REPORTING WATERSHED IMPROVEMENT
Based on Statistical Evidence of Watershed-wide Improvement
(SP-12, Option 2a)

Tualatin River Basin, Oregon
February 1, 2012

Watershed Identification

a	Organization	Oregon Department of Environmental Quality
b	Point of Contact	Avis Newell, Tualatin Basin Coordinator Oregon Department of Environmental Quality Phone: 503-229-6018 E-mail: Newell.Avis@deq.state.or.us
c	Project Title	Watershed-Based Planning Approach to Restoration Reduces Phosphorus, Bacteria and Chlorophyll *a* levels in the Tualatin River Basin, Oregon

Description of 2002 Baseline Condition

d	Watershed(s)	In the Tualatin River Basin (HUC 1709001), Seasonal Kendall analyses of data show that water quality in the following 6th-field watersheds has significantly improved: (1) HUC 170900100101 (Upper Gales Creek) (2) HUC 170900100102 (Middle Gales Creek) (3) HUC 170900100103 (Lower Gales Creek) (4) HUC 170900100203 (Scoggins Creek/Sain Creek) (5) HUC 170900100204 (Middle Tualatin River) (6) HUC 170900100205 (Lower Tualatin River) (7) HUC 170900100206 (Tualatin River) (8) HUC 170900100304 (Upper East Fork Dairy Creek) (9) HUC 170900100305 (Lower East Fork Dairy Creek) (10) HUC 170900100306 (Upper McKay Creek) (11) HUC 170900100401 (Beaverton Creek/Bronson Creek) (12) HUC 170900100402 (Upper Rock Creek/Tualatin River) (13) HUC 170900100403 (Lower Rock Creek/Tualatin River) (14) HUC 170900100404 (Davis Creek/Tualatin River) (15) HUC 170900100405 (Mcfee Creek) (16) HUC 170900100406 (Christensen Creek) (17) HUC 170900100501 (Chicken Creek) (18) HUC 170900100502 (Fanno Creek) (19) HUC 170900100503 (Rock Cr south/Lower Tualatin River) (20) HUC 170900100504 (Lower Tualatin/Saum Creek)
e	2002 Impairments	See Attachment A, Table A-2 (Includes all impairments listed as of 2002)

f	Map (optional)	See Attachment A

Evidence of Watershed Approach

g	Area of Effort	Throughout the 712-square-mile Tualatin River Basin
h	Stakeholders Involved and Their Roles	**Oregon Department of Agriculture**: • Develops, implements and enforces Agricultural Water Quality Management Plans (WQMP) • Adopted Agricultural WQMP rules under Oregon statute to clearly address total maximum daily load (TMDL) and load allocations. • Conducts confined animal feeding operation permitting and enforcement • Provides technical assistance • Manages riparian areas **Oregon Department of Environmental Qualit**y: • Develops and implements water quality standards • Collects and evaluates water quality data • Develops and helps to implement Clean Water plans (including TMDL or water quality improvement plans) • Provides grants and technical assistance to reduce nonpoint pollution sources • Regulates sewage treatment systems and industrial dischargers through permits (National Pollutant Discharge Elimination System and water pollution control permits) and enforcement • Provides loans to communities to build treatment facilities **The Oregon Department of Forestry**: • Implements Forest Practices Act (FPA) • Carries out the Conservation Reserved Enhancement Program • Revises statewide FPA rules and/or adopt sub-basin specific rules as necessary • Manages riparian areas **Oregon Department of Transportation:** • Constructs, operates and maintains state-owned roadways, bridges, etc. **Clean Water Services**, a public utility (formerly Unified Sewerage Agency): • Constructs, operates and maintains four wastewater treatment plants and sanitary sewer systems • Constructs, operates and maintains most of the municipal separate storm sewer system and within the urban growth boundary of Washington County • Permits stormwater facilities • Manages riparian areas

	Cities of Portland, West Linn and Lake Oswego: • Construct, operate, and maintain the municipal separate storm sewer system within the city limits • Conduct land use planning and permitting • Construct, operate, and maintain parks and other city owned facilities and infrastructure • Manage riparian areas **Counties of Multnomah, Clackamas and Washington:** • Construct, operate, and maintain county roads and county storm sewer system • Conduct land use planning and permitting • Construct, operate, and maintain parks and other county owned facilities and infrastructure • Inspect and issue permits for septic systems • Manage riparian areas **United States Department of Agriculture, Natural Resource Conservation Service and local Soil and Water Conservation Districts:** • Help private landowners and managers implement accepted conservation practices to improve land stewardship • Conduct education and outreach **Tualatin Watershed Council** (www.trwc.org), locally organized, voluntary, non-regulatory group; includes local, state and federal representatives: • Collaborates to identify issues, promotes cooperative solutions, focuses resources, agrees on goals for watershed protection and enhancement, and fosters communication among all watershed interests **Tualatin Riverkeepers** (www.tualatinriverkeepers.org), a community-based organization: • Builds watershed stewardship through public education, access to nature, citizen involvement and advocacy **Rock Creek Watershed Partners** (www.rcwp.org), a coalition of the stream groups representing the Rock Creek sub-watershed: • Preserves, protects, and restores streams in the Tualatin River basin by building the organizational capacity and providing support to stream friends
i Watershed Plans	• **Tualatin Sub-basin Total Maximum Daily Load and Water Quality Management Plan—Revised** (www.deq.state.or.us/wq/tmdls/willamette.htm#w). ODEQ, 2011. • **Lower Gales Creek Enhancement Planning Geomorphic Assessment** (www.trwc.org/tualatin_info.html). Tualatin Watershed Council, 2006.

		• **Lower Gales Creek Habitat Enhancement Plan** (www.trwc.org/tualatin_info.html). Tualatin Watershed Council, 2003. • **Tualatin Total Maximum Daily Load and Water Quality Management Plan** (www.deq.state.or.us/wq/tmdls/docs/willamettebasin/tualatin/tmdlwqmp.pdf). ODEQ, 2001. • **Tualatin Sub-basin Analysis and Planning documents** (all available at www.trwc.org/tualatin_info.html). U.S. Department of the Interior, Bureau of Land Management; multiple years. Include watershed characterizations, assessment of current conditions, impact of current management activities, and recommendations for future management and restoration efforts: - Upper Tualatin – Scoggins Watershed Analysis (2000) - Gales Creek Watershed Assessment Project (1998) - Dairy – McKay Watershed Analysis (1999) - Middle Tualatin - Rock Creek Watershed Analysis (2001) - Lower Tualatin Watershed Analysis (2001) • **Tualatin River Watershed Action Plan** (www.trwc.org/about/plans.html). Tualatin Watershed Council, 1999. Contains the Tualatin Watershed Council's goals, objectives, and priority action items for the Tualatin River Watershed. • **Tualatin River Watershed Action Plan Technical Supplement** (www.trwc.org/tualatin-info/tech-supplement.html**).** Tualatin Watershed Council, 1998. Contains detailed watershed characterization data. • **Analysis of Pollution Control Strategies for the Tualatin River Watershed** (www.trwc.org/water/docs/pfiles.pdf). Oregon Water Resources Research Institute, 1995. • **Estimated Cost of Reducing Nonpoint Phosphorus Loads from Agricultural Land in the Tualatin Basin** (www.trwc.org/water/docs/sfiles.pdf). Oregon Water Resources Research Institute, 1995. • **Benefits and Costs of Riparian Improvements in the Tualatin River Basin** (www.trwc.org/water/docs/ufiles.pdf**).** Oregon Water Resources Research Institute, 1995.
j	Restoration Work	From the 1970s into the early 1990s, numerous actions improved water quality in the mainstem Tualatin River. Clean Water Services (CWS) closed several small treatment plants. Upgrades in treatment were made at the remaining large facilities. Stream flows increased and were better managed after completion of Scoggins Reservoir in 1978. Since the late 1980s, municipalities and management agencies representing urban, agriculture and forestry have developed and implemented management plans that address potential sources of nonpoint source pollution and improve fisheries habitat in the Tualatin River and its tributary watersheds. For more information, see Attachment A.

