conditions, to aid in the identification of pollutant sources, to monitor the effectiveness of best management practices (BMPs), and to provide baseline water quality data for establishing water quality trends within the basin for various pollutants, particularly phosphorus and ammonia.

The comprehensive plan was approved by DEQ in the original TMDL program, and continues to the present day under the new TMDLs. Specific attention and program goals in monitoring the water quality parameters of TP, bacteria (E. coli and other indicators), dissolved oxygen and temperature will aid in determining progress towards meeting water quality standards.

The Willamette Basin TMDL for mercury was approved by EPA in September 2006. DEQ developed the TMDL to meet the mercury criterion in place at the time, of 0.3 mg/kg (milligram of methylmercury per kilogram of fish tissue). In 2011, EPA approved DEQ's methylmercury fish tissue criterion of 0.040 mg/kg, which was based on a more protective fish consumption rate of 175 g/day (or about 24 fish meals per month). Subsequent challenges filed in 2012 followed by a U.S. District Court ruling requiring EPA to revise the TMDL by April 2019, while allowing the 2006 TMDL to remain in effect.[102] EPA established a new TMDL on Dec. 30, 2019. After the required 30-day public comment period and another year to address comments, EPA issued the final Revised Willamette Basin Mercury TMDL on Feb. 4, 2021.[103]

[102] **DEQ Fact Sheet: Willamette River Basin Mercury TMDL; 2017. See:**
[103] **https://www.epa.gov/sites/default/files/2021-02/documents/tmdl-willamette-mercury-final-02-04-2021.pdf**

Program Goals

To address the Tualatin Basin TMDL parameters and to build on the existing comprehensive monitoring program done by each DMA at the time, the Regional Monitoring Subcommittee of the DMA representatives met with DEQ to develop a watershed-wide comprehensive water quality monitoring plan. Monitoring goals and necessary program elements were agreed upon and established. As of 2022, the program stands as originally intended. Long-term trends are monitored by CWS and DEQ, and sent to EPA.

DEQ and the committee developed the following goals for monitoring the watershed as a whole:

- Determine whether instream water quality standards are being achieved and identify instream trends.
- Monitor outfall discharges to determine whether benchmarks are being achieved and to identify trends.
- Identify specific sources of pollutants of concern.
- Evaluate the source of specific pollutants.
- Identify the most suitable best management practices (BMPs) for addressing the problems.

The Water Quality Monitoring Plan for Washington County DLUT relies on Clean Water Services and other agencies' sampling data for instream monitoring and outfall monitoring. To address County specific practices, BMP effectiveness monitoring will be evaluated, working with other counties and the Oregon Department of Agriculture.

4.1 Monitoring Program for Rural Tualatin Basin

4.1.0 Watershed-Wide Monitoring Program

Historical Development of Monitoring Program: Streams have been monitored in rural Washington County for decades. Traditionally, USGS monitored for flow and still maintains many flow gauges throughout the Basin. The USGS has up-to-the-hour present day flow data on their website.

> To determine the most useful proposed monitoring program within rural Washington County, current and historic instream water quality monitoring sites were reviewed and mapped.

In development of a watershed-wide approach to monitoring, a Monitoring Program Sub-Committee was created consisting of representatives from all DMA's in the Watershed.

CWS provided several sources of information regarding all of the instream water quality monitoring sites that have been located in the Tualatin River watershed. The information provided from CWS included:

- 2001 Annual Report to the Oregon Department of Environmental Quality – Nonpoint Source Program for Total Maximum Daily Load Requirements, January 2002.
- A comprehensive list of CWS Ambient Monitoring Sites giving sampling events per year from each site beginning in 1973 and ending in 2001.
- A list of non-CWS Tualatin Basin Monitoring Sites which shows sampling events per year from each site beginning in 1980 and ending in 2001.
- A list of the locations of stream gaging stations used to measure flow.

- A list of the location of temperature monitoring stations (CWS and Water Master).
- A list of USGS continuous monitoring sites (2001 – 2003).
- A list of parameters monitored by each agency.

The information provided by Clean Water Services included sites that have been owned and operated by several entities including: CWS, Oregon Department of Agriculture (ODA), DEQ, Oregon Department of Forestry (ODF), Oregon Graduate Institute (OGI), Tualatin Valley Irrigation District (TVID), the United States Geological Survey (USGS), City of Portland, Multnomah County, and Clackamas County.

For additional details regarding each of the monitoring sites (historic monitoring sites include current), see Appendix A, herein. The table includes the Station ID number, the closest location in terms of a road crossing, the agency operating the station, and the TMDL listed parameters that were analyzed in the samples.

In the rural Washington County area, Clean Water Services (CWS) and the Oregon Department of Agriculture (ODA) have traditionally maintained ambient monitoring sites. Clean Water Services serves as the lead agency. Up until 2008, CWS and ODA conducted joint monitoring of these sites. In 2008, ODA discontinued its' Tualatin Basin monitoring program because three ODA monitoring locations were also being monitored by CWS, and ODA felt that this effort was duplicative. In addition, one of the ODA monitoring sites is located on private property, and the property owner was no longer amenable to ODA staff accessing the site from his property.

In the original Water Quality Implementation Plan developed for Washington County, a total of 17 instream water quality monitoring sites were selected to represent conditions from rural Washington County. Six of these original sites were located on tributaries to the Tualatin River, and 11 sites were located on the Tualatin River main stem. Starting with the 2008–09 reporting year, CWS solely has conducted monitoring of rural Washington County sites. **Figure 4.1**, below, shows the locations of the original monitoring sites.

Changes since inception include discontinuation of sampling at two of the 12 mainstem monitoring locations, as they were discontinued and replaced during the 2012-2013 reporting year. Monitoring of the original mainstem monitoring location at Elsner Road (Station #3701165) was discontinued in August 2012. The site was replaced with the Jurgens Park location (Station #3701106). The Elsner Road site presented safety concerns prompting its relocation. For the 2012-2013 monitoring year, data from both sites was collected.

Monitoring of the original mainstem monitoring location at Springhill Road (Station #3701612) was discontinued about 2013. The site was replaced with the Fernhill Road location (Station #3701569). The Fernhill Road location is considered more representative of background instream water quality conditions above the Forest Grove wastewater treatment plant (WWTP), which prompted the relocation of the Springhill Road site. For the 2012-2013 monitoring year, data from both sites was collected.

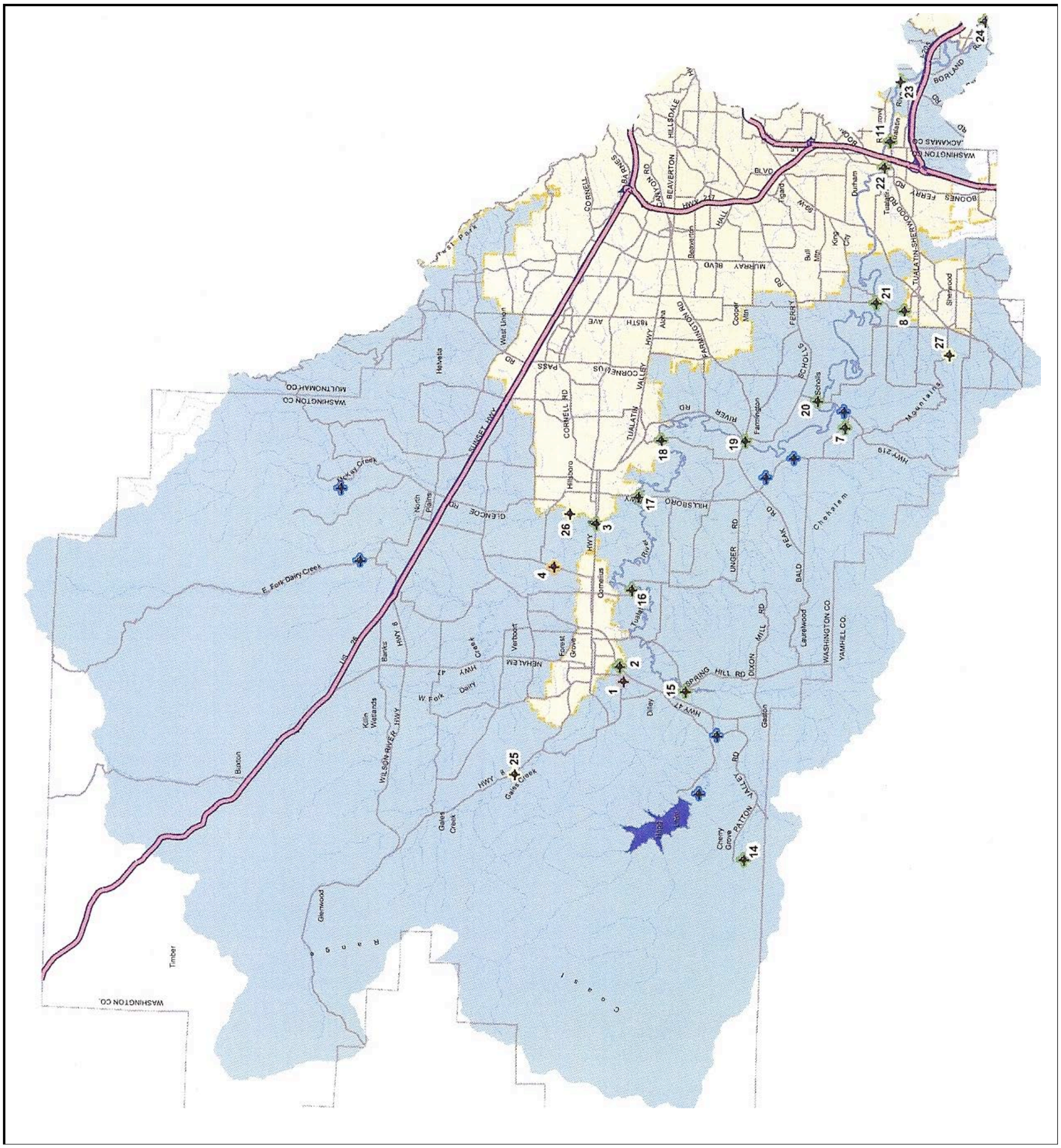
CWS conducted monitoring for the 2015–16 reporting year on seven tributary sites and eleven mainstem Tualatin River sites. Five of these sites reflect original tributary monitoring stations, and two of these sites reflect additional rural tributary stations added in 2008. Of the five original tributary monitoring stations, the McKay Creek site (Station 3816010) was relocated from Hornecker Road to its current location at Padgett in 2008.

Specific for the 2015-16 reporting year, monitoring was discontinued in December 2015 at the Water Treatment Plant site (Station 3701580), due to safety concerns. This site was replaced by the previously monitored Fernhill site (Station 3701569).

From July 2015 to June 2016, CWS collected monitoring data biweekly or monthly, on average, from most of the tributary and mainstem monitoring sites. TMDL parameters monitored and reported by CWS include the relevant TMDLs of bacteria (E Coli), temperature, dissolved oxygen (DO), and total phosphorus (TP). For the 2016-2017 reporting year, CWS began implementation of the updated NPDES stormwater watershed-based permit which includes revised monitoring requirements. Thus, the number of monitoring samples collected at each site is reduced from previous years. Additionally, only a partial year of monitoring is reflected for the Highway 219 site (Station 3701450) because sampling only occurs when the Hillsboro Wastewater Treatment Plant is discharging to the Tualatin River.

Current Monitoring Program: The primary monitoring period for the TMDL is the summer (May 1 to October 31, except ammonia which goes to November 15). With incorporation of certain aspects of the TMDL program into the MS4 NPDES permit process, the monitoring data is now submitted by CWS in November each year. TMDL parameters monitored and reported by CWS include bacteria (E Coli), temperature, dissolved oxygen (DO), total phosphorus (TP), and mercury. The data is submitted to DEQ.

Figure 4.1: Locations of Rural Water Quality Monitoring Sites



4.1.1 Rural Washington County: Listed Streams

As explained in Chapter Two, in the Tualatin River watershed, 28 creeks in addition to the mainstem river, are listed by the State as water quality limited. Of the 28 creeks that are listed, 18 and the mainstem have some portion that flows through rural Washington County. Each of these 18 creeks is listed as water quality limited for up to six parameters including: bacteria, biological criteria, dissolved oxygen (DO), temperature, phosphorus, and chlorophyll a (see Table 4.1). Total maximum daily loads (TMDLs) were finalized by DEQ for these waterbodies in August of 2001, and amended in 2012.

In 2021, U.S. EPA approved a Mercury TMDL for the Willamette Basin. It applies basin-wide, not to specific streams, so it is not included in the List of TMDL Parameters by Stream.

Table 4.1
Tualatin TMDL Listed Creeks in Rural Washington County

Stream	Segment	TMDL Parameters
Burris Creek	Mouth to Headwaters	Bacteria, Biological Criteria, DO, Temperature
Butternut Creek	Mouth to Headwaters	Bacteria, Biological Criteria, DO, Temperature
Carpenter Creek	Mouth to Headwaters	Bacteria, Biological Criteria, DO, Temperature, Chlorophyll a
Cedar Creek	Mouth to Headwaters	Bacteria, DO, Chlorophyll a
Chicken Creek	Mouth to Headwaters	Bacteria, DO
Christenson Creek	Mouth to Headwaters	Bacteria, DO
Council Creek	Mouth to Headwaters	DO
Dairy Creek	Mouth to East/West Forks	Bacteria, Temperature
E. Fork Dairy Creek	Mouth to Whiskey Creek	PH (summer), Temperature
W. Fork Dairy Creek	Mouth to Headwaters	Bacteria (summer), DO, Temperature
Gales Creek	Mouth to Clear Creek	Bacteria (summer), DO, Temperature
Heaton Creek	Mouth to Headwaters	Bacteria
McFee Creek	Mouth to Headwaters	Bacteria, DO
McKay Creek	Mouth to East Fork	Bacteria, Temperature
Rock Creek	Mouth to Headwaters	Bacteria, Biological Criteria, DO, Temperature, chlorophyll a
Rock Creek – South	Mouth to Headwaters	Biological Criteria
Scoggins Creek	Mouth to Hagg Lake	DO (Nov-Apr)
Summer Creek	Mouth to Headwaters	Bacteria, Biological Criteria, DO, Temperature
Tualatin River	Mouth to Dairy Creek	DO, Chlorophyll a, Bacteria, Temperature

4.1.2 Rural Area Monitoring

For Washington County, to justify the rural area monitoring plan, technical consultants looked at these stations in terms of relevance to rural Washington County. Stations were compared to the list of TMDL listed streams in rural Washington County (Table 4.1, above). Then, a total of 17 instream water quality monitoring sites were selected (by the Subcommittee) to represent conditions from rural Washington County. Six of these original sites were located on tributaries to the Tualatin River, and 11 sites were located on the Tualatin River main stem.

For each reporting year through 2017, Washington County technical consultants have analyzed the rural area data provided by Clean Water Services, as reported in the Washington County Annual TMDL Reports. For 2018, due to the Five-Year TMDL Summary required by DEQ (the Survey), an abbreviated Annual Report is submitted on March 1, 2019 without the usual monitoring reporting. It is important to note the raw data is still provided to DEQ by Clean Water Services.

Additional trends analysis is occasionally available for agricultural land, and rural area streams through DEQ. The analysis is done to support the Oregon Department of Agriculture in their development of the Agricultural Water Quality Management Plan for the Tualatin.[104]

Extensive monitoring also occurs for TMDL parameters by Clean Water Services (District), including rural area sites. It is uploaded to the DEQ (and EPA) database annually. The most recent data summary can be seen in the CWS Annual Report.[105] According to the Annual Report for FY 2020-2021, the District conducted ambient monitoring in the Tualatin Basin at seven Tualatin River sites and 10 tributary sites in 2020. That data was submitted to DEQ in December 2020.

4.2 Elements of the Basin-Wide Monitoring Plan

The first goal of the water quality monitoring program is to track compliance with instream water quality standards and to track ambient concentration trends. To address this goal the DMA monitoring subcommittee developed a proposed instream ambient monitoring program. The committee decided to select a representative instream sampling point for each TMDL listed stream. The committee looked at each of the listed streams (moving from upstream to downstream) to select benchmark ambient monitoring sites. An attempt was made to select sites that were already monitored.

4.2.0 Monitoring Sites Selected

The selected TMDL monitoring sites for the watershed as a whole are summarized in Table 4.2, with each of the listed streams, and the site proposed as representative of each stream. The sites that are not located in rural Washington County (i.e., in the urban area) are shaded.

In summary, most of the listed streams included a proposed benchmark ambient instream monitoring site. The exceptions were Scoggins, which is dominated by the water released from Scoggins Reservoir; and Butternut, Christensen, Burris, Rock South and Heaton as these are very similar subbasins that will be represented by the benchmark monitoring site located on McFee Creek. There are also 11 Tualatin River (4th field) monitoring sites that are retained as benchmark sites.

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[104] **Tualatin River Subbasin: DEQ's Water Quality Status and Trends Analysis for the Oregon Department of Agriculture's Biennial Review of the Agricultural Area Rules and Plans; Nov. 2017. See: https://www.oregon.gov/deq/FilterDocs/strTualatinreport.pdf**

[105] **See: https://cleanwaterservices.org/wp-content/uploads/2022/06/stormwater-annual-report-2021.pdf**

Table 4.2
Monitoring Sites Selected for Ambient Benchmark Monitoring

Monitoring Site Map Reference #	Listed Stream	Selected Ambient Monitoring Station ID, Owner, and Location	Rationale
	Scoggins 5th Field	None	This site is dominated by the release of water from Scoggins Reservoir. The DMA's don't have issues in this subbasin.
#1	Carpenter 5th Field	3809012 – ODA @ Stringtown Rd.	This is an existing ODA monitoring station that represents agricultural runoff and will be kept for that purpose. There have recently been some bacteria issues in this creek that are currently being investigated with respect to a nursery and a transient located upstream.
#2	Gales 5th Field	3810015 – CWS @ New Highway 47	This watershed is mostly rural with the exception of Forest Grove. The selected station is located at the downstream end of the subbasin near the mouth and will represent the whole subbasin.
#3	Dairy 5th Field	3815021 – CWS @ Highway 8	This monitoring station is located at the downstream end of the subbasin and will represent both forks of Dairy Creek and McKay creek. This station is representative of those two systems as they are both mostly rural.
#4		New Site – 3815083 ODA @ Scheflin	ODA has two existing sites in the upper portion of the Dairy subbasin on the East Fork, and on McKay Creek. They will consider replacing these two sites with a site on Dairy Creek just below the confluence of the two forks. Note: This differs from the CWS station on Dairy Creek that is listed above because it is above the confluence of McKay Creek.
	E. Fork Dairy 6th Field	None	Represented by #3 and #4.
	W. Fork Dairy 6th Field	None	Represented by #3 and #4.
	McKay 6th Field	None	Represented by #3.
	Council 6th Field	None	Represented by #3
#5	Rock 5th Field	3820012 – CWS @ Highway 8	CWS will keep the lowest site on Rock Creek that they can to represent the whole system. Depending on access issues, this will either be located at Highway 8 or Brookwood. Monitoring is difficult in upper Rock Creek due to low flows. The Rock Creek site at Quatama will be monitored and could be used to characterize upper Rock Creek. However, it will be used as decision support and will not be monitored as a benchmark site.

Monitoring Site Map Reference #	Listed Stream	Selected Ambient Monitoring Station ID, Owner, and Location	Rationale
#6	Beaverton 6th Field	3821008 – CWS @ Beaman's (Beaman's is a private home located just downstream of Cornelius Pass Rd.)	This site was selected to represent the Beaverton Creek subbasin. It is located below all of the tributaries to Beaverton Creek.
	Bronson 7th Field	None	Represented by #6.
	Cedar Mill 7th Field	None	Represented by #6.
	Johnson N. 8th Field	None	Represented by #6.
	Johnson S. 7th Field	None	Represented by #6.
	Willow 7th Field	None	Represented by #6.
	Hall 7th Field	None	Represented by #6.
	Butternut 5th Field	None	Represented by #7.
	Christensen 5th Field	None	Represented by #7.
	Burris 5th Field	None	Represented by #7.
#7	McFee 5th Field	3811010 – ODA McFee Creek @ 219 (SW Hillsboro Highway)	There are several small tributaries to the Tualatin located in Townships 1S2W and 2S2W. These tributaries drain into the Tualatin between Rock and Fanno Creeks. They all have similar land uses and are similarly sized subbasins. McFee Creek was selected for monitoring to represent these small tributaries.
	Heaton/ Baker 5th Field	None	Represented by #7.
#8	Chicken 5th Field	3835020 – CWS Chicken @ SW Scholls-Sherwood Rd.	This is close to the mouth of Chicken Creek and catches all upstream tributaries. In terms of land use it represents a small urban basin as it includes drainage from Sherwood.
	Rock Creek South 5th Field	None	Represented by #7.
	Cedar 6th Field	None	Represented by #8.
#9	Fanno 5th Field	3840012 – CWS Fanno Creek @ Durham	This site is close to the mouth of Fanno Creek and therefore represents the Fanno subbasin.
#10		3840126 – City of Portland Fanno Creek @ 56th	Represents the upper reaches of Fanno Creek.
	Ash	None	Represented by #9.

Monitoring Site Map Reference #	Listed Stream	Selected Ambient Monitoring Station ID, Owner, and Location	Rationale
	6th Field		
	Summer 6th Field	None	Summer Creek is a tributary of Fanno Creek that is located in Tigard. Only a very small portion of the upper creek is showing up on the map as being located in rural Washington County. This portion of the creek, if the map is correct, may not even have flow in the summer months. Field verification of this creek location is recommended.
	Hedges 5th Field	None	Represented by #8.
#11	Nyberg 5th Field	To be determined.	CWS looked at data from Hedges and Nyberg to see whether the data from Chicken Creek would also be representative of these creeks. Based on this review, a benchmark monitoring site was chosen for Nyberg.
#12	Saum Creek 5th Field (Note: Not a listed stream.)	3867004 – Clackamas County	This site represents many small rural tributaries entering the Tualatin between Nyberg Creek and the mouth. The subbasin includes both rural Washington County, Clackamas County and the City of Tualatin.
#13	Lake Oswego	3960045 – Lake Oswego Springbrook Creek Iron Mountain Road	This is a benchmark monitoring station for the Lake Oswego phosphorus TMDL.
#14 - #24	Main Stem Tualatin 4th Field	11 CWS Sites – 3701715 – Cherry Grove, – 3701612 – Springhill, – 3701528 – Golf Course, – 3701450 – Highway 219, – 3701391 – Rood Rd., – 3701333 – Farmington Rd., – 3701271 – SW Scholls Ferry Rd., – 3701165 – Elsner – 3701087 – Boones Ferry Rd., – 3701054 – Stafford – 3701002 – Weiss Rd.,	All 11 of the current Tualatin Main Stem monitoring sites will be retained for benchmark monitoring purposes.

***Shaded Cells = Monitoring site is located in an urban area, *not* rural Washington County.**

4.2.1 Sampling Parameters and Frequency of Instream Monitoring

The frequency of sampling at the benchmark sites was originally set at twice a month. As of FY 2020-2021, land-use based stormwater monitoring occurs at 5 locations at least 3 times per year, as well as during six storm events.

Temperature	Specific conductance Turbidity
E. coli.	Hardness
Total Organic Carbon	Total Suspended Solids
Total Phosphorus as P	Orthophosphorus as P
Ammonia (NH_3-N)	Nitrite + Nitrate as N
Copper	Lead
Zinc	Mercury

4.2.2 Outfall Discharge Monitoring

Limitations

A significant amount of regional stormwater monitoring data have already been collected and analyzed as part of the Phase I NPDES permits process. Stormwater pollutant concentrations from various land uses have been analyzed and described for the basin, and best management practices were developed to address discharges.

> Concentrations in stormwater runoff can vary by orders of magnitude based on activities in the watershed, soils/topography, length of the dry period prior to rainfall, and the duration and intensity of rainfall.

There were several arguments opposing outfall monitoring:

- This variability would make it extremely difficult, if not impossible to find a reasonable number of outfall sites that could be used to accurately represent stormwater runoff concentrations and loadings basin-wide.
- Stormwater managers in the DMA group believe that instream monitoring should be sufficient in addressing the new TMDLs. If the streams are improving and meeting water quality standards, then the goals are being met and discharge monitoring is not necessary.
- With respect to conducting discharge monitoring for trends, it takes a significant amount of samples to show, with statistical significance, that the variability in the concentrations actually does represent a trend. For example, a statistical analysis showed that for one Portland station in Fanno Creek, where a mean TSS concentration had already been established, it would take approximately 200 additional samples to statistically show a 5% reduction in the mean.
- Monitoring is extremely resource intensive. Even when automated equipment has already been purchased, it costs approximately $1,000 per station per event. When this cost is multiplied over the number of sites and events that it would take to obtain data with statistical significance, it becomes prohibitive.

The DMA Monitoring Committee decided not to develop a basin-wide approach for stormwater outfall monitoring, except to the extent of agreement to follow the same protocols when stormwater discharge monitoring is conducted in the basin. Each DMA conducts their own stormwater outfall monitoring plans to

DEQ, primarily within the context of municipal NPDES permits. Washington County is a co-implementer to the CWS' NPDES permit, but no longer a co-permittee. CWS therefore conducts all required stormwater monitoring.

4.3 Summary of Monitoring Goals for Rural Washington County

Designated Management Agencies worked together with DEQ to develop and implement the monitoring program to address the TMDL parameters. As explained in the previous sections, most of the monitoring in the rural area is accomplished by Clean Water Services. Washington County works with the DMA Monitoring Committee and technical consultants to track representative sites for ambient monitoring and trend analysis. The following Table 4.3 summarizes the four basin-wide TMDL monitoring goals considered by the DMA Monitoring Subcommittee, as relevant to rural Washington County.

Table 4.3
Summary of TMDL Monitoring Activities
For Rural Washington County

Basin-wide TMDL Monitoring Goal	TMDL Monitoring Goal for Rural Washington County
1. Determine whether instream water quality standards are being achieved and identify instream trends.	Evaluate the results of water quality data from the 14 instream monitoring stations in the rural area (operated by other basin jurisdictions) on an annual basis. (Done, and ongoing).
2. Monitor outfall discharges to determine whether benchmarks are being achieved and to identify trends.	No outfall monitoring is recommended in the rural area. Monitoring to address this goal is relevant in the Urban NPDES permitted areas.
3. Identify specific sources.	• Participate in the DNA study conducted by CWS to identify sources of E. coli. (Done) • Monitor sediment discharges from County ditches. This monitoring could be conducted to also serve the purpose of evaluating a BMP (Done).
4. Identify the most suitable best management practices (BMPs) for addressing the problems.	• Track and evaluate results from relevant local and national BMP studies. (Done) • Monitor the effectiveness of the County's ditch design and practices with respect to preventing erosion and sediment discharges. (Done; Adaptive Management applied)

Chapter Five
TMDL WQ Implementation Plan
Management Measures

5.0 DEQ's Goals and Objectives for a WQMP

The overall goal of the DEQ's Tualatin Sub-Basin TMDL Water Quality Management Plan (WQMP) is to achieve compliance with water quality standards for each of the 303(d) listed parameters and streams in the Tualatin River Subbasin.[106] The specific goal of their WQMP is to describe a strategy for reducing discharges from nonpoint sources to the level of the load allocations and for reducing discharges from point sources to the level of the wasteload allocations described in the TMDL. The plan is designed to rely on existing programs wherever possible, and to be adaptive to changing conditions as more information and knowledge is gained regarding the pollutants, allocations, management measures, and other related areas.[107]

Update re: Mercury: DEQ has ordered Stormwater Control Measures for Mercury Reductions in their WQMP. For Counties, NPS requirements are described in DEQ's WQMP submitted to EPA.[108] Washington County meets these required Management Program measures as they have implemented for many years, as diligently selected and revised as need through Adaptive Management.

This WQIP for Nonpoint Source TMDL Parameters describes the extensive programmatic response, and exceeds the minimum management measures for Mercury reduction. The DEQ-mandated four minimum management program requirements for counties (Mercury) include:

1. Pollution Prevention and Good Housekeeping for County Operations
2. Public Education and Outreach
3. Enforcement of Prohibited Pollutants
4. Construction Site Runoff Control.

[106] Tualatin River Subbasin TMDL, Appendix I, Water Quality Management Plan, Oregon DEQ, August, 2001; and Tualatin Subbasin TMDL, Chapter 4, Water Quality Management Plan, August, 2012.
[107] Id. (2012).
[108] Final Revised Willamette Basin Mercury TMDL and WQMP, Oregon Dept. of Environmental Quality; November, 2019, p. 97

5.1 BMP's Selection Process

The BMP's utilized by Washington County to address TMDL parameters are informed by the original stormwater program BMP selection process (explained below), the Tualatin Basin Watershed Technical Committee, the related NPDES Stormwater Program, national and local standards to address water quality, the literature review, and BMP database results (explained herein, in Chapter 3), field experience, and finally Adaptive Management. This combination has resulted in a robust, yet ever-evolving process, which confidently addresses the TMDL parameters as well as other potential pollutants.

Management measures and Best Management Practices (BMP's) have evolved to the current BMP's (2022) through a review and improvement process called Adaptive Management. This BMP selection process included:

5.1.0 Original Municipal NPDES BMP's

To comply with CWA requirements under the original MS4 NPDES permits, Washington County, as a named co-permittee[109], was required to submit an application for a NPDES permit to cover their MS4 discharges. The application was submitted in two parts. The first part of the application required the compilation of information related to the stormwater system within the permit area including outfall investigation results, maps and monitoring data. The second part of the application required the development of a Stormwater Management Plan (SWMP). The SWMP included BMPs to address several categories of stormwater management issues such as construction site runoff, street sweeping, public education, structural controls, etc. Collectively, the BMPs were developed to reduce pollutants to the maximum extent practicable (MEP standard).

5.1.1 Specific BMP Selection Criteria

The 2-year process for the original SWMP's included semi-monthly regional MS4 permittee meetings and extensive discussion. The individual actions that were considered for inclusion in the SWMP are referred to as the BMPs. The specific steps in the process to select BMPs for the SWMP included the following:

Step 1:	Identify local stormwater quality problems.
Step 2:	Define objectives of the SWMP.
Step 3:	Identify a comprehensive list of candidate BMPs.
Step 4:	Define and evaluate selection factors for initial screening of BMPs.
Step 5:	Conduct preliminary screening of candidate BMPs.
Step 6:	Conduct final evaluation, screening, and selection of SWMP BMPs.

Each step of the process is described below:

BMP Selection Criteria - Step 1: Identify Local Stormwater Quality Problems: Information on water quality problems in the permit area was compiled from previous monitoring studies conducted by the District.[110] Additional information was obtained from DEQ's Section 305(b) biennial reports in which DEQ identified a number of local water bodies or segments of water bodies where water quality criteria were

[109] Clean Water Services (then known as Unified Sewerage Agency), and ODOT were the other co-permittees. By Intergovernmental Agreement and approval by DEQ, Washington County was removed as a co-permittee in 2005, becoming a co-implementer similar to cities within CWS boundaries.
[110] District = Unified Sewerage Agency (USA), now Clean Water Services of Washington County.

exceeded. When DEQ developed a TMDL for the Tualatin Subbasin that included requirements to reduce total phosphorus in stormwater, this information was used to aid in the selection of BMPs most likely to be effective at addressing water quality issues of concern.

BMP Selection Criteria - Step 2: Define Objectives of the Stormwater Management Program: The co-permittees and other participants defined an explicit set of objectives broad enough to capture the full range of issues to be considered in program planning but specific enough to use as the basis for decision-making. The following objectives were developed:

- Meet the requirements of the NPDES MS4 permit.
- Focus the management program on existing stormwater quality problems that warrant the greatest attention (such as the TMDL parameters).
- Focus on problems and BMPs for which a reasonable degree of control would yield the greatest benefits.
- Propose a SWMP that emphasizes and builds upon stormwater controls and practices already in place.
- Rely on and enhance existing practices where possible; where needed, phase in new practices during the term of the permit.
- Based on best professional judgment, the development and implementation of BMPs should:
    - Emphasize practices that are the most likely to be effective in reliably controlling targeted problems.
    - Emphasize practices that will be practical to implement and sustain, including consideration of liability and legal authority.
    - Emphasize practices that have acceptable initial and continuing costs.
    - Emphasize practices that have acceptable environmental impacts.
    - Emphasize programs that are politically acceptable to the elected officials and the public.
- Develop the SWMP with input from the cities in the permit area, outside groups/agencies, and the public.

BMP Selection Criteria - Step 3: Identify a Comprehensive List of Candidate BMPs: A comprehensive list of 130 candidate BMPs was developed by the technical consultants representing virtually all types of management practices that might beneficially affect stormwater quality, as well as receiving water quality, regardless of the technical, economic or political feasibility of implementation. A matrix was created which summarized significant information with respect to each BMP including:

- Whether NPDES Regulatory Requirements would be met by the BMP;
- Which pollutants would be addressed by the BMP;
- The current implementation status of the BMP within the permit area;
- The probable lead agency responsible for the BMP if it was selected.

It would have been physically and fiscally impossible to implement all 130 BMPs; therefore, a screening process was conducted to rank and select the highest priority BMPs. The BMP matrix developed under this step was used as the template for scoring the 130 BMPs (Step 5) using the evaluation factors described in Step 4.

BMP Selection Criteria - Step 4: Define and Evaluate Selection Factors for Preliminary Screening of BMPs: In order to select the BMPs to implement, the program participants initially considered eleven selection factors to evaluate, score and rank candidate BMPs. Out of those eleven, the following six factors were selected as the highest priority for use in screening candidate BMPs.

- Addresses pollutants of concern;
- Life cycle costs;
- Meets regulatory requirements;
- Public acceptance;
- Risk/liability;
- Reliability.

As information becomes available and as more is learned about BMPs and sources over time, the SWMP activities, programs, monitoring and BMPs have been revised and improved as described in the following sections through an adaptive management process.

BMP Selection Criteria - Step 5: Conduct Preliminary Screening of Candidate BMPs: Each participant scored each of the candidate BMPs for each selection factor. The consultant compiled net scores for each candidate BMP. A cutoff score was identified that resulted in a discreet group of 46 of the most highly scored BMPs. The consultant reviewed the results and some additional BMPs were added based on those that would be necessary to meet minimum requirements, and those that should be reconsidered due to a wide range in individual scores for that BMP. As a result, an initial list of 57 BMPs were chosen for further consideration.

BMP Selection Criteria Step 6: Final Evaluation, Screening, and Selection of BMPs for the Stormwater Management Plan: Fact sheets were prepared for the 57 BMPs selected in Step 5 for further consideration. The fact sheets provided more detailed information on each BMP that allowed the process participants to better evaluate its practicability, effectiveness and financial feasibility. The participants reviewed the fact sheets and offered their comments on the selected BMPs. A meeting was then held to come to a consensus on a final list of BMPs for inclusion in the stormwater management plan. This meeting included process participants, co-permittees, and the cities in the service area. A number of BMPs were eliminated from consideration during the meeting (mainly due to taking a more detailed look at cost/effectiveness issues and overall program costs), and several others were combined into a single BMP description (e.g., combining some of the public education measures into one BMP). A final list of 40 BMPs was selected and incorporated into the proposed SWMP. The SWMP provided in the permit application includes a rationale for the selection of BMPs in each major permit category.

As a result of the earlier total phosphorus TMDL, a large number of existing programs were already in place (e.g., storm system operation and maintenance practices; erosion control and water quality standards for new development; etc.) and therefore, typically the main rationale for the selection of BMPs included building on already existing programs and modifying/refining those programs to maximize water quality benefits.

5.2 Water Quality Management Plan (Implementation Plan) Development

To meet the overall goal of their WQMP, DEQ assigned Designated Management Agencies (DMA's) with responsibility for managing activities and programs under their respective jurisdictions and authority, to implement DEQ's Plan. The resulting individual DMA plans are deemed Water Quality Implementation Plans, or WQIP's for addressing the Tualatin Basin TMDL's.

The major areas of responsibilities identified by DEQ for the three Tualatin Basin DMA counties of Washington, Clackamas and Multnomah were:

- Construction, operation and maintenance of County roads and County storm sewer systems;
- Land use planning and permitting;
- Maintenance, construction and operation of parks and other County owned facilities and infrastructure;
- Inspection and permitting of septic systems; and
- Riparian area management.

The identified responsibilities above generally apply to Washington County rural area management, other than parks, which are owned and operated by Tualatin Hills Park and Recreation District.

Each of these areas of responsibility have associated management measures, developed over time to the present (September 2022) as Best Management Practices (BMPs) which reflect the experience and knowledge acquired during the development and implementation of programmatic activity protective of the environment, water quality, and natural resources. These BMPs are summarized in this Chapter, below, Sections 5.4 – 5.8, with applicable TMDL parameters addressed, where applicable.

The final SWMP (with selected BMPs) was developed and submitted in the CWS/County/ODOT permit application to DEQ as required under the Clean Water Act. The application was approved by DEQ and a permit was issued. Therefore, the SWMP was deemed to meet the MEP standard. As mentioned in the introduction, this original SWMP has been the foundation for the CWS and County's stormwater management activities. As new information has become available and as more has been learned about BMPs and sources over time, the SWMP activities, programs, monitoring and BMPs have been revised and improved as described in the following sections through an adaptive management process.

5.3 Adaptive Management

5.3.0 Tualatin Basin TMDL Status Report[111] (Historical Background)

The DEQ initiated a formal process, finished in 1998 to review and revise the then-current Tualatin Basin TMDLs. An outcome of this process was a recommendation to modify the current TMDLs for certain parameters: bacteria, temperature, DO, Total Suspended Solids and possibly toxics. The Environmental Quality Commission (EQC) in June 1998 extended the Tualatin Basin TMDL Compliance Order and Schedule which has been in effect since 1993, and included new tasks to incorporate the new TMDL program. The Status Report, developed collectively by Clean Water Services (then USA) and the other DMAs (Cities of Portland, West Linn, Lake Oswego; Counties of Washington, Multnomah, and Clackamas), was an EQC and Compliance Order Requirement (Task 5).

That status review resulted in a fresh look at BMP's. A Matrix was developed (Table 2 of that report) including the following considerations:

- Purpose of each Best Management Practice;
- When and How Applied;
- How Much applied to Date;
- Area of Application (Rural & Urban);

[111] **Washington County Status Report for the Tualatin Basin Nonpoint Source Management Implementation Schedule/Order submitted to DEQ in satisfaction of the Task 5 of the State EQC Order to all Tualatin Basin jurisdictions (1999).**

- New or Existing Development;
- Applicable TMDL Parameters Addressed;
- Estimated Effectiveness; and
- Proposed Changes based on TMDL

The comprehensive review of programs and BMPs demonstrated how BMPs were working well, and should be continued. Improvements were made at that time, for example: The Operations Division reviewed revegetation practices including contracting with professionals to provide new hydro-seeding services; County maintenance workers now routinely apply hay bales, silt fencing, energy dissipators, and bio-bags for erosion control devices to minimize sediment runoff and removal.