Evidence of Watershed-wide Improvement

k	Impairments Removed (if applicable)	No impairments have been removed. However, TMDL targets for total phosphorus have been met in the mainstem Tualatin and monitoring data show significant decreases in numerous pollutants.
l	Statistical Results	Analyses of data from 1992 through 2010 shows that significant water quality improvement has occurred (with a 90 percent or greater level of confidence) in one or more listed parameters in 20 HUC-12 watersheds in the Tualatin River Basin. For more information, see Attachment A (Rationale Document, Table A-2) and Attachment B (results from Seasonal Kendall analyses).
m	Environmental Significance	Watershed-wide efforts to reduce pollution from both point and nonpoint sources are making a difference. Data show reductions in phosphorus, chlorophyll *a* and/or bacteria levels in 20 of the Tualatin River's 27 HUC-12 basins that are designated as impaired for one or more of these pollutants. Two additional HUC-12 watersheds have experienced significant reductions in pollutant levels; however, these HUC-12 watersheds do not qualify under SP-12 because the pollutants were not originally listed as a source of impairment for that basin. These improvements in non-listed pollutants highlight the extent of the widespread water quality improvements that have taken place across the watershed. Water quality management plans currently in place are expected to continue reducing pollutant levels throughout the basin.
n	Photos/Graphics (optional)	See Attachment A

Attachment A

Watershed-Based Planning Approach to Restoration Reduces Pollutant Levels and Improves Water Quality in Oregon's Tualatin River Watershed

SP-12 Submission Option 2a, Supporting Documentation
Rationale Document

February 1, 2012

The Following People Contributed Information to this Report:

Jan Miller, Clean Water Services

Steve Anderson, Clean Water Services

Rajeev Kapur, Clean Water Services

Lacey Townsend, Tualatin Soil and Water Conservation District

April Olbrich, Tualatin River Watershed Council

Steve Aalbers, Oregon Department of Environmental Quality

Avis Newell, Oregon Department of Environmental Quality

A.1. Background

The Tualatin River drains an area of 712 square miles in the northwest corner of Oregon. It is a sub-basin of the Willamette River Basin. The headwaters are in the Coast Range and flow in a generally easterly direction to the confluence with the Willamette River. Most of the Tualatin River watershed lies within Washington County; small portions also fall within Multnomah, Clackamas, Yamhill, Tillamook and Columbia counties.

The Tualatin River is approximately 83 miles long and, for the most part, has a very flat gradient. A reservoir-like section stretches between river mile (RM) 24 and 3.4. Major tributaries to the Tualatin River include Scoggins, Gales, Dairy (including East Fork, West Fork and McKay Creeks), Rock (including Beaverton Creek), and Fanno creeks (Figure A-1). Summer flow is supplemented with releases of water from Hagg Lake (Scoggins Reservoir) on Scoggins Creek and from Barney Reservoir, located on the Trask River, which diverts water into the upper Tualatin River. Effluent flow from the waste water treatment plants comprises a significant percent of summer river flow. Flow is also diverted from the Tualatin River to Oswego Lake in the lower portion of the river near river mile 6.7.

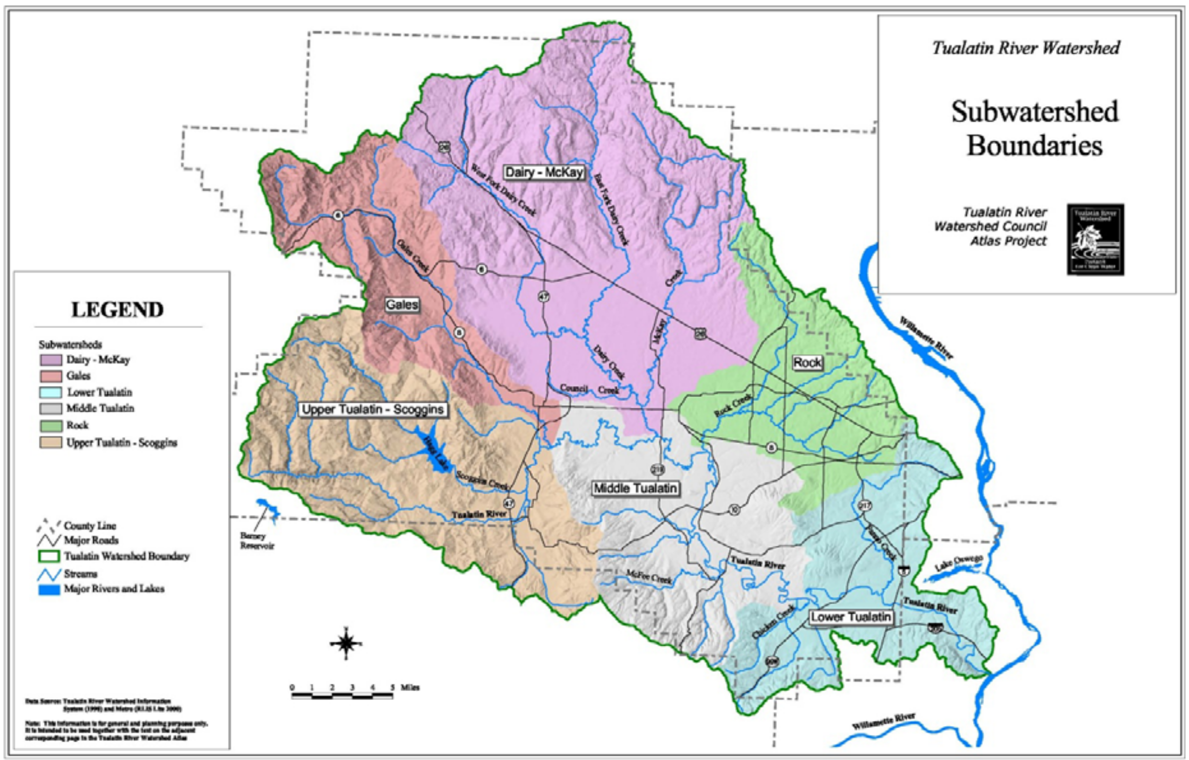

Figure A-1. Tualatin River Watershed.

The Tualatin River is home to Winter Steelhead, Coho Salmon, and resident Cutthroat Trout. Winter Steelhead are currently listed as threatened by the National Marine Fishery Service under the Endangered Species Act. These fish are generally in decline in the Tualatin River watershed and have been lost from some tributaries due to changes in habitat and water quality and other factors. Water contact recreation use (e.g., canoeing, fishing, and swimming) is on the rise, thanks to a growing population with increased access to the river through parks and boat ramps.

The Tualatin River watershed supports a population that doubled between 1970 and 1990 to 311,000, and surpassed 500,000 by 2010 (Figure A-2). The watershed supports urban, agricultural and forest-related land uses. The urban area is served by four wastewater treatment plants (WWTPs), all of which are operated by Clean Water Services (CWS, formerly the Unified Sewerage Agency of Washington County).

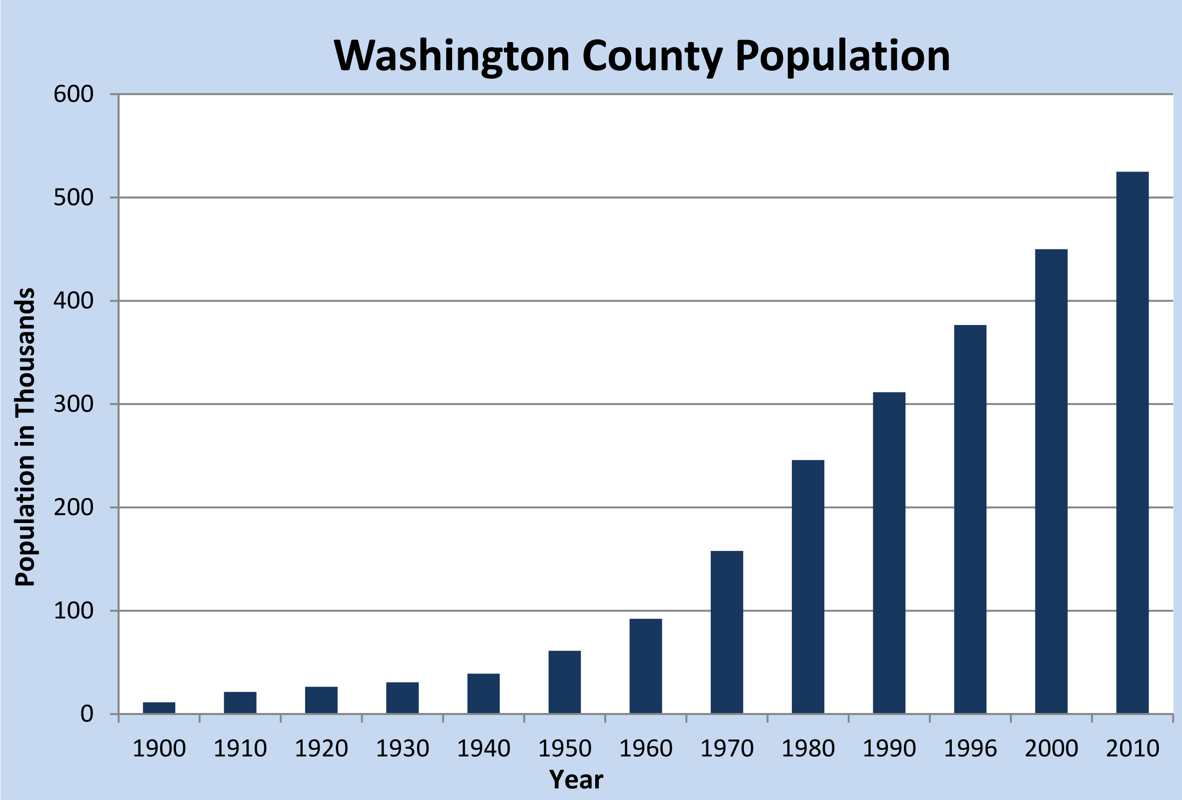

Figure A-2. Washington County Population Growth, 1900-2010.

A.2. Pollution Problems and Water Quality Impairments as of 2002

Prior to the 1970s, wastewater treatment plants (WWTPs) discharged high concentrations of ammonia and phosphorus into the main stem of the Tualatin River. The high ammonia concentrations often caused significant in-river nitrification during the summer, resulting in a high oxygen demand and low dissolved oxygen concentrations downstream of the WWTPs. In addition, large populations of phytoplankton thrived in the mainstem of the Tualatin River during the summer; the algal blooms and subsequent population crashes contributed to violations of Oregon's minimum dissolved oxygen standard of 6.0 milligrams per liter (mg/L) (now 6.5 mg/L) and the maximum pH standard of 8.5 standard units. Several sites on the main stem also exceeded the action level for nuisance algal growth of 15 micrograms per liter (μg/L) of chlorophyll *a*.

In 1970, the Unified Sewerage Agency of Washington County was formed to address health and pollution problems in the Tualatin River and its tributaries. The Unified Sewerage Agency consolidated 26 inefficient wastewater treatment plants in the Tualatin River watershed into a coordinated system and constructed new treatment facilities. These facilities provided advanced treatment and were complying with their technology-based permits by the late 1970s. Flow augmentation from Hagg Lake first occurred in June 1975, after the completion of Scoggins Dam. However, in the early 1980s, data showed that the Tualatin River was still experiencing water quality problems. In 1988, the Oregon Department of Environmental Quality (DEQ) developed a total maximum daily load (TMDL) to address the water quality impairments, which triggered additional improvements by both point and nonpoint sources in the Tualatin River watershed. This TMDL pre-dated Oregon's first list of impaired water bodies (Clean Water Act section 303(d) list) issued in 1998. By 2002, many waterbodies within the Tualatin River watershed had been identified as being impaired but having a TMDL in place to address a variety of pollutant sources. The complete list is available in Table A-2 (see page A-16).

A.3. Evidence of Watershed Approach and Widespread Restoration Efforts

During the 1990s, Oregon adopted or updated several statewide environmental laws and policies to better protect water quality and restore dwindling fish populations. Oregon forest practices were regulated by the Oregon Department of Forestry starting in 1987 with the adoption of the Forest Practices Act. These rules were updated in 1994 to provide additional protection for fish passage, fish habitat, and water quality. TMDLs point to these rules as being the vehicle for TMDL implementation on forested lands, so effectiveness monitoring under these rules has continued to the present time. Recent studies show that these rules may not fully protect water quality and temperature so in keeping an adaptive management approach, the rules are currently under review. The Agricultural Water Quality Management Act (ORS 568.900 – 568.933), which was adopted in 1993 and funded in 1997, required the adoption of area plans and rules regarding management practices and water quality. Implemented by the Oregon Department of Agriculture, the Act requires that local plans be reviewed every two years, and revised as needed to boost water quality protection. During the same time period, the DEQ began adopting TMDLs and maintaining an inventory of impaired waters. These statewide programs helped to shape the efforts taken to address local water quality problems in the Tualatin River watershed.

Concerted efforts to improve water quality in the Tualatin River watershed have been underway since the 1980s. Initially focused on the mainstem Tualatin, watershed stakeholders expanded their restoration and pollution reduction efforts to Tualatin River tributaries beginning in the mid-1990s). Some of these ongoing efforts are highlighted below, but many more projects have already been completed, are underway or are in planning stages.

A.3.1 TMDLs Promote Restoration Efforts through Water Quality Management Plans

In 1988 DEQ developed a TMDL for ammonia to address problems with low dissolved oxygen (DO) and TMDL for total phosphorus to address problems with high pH and nuisance algal growth in the reservoir-like section of the Tualatin River. In 2001, the TMDLs for ammonia and total phosphorus were revised and additional TMDLs were developed for temperature and bacteria (to address elevated levels basin-wide) and for settleable volatile solids (to address low dissolved oxygen in the tributaries).

DEQ and other watershed stakeholders developed a Water Quality Management Plan for the entire Tualatin River watershed (which includes 27 HUC-12 watersheds) that assigned specific management agencies responsibilities for implementing pollution limits and addressing pollution problems in their control. These Designated Management Agencies (DMAs) include the following local, state and federal government agencies and other entities:

- Washington, Multnomah and Clackamas Counties; the Cities of Portland, Lake Oswego and West Linn; and Clean Water Services (water resources management utility). Responsible for urban issues.
- Oregon Department of Environmental Quality. Responsible for regulated waste water discharges.
- Oregon Department of Agriculture. Responsible for agriculture on private lands.
- Oregon Department of Forestry. Responsible for forestry on private lands.
- Oregon Department of Transportation. Responsible for impacts from roadways.

DEQ is currently updating the Tualatin River watershed's existing TMDLs and Water Quality Management Plan, and has proposed to add the following as Designated Management Agencies:

- Metro. Regional government planning entity and landholder.
- Tualatin Valley Irrigation District and Wapato Improvement District. Responsible for irrigation issues.
- Oregon Department of Geology and Mineral Industries. Responsible for mining operations.
- Oregon Department of State Lands. Responsible for wetland jurisdiction, fill and removal permits, and permits for in-water structures.
- Oregon Parks and Recreation Department. Landholders.
- U.S. Bureau of Reclamation. Responsible for Henry Hagg Lake operation.
- U.S. Bureau of Land Management. Landowner.
- U.S. Fish and Wildlife Service. Landowner.