5.3.1 BMP Formalization

Following another 2-year process, Washington County formalized a "Limit 10"[112], whereby after formal adoption by the County Board of Commissioners, publication in the Federal Register, and approval from the NOAA Fisheries Regional Administrator, the County Operations' Division's Routine Road Maintenance Practices were federally approved as sufficiently protective of the listed salmonid species and their habitat. The program was developed by County personnel in 2000, with specific work activities and specific BMPs for each work activity. Through Adaptive Management it has been updated and improved, and continues to be utilized through the present (2022).

It is essentially a Post-Construction BMP Program, and is the primary implementation element for meeting the TMDL WQMP. The Washington County Limit 10 Program consists of:

- Activity-Based BMP's documented by Activity-Code in *Best Management Practices for Routine Road Maintenance*;[113]
- Site Specific BMP's;
- Designated Riparian Management Areas (RMA's generally 250' either side of a fish resource stream);
- Training Program;
- BMP Field Manuals for crew and inspectors (The Quick Reference Guides, or QRGs);
- Environmental Services Senior staff to oversee compliance;
- Adaptive Management and annual reporting.

5.3.2 BMPs and Adaptive Management

Best Management Practices are continuously under review by Managers and Environmental Staff, as well as crew supervisors and Project Managers. Any proposed improvements or changes are discussed with managers, staff, and the environmental compliance consultant throughout the year and during annual compliance report time. Each year, the County is required to submit an annual compliance report.

In 2012, a comprehensive environmental compliance review was done of all environmental programs for the Washington County Dept. of Land Use & Transportation. Specific recommendations were made to Division

[112] Limit 10 is a limitation on the application of the Endangered Species Act Rule 4(d) prohibition against harm to Pacific NW Salmon and their habitat. It is specific to Routine Road Maintenance Practices (BMPs).
[113] The 2017 version is on the web at: https://www.co.washington.or.us/LUT/Divisions/Operations/upload/2017-BMPs-RoutineRdMaint.pdf

Managers at that time, resulting in BMP improvements, such as documentation of erosion control inspections and procedures.

With a solid foundation of BMP's developed, reviewed, and revised over the last 2 decades, Washington County continues to adapt to new technology, ideas, and practices with the specific purpose of water quality management. All of the above steps and processes are collectively adaptive management.

To ensure that the WQIP continues to meet the TMDL narratives standard, the effectiveness of the programs, activities, and BMPs contained in the WQIP is revisited annually. If there were changes identified during the annual reporting period, they were documented in the annual report. These changes (annual and internal evaluations) are made as part of an adaptive management process to ensure that the program continues to meet the Nonpoint TMDL standards.

5.4 Management Measures for Washington County Rural Area:

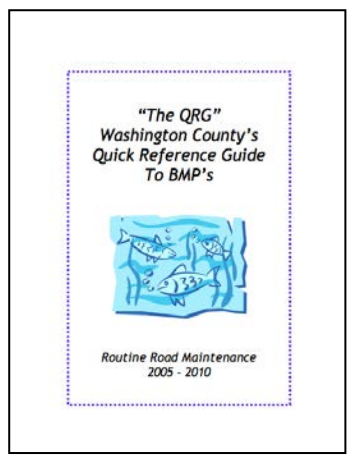
Operations and Maintenance; Capital Projects

***TMDL Pollutants Addressed*: Sediments (DO), Sediments (Mercury), Nutrients (TP), Bacteria**

The first TMDL Program originated changes to Washington County Operations, Maintenance, and Construction and Engineering practices as early as 1990. The first TMDL for the Tualatin Basin included a State Rule for water quality treatment to remove 60% phosphorus loadings on any new construction. This resulted in design changes, and eventually with the addition of Municipal Stormwater NPDES requirements, and continual revisions and improvements, grew into the current Best Management Practices Program. Both the Operations & Maintenance, and the Engineering & Construction Services Divisions of the County Dept. of Land Use & Transportation have comprehensive environmental standards built into nearly every activity, from design to construction to post-construction.

The summaries in this Section 5.4, and the BMP Table 5.3 at the end of Chapter 5, are a general overview of these extensive programs. There are many drivers for attention to water quality, including the TMDL program. Washington County will continue to meet and exceed environmental standards. Below is an overview of the Management Measures utilized on a frequent basis.

5.4.0 County Roadway Operations and BMPs



Best management practices to ensure that pollutant loadings from roadway operations are minimized are designed to prevent sediment and pollutant loadings that could impair surface waters. In the year 2000, Washington County DLUT developed and the Board of County Commissioners approved new Road Maintenance management measures based on the ODOT routine road maintenance program submitted to National Marine Fisheries Service. The program resulted in a document called "BMPRO 2000".[114] This was improved and revised in 2004, 2011, 2016, and 2017. For example, through the adaptive management process, a new section specifically addressing vegetation management and BMPs was added.

Since then, these management measures have been reviewed and revised due to field experience and continuing attention to water quality and habitat concerns (Adaptive Management). The current document

[114] **Roadway Operations Best Management Practices: Water Quality & Habitat Guide; (BMPRO 2000); and Id. (2017).**

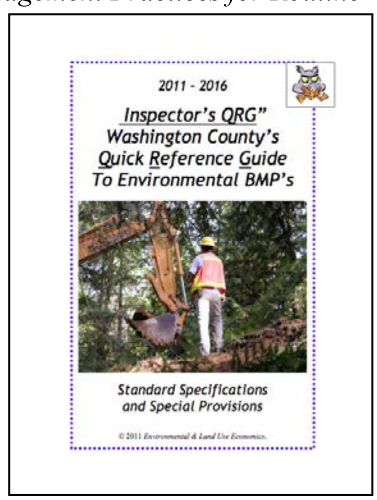
is known as "*Best Management Practices for Routine Road Maintenance*"[115], which incorporates the Vegetation Management practices (Series 300) at a consistent level to the other BMP categories of Bridge Operations (Series 100), Roadway Surfaces (Series 200), Drainage Operations (Series 400), Traffic Operations (Series 500), Emergency Response (Series 900), and Environmental Management (Series 1000). This document became the basis for the federally approved program for Washington County DLUT pursuant to Limit 10(i) under the Endangered Species Act 4(d) rule for threatened salmon and steelhead (65 FR 42422, July 10, 2000). In 2011, the document was updated and submitted to NMFS for renewal approval, which was formally accepted in June 2011.[116] It was revised again in 2017.

Successful implementation of the program is dependent on the BMPs, which include the following categories:

Series 100	**Bridge Operations**
Series 200	**Roadway Surfaces**
Series 300	**Vegetation Management**
Series 400	**Drainage Operations**
Series 500	**Traffic Operations**
Series 900	**Emergency Response**
Series 1000	**Environmental Management**

The BMP's are implemented in the field by the County Operations and Maintenance Crew. Each crew member has received BMP training provided by the Operations' Environmental Services group. Part of this training involves a Quick Reference Guide, "The QRG", organized by BMP category. A similar document, the Inspector's QRG, a quick reference guide to Environmental BMP's includes Standard Specifications and County-supplied Special Provisions.

Riparian Management Areas are field-marked with RMA signage (about 80% complete) for special attention to RMA-BMPs. An RMA is an area adjacent to natural streams, rivers, wetlands, or other resource waters within which operational limitations may be assigned. DLUT jurisdiction extends no further than the limits of the public right-of-way. These limits often extend no further than 30 feet either side of the roadway centerline. The RMA is used in the implementation and training of *Best Management Practices for Routine Road Maintenance.*



An example of BMP descriptions from the Series 100 BMPs (Bridge Operations) **[BMP-RRM]** is given below:

- Schedule and perform any in-water work activity within the appropriate ODFW in-water work window or within the time framework as negotiated with and agreed upon by ODFW.
- Coordinate with ODFW (where and when necessary) to divert or otherwise segregate resource waters from areas where concrete is used during structural repairs of bridges and culverts.
- Re-fuel equipment outside of the Riparian Management Area.
- Avoid use of creosote or "penta" treated wood for permanent structures.

[115] Best Management Practices for Routine Road Maintenance, Washington County, Oregon, DLUT, 2011.
[116] Letter from NOAA Fisheries Regional Administrator (W. Stelle); dated June 13, 2011.

- Provide for the collection and proper disposal of recycling of sandblasting materials and other bridge cleaning debris and prevent those materials from entering resource waters or habitat.

- Remove any excess material or construction debris from the channel after maintenance work activities have been completed. No materials that could potentially contribute sediment to downstream habitats will be deposited below the floodplain level, in waterways or wetlands.

- Avoid work during heavy rainfall.

Table 5.1 below is an abbreviated version and example of typical work activities performed by the Operations Division field crews, with notations of TMDL parameters positively affected by BMP implementation. Each of the work activities has associated BMPs (similar to that described above for Series 100), including a training program and field manual to help remind crews of the BMP responsibilities. Crew leaders and supervisors perform the BMPs on a daily basis, with guidance and oversight by the Operations Divisions' full-time environmental resources staff.

Table 5.1 (Abbreviated)
Routine Road Maintenance Water Quality Considerations

SERIES 100 DESCRIPTION: BRIDGE MAINTENANCE					
Bridge repair activity may include the repair of bridges and large culverts. In-water bridge repairs may include the installation, repair or replacement of rip-rap, drainage structures and catch basins, and the replacement of structural components.					
WATER QUALITY CONSIDERATIONS					
These practices are focused on the protection of habitat and ensuring that potentially harmful materials are not allowed to enter resource water. This is achieved through the proper use of containment devices, sound work-site practices and minimum removal of vegetation.					
RRM-BMP Activity Code*	Roadway Operations Activity Category	APPLICABLE TMDL PARAMETER			
		Bacteria	Phosph	Temp.	TSS- DO; Hg
101	Bridge Construction	✱	✱		✱
102	Bridge Demolition		✱		✱
106	Shoulder Erosion Repair		✱		✱
107	Place Concrete Barriers		✱		✱
108	Clean Bridge & Bridge Rail	✱	✱		✱
109	Debris Removal - Stream	✱	✱		✱
127	Guardrail Installation		✱		✱

5.4.1 Capital Projects (Construction) and BMPs

The Capital Project Services Division (formerly the Engineering & Construction Services Division of Washington County DLUT, and previously CPM: Capital Project Management) administers major road and bridge projects, as well as other infrastructure such as major culverts, water quality facilities (WQF's), underground storage facilities associated with the WQF's. Dozens of major projects are in the design or construction phase in any given year.

More information on these projects can be found at the following website:
https://www.co.washington.or.us/LUT/TransportationProjects/capitalprojects.cfm

5.4.1-0 Runoff Treatment and Control

When a capital project involves new road-building, road-widening, and other significant projects, water quantity and water quality facilities (WQF's) are usually part of the project. For the urban area, these are subject to review and approval by Clean Water Services and certain cities within Washington County. The standards protect existing WQF's from construction impacts (such as erosive flows into a WQF) and require new or updated WQF's in most cases. Specific criteria followed by the County can be found in the CWS Design and Construction Standards, Chapter 4.[117]

Water quantity and quality control requirements are standardized, to lessen the impact to the existing system. The Runoff Treatment and Controls in CWS Standards include the following categories:

- Erosion Protection of Existing WQF's
- Vegetation – Planting requirements and prohibited species
- Fencing Protection of Existing WQF's
- Access for maintenance of WQF's
- Dedicated easement to CWS or City for maintenance
- Water Quantity Controls – Detention, Improvement, SDC fee
- Hydraulic Design Criteria – No increase in peak runoff rates
- Water Quantity Facility Design Standards
- Water Quality Treatment Design Requirements
- Water Quality Storm, Volume, and Flow Considerations
- Pre-Treatment Required
- Approved Proprietary Treatment Systems
- Water Quality Manhole Design Criteria
- Vegetated Swale Design Criteria
- Extended Dry Basin Design Criteria
- Constructed Wetland for Water Quality
- Low Impact Development Approaches (LIDA)

- Porous Pavement
- Green Roof
- Infiltration Planters
- Flow-thru Planters

[117] https://cleanwaterservices.org/wp-content/uploads/2022/06/final-chapter-4.pdf

- LIDA Swales
- Vegetated Filter Strips

5.4.1-1 Erosion and Sediment Control NPDES 1200-CA Permit

Washington County Capital Projects Services Division (CPS); (formerly the Division of Engineering & Construction Services, or ECS) holds an NPDES 1200-CA [**C**onstruction-**A**gency] permit for erosion and sediment control. Sources covered by the permit include clearing, grading, excavation, and stockpiling activities under the authority or jurisdiction of the County that disturb one or more acres.[118] The permit does not authorize in-water or riparian work. It does not authorize direct or indirect discharges to waters of the State, including discharges to an underground injection control (UIC) system. It covers both urban and rural activities for CPS projects.

A copy of the permit can be found at: https://www.oregon.gov/deq/FilterPermitsDocs/1200caPermit.pdf

Erosion Control Measures Followed by the Capital Project Services, Division of DLUT:

- A conditional Erosion and Sediment Control Plan (ESCP) must be implemented to *prevent the discharge* of significant amounts of sediment to surface waters. Significant amounts of sediment are described as:
  - Earth slides or mud flows that leave the construction site*;
  - Evidence (such as the presence of rills, rivulets or channels) of concentrated flows* of water causing erosion when such flows are not filtered or settled to remove sediment prior to leaving the construction site;
  - Turbid flows* that are not filtered or settled to remove turbidity prior to leaving the construction site;
  - Deposits of sediment at the construction site in areas that drain to unprotected storm water inlets or catch basins that discharge to surface waters.
  - Deposits of sediment from the construction site on public or private streets outside of the permitted construction activity that are likely to discharge to surface waters;
  - Deposits of sediment from the construction site on any adjacent property outside of the permitted construction activity that are likely to discharge to surface waters.

> *Flow to stormwater inlets or catch basins located on the site are considered "leaving the site" if there are no sediment control structures designed for expected construction flows downstream of the inlets or catch basins.

- ESCP Preparation, Retention, Implementation:

[118] **The original DEQ-issued permit covered construction activities disturbing 5 or more acres. This changed due to case law at the national level, and now covers construction activities disturbing 1 or more acre. See: https://www.oregon.gov/deq/FilterPermitsDocs/1200caPermit.pdf**

- The ESCP must be prepared, retained on project site, and made available to DEQ upon request.
- The ESCP shall include any procedures necessary to met local ESC requirements or stormwater management requirements.
- Additional erosion control measures may be required, especially in the wet weather period of October thru May.

- Erosion and Sediment Control Plan must include:
  - Site description (construction activity, proposed timetable, area of the site, nature of the fill material, erosion potential of soils, names of receiving waters);
  - Site Map (see permit for detailed requirements);
  - Required controls and practices:
    - Each site must have graveled, paved, or constructed entrances, exits and parking areas prior to beginning any other work;
    - All unpaved roads located on site must be graveled (or erosion control measures down gradient may be used in place of graveling);
    - Water-tight trucks must be used to haul saturated soils from the site (or loads must be drained until dripping has been reduced);
    - Controls to prevent the discharge of all wash water from concrete trucks;
    - Procedures for correct installation or use of all ESC measures;
    - Procedures for prompt repair and maintenance of ESC measures being used on-site.
  - Required Site-Dependent Additional Controls and Practices – ESCP must describe:
    - Clearing and grading practices, including schedule of phasing;
    - Vegetative erosion control practices, including temporary and permanent seeding, mulching, sod stabilization, buffer strips, and tree protection;
    - Protection of exposed areas from stormwater, including mulching, erosion control blankets, and soil tackifiers;
    - Practices to divert flows from exposed soil, store flows to allow for settling, filter flows, or reduce soil laden runoff. ESC practices must consider use of silt fences, earth dikes, brush barriers, drainage swales, check dams, sediment traps, and sedimentation basins;

- Stockpiles management, including locating away from construction activity, and stabilization or covering at the end of the work day;

5.4.1-2 401 Water Quality (State) Certification

Section 401 of the Clean Water Act requires that activities permitted under Section 404 meet state water quality standards. Usually, ACOE will determine whether a discharge will take place under the project description, and inform the applicant whether 401 WQ Certification is also needed. If so, the activity must demonstrate to DEQ they are meeting State water quality standards. WQ standards include not only specific effluent or discharge limits and implementation plans, but also TMDL standards and implementation plans – such as those for the Tualatin Basin TMDL.

5.4.1-3 Army Corps Section 404 Permits for WQ Protection

Section 404 of the Clean Water Act requires permit approval for projects that discharge certain limits of soil to waters of the U.S., or may disturb land that will discharge to waters of the U.S. This can be issued as an individual permit, or under a general permit (for ongoing repetitive project types).

A type of § 404 permit, a nationwide permit (NWP), is a form of general permit that authorizes various categories of activities throughout the nation. Nationwide permits are currently available for nearly 50 types of activities ranging from bank stabilization and wetland restoration projects, to oil and gas development and mining activities, to agricultural and recreational activities. The Corps reissues its nationwide permits every five years, while the local District or District engineer issues regional general permits.

Advantages of NWP's were:

- Expedited ACOE processes – such as Nationwide Permits and Regional General Permits – were pre-approved from Oregon DEQ, i.e., have existing 401 Water Quality Certification[119].

- Projects are already approved by ACOE.

Other categories that could be utilized by Washington County include:

NWP 33 – Temporary Construction, Access, and Dewatering,
NWP 41 – Reshaping Existing Drainage Ditches,
NWP 43 – Stormwater Management Facilities (WQF's) Construction and Maintenance,
NWP 46 – Discharge in Ditches,
NWP 19 – Minor Discharges,
NWP 25 – Structural Discharges for standard pile supported structures (bridges).

Each of these NWP's have erosion control measures and/or other protective water quality activity requirements. These NWP's are rarely used at this point for Washington County construction projects.

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[119] **However, Nationwide Permits in a category involving impervious area (NWP 3 - Maintenance, and NWP 14 – Linear Transportation Projects), must also submit a Post-Construction Stormwater Management Plan to DEQ for approval. See also:** https://www.oregon.gov/deq/FilterDocs/401CertNWPletter.pdf

5.5 Management Measures for Washington County Rural Area: Land Use Planning and Permitting

***TMDL Pollutants Addressed*: Sediments (DO); Sediments (Mercury); Nutrients (TP); Temperature**

5.5.0 County Erosion Control, Flood Plain Protection, Natural Resources, Water Resources

Management measures for urban areas to control erosion, protect flood plains, and water resources are intended to accomplish the following: (1) decrease the erosive potential of increased runoff volumes and velocities associated with development-induced changes in hydrology; (2) remove suspended solids and associated pollutants entrained in runoff that result from activities occurring during and after development; (3) retain hydrological conditions to resemble those of the pre-disturbance condition; and (4) preserve natural systems including instream habitat. These measures are the responsibility of Clean Water Services within their service area, i.e., the urban area of the Basin.

Management measures for rural areas to control erosion, protect flood plains, natural resources and water resources are accomplished through application of the Rural/ Natural Resource Plan, County Code requirements for erosion control and flood plain management, and protective policies to implement those standards. These are described below.

5.5.1 Rural/ Natural Resource Plan

The Washington County DLUT identified and mapped Significant Natural Resources within the County rural area as part of the Rural/ Natural Resource Plan[120]. The map clearly identifies the following resources:

- **Water Areas and Wetlands:** 100 year flood plain, drainage hazard areas and ponds, except those already developed.
- **Wildlife Habitat:** Sensitive habitats identified by the Oregon Department of Fish and Wildlife, and forested areas coincidental with water areas and wetlands.
- **Water Areas and Wetlands & Fish and Wildlife Habitat:** Water areas and wetlands that are also fish and wildlife habitat.
- **Mineral and Aggregate Overlay:** Regulates resource extraction and processing activities to minimize their impact on adjacent land uses.
- **Significant Natural Areas:** Site of special importance, in their natural condition, for their ecologic, scientific, and educational value.
- **Scenic Resources:** Scenic routes, views, or features. Scenic features includes land forms, vegetation or water courses with aesthetic value to the surrounding area.