A.3.2 Implementing Water Quality Management Plan Generates Diverse Restoration Efforts

The goal of the TMDL for ammonia was to meet the DO criteria that are necessary to support the beneficial use of "resident fish and aquatic life." The ammonia TMDL focused mainly on the discharge from the WWTPs, which were the major sources of ammonia to the river during the period between May to mid-November. After ammonia removal processes were added to the WWTPs, the levels of ammonia have dropped dramatically and DO has improved in the lower Tualatin River.

The goal of the total phosphorus TMDL was to reduce the nuisance algal growth and resultant high pH levels in the reservoir-like section of the Tualatin River. In addition, the TMDL aimed to reduce the phosphorus loading to Lake Oswego, which also experienced nuisance algal growth and high pH levels. This was necessary to support the beneficial use of "resident fish and aquatic life" and "aesthetics." This TMDL had both point source and nonpoint source components. The WWTPs upgraded their capacity to remove total phosphorus to meet the TMDL requirements. The DMAs have been implementing best management practices (BMPs) to reduce the total phosphorus from nonpoint sources and urban runoff throughout the Tualatin River watershed.

The levels of total phosphorus have dropped dramatically in the Tualatin River since the WWTPs enhanced their total phosphorus removal capabilities. Additional efforts such as implementing water quality facilities to manage storm water runoff, sweeping streets, conducting educational programs, installing agricultural and forest-related BMPs and restoring riparian areas have successfully reduced total phosphorus in the tributaries. As a result, in recent years, the peaks of the nuisance algal blooms have been reduced and pH values in the lower mainstem are being met. The extensive nonpoint source control efforts have been successful in preventing the increase in pollution that might be expected with the 39 percent increase in population growth that the Tualatin River watershed experienced between 1996 and 2010.

The 2001 TMDLs added three additional parameters to be addressed by management agencies in the Tualatin. The temperature and settleable volatile solids TMDLs were targeted to meet the temperature and dissolved oxygen standards, respectively, which support resident fish and aquatic life. The bacteria TMDL targeted the bacteria standard that protects water contact recreation. The focus was again basin-wide but water quality problems were particularly noted in the tributaries to the Tualatin. Pollution reduction programs and projects have been underway to address these three parameters.

A.3.2.1. Restoration Projects Led by CWS

Clean Water Services (CWS) is a special service district that provides wastewater and stormwater services to more than 520,000 customers in the urban portion of Tualatin River watershed. CWS has 12 member cities and owns and operates four wastewater treatment facilities, and implements the municipal stormwater program in urban portion in the Tualatin River watershed. The issuance of a 2004 Watershed-Based National Pollutant Discharge Elimination System (NPDES) permit provided additional opportunities for CWS to improve the water quality in the Tualatin River watershed. The 2004 NPDES permit has a unique feature; it allows the trading of carbonaceous biological oxygen demand and nitrogenous oxygen demand within a WWTP and between the WWTPs. Additionally, the 2004 NPDES permit requires CWS to mitigate for the WWTPs' thermal load impacts on the Tualatin River. The watershed-based permit enables CWS to generate water quality credits by planting riparian areas in the rural and urban portions of the watershed and augmenting stream flow. The credits from the riparian plantings and flow augmentation are used to offset the excess thermal loads from the WWTPs. These riparian planting efforts also help to filter stormwater runoff and reduce erosion, thereby reducing the levels of phosphorus and bacteria reaching the Tualatin River and its tributaries.

CWS conducts or supports riparian plantings in the Tualatin River watershed. From 2004-2010, CWS implemented a total of 77 riparian planting projects in both urban and rural areas of the watershed, which resulted in 36.4 stream miles being planted and 329 million kilocalorie (kcal) of shade credit being generated (Figure A-3).

In the watershed's urban areas, CWS implements a riparian planting program. The projects in the urban areas include riparian planting as well as stream enhancement activities such as channel reconfiguration, large wood placement, floodplain reconnection, and off-channel habitat creation. Stream enhancement activities are conducted based on site-specific needs. From 2004-2010, CWS implemented a total of 44 projects in urban areas of the watershed, which resulted in 17.1 stream miles being planted.

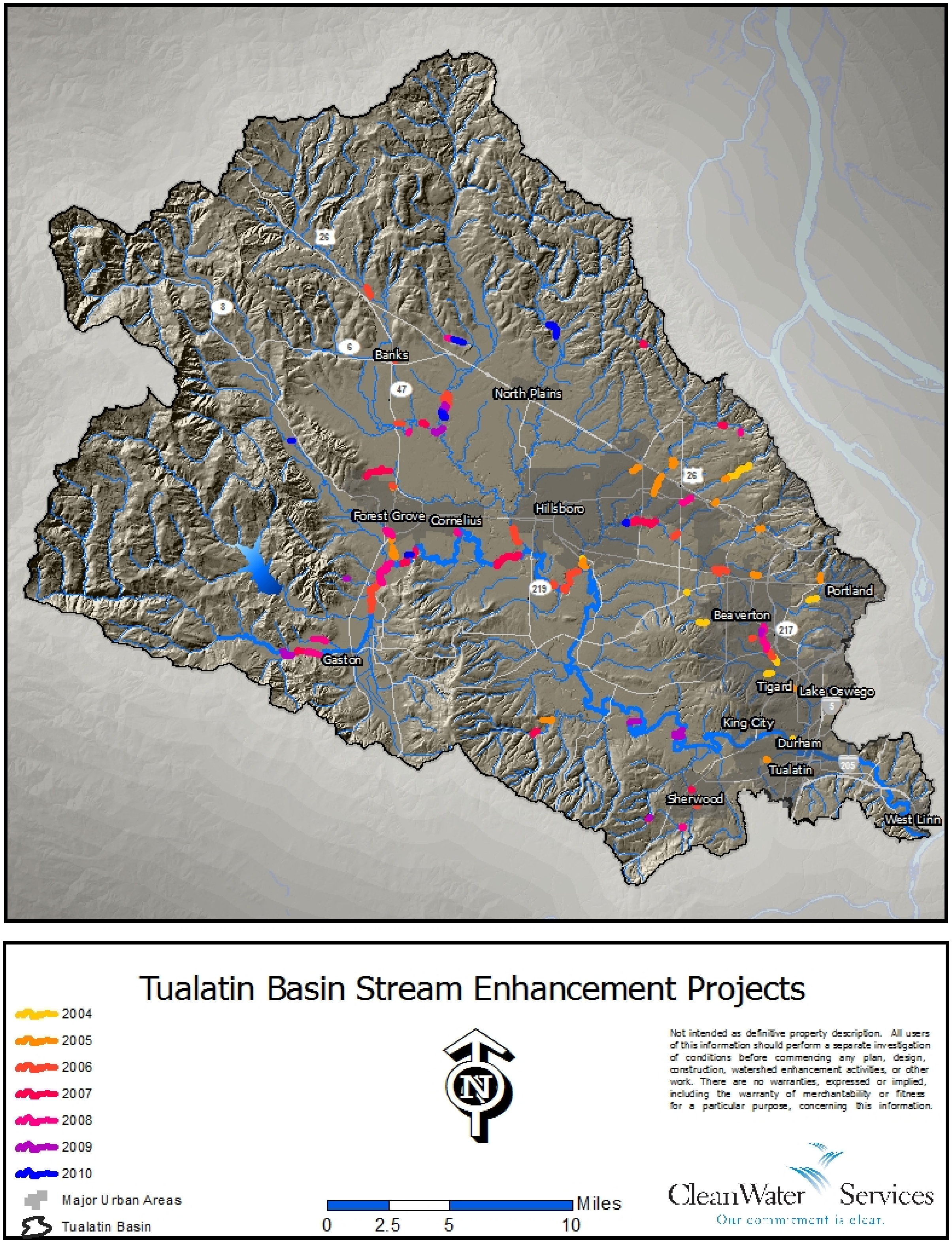

Figure A-3. Stream Enhancement Projects Implemented by Clean Water Services, 2004-2010.