[120] Rural/Natural Resource Plan, official maps and texts filed with the Records Division of the Washington County Department of Assessment and Taxation. The Rural/Natural Resource Plan Element is one of a number of planning documents which in total comprise the Washington County Comprehensive Plan. The updated 2017 Plan can be found at: https://www.co.washington.or.us/LUT/Divisions/LongRangePlanning/upload/Rural_NaturalResourcePlan_112417.pdf

- **Historic and Cultural Resources:** Historic buildings and structures are protected by regulations in the County's Historic and Cultural Resource Overlay District.

- **Resource Overlap:** Indicates that more than one significant natural resource is located on a site. The provisions of the Plan and Code for each resource apply.

5.5.2 Grading and Erosion Control Activities

Within Clean Water Services' service boundary, all erosion control activities and permits are reviewed and processed by CWS. Outside CWS boundary in Washington County (primarily rural area), the County Land Development Division administers grading and erosion control activities.[121] These include, in general, the following standards and process:

- Property owners proposing a new building or other major improvement requiring development review through the County land use rules are required to meet grading and erosion requirements as part of the Land Development review process.

- Property owners proposing only to grade soil or materials in excess of 150 cubic yards, or within sensitive areas, are required to submit grading and erosion control plans for processing through the County Building Services Section, part of the Land Development Division. Based on slope gradient and/or stability of the proposed development site, Building Services may ask the applicant to have an Engineered Grading Permit proposal.

- Property owners proposing to grade soil or materials of total volume less than 150 cubic yards are required to provide erosion control measures and are processed through the County Building Services Section.

- Sensitive areas include flood areas, riparian areas, wetlands, or steep slopes.

- All erosion control practices are required to conform to the latest CWS Guidance Manual practices.

- Activities in Washington County associated with agricultural practices or forest practices are exempt from County review by state law.

Typically, an erosion and sediment control plan for controlling the adverse impacts of construction and land development will fulfill the intent of this management measure. The plan should include the following elements:

- Description of predominant soil types;
- Details of site grading including existing and proposed contours;
- Design details and locations for structural controls;
- Provisions to preserve topsoil and limit disturbance;

[121] **https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_410GRDR;**

- Details of temporary and permanent stabilization measures; and
- Description of the sequence of construction.

5.5.3 Washington County Code (Article IV) Provisions Related to Rural Area Development

The following Code Sections and Policies provide authority/regulatory action related to water quality in the rural areas of Washington County.

Article IV; Development Standards

426 – Erosion Control
Summary of Erosion Control Ordinance[122] – The purpose of the Erosion Control Ordinance is to implement the administrative rules of the Oregon Department of Environmental Quality mandating erosion control measures in the Tualatin River and Oswego Lake sub-basin which are to be applied during construction to control and limit soil erosion. The Ordinance requires that any "development" is required to have an Erosion Control Plan.

421 – Flood Plain and Drainage Hazard Area Development
Summary of Flood Plain and Drainage Hazard Area Ordinance[123] – This Ordinance regulates all development within identified flood plain and drainage hazard areas. These areas are identified in "Flood Plain Series, Washington County, Oregon". It requires that development is "flood proofed" and it also restricts development to that which minimizes the impact of disturbance or alteration of riparian wildlife and vegetated areas.

421-7.6 - All cut and fill shall be structurally sound and designed to minimize erosion. All fill below the flood surface elevation shall be accompanied by an equal amount of cut or storage within the boundary of the development site unless the proposed cut and fill is found to be in compliance with an adopted Drainage Master Plan or certain other provisions.

422 – Significant Natural Resources
Summary of Significant Natural Resources Standards[124] – The purpose of these standards is to permit limited and safe development in areas with significant natural resources, while providing for the identification, protection, enhancement and perpetuation of natural sites, features, objects and organisms within the County, here identified for their uniqueness, psychological or scientific value, fish and wildlife habitat, education opportunities or ecological role. The standards restrict most development with riparian corridors, wildlife areas and wetland and water areas and wetland and fish and wildlife habitat areas. It does allow street crossings, transportation facilities and enhancement of degraded riparian corridors, water areas or water areas and wetlands and fish and wildlife habitat.

[122] https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_426ERCO
[123] https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_421FLPLDRHAARDE
[124] https://library.municode.com/or/washington_county/codes/community_development_code?nodeId=ARTIVDEST_422SINARE

5.6 Management Measures for Washington County Rural Area: Facilities

TMDL Pollutants Addressed: ***Temperature, Sediments (DO); Sediments (Mercury)***

5.6.0 County Owned Facilities

Washington County has no parks in the urban area. These are owned and operated by Tualatin Hills Parks and Recreation District. In the rural area, county parks are maintained by the Facilities Management Division of the Support Services Department. Staff supervise and maintain Scoggins Valley Park at Henry Hagg Lake under a cooperative agreement with the federal Bureau of Reclamation, and operate Metzger Park under its Local Improvement District structure. The parks are primarily kept as natural area.

Closed landfills in the rural area (2) are naturalized with vegetative cover. They are monitored for hazardous substances.

A municipal yard including storage facilities and fleet management is located in the City of Hillsboro at the Washington County DLUT Walnut Street facility. This location has an individual NPDES 1200-Z permit for stormwater discharge, including a Stormwater Pollution Prevention Plan.

5.7 Management Measures for Washington County Rural Area: Inspection and Permitting of Septic System

TMDL Pollutants Addressed: ***Bacteria (E. coli)***

5.7.0 Septic System Permitting

The Oregon DEQ identified failing septic systems as a potential source to discharge bacteria during non-runoff periods as well as during runoff periods.[125] In Washington County, the Department of Health & Human Services, Environmental Health Division, works in cooperation with DEQ requirements to implement an On-Site Sewage Disposal System (Septic) permit program. Through this program, on-site sewage disposal is controlled to work properly, thereby meeting the intent of the management measure. The application for a construction permit for a septic system requires the following:

- Site evaluation, approved by Health Department, including maps showing exact location, parcel size, two test pits, location of streams, creeks, natural drainage ways, field tiles, roads, other septic systems, wells or springs within 200' of test pit.

- A Land Use Compatibility Statement must be signed showing compliance with all applicable state and local land use requirements.

- The plot plan must show proximity to water features and streams, including intermittent streams, property lines, and placement of septic tank.

[125] **Tualatin Basin Total Maximum Daily Load document, Oregon DEQ, p. 75, August 2001.**

5.7.1 How Septic Systems Treat Waste

Primary Treatment

As stated, the main function of the septic tank is to remove solids from the wastewater and provide a clarified effluent for disposal to the drain field. The septic tank provides a relatively quiescent body of water where the wastewater is retained long enough to let the solids separate by both settling and flotation. This process is often called primary treatment and results in three products: scum, sludge, and effluent.

Effluent is the clarified wastewater left over after the scum has floated to the top and the sludge has settled to the bottom. It is the clarified liquid between scum and sludge. It flows through the septic tank outlet into the drain field.

Anaerobic Decomposition

While fresh solids are continually added to the scum and sludge layers, anaerobic bacteria (bacteria that live without oxygen) consume the organic material in the solids. The by-products of this decomposition are soluble compounds, which are carried away in the liquid effluent, and various gases, which are vented out of the tank via the inlet pipe that ties into the house plumbing air vent system.

Anaerobic decomposition results in a slow reduction of the volume of accumulated solids in the septic tank. This occurs primarily in the sludge layer but also, to a lesser degree, in the scum layer. The volume of the sludge layer is also reduced by compaction of the older, underlying sludge. While a certain amount of volume reduction occurs over time, sludge and scum layers gradually build up in the tank and eventually must be pumped out.

What The Drain Field Does

Once sewage undergoes primary treatment in the septic tank, the clarified effluent flows to the drain field. The drain field is designed to discharge the septic tank effluent below ground into the natural soil for final treatment and disposal. A typical drain field consists of several relatively narrow and shallow gravel-filled trenches with a perforated pipe near the top of the gravel to distribute the wastewater throughout the length of each trench.

How The Drain Field Works

The drain field provides both disposal and treatment of the septic tank effluent. Effluent flows from the septic tank to the drain field through a watertight pipe and is then distributed within the drain field trenches through perforated pipes in the gravel. The effluent flows through the gravel filling and then seeps (infiltrates) into the soil beneath and beside the trench. Here the main purification of the wastewater takes place through filtration and biological activity as it infiltrates through the biological mat on the sidewalls and at the bottom of the trench and then percolates through unsaturated soil. (However, in seasoned fields, there is practically no percolation through the trench bottom.) The purified liquid then eventually evaporates, is taken up by plants, or percolates into the groundwater.

Treatment Of Effluent

Effluent gets treated in the drain field: 1) as it infiltrates into the soil: the bio-mat is the tool, and 2) as it percolates through the soil.

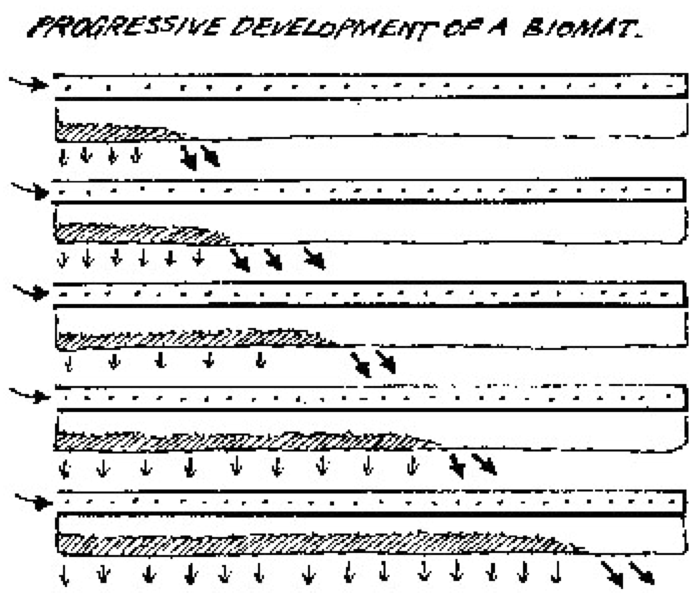
The Biomat

What It Is

The bio-mat (biological mat) is a black, jelly-like mat that forms along the bottom and sidewalls of the drain field trench. It is composed of anaerobic microorganisms (and their by-products) that anchor themselves to soil and rock particles. Their food is the organic matter in the septic tank effluent. Since the bio-mat has a low permeability, it slows down the rate of flow out of the trench into the drain field soil and also serves as a filter to provide effluent treatment. With a well-developed bio-mat, wastewater may be temporarily ponded in the drain field trench, yet the soil a few inches outside the trench will be unsaturated.

Bio-mat Formation

The bio-mat forms first along the trench bottom and then up along trench walls. It has less permeability than fresh soil, so incoming effluent will pond over the bio-mat and trickle along the trench bottom to an area where there is little or no bio-mat; eventually the bio-mat will line the bottom of the trench and form up along the walls as well.



The Bio-mat Is a Living Filter

Through filtration and biological activity, the bio-mat is very effective at removing viruses and, in fact, filters out pathogenic bacteria and parasites.

Since the bio-mat is a living, dynamic system, its equilibrium can be upset. Failure to regularly pump out the septic tank can result in an excess of organic material (food) to the bio-mat organisms, causing excessive growth and, therefore, reduced permeability. Saturated soils are also undesirable. If the soil outside of the trench is saturated due, for example, to high groundwater, aerobic conditions will no longer exist, and the controlled breakdown of the bio-mat by aerobic soil bacteria will not occur.

If the septic system is poorly maintained, too much wastewater is flushed down the drain, or the drain field soil remains saturated, the bio-mat eventually will grow too thick and dense, and the effluent sent to the drain field will exceed the amount that can filter through the bio-mat. This can result in excessive ponding in the trenches, back-flow into the septic tank (and possibly also into the house), or surfacing of effluent above ground over the drain field--in other words "failure."

5.7.2 Septic System Inspection

Source control for Septic:

- Washington County requires repair if notified by resident or neighbor.
- Permits are reviewed and issued – can include requirement for sand filters in certain circumstances.
- Washington County has 100' setback from waterways, intermittent streams, wetlands, etc.
- Washington County has a program to regularly inspect septic system hauler's trucks.
- Installers are licensed by DEQ.
- In NW Region (DEQ), the DEQ permits large systems; uses WPCF permits process.

5.8 Management Measures for Washington County Rural Area: Riparian Management Area

TMDL Pollutants Addressed: ***Temperature, Nutrients (TP); Sediments (Mercury); Sediments (DO); Bacteria***

5.8.0 Riparian Area Function

Riparian areas occur next to the banks of streams, lakes, and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Streamside vegetation protects water quality and provides a "green zone" of vegetation that stabilizes streambanks, regulates stream temperatures, and provides a continual source of woody debris to the stream channel. The majority of fish food organisms come from overhanging vegetation and bordering trees while leaves and twigs that fall into streams are the primary nutrient source that drives aquatic ecosystems.

> Riparian areas are defined as: A vegetated ecosystem along a water body through which energy, materials and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body.

Riparian areas frequently contain the highest number of plant and animals species found in forests, and provide critical habitats, home ranges, and travel corridors for wildlife. Biologically diverse, these areas maintain ecological linkages, connecting hillsides to streams and upper headwaters to lower valley bottoms.

The typical Riparian Management Area (RMA) consists of a riparian management zone and, where required by regulation, a reserve zone. The width of these zones is determined by attributes of streams, wetlands or lakes, and adjacent terrestrial ecosystems.

Table 5.2 outlines the Riparian Management Area by function, shows the type of plants and their role, and the potential effects on a water resource without the RMA.

Table 5.2 Riparian Management Area Function and Protective Plant Types

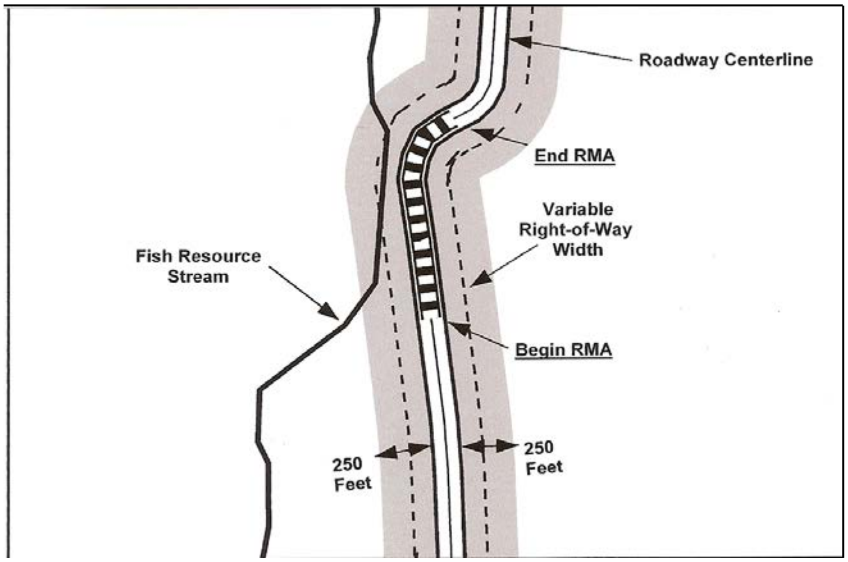
Riparian Management Area Function	Plant Functions	Potential Effects without RMA	Important Plant Types
Sediment Filtering and Retention	Vegetation, leaves and decaying plant material help trap sediment, keeping it from reaching streams.	Degraded fish habitat and water quality; sedimentation of culverts and reservoirs.	Grasses and shrubs
Water Quality	Plants absorb fertilizers, organic animal waste, and pesticide, keeping them from reaching streams.	Potential harm to fish; health hazards to property residents and downstream neighbors.	Grasses and some trees, especially fast-growing
Streambank Stability	Plant stems absorb the erosive force of flowing water while roots hold soil in place.	Eroding and collapsing banks can remove valuable agricultural and forest land; collapsed banks create sediment in the water way.	Shrubs and trees
Creek Environment	Overhanging vegetation harbors insects for fish food and shades the water, creating cooler habitat for fish and other aquatic species.	Lack of shade creates higher temperatures potentially deadly to aquatic life; ecology of creek harmed by reduced food supply.	Shrubs and trees

5.8.1 Riparian Area Management; Washington County Rural Road Operations, BMPs and RMAs

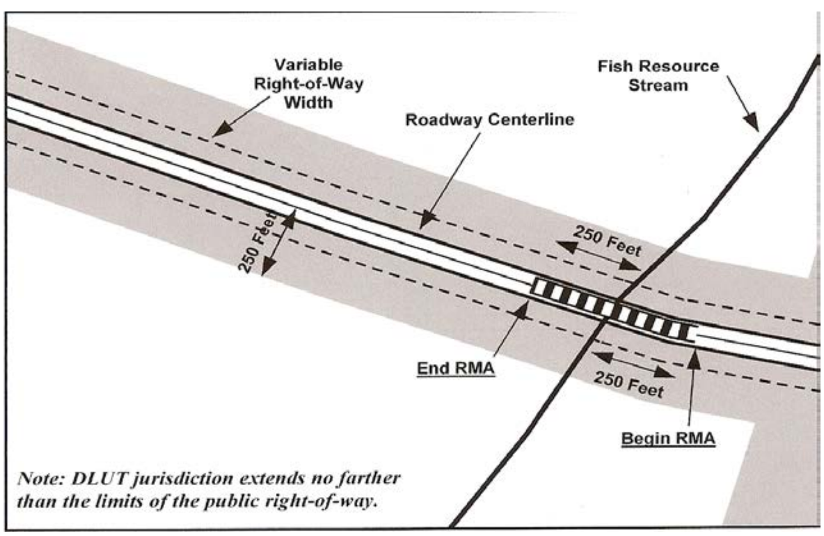
Recognizing the function and support of a properly operating riparian management area, in part due to NOAA Fisheries' guidance, Washington County DLUT incorporated Riparian Management Areas (RMA's) into their original Best Management Practices for Roadway Operations 2003 manual[126]. Updates in 2004 2011, and 2017, including RMA's, became the *"*Best Management Practices for Routine Road Maintenance*"*[127] This document demonstrates typical applications for roadway maintenance and operations, and roadside vegetation management which will protect significant natural resources and sensitive areas. The RMA incorporates a 250-foot margin of no chemical spray harmful to a riparian area, special brush clearing and ditch maintenance methods, considerations for road construction handling, and other minimization and avoidance methods to protect the riparian area. RMA's are marked with a sign for crew awareness.

[126] **Original Best Management Practices for Roadway Operations; (BMPRO 2003); approved by Washington County Board of Commissioners about August 2003.**
[127] **See: https://www.co.washington.or.us/LUT/Divisions/Operations/upload/2017-BMPs-RoutineRdMaint.pdf**

1) Operational limitations may be assigned to areas up to 250 feet from a resource water. Best Management Practices (BMPs) are followed to reduce the potential impacts roadway operations may have on the quality of RMAs.



Riparian Management Area – Road Adjacent to a Water Resource



Riparian Management Area – Road Crossing a Water Resource

2) The RMA is measured from the outer edge of an intersecting stream or the centerline of an adjacent roadway. 250 feet is the objective; however, roadway design or other limiting factors may cause this standard to be adjusted.

5.8.2 Riparian Area: Natural Resource Management; County Land Use Planning

The Washington County Code restricts most development within riparian corridors, wildlife areas, wetland and water areas, and wetland and fish and wildlife habitat areas. Allowable development includes street crossings, transportation facilities and enhancement of degraded riparian corridors.

All proposed projects are screened by Washington County DLUT for flood hazard and habitat considerations. Habitat area screening is dependent on the mapped Natural Resource (NR) area. The reviewer checks the applicant's location for flood hazard areas and Significant Natural Resource zone (mapped for entire County: digitized and hard copy). The mapped area includes a "pink line" of 250' added to either side of an identified NR zone (total 500' error rate). This NR area can be in or out of the flood plain. Filling outside the flood plain and greater than 150 cubic feet material displacement will trigger the same review, and the need for a grading (erosion control) permit. About 10% of development applications will trigger attention to erosion and sediment control, i.e., have some encroachment on resource area/ flood or drainage hazard area.

Riparian management is accomplished through the Floodplain and Drainage Hazard areas and Code Sections 421 and 422. A Section 421 Type I procedure allows certain development to be approved in a flood area, including restoration and stabilization of a river or other waters for erosion control purposes, within certain provisions. If this occurs, vegetative cover for bank stabilization is required. Section 421 Type II or Type III procedures allow development in a flood area subject to specific restrictions.[128]

Section 422 permits limited and safe development in areas with significant natural resources, while providing for the identification, protection, enhancement and perpetuation of certain valuable resources, including fish and wildlife habitat. Land subject to this section includes water areas, wetland, fish and wildlife habitat, sensitive habitats, certain forested areas, and other significant natural areas.

5.8.3 Riparian Area Management and the Temperature Standard

The DEQ TMDL document says revised Water Quality Management Plans should identify constraints of achieving system potential (e.g., effective shading), and gives an example that an existing road or highway may preclude attainment of system potential. It also suggests consideration should be given of designs that support TMDL load allocations (i.e., shading, etc.) whenever construction or restoration activities occur. There is considerable research that even large open parking lots do not increase instream temperatures due to summer rains: there is potential for increased temperatures on extremely hot days, although there is also evidence that the cooling rains do not significantly increase instream temperature. Section 4.2.5.3 of the 2012 TMDL says for Roads, Highways and Bridges, "stormwater is not a significant heat source, thus the MS4 permit is not expected to address ODOT's thermal impact on streams". [129]Section 5.2.5.2 of the TMDL states "because stormwater is not a significant source of heat to subbasin streams during the TMDL period, temperature impacts are not addressed by the MS4 (urban) permit". By that measure, rural road runoff is even less likely to cause any changes to instream temperature. Washington County practices include the "Riparian Management Area", or RMA, which is essentially a 250' vegetated buffer at any road-stream crossing. We believe that is sufficient to avoid the unlikely event of rural road runoff causing instream temperature increase.

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[128] For more detail refer to Washington County Code Section 421-5 and 6. At: https://www.co.washington.or.us/LUT/Divisions/LongRangePlanning/Publications/upload/421-422.pdf
[129] Tualatin Basin TMDL Ch. 4 Water Quality Management Plan, Aug. 2012, p. 102.

5.9 Management Measures for Washington County Rural Area: Inventory of Water Quality Facilities

TMDL Pollutants Addressed: ***Temperature, Nutrients (TP); Sediments (DO); Sediments (Mercury); Bacteria***

The Washington County Operations Division maintains an inventory and mapping of County road systems, and associated facilities. The maps show the geographic locations of drainage facilities, Water Quality Facilities, Catch Basins, and Downstream Defenders.[130] These systems are primarily maintained by the Operations Division, although certain catch basins and non-proprietary WQF's are maintained by CWS within their urban services boundaries. For this and other reasons, the County maintains an extensive GIS that includes online map access.

5.10 Management Measures for Washington County Rural Area: BMP Implementation Matrix

TMDL Pollutants Addressed: ***Temperature, Nutrients (TP); Sediments (DO); Sediments (Mercury); Bacteria***

Management Measures to address and target TMDL Parameters are an important part of the big picture and comprehensive approach utilized by Washington County to address water quality, water quantity, habitat, and other environmental programs. The Table 5.3 on the following 10 pages summarizes Washington County's Best Management Practices and general Implementation strategies that collectively meet the County's TMDL Compliance standards for the Nonpoint Source Rural Area Management component of the Tualatin Basin. Where noted, BMP documents, 1200-CA permit, field manuals, etc. are available separately and not included herein.

Best Management Practices (BMP's) are the foundation of the Operations Divisions' actions to meet environmental standards. In the NPDES permit, TMDL program, and ESA 4(d) Rule mandates, BMP's are the techniques used to minimize or prevent adverse impacts to water quality or habitat. These techniques are used to control stormwater runoff, sediment control, soil stabilization, pollution prevention, vegetation management, fish preservation, and emergency response to spills. Management decisions are also BMP's, as are reports, plans, and programs.

Schedules, timelines, and measurable milestones are incorporated into Adaptive Management and Annual Reporting. Most of the BMP's in Table 5.3 are described in more detail in separate documents. The BMP Matrix is an outline of the extensive Washington County BMP Program, which meets not only the TMDL Nonpoint Source Program requirements, but also regulatory requirements through NOAA Fisheries, Army Corps Permits, ODF&W rules, and NPDES permits.

[130] A Downstream Defender is an advanced hydrodynamic vortex separator designed to provide high removal efficiencies of settleable solids and floatables over a wide range of flow rates.

1.	Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management					
2.	**BMP or Work Activity Type**	**Wash. Co. Responsible Party**	**BMP Implementation Activities**	**Applies To:**	**Schedule for Implementation**	**Tracking Measure for Reporting**	**Water Quality Considerations[131]**
3.	**Operation and Maintenance of County Roads and County Storm Sewer Systems (Rural NPS[132])**						
4.	Bridge Operations	Operations Division	Follow the best management practices for bridge operations as outlined in the "Best Management Practices for Routine Road Maintenance". These BMPs are focused on: - Protecting habitat; - Keeping debris from entering waterways; - Coordinating in-water work activities with ODFW; - Determining whether activities will require consultations with NMFS or USFWS; - Coordinating with wetland permitting agencies such as USACOE and DSL; - Incorporating fish passage solutions as appropriate.	Implementation applies to all County Bridges and Large Culverts (over 36" in diameter), urban and rural for the 25 specific Series-100 work activities listed in the "BMPs for Routine Road Maintenance" Manual (e.g., bridge construction, bridge demolition, shoulder erosion repair, guardrail installation, etc.).	Ongoing as bridge operations are conducted.	Number of bridge replacement projects and reason for project. Number of bridge repair projects and reason for project. Number of culvert repair projects and reason for project. Number of stream work projects and reason for project. Number of culvert replacement projects and reason for project.	These practices are focused on the protection of habitat and ensuring that potentially harmful materials are not allowed to enter resource water. This is achieved through the proper use of containment devices, sound work-site practices and minimum removal of vegetation.
5.	Roadway Surfaces Management	Operations Division	Follow the best management practices for roadway surfaces as outlined in the "Best Management Practices for Routine Road Maintenance". These BMPs are focused on: - Keeping related debris from entering waterways; - Using environmentally sensitive cleaning agents; - Conducting erosion control as needed; - Maintaining vehicles in a way that protects water quality; - Avoiding work during heavy rainfall.	The Roadway Surfaces program is responsible for all road surface management activity, including aggregate surfaced, asphalt pavement, and concrete pavement roadways, as well as surface-related maintenance activity designed to ensure the structural integrity of the roadway system and to preserve and enhance the safety of the roadway user. Implementation applies to roadway surface	Ongoing as roadway surfaces are managed.	CASI system. Tracks implementation activity. Number of inspection records for erosion control. Number of curb miles swept (CWS does this for County in urban area). Number of catch basins cleaned.	These activities focus on limiting the amount and concentrations of solids and chemicals that reach surface waters and reducing the likelihood of detrimental effects on receiving water bodies.

[131] The County WQMP Program addresses water quality, fish habitat, natural resources, floodplain management, etc. Thus, BMP activity generally targets all TMDL parameters.
[132] Primarily rural County roads and ditches. Some exceptions as noted in "Applies To" column.

1.	Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management					
2.	**BMP or Work Activity Type**	**Wash. Co. Responsible Party**	**BMP Implementation Activities**	**Applies To:**	**Schedule for Implementation**	**Tracking Measure for Reporting**	**Water Quality Considerations[131]**
				management for the 18 specific Series-200 work activities listed in the "BMPs for Routine Road Maintenance" Manual (e.g., blade patching, machine patching, gravel road aggregate, grading gravel roads, etc.).			
6.	Vegetation Management	Operations Division	Follow the best management practices for vegetation management as outlined in the "Best Management Practices for Routine Road Maintenance" Manual, and the "Integrated Vegetation Management Plan" (part of the IPM: Integrated Pest Management Plan). These practices are focused on: - Reducing impacts associated with vegetation removal; - Limiting mowing; - Maintaining shade; - Limiting vegetation removal; - Minimizing the application of chemical controls.	Implementation applies to vegetation control activities within Washington County roadside rights-of-way for the 16 specific Series-300 work activities listed in the "BMPs for Routine Road Maintenance" Manual (e.g., brush mowing and cutting, roadside clearing, landscape mowing, pest management, seeding, etc.). Activities include selective application of approved chemical agents to control the growth and spread of noxious weeds and other undesirable species, brush removal and planting along roadways.	Ongoing as vegetation management activities occur within Washington County ROWs.	CASI system. Tracks implementation activity. Number or miles of Vegetated Facilities maintained (swales, vegetated ditches, culverts, etc.)	Vegetation control activity focused on controlling erosion and the transport of sediments in streams.
7.	Drainage Operations	Operations Division	Follow the best management practices for drainage operations as outlined in the "Best Management Practices for Routine Road Maintenance" manual. These practices are focused on:- Applying erosion control measures such as check dams to reduce sediment discharges to waterways.- Applying caution in sensitive areas;- Conducting ditch maintenance in an environmentally sensitive manner.	The Drainage Operations program constructs and maintains roadside drainage facilities and related structures throughout the roadway system, working closely with Vegetation Management to ensure proper re-vegetation of	Ongoing as ditch and culvert maintenance and construction occurs.	Number of erosion control measures installed. Number of environmental daily reports.	These activities focus on the use of erosion control methods to provide good flow and filtration for water run-off and to prevent flooding and roadway structure failure.

1.	Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management						
2.	**BMP or Work Activity Type**	**Wash. Co. Responsible Party**	**BMP Implementation Activities**	**Applies To:**	**Schedule for Implementation**	**Tracking Measure for Reporting**	**Water Quality Considerations[131]**
				project sites and other disturbed areas. Implementation applies to construction and maintenance of rural roadside drainage facilities including the 15 specific Series-400 work activities listed in the "BMPs for Routine Road Maintenance" Manual (e.g., ditch maintenance, ditch relocation and construction, culvert maintenance, etc.).			
8.	Emergency Response	Operations Division	Follow the best management practices for emergency response as outlined in the "Best Management Practices for Routine Road Maintenance" Manual. These practices are focused on: - Repair of damages to waterways as a result of emergency response activities: - Coordinating response efforts with NOAA and ODFW. - Managing slide debris disposal; - Preventing and minimizing discharge of sediment and other debris associated with response activities.	Implementation applies to 12 specific Series- 900 activities related to emergency response that are listed in the "BMPs for Routine Road Maintenance" Manual (e.g., roadway emergency inspections, storm debris removal, HazMat response, emergency traffic control, etc.).	Ongoing as emergency response occurs.	Number and list of Emergency Response projects per year. Number of projects requiring state or federal agency coordination.	When emergency activities are required, specific measures are taken to provide the adequate erosion control or bank stabilization measures necessary to keep undesirable materials from entering a protected resource area and avoid impacts to wetlands and streams.
9.	Fish Preservation and Enhancement	Operations Division	Follow the best management practices for fish preservation and enhancement as outlined in the "Best Management Practices for Routine Road Maintenance" manual. These practices are focused on design and construction activities that impact fish habitat and include the following: - Isolating work areas from active flowing	Implementation applies to design and construction activities that may impact fish habitat and streams - specifically, the 6 Series-1000 activities listed in the "BMPs for Routine Road Maintenance" Manual	Ongoing as design and construction activities occur that could potentially impact fish habitat and streams.	Number and list of Fish Preservation (instream) projects per year.	When in-water work activity is necessary, all precautions are taken to protect habitat and the stream to have the least minimal

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			streams; - Eliminating ground disturbance activity within a streams ordinary high water mark; - Conducting in-water work during the dry season; - Protecting riparian management areas; - Maintaining shade trees.	(e.g., work area isolation, pollution and erosion control plans, fish isolation techniques, etc.).			impact. In-water work Is coordinated with ODFW. The stream will be protected so that no sediment or other materials enters during work activity.
10.	Erosion Prevention and Sediment Control	Operations Division	Follow the Best Management Practices for Erosion and Sediment Control as outlined in the "Best Management Practices for Routine Road Maintenance" Manual. These practices are focused on: - Methods to direct runoff away from disturbed areas; - Scheduling work activities to minimize soil exposure; - Installing sediment control to settle and filter sediment; - Inspecting for proper placement and operation; - Repairing or replacing erosion control as needed; - Inspection following storm events; etc.	Implementation for O&M applies to all work activities within Routine Road Maintenance. It is the basis for most of the accompanying BMP's.	Ongoing as all activities, or emergency responses occur.	Number of projects. Amount of sediment control materials. Inspection records.	Preventing erosion and controlling sediment is paramount to all program areas. This beneficially impacts TMDL's DO, Nutrients (TP); Temperature, and Mercury. Preserve instream habitat.
11.	**Land Use Planning and Permitting**						
12.	Natural Resource Area Mapping	Land Development Division; and Engineering	Maintain up to date maps associated with the County's Natural Resources Plan to include: 100 -year floodplain, drainage hazard areas, wetlands, wildlife habitat, significant natural areas, and historic/cultural resources.	Rural Washington County	As needed	Have maps been updated as necessary.	Protects floodplain, wetlands, associated stream impacts.
13.	Erosion Control Permitting	Land Development Division and County Building Services Section;	**Grading Requirements (outside CWS)** Property owners proposing a new building or other major improvement requiring development review through the County land use rules are required to meet grading and erosion control requirements as part of the Land Development review process. All erosion control practices are required to conform to the latest CWS Guidance Manual practices.	Implementation applies to new building or other major improvements requiring development review through the County land use rules. See CWS Implementation Plan for urban areas, which are permitted directly through CWS.	Ongoing. Permanent.	Number of grading permits issued per year. May be estimated.	Remove suspended solids and associated pollutants in runoff that may result from activities occurring during or after development.

1.	Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management					
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		Clean Water Services (urban).	- County Land Use Rules require property owners grading soil or materials in excess of 150 cubic yards, or within sensitive areas, are required to submit grading and erosion control plans. Based on slope gradient and/or stability of the proposed development site, Building Services may ask the applicant to have an Engineered Grading Permit proposal. - Property owners proposing to grade soil or materials of total volume less than 150 cubic yards are required to provide erosion control measures and are processed through the County Building Services Section. - Agricultural and forest practices are exempt from County review by state law.				
14.	ESCP Requirements	Land Development Division and County Building Services Section	**Erosion and Sediment Control Plans** Erosion and sediment control plans (ESCPs) for the above listed developments (i.e., with grading in excess of 150 cubic yards) are required. The ESCPs must include the following elements: - Description of predominant soil types; - Details of site grading including existing and proposed contours; - Design details and locations for structural controls; - Provisions to preserve topsoil and limit disturbance; - Details of temporary and permanent stabilization measures; and - Description of the sequence of construction.	Coverage applies to property owners grading soil or materials in excess of 150 cubic yards or within sensitive areas.	Ongoing. Permanent	Number of ESCP plans reviewed annually. May be estimated.	Remove suspended solids and associated pollutants in runoff that may result from activities occurring during or after development. Where structural controls are included, decrease the erosive potential of increased runoff volume or velocities associated with development-induced changes in hydrology.
15.	Floodplain and Drainage Hazard Area Requirements	Land Development Division and County	For all development located within the identified floodplain and drainage hazard area, flood proofing is required. In addition, the development must minimize the impact of	All development located within the identified floodplain and drainage hazard area.	Ongoing. Permanent.	Number of identified development applications involving the floodplain or	Sensitive areas include floodplains, riparian areas, wetlands.

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		Building Services Section	disturbance or alteration of riparian wildlife and vegetated areas. All cut and fill shall be structurally sound and designed to minimize erosion. All fill below the flood surface elevation shall be accompanied by an equal amount of cut or storage within the boundary of the development site unless the proposed cut and fill is found to be in compliance with an adopted Drainage Master Plan or certain other provisions.			drainage hazard areas per year. May be estimate.	Protection enhances water quality in receiving waters.
16.	Natural Areas Development Requirements	Land Development Division and County Building Services Section	The County's Significant Natural Resources (SNR's) Standards restrict most development with in riparian corridors, wildlife areas and wetland and water areas and wetland and fish and wildlife habitat areas. It does allow street crossings, transportation facilities and enhancement of degraded riparian corridors, water areas or water areas and wetlands and fish and wildlife habitat.	Identified SNR's when an application for development occurs.	Ongoing. Permanent.	Number of development applications within SNR's per year. May be estimate.	Significant Natural Resource is a specific geographic area identified by County LUP. Restricting development in these areas protects water quality (including TMDL loading).
17.	**Maintenance, Construction and Operation of Parks and other County Owned Facilities and Infrastructure**						
18.	Landfill Monitoring	Operations	A site at Bridgeport Village is monitored for methane on a regular basis.	Site specific.	Monitoring occurs x4-12 times per year.	Records are kept. Any problems are directed to DEQ.	NA (Air Quality issue).
19.	Stormwater Management of Washington County Facilities	Facilities Division	Corporate yards for storage facilities and fleet management are located in the City of Hillsboro at the Washington County DLUT Walnut Street Facility. This location has an individual NPDES 1200-Z permit for stormwater discharge. A formal Stormwater Pollution Control Plan is a part of the permit. The Plan includes monitoring of stormwater discharge, proper storage of materials and pollutants, project site controls, spill prevention and response procedures, etc.	Walnut Street Center; Project site and source control measures have been implemented at the WSC to satisfy NTBELs in the 1200-Z permit.	Ongoing, permanent. Sampling and DEQ site visit occur annually.	Annual Report	Stormwater runoff and associated pollutants are minimized through a new wq treatment structural control. Zinc has been an identified issue, runoff is pre-treated.
20.	Parks Management	Facilities Management Division of the Support	Washington County parks in the rural area are maintained by the Facilities Management Division of the Support Services Department. Staff supervise and maintain Scoggins Valley Park at Henry Hagg Lake under a cooperative	County owned Parks. 97% of Parks in the Tualatin Basin are under the jurisdiction of the Tualatin Hills Parks &	Ongoing, Permanent.	N/A	Proper management of Open space prevents sediment and pollutants from

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		Services Department.	agreement with the federal Bureau of Reclamation, and operate Metzger Park under its Local Improvement District Structure. The parks are primarily kept as natural area.	Recreation District (not County).			entering receiving waters.
21.	**Inspection and Permitting of Septic Systems**						
22.	Septic System Permitting	Department of Health and Human Services, Environmental Health Division	For construction of a septic system, a permit is required which includes the following: - Site evaluation, approved by the Health Department, including maps showing exact location, parcel size, two test pits, location of streams, creeks, natural drainage ways, field tiles, roads, other septic systems, wells or springs within 200' of test pit. - A Land Use Compatibility Statement must be signed showing compliance with all applicable state and local land use requirements. - The plot plan ust show proximity to water features and streams, including intermittent streams, property lines, and placement of septic tank. Washington County reviews permits and can potentially include requirements for sand filters in certain circumstances. The County has a 100' setback requirement from waterways, intermittent streams, wetlands, etc. DEQ permits large systems through their WPCF permitting process.	New or replacement septic systems in rural area.	Ongoing. Permanent.	Number of septic systems permitted in year, if available.	Prevent bacteria (e. coli) from migrating to any waterway.
23.	Septic System Inspections	Department of Health and Human Services, Environmental Health Division	Washington County regularly inspects septic system hauler trucks and inspections of septic systems are conducted on a complaint basis.	Trucks and/or systems as needed.	As needed	NA	Prevent bacteria (e. coli) from migrating to any waterway.