In rural areas, CWS contracts with the Tualatin Soil and Water Conservation District (SWCD) to provide incentives for enrolling landowners in a modified version of the U.S. Department of Agriculture's Conservation Reserve Enhancement Program (ECREP) and Vegetated Buffer Areas for Conservation and Commerce (VEGBACC) programs. The rural ECREP and VEGBACC programs focus on riparian plantings and do not include in-stream work. From 2004-2010, a total of 33 projects were implemented in rural areas of the watershed, which resulted in 19.3 stream miles being planted. See www.cleanwaterservices.org/OurWatershed/Projects for a map of recent CWS riparian restoration and other water quality improvement projects.

In addition to implementing restoration projects, the District also works to improve water quality by augmenting flow in the Tualatin River during the dry season using its stored water in Hagg Lake and Barney Reservoir. From 2004-2010, the District released an average of 34.3 cubic feet per second (cfs) of its stored water during the critical months of July and August to augment flows in the Tualatin River. The augmented flow results in cooler temperatures and higher dissolved oxygen levels in the Tualatin River. Credit for stored water releases are based on the quantity of water released and the percent of the total flow of the Tualatin River the stored water releases constitutes. Between 2004 and 2010, stored water releases provided an average credit of 498 million kcal/day at the Rock Creek Advanced Wastewater Treatment Facility (AWTF) and an average credit of 347 million kcal/day at the Durham AWTF.

A.3.2.2. Restoration Projects Led by Other Organizations

Numerous additional riparian restoration and fish habitat enhancement projects have been completed over the past two decades by diverse stakeholders in the Tualatin River watershed. The Oregon Watershed Enhancement Board (OWEB) is a state agency led by a 17-member citizen board drawn from the public-at-large, tribes, and federal and state natural resource agency boards and commissions. OWEB provides grants to help Oregonians take care of local streams, rivers, wetlands and natural areas. OWEB maintains the Oregon Watershed Restoration Inventory (OWRI) online database (see http://oe.oregonexplorer.info/RestorationTool) to help track Oregonians' voluntary stream and habitat restoration efforts. While the database is managed by OWEB and contains information about grants funded by OWEB, the majority of OWRI entries represent voluntary actions of private citizens and landowners who have worked in partnership with federal, state and local groups to improve aquatic habitat and water quality conditions. Figure A-4 shows the many Tualatin River watershed projects identified in OWRI as occurring between 1995 and 2009. The highlighted projects include riparian, upland, wetland, in-stream, urban and combined restoration projects—the types of projects that likely contributed to the improvements seen in phosphorus, bacteria and chlorophyll *a* levels. Details about individual projects (e.g., project elements, location, funding, participants, etc.) can be accessed through the online OWRI database.

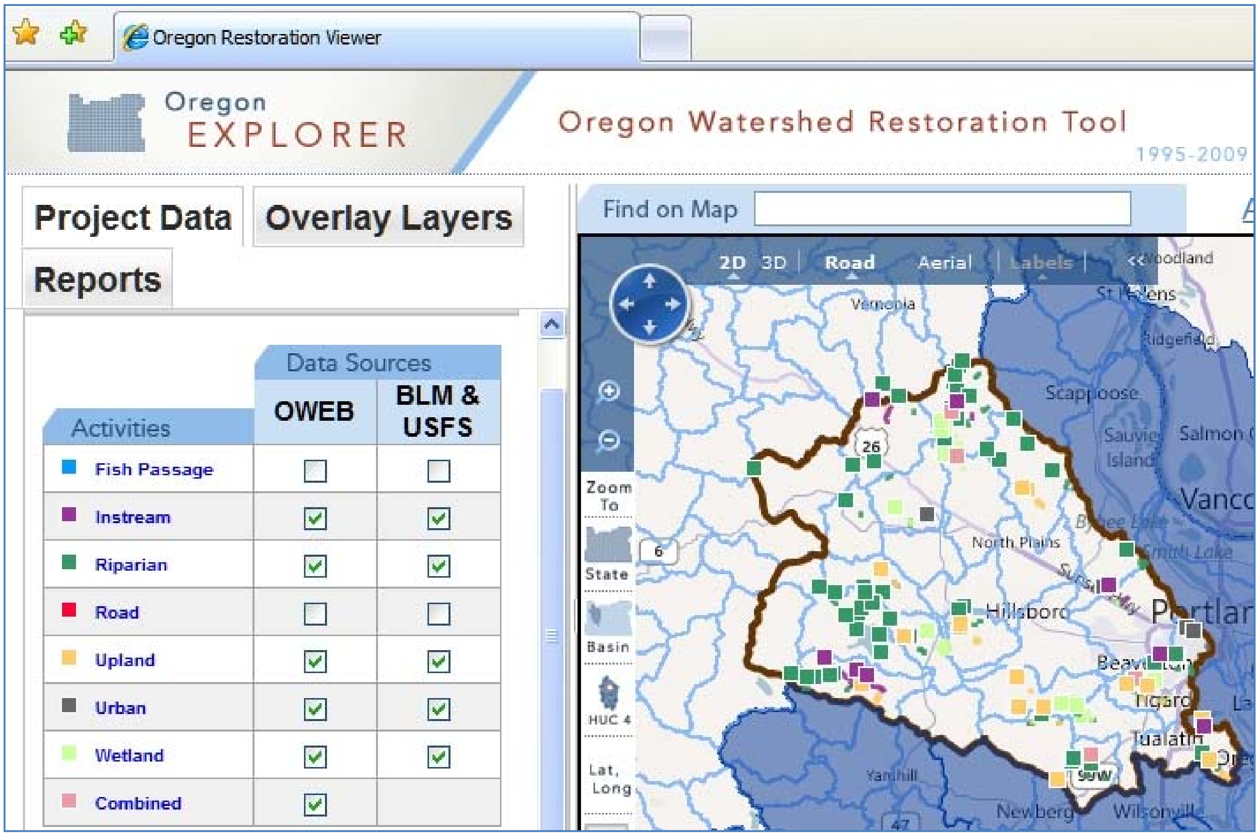

Figure A-4. The online OWRI database includes detailed information about a variety of restoration projects implemented by private citizens and landowners with help from local, state and federal agencies.

The Tualatin River Watershed Council (TRWC), a local watershed-stewardship organization, is also active in restoration efforts. Formed in 1993, TRWC is comprised of 20 local stakeholder representatives that work to promote and encourage sustainability and watershed-wise practices in Tualatin River watershed. The TRWC obtains grant money and works with private landowners to help implement restoration projects. Examples of the projects they have helped to coordinate in the Tualatin River watershed include:

- **Fanno Creek, Moonshadow Park Enhancement Project** (www.trwc.org/council-projects/moonshadow.html). Starting in 1996 TRWC, various Tualatin River watershed partners, and the Tualatin Hills Park and Recreation District (THPRD) began working in a park along the highly urbanized Ash Creek, a tributary of Fanno Creek. Partners and volunteers have removed invasive plants; restored the filtering capacity of riparian areas by planting thousands of native trees, shrubs and herbs; and enhanced the fish habitat in stream channels by placing wood and boulders in and along the creek. In 2006 CWS completed a complementary stormwater project, which included upgrading the outflow and adding a rock-lined catchment at to reduce the potential for erosion and to allow stormwater to better percolate into the wetlands along Ash Creek. Crews planted 345 native trees and shrubs as well as 1,000 wetland plants surrounding the outfall to restore and enhance the upland habitat.

- **Hall Creek Enhancement** (www.trwc.org/basin_projects/hall-creek.html). In this 64-acre project, watershed partners (TRWC, THPRD, CWS, private landowners, SOLV and its volunteer teams) installed more than 45,000 native trees and shrubs to provide shade and increase ecological function along Hall Creek (a tributary of Fanno Creek) from Cornelius Pass Road to 185th Street. The restored area now boasts a diversity of plant communities including forest wetland, riparian forest, upland forest and scrub shrub wetlands.

- **Gales Creek Riparian and Stream Channel Restoration** (http://www.trwc.org/council-projects/gales-creek.html). The Tualatin River Watershed Council coordinated with various local partners including schools, scouts, soil and water conservation districts, SOLV and its volunteer teams, and others to implement numerous projects within the Gales Creek sub-basin over the past decade. Projects have been taking place in multiple places within the sub-basin and include improving in-stream fish habitat, removing invasive plants and restoring native plants in riparian areas, and holding workshops to educate landowners about invasive plants and stream restoration.

- **Upper West Fork Dairy Creek Fish Passage and Water Quality Enhancement Project** (http://www.trwc.org/council-projects/upper_dairy_creek.html). Beginning in 2005, the Tualatin River Watershed Council and the Oregon Parks and Recreation Department have been working to improve fish passage, fish habitat and water quality in the new 1,654-acre L. L. "Stub" Stewart State Park. Efforts have included removing invasive plants, removing culverts that block fish passage, decommissioning unused logging roads and stream crossings, placing logs in the stream to improve fish habitat, re-grading stream banks and planting native plants in riparian areas.

Many other organizations have completed restoration and enhancement projects in the Tualatin River watershed. For instance, CWS has partnered with local municipalities supporting a Tree For All Program that has now exceeded its goals and planted 519,000 trees and shrubs in riparian areas of public lands across urban areas of the watershed. Metro, a local government agency, has acquired lands in the watershed as part of its Greenspaces program, and provides grants to local governments that protect and improve natural areas, water quality and access to nature. Culvert replacements and riparian projects have occurred on both state forest and private forestlands; some are included in Figure A-3. Washington County has also improved many stream crossings on county roads throughout the watershed, improving fish passage as well as addressing erosion issues on these roads.

The Natural Resources Conservation District (NRCS), Tualatin SWCD, and Metro Regional Government (Metro's jurisdiction includes portions of the Tualatin River watershed) have partnered on nine wetland restoration projects totaling 606 acres that were funded in part by the Wetland Reserve Program (WRP). Three other WRP projects, totaling 403 acres, were implemented without Metro's involvement. These projects have restored riparian forest, oak savannah, wet prairie and vernal pool plant communities. The U.S. Fish and Wildlife Service has restored wetlands on the Tualatin River National Wildlife Refuge (along the lower Tualatin River near Sherwood), and is now beginning to develop its Wapato Lake Unit of the refuge on the upper Tualatin River near Gaston.

The projects highlighted above include examples of the diversity of the extensive efforts that have been made throughout the Tualatin River watershed over the last 20 years. Please note that these examples represent only a small portion of the wide spectrum of projects that urban and rural stakeholders have implemented throughout the watershed.

A.3.2.3 Restoration Projects in Agricultural Areas

The steep terrain of the Tualatin River headwaters is largely forested. However, the flatter lands and rolling hills sandwiched between the urban and forested lands in the Tualatin River watershed support agricultural lands. These fertile soils have made Washington County the third largest agricultural producer of nursery stock and crops in Oregon. The *Tualatin River Sub-basin Agricultural Water Quality Management Plan* (Agricultural Water Quality Management Act (ORS 568.900-933 and OAR 603-095-0140) requires that all agricultural activities along perennial streams maintain vegetative buffers. Vegetative buffers keep streams healthy by filtering chemicals, manure, and other pollutants; providing shade that keeps water temperature low for trout and salmon; and protecting against excessive erosion of streambanks. Riparian buffers also improve fish and wildlife habitat by providing large wood, food, shelter, and migration corridors.

The Tualatin SWCD offers technical and financial assistance for landowners to establish voluntary water quality farm plans and farm conservation plans. Table A-1 describes the assistance offered and accomplishments made by the Tualatin SWCD since 2000. Included are the number of technical assistance inquiries, site visits, completed plans, and acres of farm land addressed in the Tualatin River watershed.

Table A-1. Summary of Water Quality Activities Implemented by the Tualatin Soil and Water Conservation District, 2000 through 2011.

Year	WQ Technical Assistance[1] Inquiries	Site visits	Farm Plans completed	Acres addressed in Plans
2000-2001	N/A[2]	30	10	N/A
2001-2002	1106	43	29	2194
2002-2003	529	N/A	10	1070
2003-2004	N/A	N/A	N/A	N/A
2004-2005	N/A	38	22	N/A
2005-2006	N/A	4	N/A	N/A
2006-2007	90	41	N/A	N/A
2007-2008	82	36	4	350
2008-2009	129	32	5	104
2009-2010	75	22	7	537
2010-2011	65	33	14	484
Totals	**2076**	**279**	**101**	**4739**

[1] Water Quality Technical Assistance Inquiries include any general soil, management area plan or water quality related topics.
[2] N/A: Information not available

CWS also implements the ECREP and the VEGBACC programs, which provide shade credits for CWS' watershed permit. Both programs offer planting assistance, annual payments, and financial incentives to landowners who enroll stream side property. These programs (summarized in more detail in Section A.3.2.1) are funded by CWS and implemented in partnership with the Farm Service Agency, the NRCS, CWS, OWEB, and the Oregon Water Trust.

In 2009 Tualatin SWCD launched a "Manure Link" program (www.swcd.net/manure-ads) for the Tualatin River watershed. The program helps livestock owners and managers dispose of unwanted manure, provides a source of fertilizer to interested landowners in Washington County, and protects water resources by removing a potential source of bacteria and nutrient pollution from farms. To advertise their manure, farmers post information about the availability and type of manure directly on the SWCD's web site.

A.4. Results: Restoration Efforts Led to Declines in Levels of Multiple Pollutants

Watershed-wide restoration and pollution reduction efforts have led to widespread and significant water quality improvements. CWS maintains a comprehensive monitoring network throughout the Tualatin River watershed which captures water quality throughout almost all of the HUC-12 watersheds (Figure A-5).