1.	**Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management**						
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24.	**Public Involvement/Education/Training**						
25.	Training	Operations Division, Capital Services Division	Provide training for Washington County DLUT managers and staff related to NPDES, water quality, erosion and sediment control and other environmental seminars, conferences and presentations throughout the year.	Annual training elements. For example, any staff who conduct or review erosion control measures will attend annual training.	Annually.	List of training activities, number of attendees, list of attendees where applicable.	Training includes basics of environmental law, pollution prevention, TMDL's in Tualatin. Applies to all water quality considerations (pollutants, resources, habitat, etc.)
26.	Employee Awareness	Facilities Division, Capital Project Services Division, Operations Division	Employee Awareness and Safety Meetings are conducted on a regular basis, including water quality, pollution control, and spill response. Examples include: - Facilities and Operations Divisions conduct Stormwater Pollution Control Training for the Operations yard for relevant employees within 30 days of hire, and annually as needed. - Ops Division conducts regular BMP crew training depending on their work activity. - CPS Division conducts BMP and Erosion Control training.	All relevant County DLUT employees.	Ongoing, at least annually.	Employee Training records; Number of attendees.	Employee awareness applies to all water quality considerations (pollutants, resources, habitat, etc.)
27.	Public Outreach	Dept. of Land Use & Transportation; Thru active participation in Tual. Basin Public Awareness Committee (TBPAC);	Public outreach begins in the schools, with the River Ranger educational program, community events, and other efforts such as the "Canines for Clean Water" program. Water quality protection is promoted through print and social media on proper disposal and use of household pollutants. Often included in CWS billing inserts, CWS website, radio, etc. The County supports these efforts through financial contributions as well as active participation in the TBPAC.	TBPAC coordinates public outreach efforts, with active participation by Washington County and others on the TBPAC.	Ongoing. Permanent.	Activities are summarized on an annual basis in the TBPAC Annual Report submitted to DEQ.	Benefits water quality thru reductions in waste disposal, litter in streams, oil in outfalls, all TMDL parameters.
28.	Public Education	Dept. of Land Use & Transportation;	Address water quality by increasing awareness of daily activities and the potential environmental consequences. Typical BMPs include:	Implementation increases awareness of the Tualatin Watershed to motivate individuals to protect water	Ongoing, permanent	TBPAC Annual Report submitted to DEQ.	Public awareness of watershed benefits water quality by reminding citizens

1.	Table 5.3: Washington County: Water Quality Implementation Activities for Rural Nonpoint Source TMDL Management					
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		Thru active participation in Tual. Basin Public Awareness Committee (TBPAC); Dept. of Support Services	- Signage (250+ signs) at major creek crossings "Entering Tualatin Watershed"; - "Partners for Clean Water" Brochures at County Land Development and O&M offices; - "Adopt a Road" programs within Wash. Co. (approx. 200m of County roads are maintained thru this program). - Link (Facilities/Parks County website) to Natural Gardening videos and tips on composting, safe pest control, rain gardens. - Link (Facilities/Parks County website) to EcoBiz certification program for businesses to reach high environmental standards. - Storm Drain Stenciling "Dump no Waste, Drains to Stream": thousands of storm drains have been marked; - Wash. Co. financially contributes to programs such as the annual Discovery Day (Tualatin Riverkeepers), the Will Hornyak "Living Stream" school presentations reaching up to 5,000 students per year, and the Rumba al Rio program for women and children, the METRO SOLV litter program, and many more programs.	quality.; and to keep pollutants out of receiving streams and waterways. TBPAC coordinates joint projects to increase public awareness of NPS pollution.			to take care of their resources; not to dump in storm drains; know their local waterways. Applies to all TMDL's and other pollutants.
29.	**Capital Projects and County Storm Sewer System (Rural NPS)**						
30.	General Water Quality Projects Structural Controls	Capital Project Services Division	Address water quality in capital projects through the construction of water quality facilities such as swales, rain gardens, filters, water quality manholes, etc.	Implementation applies to road and bridge construction projects.	Year round. See road construction schedule for locations.	List of completed projects and associated water quality facilities per year.	Addresses reduction of TMDL pollutants and other pollutants thru water quality treatment.
31.	Water Quality Swales	Capital Project Services Division	Address water quality by constructing permanent BMPs through which runoff is conveyed. They are designed to allow sediment to settle out and water to infiltrate into the ground soil.	Implementation applies to road and bridge construction projects, where applicable.	Ongoing. See road construction schedule for locations.	List of completed projects and associated water quality swales.	Addresses reduction of TMDL pollutants and other pollutants via vegetated water quality treatment.
32.	LIDA	Capital Project Services Division	Reduce impact of increased impervious surface area by Low Impact Development Approaches.	Road projects and new development where required, such as N. Bethany Sub-Basin.	Ongoing.	List of completed projects where LIDA was required or implemented.	Decreases stormwater runoff and velocities to address erosive activity.

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33.	Erosion Prevention and Sediment Control	Capital Project Services Division; Operations Division	Reduce or eliminate sediment loading due to construction activities by specific BMP's designed to prevent erosion and control runoff. CPS Division follows all 1200-C A permit requirements for capital projects. Ops Division follows enhanced Erosion Control BMPs as described in the Washington County BMP's for Routine Road Maintenance Manual.	Implementation applies to all County road, bridge and culvert projects in rural and urban area.	Ongoing. See wc-roads.com for list of current projects.	Number of Inspection Records or equivalent per year.	Controls potential adverse wq impacts of construction and land development. Prevents sediment and other pollutants from migrating to receiving waters.
34.	Erosion and Sediment Control Inspection	Capital Project Services Division; Operations Division	Inspection of On-site BMP's; ESC Site Plan; Materials storage areas; Emergency supplies; Visual inspection; turbidity monitoring; storm event monitoring; Stabilization of disturbed area; Perimeter controls; Protection of storm drain inlets; Construction Exits; Trash/Litter not exposed to stormwater; Equipment fueling areas free of spills; pump discharge bags working, etc.	Implementation applies to road and bridge construction projects, culvert replacements, all in-field land disturbing activities.	Ongoing.	How many sites were permitted, how many inspections were conducted and how many violation notices were issued, what was follow up on violations.	Addresses any site-specific issues ASAP, helping to prevent sediment and other pollutants in receiving waters.
35.	Maintain County Water Quality Facilities	Operations Division (Rural area) or Clean Water Services (Urban district)	Maintenance of a WQF is itself a BMP. BMP's are performed during work activity according to the Washington County Routine Road Maintenance BMP Manual.	County-owned Water Quality Facilities	Depends on the WQF type and condition. Range is 2x/year to once every 3-5 years.	Number of facilities maintained per year.	Proper functioning of WQ facilities reduces or eliminates adverse wq impacts of stormwater runoff.
36.	**Monitoring**						
37.	Conduct Ambient Monitoring	Clean Water Services, OR Dept. of Agr.	Conduct comprehensive water quality sampling at specific monitoring points in the mainstem and identified tributaries, according to the Watershed Wide Monitoring Plan for the Tualatin Basin.	Rural area stations identified in the Tualatin Basin watershed-wide Monitoring Subcommittee's Monitoring Plan	Hundreds of samples are collected each year. Frequency depends on parameter (seasonal).	Sampling data and reports are submitted to DEQ each year.	This sampling helps inform existing wq conditions, identifies wq trends, aids in id'ing pollutant sources.
38.	Monitoring under 1200-Z	Facilities Division	Stormwater runoff is conveyed by 20 catch basins and 6 ditch inlets to one outfall, released into a water quality swale. WQ samples are taken for T Copper, T Lead, Zinc, TSS, Cadmium, Chromium and Nickel as described in the DEQ approved Stormwater Poll. Control Plan.	County Facilities, specifically Walnut Street Center (similar to a Public Works Yard).	Monthly (visual for solids, oil/grease). 2-4 times per year, depending on pollutant parameter.	Data is submitted to CWS by July 31 of each year, with the facility Discharge Monitoring Report.	This monitoring and sampling identifies any wq issues to be addressed for copper. Lead, zinc, TSS, cadmium, Chromium and nickel.

Chapter Six
Evaluation and Reporting

Chapter 6 Evaluation and Reporting includes:

6.0 Introduction

Total Maximum Daily Loads (TMDLs) are numerical loadings that are set to limit pollutant levels such that instream water quality standards are met. Oregon DEQ recognizes that TMDLs are values calculated from mathematical models and other techniques designed to predict very complex physical, chemical, and biological processes. In the Tualatin Basin TMDL document, they say "Models and techniques are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures."[133]

Nonpoint Source (NPS) management measures address diffuse runoff sources that are not channeled into a storm sewer system. An attempt to provide the "reasonable assurance" expected by DEQ is made to demonstrate progress in achieving water quality standards. At the same time, it must be recognized that the best "reasonable assurance" for nonpoint source will be an iterative long-term process. In the meantime, "reasonable assurance" will be provided that the Water Quality Implementation Plan for Nonpoint Sources addresses the parameters of concern.

6.1 Target Allocation Concentrations

To estimate the load allocation for runoff from a specific land area, the total volume of runoff due to typical seasonal precipitation is multiplied by an appropriate target concentration. The resulting allocation will be in the form of a seasonal load, which may then be divided by the number of days per season to give an average daily load. To determine the total loading that a designated management agency (DMA) is responsible for, the allocations for all land areas within an agency's jurisdiction are then summed.[134]

[133] Tualatin Basin Total Maximum Daily Load document, Oregon DEQ, August 2001, page 156.
[134] Tualatin SubBasin TMDL document, Oregon DEQ; August, 2001; Appendix C, page C-33.

6.1.1 Bacteria:

The bacteria load allocations for the Tualatin Basin are shown in Tables 6.1 and 6.2.

A Load Allocation (LA) is the amount of pollutant that nonpoint sources can contribute to a receiving water's loading capacity. The equation used for the conversion of concentration-based allocations to load-based allocations is[135]:

Load Allocation (E. coli counts/day)
= Load Allocation (E. coli counts/100 mL) x Daily Discharge Volume (ft^3)
x 283 (100 mL/ ft^3)

Table 6.1: Summer (May 1 – October 31) Bacteria Load Allocations

Designated Management Agency	5^{th} Field Subbasin	Load Allocation – E. coli counts/ 100 mL	
	All Land Uses except as noted	During Runoff Events; Measured as an event mean concentration	All other times; Measured as a grab sample
OR Dept of Forestry	Forest Land Use	10	10
Washington County, Clackamas County, Multnomah County, OR Dept of Agriculture	Gales	9500	406
	Rock	3000	406
	Dairy	7000	406
	Scoggins/Upper Tualatin	9500	406
	Middle Tualatin	12000	406
	Lower Tualatin	12000	406
	All Septic Systems	0	0

Table 6.2: Winter (November 1 – April 31) Bacteria Load Allocations

Designated Management Agency	5^{th} Field Subbasin	Load Allocation – E. coli counts/ 100 mL	
	All Land Uses except as noted	During Runoff Events; Measured as an event mean concentration	All other times; Measured as a grab sample
OR Dept of Forestry	Forest Land Use	10	10
Washington County, Clackamas County, Multnomah County, OR Dept of Agriculture	Gales	3500	406
	Rock	700	406
	Dairy	3500	406
	Scoggins/Upper Tualatin	1500	406
	Middle Tualatin	11000	406
	Lower Tualatin	5000	406
	All Septic Systems	0	0

[135] **Id, page 83.**

6.1.2 Phosphorus:

Load Allocation = Lb. of Total Phosphorus/Season
= Allocation (mg/L Total Phosphorus) x Runoff Volume (ft^3) x Conversion Factor

The allocations for the Tualatin Basin are shown in Table 6.3:

Table 6.3: Tualatin Subbasin Total Phosphorus Allocations (in the form of concentrations)

Subbasin	Total Phosphorus Concentration: (Summer Median – mg/L)
Bronson Creek	0.13
Burris Creek, Baker Creek, McFee Creek, Christensen Creek	0.12
Cedar Creek, Chicken Creek, Rock Creek south, Nyberg Creek, Hedges Creek, Saum Creek	0.14
Dairy Creek	0.09
Fanno Creek	0.13
Gales Creek	0.04
Rock Creek	0.19
All sources to the Mainstem Tualatin below Dairy Creek	0.14
All sources to the Mainstem above Dairy Creek	0.04

6.1.3 Dissolved Oxygen:

The loading capacities for dissolved oxygen in the tributary streams are given in the form of sediment oxygen demand (SOD) at 20º c, (in units of g/m^2d) for specific sites along the tributaries. (See Table 6.4, below). For tributaries where SOD data are not currently available, the loading capacities are given as a percent reduction in SOD.[136] Sites in or partially in rural Washington County are shaded in gray in the Table.

Table 6.4: Tualatin River Tributary Loading Capacities related to DO

Site[137]	1995-1997 Median SOD_{20} Values (g/m^2d)	Percent Reduction Baseline Values	SOD_{20} Loading Capacity (g/m^2d)
Ash, Bronson, Burris, Butternut, Carpenter, Cedar, Christensen, Council, Hall, Hedges, Johnson (south), Nyberg, and Summer Creeks	no data	20	unknown
W.F. Dairy, Chicken, McFee, and Upper Rock Creeks	no data	30	unknown
Scoggins Creek		No measurable decrease in DO beyond natural conditions	
Willow Creek	4.4	20	3.5

136 Tualatin River Subbasin TMDL document, page 107, Oregon DEQ, August 2001.
137 Sites in or partially in rural Washington County are shaded in gray.

Site[137]	1995-1997 Median SOD_{20} Values (g/m²d)	Percent Reduction Baseline Values	SOD_{20} Loading Capacity (g/m²d)
Beaverton Creek at Arleda Park	4.4	20	3.5
Beaverton Creek at Walker	7.3	20	5.8
Dairy Cr. at Dairy Creek Park	3.1	30	2.2
Fanno Creek at Fanno Creek Park	2.3	50	1.15
Fanno Creek at Englewood Park	4.3	50	2.2
Gales Creek at Zurcher Irrigation	2.8	30	2.0
Rock Creek at Rock Creek WWTP	2.5	20	2
Rock Creek near Southeast 59th Ave	2.4	20	1.9

6.1.4 Temperature:

Solar radiation is the obvious primary source of temperature loading in the rural area of Washington County. The Willamette Basin Temperature Standard, of which the Tualatin is a Subbasin states[138]:

> No measurable surface water temperature increase resulting from anthropogenic activities is allowed:
>
> - In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64º F (17.8º C);
> - In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation and fry emergence from the egg and from the gravels in a basin which exceeds 55ºF (12.8º C);
> - In waters determined by the Department to be ecologically significant cold-water refugia;
> - In stream segments containing federally listed Threatened and Endangered species if the increase will impair the biological integrity of the T&E population; (for Bull Trout this would be 50º F).

The loading capacity, however, for temperature is based on the condition that meets the standard:

No measurable surface water temperature increase resulting from anthropogenic activities.[139]

This condition is termed **System Potential** and is achieved when:

(1) nonpoint source solar radiation loading reflects a riparian vegetation condition without human disturbance, and

(2) point source discharges cause no measurable increases in surface water temperatures.

The summation of the temperature standards is the following:

[138] Oregon Administrative Rules 340-41-445(2)(b)(A). Note: These standards are subject to change through the State's Triennial Review process. This list is from the DEQ Tualatin Basin TMDL document, Aug. 2001.

[139] Tualatin River Subbasin TMDL, Appendix A, page A-217, Oregon DEQ, August 2001.

Load Allocations (Nonpoint Sources): The Temperature Standard targets system potential (i.e. no measurable temperature increases from anthropogenic sources). To meet this requirement the system potential solar radiation heat load (9.2×10^6 Kcal/day) is allocated to background nonpoint sources. Anthropogenic nonpoint sources are not given a heat load, i.e., it is zero.

The temperature standard for the Tualatin Sub-basin was not amended in 2011/2012 due to legal challenges. When the temperature standard is amended, a re-evaluation will occur, but is unlikely to change Washington County's implementation plan for the rural area.

6.1.5 Mercury:

Mercury is a TMDL for the entire Tualatin River and Tualatin Sub-Basin to the Willamette Basin. There is not a specific Load Allocation or Wasteload Allocation for Mercury for the Tualatin Sub-basin as for other TMDL Parameters, due to the variable and diffuse sources, including atmospheric deposition from Asia. However, there is a required percent reduction of 89%, and the following Total Mercury loading capacities for the Tualatin Basin[140]:

HUC8/Waterbody	Median THg Concentration (ng/l)	Required Percent Reduction	At source THg Load (g/day)	THg Loading Capacity (g/day)
17090010 (Tualatin)	1.32	89%	22.93	1.91

EPA's analysis of reduction goals for mercury loading varies depending on the source. The common thread is that reduction is a very long-term process. For example, atmospheric deposition (across North America) is to assume reductions of 35% over the next 28 years.[141] DEQ anticipates incremental TMDLs by Sector (e.g. wastewater treatment plants; industrial dischargers; urban, agricultural, and forested lands).

Table 6.5: Tualatin Sub-basin: Sector-Specific Contributions and Allocations

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

*Relative percent contribution of subbasin total mercury load.

[140] **TMDL targets and allocations in <u>Willamette Basin Mercury Total Maximum Daily Load, December 30, 2019, as revised on February 4, 2021</u>; U.S. EPA, Region 10; February 4, 2021.**
[141] **Id, p. 7.**

6.2 Evaluation, Reasonable Assurance Used for Nonpoint Sources

6.2.0 DEQ's Reasonable Assurance for NPS

The Oregon DEQ Tualatin Basin TMDL document[142] addresses "reasonable assurance" for Nonpoint Rural Sources:

"Tualatin River Subbasin DMAs are expected to continue to provide reasonable assurance that TMDL-related management measures will be implemented and that they will result in meeting the load allocations set forth in the TMDLs. The reasonable assurance will be quantified as much as possible but may include narrative portions. This process will include a description of parameter-specific BMPs and an estimate of load reductions expected from implementing these activities.

> The reasonable assurance will be quantified as much as possible but may include narrative portions.

It recognized [sic] that some sources do not lend themselves to quantification. This may be especially true of some **nonpoint sources** [emphasis added] that have discharges that may not be readily monitored or estimated".

6.2.1 EPA's Reasonable Assurance Standard

The U.S. Environmental Protection Agency (EPA) issued a final TMDL rule in 2000 to improve the national program for identifying polluted waters, determining the sources of pollution, and designing clean-up plans. The goals of the final TMDL rule included a statement to "assure that TMDLs include implementation plans that define specific actions and schedules for meeting clean water goals." Although this rule was ultimately withdrawn by Congress due to lack of funding, the rule included the following definitions for Reasonable Assurance[143]:

Likewise, the current (2019) EPA website[144] cites Reasonable Assurance within the TMDL context, based on it's guidelines issued in 1992. It is safe to assume this approach is still valid.

For point sources, reasonable assurance is to be provided through National Pollutant Discharge and Elimination System (NPDES) permits.