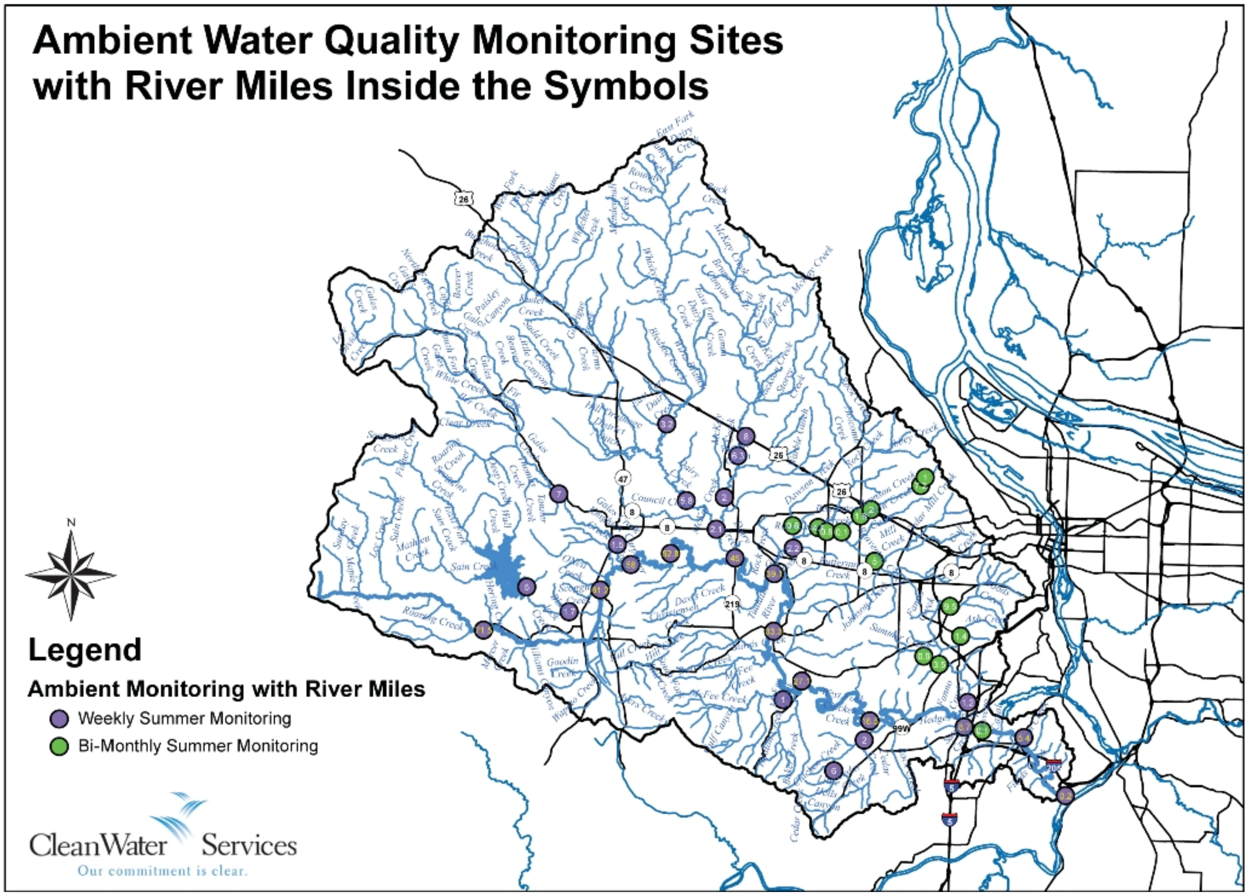

Figure A-5. Clean Water Services' Ambient Monitoring Station Network.

Total phosphorus concentrations in Tualatin streams have declined since the adoption of the 1988 TMDL (Figure A-6). The occurrence of pH violations has markedly declined in the same time period, and while the trend for chlorophyll *a* has been more variable, it too, has decreased in the Tualatin since 1989. While several factors influence bloom formation, both water quality models and experience to date indicate that maintaining lower total phosphorus concentrations is helping to control excess algal growth.

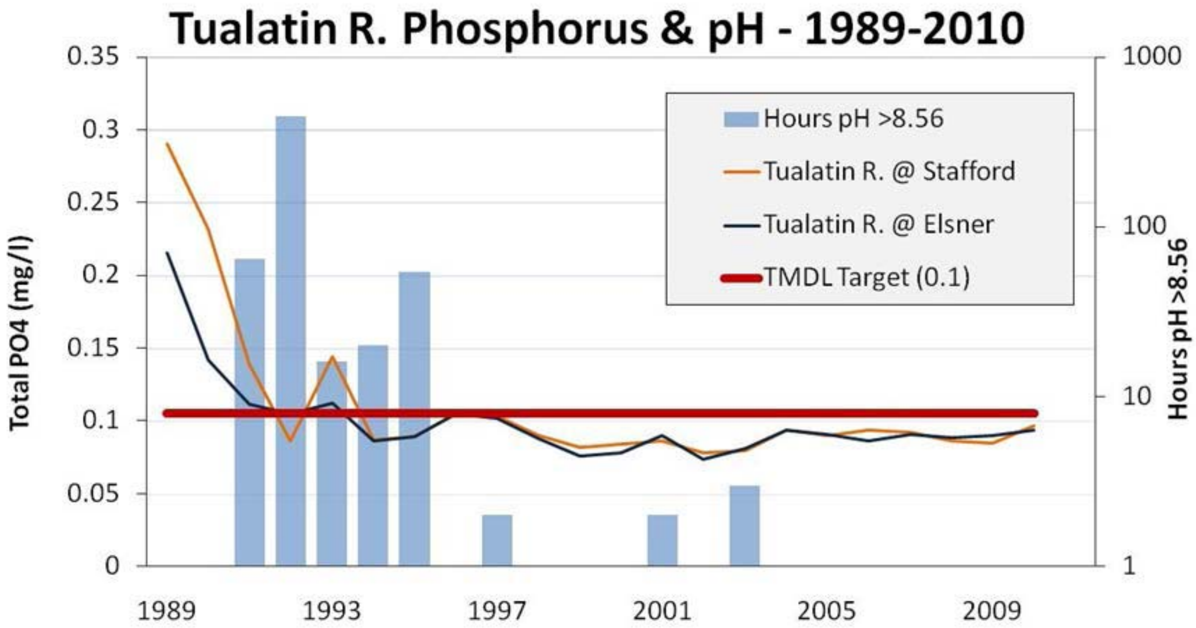

Figure A-6. Total phosphorus concentrations at two sites in the Lower Tualatin River, juxtaposed with the number of hours of pH violations each summer at the Lake Oswego Diversion Dam. [Note: The bar graph reflects zero hours of pH violations since 2004 (not missing data). The Elsner and Stafford sites are at river miles 16.5 and 5.4, respectively.]

In 2011 CWS performed trend analyses on total phosphorus, *E. coli* and chlorophyll *a* data collected between 1992 and 2010. A seasonal Kendall trend test shows significantly improving trends (at a 90 percent confidence level or greater) in one or more pollutants contributing to impairments in 20 of 27 HUC-12 watersheds (Figure A-7), including:

(1) HUC 170900100101 (Upper Gales Cr)
(2) HUC 170900100102 (Middle Gales Cr)
(3) HUC 170900100103 (Lower Gales Cr)
(4) HUC 170900100203 (Scoggins Cr/Sain Cr)
(5) HUC 170900100204 (Middle Tualatin R)
(6) HUC 170900100205 (Lower Tualatin R)
(7) HUC 170900100206 (Tualatin R)
(8) HUC 170900100304 (Upper E. Fork Dairy)
(9) HUC 170900100305 (Lower E. Fork Dairy)
(10) HUC 170900100306 (Upper McKay Cr)
(11) HUC 170900100401 (Beaverton Cr/ Bronson Cr)
(12) HUC 170900100402 (Upper Rock Cr/Tualatin R)
(13) HUC 170900100403 (Lower Rock Cr/Tualatin R)
(14) HUC 170900100404 (Davis Cr/Tualatin R)
(15) HUC 170900100405 (Mcfee Cr)
(16) HUC 170900100406 (Christensen Cr)
(17) HUC 170900100501 (Chicken Cr)
(18) HUC 170900100502 (Fanno Cr)
(19) HUC 170900100503 (Rock Cr/L. Tualatin)
(20) HUC 170900100504 (Lower Tualatin/Saum Cr)

The seven remaining watersheds (not included as part of this SP-12 submission) either have no data available or the data show no significantly decreasing trends (see Attachment B for Seasonal Kendall results for all sampling stations).

Table A-2 shows details about each sub-basin, the impairments listed as of 2002, and which of these three pollutants are showing significant decreases at representative monitoring stations. All statistically significant decreasing trends are indicated with a "yes" in the trend column. However, only significantly

Figure A-7. Data show that numerous Tualatin River sub-basins have significantly decreasing levels of phosphorus, chlorophyll *a* and bacteria.