For nonpoint and other sources, load allocations in each TMDL must meet a four-part test:

- they apply to the pollutant;
- they will be implemented expeditiously;
- they will be accomplished through effective programs;
- they will be supported by adequate water quality funding.

Reasonable assurance in the EPA context within implementing rules for the TMDL program did not include a statement that "reasonable assurance" means management measures will be implemented and will result in meeting the load allocations.

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[142] **Id, Appendix I, page I-20.**
[143] ***Final TMDL Rule: Fulfilling the Goals of the Clean Water Act;*** **EPA 841-F-00-008; July 2000.**
[144] **EPA, Impaired Waters and TMDLs. See: https://www.epa.gov/tmdl/overview-total-maximum-daily-loads-tmdls**

6.2.2 Nonpoint Source: Reasonable Assurance and Adaptive Management

According to the EPA definition for nonpoint sources, selection of BMPs and development of a water quality implementation plan (WQIP) will need to be supported by a "reasonable assurance" that load allocations will be addressed. This WQIP addresses the TMDL parameters, and will make every attempt to utilize both qualitative and quantitative information where available.

The approach for complying with an adaptive management process includes an iterative process that answers questions such as:

1. What is the Listed TMDL Parameter?
2. Are **quantitative** data available to support identification of sources and BMP types for the WQIP?
    a. If yes to #2, What BMPs are expected to be most effective at addressing sources?
    b. If no to #2, Use **qualitative** information and best professional judgment to support development of the WQIP.
3. Consider if additional monitoring could reasonably be conducted to obtain unknown information? Track national research projects where possible.
4. What percent of sources or areas will be addressed with BMPs?
5. Obtain DEQ Approval.
6. Monitor for compliance.
7. Apply Adaptive Management.

To *apply* adaptive management and the process for providing "reasonable assurance", the following questions need to be addressed:

1. What are the expected or known sources of the parameter of concern?
2. What are the BMPs that are expected to be both practical and effective at addressing the parameter of concern?
3. To what extent could the DMAs implement appropriate BMPs in the watershed?
4. Is there a sound basis through which the DMAs could provide "reasonable assurance" that their respective plans will address LAs, as expected by DEQ?

The process includes the use of both qualitative and quantitative information where available. The first step is to obtain, review and use quantitative information such as the literature reviews accomplished for the TMDL parameters, as explained herein in Chapters 3.1-3.5. This information helped us to better understand the sources of the listed pollutants in stormwater runoff, and the magnitude of the problem. It also helped us understand what BMPs would be practical and effective at controlling the anthropogenic sources. The second step involves qualitative information, and whether monitoring can reasonably be conducted to fill the information gaps. If it can reasonably be conducted, it could be part of the basin-wide TMDL monitoring program. If monitoring could not be reasonably conducted, then national research projects should be tracked, and the adaptive management approach should be used to refine the WQIP over time.

6.2.3 Reasonable Assurance and Limitations on County Authority

Washington County can give the reasonable assurance to Oregon DEQ that management measures in the rural area as outlined in Chapter 5, herein, will address the TMDL parameters of concern. The County cannot provide reasonable assurance that these management measures alone will achieve water quality standards within the receiving streams. The reason for this involves practices by private parties outside County authority, as well as statutory restrictions on county authority to regulate activities on agricultural and forest lands. These statutory restrictions are outlined in the following Table 6.6.

Table 6.6: Statutory Restrictions on County Authority to Regulate Activities on Agricultural and Forest Lands

Agricultural Practices
ORS 215.253 prohibits local governments from restricting or regulating farm use land within an exclusive farm use zone or within land designated as marginal land in a manner that would restrict or regulate farm structures or farming practices.
ORS 561.191 provides that the State Department of Agriculture is to develop “any program or rules” that directly regulate farming practices that are for the purpose of protecting water quality and applicable to agricultural lands.
Under ORS 568.909, the State Department of Agriculture may describe the boundaries of agricultural and other rural lands subject to a water quality management plan due to a DEQ establishment of a TMDL. If such an area is designated, ODA shall develop and carry out a plan for the prevention and control of water pollution from agricultural activities and soil erosion. ODA may adopt rules, require landowner compliance with plans, enter on lands for inspection, collect fees, and impose civil penalties for violation.
ORS 30.935 prohibits any local government regulation that makes a farm practice a nuisance or trespass or provides for its abatement as such, with respect to activities for which no claim or action is allowed under ORS 30.936 or 30.937 (Limits on private right of action).
Forestry Practices
ORS 527.722 prohibits local government regulation “or other action” that prohibits, limits, regulates, subjects to approval or in any other way affects forest practices on forestlands located outside of an acknowledged urban growth boundary. Local land use regulations and comprehensive plans may regulate the siting or alteration of structures, and physical alteration of land unrelated to forestry purposes. Local governments may, with some limits, regulate forest practices on forest lands *within* urban growth boundaries.
ORS 197.277 provides that the goals and rules established in ORS Chapter 195 (local Government Planning Coordination), Chapter 196 (Wetlands, Rivers, Removal and Fill), and Chapter 197 (Comprehensive Land Use Planning) “do not apply to programs, rules, procedures, decisions, determinations or activities carried out under the Oregon Forest Practices Act.” Local governments are prohibited from taking any action that is not allowed under the Oregon Forest Practices Act.
ORS 30.934 prohibits any local government regulation that makes a forest practice a nuisance or trespass, or provides for its abatement as such, with respect to activities for which no claim or action is allowed under ORS 30.936 or 30.937.

6.3 Reporting: Water Quality Analysis

6.3.0 Ambient Data

Each year the Washington County rural area water quality ambient data is evaluated by a technical team and reported to DEQ in the Annual Report submitted by November 1. The technical memoranda (TM) provide a summary of instream water quality data collected by Clean Water Services and sometimes other agencies (such as OR Dept. of Agriculture) from monitoring stations representing rural areas in the Tualatin River Basin. The purpose of the TM is to compare the sampling results for total maximum daily load (TMDL) parameters with the water quality guidance or standards provided in the Tualatin River TMDL, in order to evaluate the extent to which the data exceed instream water quality standards.[145]

6.3.1 BMP Effectiveness Monitoring

Monitoring and evaluation of structural stormwater quality BMPs continues with variable results. Depending on the parameter of interest, BMP effectiveness is often as variable as the stormwater data. Getting useful data from BMP monitoring can be very complicated and require significant resources to accomplish accurately. However, BMP effectiveness information is highly desirable because a significant amount of money is being invested in implementing BMPs without a lot of certainty regarding their ultimate success. Washington County conducts BMP Effectiveness monitoring from a programmatic standpoint, relative to Adaptive Management. This is reported in Annual Reports.

6.4 WQ Management / Implementation Plan: Evaluation

The Washington County Implementation/Management Plan consists of at least 3 elements (Table 6.7):

Each of these elements requires differing evaluation and reporting. Some elements will be internal evaluation only, other elements will involve mandatory evaluation and reporting to Oregon DEQ. Element 1 can be evaluated on an annual basis, and will be the cornerstone of required Annual Reports. Element 2 is internal evaluation as the implementation plan is implemented on a continuous basis. Element 3 is a longer-term evaluation, and is applied on a 5-year reporting basis. Table 6.7 summarizes the expected reporting and level of evaluation during implementation.

As a program implemented primarily through the Department of Land Use and Transportation, fiscal resources are available to maintain this and other environmental programs. Within the Engineering, and Capital Project Services Divisions, BMPs (such as Erosion and Sediment Control, and Construction of Water Quality Facilities) are an integral part of any funded Road or Bridge Construction project. Within the Operations Division, BMPs (such as implementing the Post-Construction BMPs, and Road, Bridge, and Water Quality Facility Maintenance) are likewise an integral part of daily operations. Additionally, the Operations Division employs 2 Sr. Environmental Resource Specialists to oversee their BMP programs.

[145] **Data collected during ambient and rainfall conditions is compiled and reported on together.**

Table 6.7: Summary of Evaluation and Reporting

Evaluation and Reporting		
Element 1	• Implement Best Management Practices • Implement Vegetation Management Program • Continue Existing Public Awareness Program • Coordinate Water Quality Monitoring Results from CWS and others	Evaluated on an Annual Basis; Annual Reports to DEQ
Element 2	• Implement BMP Effectiveness Monitoring • Train Appropriate Staff • Research Rural Management of Pollutants • Evaluate Resources (Fiscal) Needed to Implement and Maintain Plan	Internal Evaluation; Washington County DLUT Full Funded
Element 3	• Monitor and Document Progress in Implementation Plan • Evaluate Progress towards Achieving TMDL • Apply Adaptive Management • Revise WQIP	Long-Term Evaluation; Five-Year Reporting Basis; Revise WQIP

Appendix

This Appendix includes: Historical Data Tables

Data tables have been moved from the 2014 WQMP Document to this Appendix for the 2019 WQMP/WQIP.

The arithmetic mean (based on a lognormal distribution) of the results from inflow and outflow monitoring of TP from 35 BMPs are shown in Table A-1. Table A-2 shows the results from ortho phosphate measurements from 13 BMPs, dissolved phosphorus measurements from 11 BMPs, dissolved organic phosphorus measurements from 9 BMPs, and suspended phosphorus from 5 BMPs.

See Section 3.2.2-2 for narrative interpretation of Table A-1 data (this table and 2017 compilation).

Table A-1: Draft Data Analysis from National Stormwater BMP Database (ASCE 2003) by BMP Category for Total Phosphorus

BMP Category/ BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Arith Mean Outflow (mg/L)	Are inflow & outflow results statistically different?	Difference between mean inflow and outflow
Swales						
Alta Vista Planned Development Detention w/ swales	19	19	0.5	0.8	yes	-0.3
Altadena Strip	11	12	0.1	0.4	yes	-0.3
Bioretention Area	20	6	0.3	0.4	no	-0.1
Carlsbad strip	12	9	0.5	1.0	no	-0.5
Swale - F6	30	24	0.1	0.2	yes	-0.1
Swale - F4	30	20	0.1	0.2	yes	-0.1
Swale - F8	30	23	0.1	0.3	yes	-0.2
Detention Basins						
15/78	17	17	0.7	0.3	yes	0.4
5/56	16	12	0.3	0.2	yes	0.1
605/91 edb	7	11	0.4	0.5	no	-0.1
Manchester	13	11	0.7	0.4	yes	0.3
Media Filter						
5/78	17	17	0.5	0.9	yes	-0.4
Eastern SF	11	10	0.2	0.1	no	0.1
Escondido	16	14	0.4	0.3	no	0.1
Kearny Mesa	17	16	0.4	0.3	no	0.1
La Costa PR	16	14	0.4	0.2	yes	0.2
Lakewood	10	10	0.2	0.2	yes	0.0

Table A-1: Draft Data Analysis from National Stormwater BMP Database (ASCE 2003) by BMP Category for Total Phosphorus

BMP Category/ BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Arith Mean Outflow (mg/L)	Are inflow & outflow results statistically different?	Difference between mean inflow and outflow
Retention Ponds						
Cockroach Wet Pond	48	24	1.6	0.6	yes	1.0
DeBary Detention with Filtration Pond	33	47	0.3	0.1	yes	0.2
La Costa WB	11	12	1.2	1.3	no	-0.2
Lake Ellyn	18	18	0.6	0.2	yes	0.4
Lake McCarrons Sedimentation Basin	24	24	1.1	0.2	yes	0.9
Pond A	14	12	0.1	0.1	no	0.0
Silver Star Rd Detention Pond	13	12	0.2	0.1	yes	0.1
Tampa Office Pond (1) 1990-91	22	22	0.5	0.2	yes	0.3
Tampa Office Pond (2) 1993-94	25	21	0.5	0.2	yes	0.3
Tampa Office Pond (3) 1994-95	46	46	0.6	0.1	yes	0.5
Wet detention pond, Monroe St.	30	26	0.8	0.2	yes	0.6
Wetland Basin						
Franklin Wetland	46	33	0.4	0.3	no	0.1
Hidden River Wetland	81	81	0.1	0.1	yes	0.0
Prince George's Pond	22	19	0.1	0.1	no	0.0
Queen Anne's Pond	49	47	0.1	0.1	yes	0.0
Wetland Channel						
Lake McCarrons Wetland	24	24	0.3	0.2	yes	0.1
Silver Star Rd Wetland	12	6	0.1	0.1	no	0.0
Tanners Lake Wetland	17	4	0.5	0.3	no	0.2

Table A-2 Narrative:

Ortho Phosphate (OP) Removal: Table A-2 displays the monitoring results of 13 BMPs that were monitored for removal of ortho phosphate (National BMP Database, 2003). As with TP, the 3 swales also showed negative performance with respect to OP removals. Only two of the remaining 9 BMPs (a retention pond and a wetland basin), showed reductions in OP that were considered to be statistically significant. The OP effluent concentrations from these BMPs were 0.53 and 0.50 respectively.

Dissolved Phosphorus (DP) Removal: Table A-2 also displays the monitoring results of 12 BMPs that were monitored for the removal of dissolved phosphorus (National BMP Database, 2003). Each of the 7 retention ponds showed positive removal rates that were considered to be statistically significant. The effluent concentrations of DP from these ponds ranged from 0.01 mg/L to 0.09 mg/L. The other two BMP types that were monitored (wetland basins and wetland channels) showed variable performance.

Dissolved Organic Phosphorus (DOP) Removal: Table A-2 displays the monitoring results of 9 BMPs that were monitored for the removal of dissolved organic phosphorus (National BMP Database, 2003). The results were similar to those for dissolved phosphorus where each of the 6 retention ponds showed positive removal rates with effluent concentrations varying from 0.03 mg/L to 0.11 mg/L. The other two BMP types that were monitored (wetland basins and wetland channels) showed variable performance.

Suspended Phosphorus Removal: Table A-2 displays the monitoring results of 5 BMPs that were monitored for the removal of suspended phosphorus (National BMP Database, 2003). Again the results were similar to those for DP and DOP above where the 2 retention ponds showed positive performance with effluent concentrations ranging from 0.02 mg/L to 0.08 mg/L. The other two BMP types that were monitored (wetland basins and wetland channel) showed variable performance.

Table A-2 Data Analysis from National Stormwater BMP Database (ASCE 2003) by Parameter Category
re: Orthophosphate, Dissolved Phosphorus, Dissolved Organic Phosphorus, and Suspended Phosphorus Removal

BMP Category Name	BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between inflow and outflow
Ortho Phosphate									
Swale	Swale - F4	30	26	0.1	0.1	0.2	0.2148	yes	-0.1
Swale	Swale - F6	30	20	0.1	0.1	0.2	0.2658	yes	-0.1
Swale	Swale - F8	30	23	0.1	0.1	0.2	0.3502	yes	-0.1
Detention Basin	Brooke Detention Pond	3	11	1.0	0.7	0.8	0.3763	no	0.2
Detention Basin	Manchester	10	7	0.2	0.2	0.2	0.2768	no	0.0
Detention Basin	MCTT Main settling chamber	13	12	0.3	0.1	0.3	0.113	no	0.0
Detention Basin	15/78	10	10	0.1	0.1	0.1	0.05919	no	0.0
Media Filter	5/78	10	11	0.4	0.7	0.4	0.4395	no	0.0
Media Filter	MCTT Filtering Chamber	12	12	0.3	0.1	0.4	0.2277	no	-0.1
Retention Pond	Cockroach Wet Pond	48	23	1.1	1.6	0.5	1.082	yes	0.6
Retention Pond	Pond A	14	11	0.0	0.0	0.0	0.01359	no	0.0
Retention Pond	DeBary Detention with Filtration Pond	33	47	0.0		0.0		yes	0.0
Wetland Basin	Rt 288 Mitigated Wetland	12	8	2.2	1.4	0.5	0.3764	yes	1.7
Dissolved Phosphorus									

Table A-2 Data Analysis from National Stormwater BMP Database (ASCE 2003) by Parameter Category
re: Orthophosphate, Dissolved Phosphorus, Dissolved Organic Phosphorus, and Suspended Phosphorus Removal

BMP Category Name	BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between inflow and outflow
Retention Pond	Heritage Retention Pond	13	13	0.3	0.2	0.1	0.0351	yes	0.2
Retention Pond	Lake Ellyn	18	18	0.1	0.1	0.0	0.02383	yes	0.1
Retention Pond	Lake McCarrons Sedimentation Basin	24	24	0.2	0.1	0.1	0.04562	yes	0.1
Retention Pond	Silver Star Rd Detention Pond	13	12	0.1	0.0	0.0	0.02036	yes	0.0
Retention Pond	Wet detention pond, Monroe St.	29	24	0.2	0.2	0.1	0.0717	yes	0.1
Wetland Basin	Franklin Wetland	45	32	0.2	0.2	0.3	0.2995	no	0.0
Wetland Basin	Prince George's Pond	22	19	0.0	0.0	0.1	0.09147	no	0.0
Wetland Basin	Queen Anne's Pond	49	47	0.1	0.1	0.0	0.03348	yes	0.0
Wetland Channel	Lake McCarrons Wetland	24	24	0.1	0.1	0.1	0.05229	no	0.0
Wetland Channel	Silver Star Rd Wetland	12	6	0.0	0.0	0.0	0.01759	no	0.0
Wetland Channel	Tanners Lake Wetland	17	3	0.2	0.1	0.2	0.01798	no	0.0
Dissolved Organic Phosphorus									
Retention Pond	DeBary Detention with Filtration Pond	33	47	0.1	0.04747	0.1	0.0462	no	0.0

Table A-2 Data Analysis from National Stormwater BMP Database (ASCE 2003) by Parameter Category
re: Orthophosphate, Dissolved Phosphorus, Dissolved Organic Phosphorus, and Suspended Phosphorus Removal

BMP Category Name	BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between inflow and outflow
Retention Pond	Tampa Office Pond (1) 1990-91	22	22	0.3	0.2164	0.1	0.078	yes	0.2
Retention Pond	Tampa Office Pond (2) 1993-94	25	21	0.3	0.7812	0.1	0.2788	no	0.2
Retention Pond	Tampa Office Pond (3) 1994-95	46	46	0.3	0.4646	0.0	0.2582	yes	0.3
Retention Pond	Wet detention pond, Monroe St.	27	24	0.2	0.1467	0.1	0.09764	yes	0.1
Wetland Basin	Franklin Wetland	45	32	0.2	0.1168	0.2	0.167	no	-0.1
Wetland Basin	Hidden River Wetland	81	81	0.0	0.02637	0.	0.01349	yes	0.0
Wetland Channel	Silver Star Rd. Wetland	12	6	0.0	0.03592	0.1	0.0175	no	0.0
Suspended Phosphorus									
Retention Pond	DeBary Detention with Filtration Pond	33	47	0.2	0.5168	0.0	0.02008	yes	0.2
Retention Pond	Silver Star Rd Detention Pond	13	12	0.1	0.08507	0.1	0.04339	no	0.0
Wetland Basin	Prince George's Pond	21	19	0.0	0.0341	0.0	0.05246	no	0.0
Wetland Basin	Queen Anne's Pond	48	47	0.0	0.03223	0.1	0.08389	no	0.0
Wetland Channel	Silver Star Rd. Wetland	12	6	0.1	0.04339	0.1	0.04586	no	0.0

Table A-3. Data Analysis from National Stormwater BMP Database (ASCE 2003) and Local Data by BMP Category re: TSS

BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between mean inflow and outflow
Swales								
Alta Vista Planned Development Detention w/ swales	19	19	27.2	21.3	21.6	18.29	no	5.6
Swale - F8	27	17	12.8	12.3	10.7	6.69	no	2.1
Altadena Strip	11	12	61.3	25.1	21.2	12.04	yes	40.1
Carlsbad strip	12	9	210.1	150	44.9	33.79	yes	165.2
Swale - F6	27	18	12.8	12.3	3.9	4.4	yes	8.9
Swale - F4	27	19	12.8	12.3	4.9	4.4	yes	7.9
Water Pollution Control Lab - East	8	8	115.3	NR	28.0	NR	yes	87.3
Water Pollution Control Lab - West	8	8	115.3	NR	34.0	NR	yes	81.3
Portland Russell Pond Swale	7	7	9.0	NR	6.0	NR	yes	3.0
Portland Parkrose Middle School	6	6	49.2	NR	18.4	NR	yes	30.8
Detention Basin								
605/91 edb	7	11	71.4	23	32.7	26.76	yes	38.7
MCTT Main settling chamber	13	12	40.3	51.4	4.7	3.24	yes	35.6
Manchester	14	10	206.9	114	56	32.54	yes	150.9
5/56	17	12	88.7	21.9	41.4	35.51	yes	47.3
15/78	19	18	186.9	128	48.3	32.46	yes	138.6
CWS Stoller Dry Detention	8	8	30	NR	38.2	NR	yes	-8.4
Media Filter								
MCTT Filtering Chamber	12	12	4.7	3.2	7.9	8.07	no	-3.2
Lakewood	10	10	33.4	23.8	10.3	9.41	yes	23.1
Eastern SF	11	10	52.2	26.6	11.3	5.37	yes	40.9
Escondido	16	16	104.4	66.2	45.5	107.1	yes	58.9
5/78	16	18	16.7	32.7	156.9	140.9	yes	-140.2
La Costa PR	17	14	81.6	54.7	5.2	5.62	yes	76.4

Table A-3. Data Analysis from National Stormwater BMP Database (ASCE 2003) and Local Data by BMP Category re: TSS

BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between mean inflow and outflow
Kearny Mesa	18	17	159.8	110.0	99.5	63.97	yes	60.3
Portland Parkrose Sand Filter	5	5	63.0	NR	6.0	NR	yes	57.0
Vault Structures								
Portland Buffalo Vortechnics	6	6	334.8	NR	223.2	NR	yes	111.6
Portland Whitacker Pond Vault	3	3	431.0	NR	465.0	NR	yes	-34.0
CWS Vortechnics	7	7	43.7	NR	32.8	NR	yes	10.9
Retention Pond								
Tampa Office Pond (2) 1993-94	25	21	46.1	159.1	13.2	12.1	no	32.9
Cockroach Wet Pond	48	24	35.2	69.6	23.0	21.73	no	12.2
La Costa WB	12	12	213.9	132.6	14.1	21.61	yes	199.8
Silver Star Rd Detention Pond	13	12	33.4	51.3	166.4	48.55	yes	-133.0
Heritage Retention Pond	13	13	166.2	278.6	16.4	10.51	yes	149.8
Pond A	14	12	22.7	16.6	9.4	4.88	yes	13.3
Lake Ellyn	18	18	329.5	313.1	19	8.36	yes	310.5
Tampa Office Pond (1) 1990-91	22	22	28.0	24.7	19.6	42.81	yes	8.4
Lake McCarrons Sedimentation Basin	24	24	566	845.8	46.4	74.02	yes	519.6
Wet detention pond, Monroe St.	29	24	320.4	491	33.9	31.82	yes	286.5
DeBary Detention with Filtration Pond	33	46	89.5	168.5	1.0	1.31	yes	88.5
CWS Cascade Woods	6	6	14	NR	16.6	NR	yes	-2.9
Portland WPCL - Water Garden	7	7	82	NR	15.0	NR	yes	66.6
Portland Lexington Hills	7	7	115	NR	53.7	NR	yes	61.6
Wetland Basin								
Prince George's Pond	22	19	179.8	356	108.1	219	no	71.7
Franklin Wetland	46	34	82.7	106.6	22.3	25.64	yes	60.4
Queen Anne's Pond	49	47	69.3	152.2	19.1	34.09	yes	50.2
Hidden River Wetland	81	81	10.2	6.4	2.8	2.73	yes	7.4

Table A-3. Data Analysis from National Stormwater BMP Database (ASCE 2003) and Local Data by BMP Category re: TSS

BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow (mg/L)	Inflow Standard Deviation	Arith Mean Outflow (mg/L)	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between mean inflow and outflow
Wetland Channel								
Silver Star Rd Wetland	12	6	166.4	49	133.8	53.51	no	32.6
Tanners Lake Wetland	17	3	165.8	214	18.6	5.52	yes	147.2
Lake McCarrons Wetland	24	24	120.8	166	24.2	38.44	yes	96.6

Blue Shading = Exceeds NPDES industrial benchmark of 130 mg/L.
Green Shading = Portland area site.

Table A-3 Narrative:

Vortechnics settling chamber effluent concentrations ranged from 7.6-148 mg/L and were approximately the same as the influent and in some cases greater. Effluent concentrations from the dry pond ranged from 2.8-31.2 mg/L.

Swales generally had low mean TSS outflow concentrations, but inflow concentrations were generally low as well. Of the Portland swales that were monitored (2003 study), only 1 of the 6 swales had a mean TSS inflow concentration above the 2003 NPDES benchmark of 130 mg/L, and none of the mean outflow concentrations were above the benchmark. Mean TSS reductions ranged from 2 to 165 mg/L. Mean inflow concentrations of TSS ranged from 12 to 210 mg/L, and mean outflow concentrations of TSS ranged from 4 to 45 mg/L. For three Portland swales, average TSS effluent concentrations ranged from 18.4 mg/L to 28 mg/L.

Detention basins generally had higher mean TSS outflow concentrations than swales did, but the inflow concentrations to the detention basins were also higher. Two of the 5 detention basins monitored had a mean TSS inflow concentration above the NPDES benchmark of 130 mg/L, and none of the mean outflow concentrations were above the benchmark. Mean TSS reductions ranged from 36 to 139 mg/L. Mean inflow concentrations of TSS ranged from 40 to 207 mg/L, and mean outflow concentrations of TSS ranged from 5 to 48 mg/L. For the two Portland ponds, average TSS effluent concentrations were 15 mg/L and 54 mg/L.

Media filters showed a wide variety of performance levels, likely due to system design and quality. One filter had a mean TSS outflow of 157 mg/L, which is over the NPDES benchmark and actually 140 mg/L greater than the mean inflow concentration of 17 mg/L. However, the 6 other media filters monitored reduced TSS concentrations by 23 to 60 mg/L and had mean outflow concentrations below the benchmark of 130 mg/L. Mean inflow concentrations of TSS ranged from 5 to 160 mg/L, and mean outflow concentrations of TSS ranged from 5 to 157 mg/L.

Retention ponds also showed a wide variety of performance levels, likely due to variances in pond design, detention time, and factors related to TSS sources including particle size and settling time. One retention pond had a mean TSS outflow of 166 mg/L, which is over the NPDES benchmark and actually 133 mg/L greater than the mean inflow concentration of 33 mg/L. However, the 11 other retention ponds monitored reduced TSS concentrations by 9 to 520 mg/L and had mean outflow concentrations below the benchmark of 130 mg/L. Mean inflow concentrations of TSS ranged from 23 to 566 mg/L, and mean outflow concentrations of TSS ranged from 1 to 166 mg/L.

Wetland basins were generally very effective at removing TSS. Only 1 of the 4 basins monitored had a mean TSS inflow concentration above the NPDES benchmark of 130 mg/L, and none of the mean outflow concentrations were above the benchmark. Mean TSS reductions ranged from 7 to 72 mg/L. Mean inflow concentrations of TSS ranged from 10 to 180 mg/L, and mean outflow concentrations of TSS ranged from 3 to 109 mg/L.

Wetland channels were generally effective at removing TSS. Two of the 3 channels monitored had mean TSS inflow concentrations above the NPDES benchmark of 130 mg/L, and one of the mean outflow concentrations was above the benchmark but not by a significant amount. Mean TSS reductions ranged from 33 to 147 mg/L. Mean inflow concentrations of TSS ranged from 121 to 166 mg/L, and mean outflow concentrations of TSS ranged from 19 to 133 mg/L.

Table A-4: Draft Data Analysis from National Stormwater BMP Database (ASCE 2003) re: TSS

Parameter Name / BMP Category Name	BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow	Inflow Standard Deviation	Arith Mean Outflow	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between inflow and outflow
Total Dissolved Solids									
Swale	Bioretention Area	19	8	91.9	133.4	88.6	118.8	no	3.3
Swale	Alta Vista Planned Development Detention w/ swales	19	19	70.8	20.98	91.1	19.6	yes	-20.3
Swale	Water Pollution Control Lab - East	8	8	61	NR	77	NR	yes	-16.0
Swale	Water Pollution Control Lab - West	8	8	61	NR	67	NR	yes	-6.0
Swale	Portland Russell Pond	7	7	17.7	NR	18.5	NR	yes	-0.8
Detention Basin	Manchester	10	6	96.1	53.77	107.5	38.02	no	-11.4
Detention Basin	MCTT Main settling chamber	13	12	73.3	41.55	65.5	32.74	no	7.8
Detention Basin	CWS Stoller Dry Detention	8	8	76.8	NR	91.4	NR	yes	-14.6
Detention Basin	CWS Cascade Woods	6	6	38.3	NR	47.3	NR	yes	-9.0
Media Filter	MCTT Filtering Chamber	12	12	65.5	32.74	62.1	28.91	no	3.4
Media Filter	Portland Parkrose Sand Filter	5	5	41.2	NR	46.2	NR	yes	-5.0
Vault Structure	CWS Vortechnics	7	7	34.3	NR	38.6	NR	yes	-4.3
Retention Pond	Silver Star Rd Detention Pond	13	12	157.4	56.57	150.4	51.51	no	7.0
Retention Pond	Lake Ellyn	18	18	259.9	232.8	514.7	160.3	yes	-254.8
Wetland Basin	Rt 288 Mitigated Wetland	12	7	54.9	57.78	27.2	17.03	no	27.7
Wetland Channel	Silver Star Rd Wetland	12	6	150.4	51.51	126.8	60.38	no	23.6
Total Volatile Solids									
Swale	Alta Vista Planned Development Detention w/ swales	19	19	20.9	9.55	27.5	6.59	yes	-6.6
Detention Basin	MCTT Main settling chamber	13	12	46.9	31.1	29.2	15.65	no	17.7
Media Filter	MCTT Filtering Chamber	12	12	29.2	15.65	35.8	18.34	no	-6.6
Retention Pond	Lake McCarrons Sedimentation Basin	24	24	154.4	213.7	14.3	19.45	yes	140.1

Table A-4: Draft Data Analysis from National Stormwater BMP Database (ASCE 2003) re: TSS

Parameter Name / **BMP Category Name**	BMP Name	Number of Inflow Samples	Number of Outflow Samples	Arith Mean Inflow	Inflow Standard Deviation	Arith Mean Outflow	Outflow Standard Deviation	Are inflow & outflow results statistically different?	Difference between inflow and outflow
Retention Pond	Wet detention pond, Monroe St.	29	24	107.4	71.5	50.5	50.03	yes	56.9
Wetland Channel	Tanners Lake Wetland	17	3	33.1	35.84	8.1	2.62	no	25.0
Wetland Channel	Lake McCarrons Wetland	24	24	35.2	38.68	9.5	10.23	yes	25.7
Volatile Solids									
Detention Basin	MCTT Main settling chamber	13	12	17.2	15.84	5.5	3.58	yes	11.7
Media Filter	MCTT Filtering Chamber	12	12	5.5	3.58	7.9	6.88	no	-2.4
Volatile Dissolved Solids									
Detention Basin	MCTT Main settling chamber	13	12	30.6	21.87	25.9	19.82	no	4.7
Media Filter	MCTT Filtering Chamber	12	12	25.9	19.82	28.8	14.2	no	-2.9

Gray Shading = Exceeds NPDES industrial benchmark of 130 mg/L. (At time of 2003 analysis this was benchmark).
Green Shading = Portland area site.

Table A-4 Narrative:

Total Dissolved Solids (TDS) Removal: Table A-4 displays the monitoring results of 9 BMPs that were monitored for removal of total dissolved solids (National BMP Database, 2003). Although mean reductions for 6 of the BMPs ranged from 3 to 28 mg/L, none of the BMPs showed mean outflow concentrations that were statistically less than the mean inflow concentrations based on the number of samples and the range of data points. In the 2003 review it was found that two of the BMPs, a biofilter swale and a retention pond, performed poorly for removal of dissolved solids and showed mean outflow concentrations that were statistically greater than the mean inflow concentrations. Although the results were not statistically different, the wetland basin showed the greatest mean reduction of dissolved solids and had the lowest mean outflow concentration of 28 mg/L. The 2017 analysis only looked at results of TSS removal, not TDS.

Total Volatile Solids (TVS) Removal: Table A-4 also displays the monitoring results of 7 BMPs that were monitored for the removal of total volatile solids (National BMP Database, 2003). Two retention ponds studied showed the greatest mean reductions of total volatile solids, ranging from 57 to 140 mg/L. Two wetland channels studies also showed mean reductions of volatile solids of 25 mg/L and had the lowest mean outflows of 8 to 10 mg/L, but mean influent concentrations for these BMPs were lower than for the retention ponds. Although the results were not statistically different between the mean concentrations in the inflow and the outflow, the detention basin showed a mean reduction of total volatile solids of 18 mg/L. The biofilter swale showed a statistically greater mean concentration of total volatile solids in the outflow than in the inflow, although the increase was only 7 mg/L. The media filter also showed an increase of 7 mg/L in the mean outflow concentration, but the results were not statistically different. The 2017 analysis only looked at results of TSS removal, not TVS.

Volatile Solids (VS) Removal: The results of monitoring for two BMPs that were monitored for the removal of volatile solids are also displayed in Table 3.4 (National BMP Database, 2003). The detention basin had a mean outflow concentration of volatile solids of 5 mg/L, a statistically significant decrease in mean concentration from the inflow of 12 mg/L. The media filter had a mean outflow concentration of volatile solids of 8 mg/L. Although the outflow results for the media filter show an increase of 2 mg/L over the mean inflow, the results were not statistically different. The 2017 analysis only looked at results of TSS removal, not VS**.**

Volatile Dissolved Solids (VDS) Removal: The results of monitoring for two BMPs that were monitored for the removal of volatile dissolved solids are also displayed in Table A-4 (National BMP Database, 2003). The detention basin had a mean outflow concentration of volatile dissolved solids of 26 mg/L, and the media filter had a mean outflow concentration of volatile dissolved solids of 29 mg/L, but neither of the results was statistically different. The 2017 analysis only looked at results of TSS removal, not VDS.

Table A-5: Monitoring Sites for Rural Washington County

Historic (Includes some retained as Current)

Creeks Listed in Rural Washington County	Station ID	Location (nearest cross-road)	Agency Currently Operating the Station	Bact.	Bio. Crit.	DO	Temp	Chl a	PH	TSS	Continuous Flow
Burris	3831005		ODA	X		X	X		X	X	
Butternut	3822002	River Road									
	3822014	Churchley (229th)									
Carpenter	3809020	Downstream									
	3809035	Upstream									
	3809012	Stringtown near Hwy 47	ODA	X		X	X		X	X	
	3809030	Stringtown Rd.									
	3809011	Highway 47									
	3809060	Plumlee									
Cedar	None										
Chicken	3835020	Scholls/Sherwood	USGS/CWS			X	X		X		X
Christensen	3830018		ODA	X		X	X		X	X	
Council	3812050	Beal Rd.									
	3812002	Killarney Golf @ NW 334th									
	3812009	Hobbs									
Dairy	3815021	Highway 8	CWS/USGS	X		X	X	X	X	X	
	3815083	Schef	OGI/HUA								
	3815058	Susbauer	CWS								
E. Fork Dairy	3818209	Camp	ODF								
	3818084	Dairy Creek Rd.	ODA/CWS & Water Master	X		X	X		X	X	X
	3818014	Roy	OGI/HUA								
	3818210	Upper	ODF								
	3818168	Fern									
W. Fork Dairy	3817020	Evers Rd.	OGI & Water Master								X
	3817052	Greenville	OGI/HUA								
	3817029	Highway 47	OGI/HUA								
	3817063	Highway 6	OGI/HUA								
	3817002	Marsh Rd.	OGI/HUA								
	3817078	Banks D.S.	Water Master								X
	3817079	Banks U.S.									
	3817092	Suns									
Gales (mouth to Clear Crk)	3810015	New Highway 47	CWS	X		X	X	X	X	X	

Table A-5: Monitoring Sites for Rural Washington County

Historic (Includes some retained as Current)

Creeks Listed in Rural Washington County	Station ID	Location (nearest cross-road)	Agency Currently Operating the Station	Bact.	Bio. Crit.	DO	Temp	Chl a	PH	TSS	Continuous Flow
	3810260	Forest Park	ODF								
		Old Highway 47	USGS/CWS			X	X		X		X
		Clapshaw Hill Rd.	Water Master								X
	3810038	Ritchey									
	3810190	Highway 6									
		Highway 6 MP 36.95									
		Log Rd.									
		Parson Rd. Bridge									
		Gales at B St. in Forest G.	ODF								
		Gales at Rodrick Rd.	ODF								
		Gales at Upper Headwaters	ODF								
Heaton/Baker	3813001	Scholls Ferry	ODA	X		X	X		X	X	
McFee	3811010		ODA	X		X	X		X	X	
McKay (mouth to E. Fork)	3816020	Horneker	CWS/TVID/OGI/HUA	X		X	X	X	X	X	
	3816060	Northrup	ODA/CWS	X		X	X		X	X	
	3816230	Pumkin	ODF								
		Scotch Church Rd.	Water Master								X
	3816240	Upper	ODF								
	3816080	Sunset									
Rock	3820056	Halfway between Baseline and Cornell	CWS								
	3820092	West Union Rd.	Water Master								X
Rock South	3839005	Highway 99									
Scoggins (mouth to Hagg Lake)	3805048	Stimson	CWS/TVID	X		X	X	X	X	X	
	3805017	Highway 47	CWS/TVID	X		X	X	X	X	X	
Summer											
Tualatin (mouth to Dairy Creek)	3701333	Farmington Rd.	CWS	X		X	X	X	X	X	
	3701450	Highway 219	CWS	X		X	X	X	X	X	
	3701087	Boones Ferry	CWS	X		X	X	X	X	X	
	3701165	Elsner	CWS	X		X	X	X	X	X	
	3701271	Scholls	CWS	X		X	X	X	X	X	
	3701054	Stafford	CWS	X		X	X	X	X	X	
	3701715	Cherry Grove	CWS	X		X	X	X	X	X	
	3701528	Golf Course	CWS	X		X	X	X	X	X	
	3701391	Rood Road	CWS	X		X	X	X	X	X	
	3701612	Springhill	CWS	X		X	X	X	X	X	

Table A-5: Monitoring Sites for Rural Washington County *Historic (Includes some retained as Current)*											
Creeks Listed in Rural Washington County	Station ID	Location (nearest cross-road)	Agency Currently Operating the Station	Bact.	Bio. Crit.	DO	Temp	Chl a	PH	TSS	Continuous Flow
	3701002	Weiss	CWS	X		X	X	X	X	X	
		Oswego Canal	CWS								X
		Gaston	CWS								X
		Tualatin	CWS								X
		Below Lee Falls	CWS								X
	3701018	212 Bridge	CWS								
	3701116	99 W. Bridge	CWS								
	3701352	Dumas	CWS								
	3701380	Meriwether	CWS								
	3701423	Minter	CWS								
	3701523	LaFollett	CWS								
	3701580	Water Plant	CWS								
	3701663	South Rd.	CWS								
	3701745	Raines	CWS								
Shading = Parameters that the creek is listed for.											
X = Parameters that are currently being monitored.											