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds				Significant Improvement?				
1. Gales Creek:								
(1-1) HUC 170900100101 (Upper Gales Creek):	Beaver and N. and S. Fork Gales creeks.						GALES CREEK (RM 0-11: Ammonia, DO, **E.Coli**, Phos, Temp; RM 11-20.6: E.Coli fall/winter)	No data; however, E. coli downstream has decreased. BMPs implemented have likely led to similar improvements here as well.
(1-2) HUC 170900100102 (Middle Gales Creek):	Fir, Gales, Iller and Bateman creeks	Gales Creek at Stringtown	7	No	Yes	NA	GALES CREEK (RM 0-11: Ammonia, DO, **E.Coli,** Phos, Temp; RM 11-20.6: **E.Coli** fall/winter)	
(1-3) HUC 170900100103 (Lower Gales Creek):	Gales, Roderick and Clear creeks	Gales Creek at HWY 47	1.5	Yes	No	No	GALES CREEK (RM 0-11: Ammonia, DO, E.Coli, **Phos**, Temp; RM 11-20.6: E.Coli fall/winter)	
2. Upper Tualatin River:								
(2-1) HUC 170900100201 (Upper Tualatin River):	Lee and Sunday creeks and the Upper Tualatin River	Tualatin River at Cherry Grove	71.5	Yes	Yes	No	TUALATIN RIVER (RM 0-80.67: Iron, manganese)	No listed impairments improved

[1] The only impaired parameters that do not have an approved TMDL are iron and manganese. DEQ anticipates that listings for iron and manganese will be removed from the impaired waters list in the upcoming assessment cycle because DEQ recently changed (with EPA approval) these criteria. Both pollutants meet the new criteria.

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds				Significant Improvement?				
(2-2) HUC 170900100202 (Wapato Creek):	Wapato, Goodin, Hill, and Ayers creeks							No listed waterbodies in Wapato Creek
(2-3) HUC 170900100203 (Scoggins Creek/ Sain Creek):	Scoggins, Sain and Tanner creeks	Scoggins Creek at HWY 47	1.7	Yes	No	No	SCOGGINS CREEK (RM: 0-5.1: Ammonia, DO, **Phos**)	
(2-4) HUC 170900100204 (Roaring Creek/ Tualatin River):	Upper Tualatin/Lee Falls, Roaring, Hering, Black Jack and Mercer creeks	Tualatin River at Cherry Grove	71.5	Yes	Yes	No	TUALATIN RIVER (RM 0-80.67: Iron, manganese)	Tualatin not listed for TP above mile 69.9; see next line.
	Upper Tualatin/Lee Falls, Roaring, Hering, Black Jack and Mercer creeks	Tualatin River at Springhill	61.2	Yes	Yes	No	TUALATIN RIVER (RM 0-69.9: Chlorophyll a, **Phos**; RM 0-80.67: Iron, manganese)	Lower portion of HUC includes impaired water
(2-5) HUC 170900100205 (Carpenter Creek/ Tualatin River):	Carpenter, Dilley and Harris creeks	Tualatin River at Golf Course	52.8	Yes	No	No	TUALATIN RIVER (RM 0-69.9: Chlorophyll a, **Phos**); CARPENTER CREEK (RM 0-6.3: E.Coli, **Phos**);	
(2-6) HUC 170900100206 (City of Forest Grove/ Tualatin River):	City of Forest Grove-Tualatin River	Tualatin River at Golf Course	52.8	Yes	No	No	TUALATIN RIVER (RM 0-69.9: Chlorophyll a, **Phos**; RM 0-80.67: Iron, manganese)	
	Cornelius and Blooming creeks, Middle Tualatin River and Jackson Bottom	Tualatin River at HWY 219	45	Yes	No	No	TUALATIN RIVER (RM 0-69.9: Chlorophyll a, **Phos**; RM 0-80.67: Iron, manganese)	This second monitoring site captures this subwatershed

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds				Significant Improvement?				
3. Dairy Creek								
(3-1) HUC 170900100301 (Upper West Fork Dairy):	**Williams, Mendenhall, Whitcher, Burghalzer, and W. Fork Dairy creeks**	**None**					WEST FORK DAIRY (RM 0-23.7: DO, E.Coli, Phos, Temp). WILLIAMS CANYON (RM 0-2.4: DO, FC, Phos, Temp)	No data
(3-2) HUC 170900100302 (Middle West Fork Dairy):	Garrigus, Sadd, Park Farms, Cedar Canyon, and W.F. Dairy creeks.	None					WEST FORK DAIRY (RM 0-23.7: DO, E.Coli, Phos, Temp).	No data
(3-3) HUC 170900100303 (Lower West Fork Dairy):	Lousignot and W. Fork Dairy creeks	Dairy Creek at Susbauer	5.8	No	No	NA	WEST FORK DAIRY (RM 0-23.7: DO, E.Coli, Phos, Temp).	No significant improvements
(3-4) HUC 170900100304 (Upper East Fork Dairy):	Rock, Denny, Murtagh, Plentywater and E. Fork Dairy creeks	None					EAST FORK DAIRY (RM 0-13.5: **Phos**, pH, Temp)	No data available; since the watershed downstream has decreased for TP, assume that BMPs led to similar improvements here.
(3-5) HUC 170900100305 (Lower East Fork Dairy):	Bledsoe, Gumm, and E. Fork Dairy creeks	E.F. Dairy Creek Harrington	3.2	Yes	No	NA	EAST FORK DAIRY (RM 0-13.5: **Phos**, pH, Temp)	
(3-6) HUC 170900100306 (Upper McKay	McKay, Brunswick Canyon, and Jackson creeks	McKay Creek at Sunset	8	Yes	NA	NA	McKAY CREEK (RM 0-15.8: Ammonia, E.Coli, **Phos**, Temp; RM 15.8-22.7: **Phos**)	

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds	Drainages within each HUC-12 watershed	Applicable Monitoring Site	River Mile	TP	*E. coli*	Chlor	Listed Impairments (as of 2002)[1]	Notes
				Significant Improvement?				
Creek):								
(3-7) HUC 170900100307 (Lower McKay Creek):	McKay, Storey, Warbel, and North Hillsboro creeks.	McKay @ Hornecker	2	No	No	No	McKAY CREEK (RM 0-15.8: Ammonia, E.Coli, Phos, Temp)	No significant improvements in listed parameters
(3-8) HUC 170900100308 (Lower Dairy Creek):	Council and Dairy creeks	Dairy Creek at HWY 8	2.1	No	No	Yes	COUNCIL CREEK (RM 0-6.2: DO, Phos); DAIRY CREEK (RM 0-10.1: Ammonia, E.Coli, Phos,Temp)	No significant improvements in listed parameters
4. Middle Tualatin R/Rock Creek:								
(4-1) HUC 170900100401 (Beaverton Cr):	Bronson, Cedar Mill, Willow, Rock/Lower Beaverton, Upper & Middle Beaverton, Johnson and Johnson (south) creeks	Beaverton Creek at Cornelius Pass Rd; Beaverton Creek at Guston	1.2; 0.8	No	No	Yes	BEAVERTON CREEK (RM 0-2.1: DO, FC, Phos; RM 0-9.8: DO, E.Coli, Phos, Temp). BRONSON CREEK (**Chlorophyll a**, DO, E Coli, Phos, Temp). JOHNSON CREEK (RM 0-3.7: FC, Phos, Temp); JOHNSON CREEK--South (RM 0-4: DO, E.Coli, Phos, Temp), CEDAR MILL CREEK (Fecal Col)	Bronson Creek (a tributary of Beaverton, is listed for Chlorophyll
(4-2) HUC 170900100402 (Upper Rock Creek/ Tualatin R):	Upper Rock, Holcomb, Abbey, Bethany and Rock creeks	Rock Creek at Quatama	4.7	Yes	No	No	ROCK CREEK (RM 0-18.2: Ammonia, Chlorophyll, DO, E.Coli, **Phos**, Temp)	
(4-3) HUC 170900100403	Dawson, Lower Rock creeks	Rock Creek at HWY 8; Rock	1.2; 2.2	Yes	No	Yes	ROCK CREEK (RM 0-18.2: Ammonia, **Chlorophyll**, DO,	

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds	Drainages within each HUC-12 watershed	Applicable Monitoring Site	River Mile	TP	*E. coli*	Chlor	Listed Impairments (as of 2002)[1]	Notes
				Significant Improvement?				
(Lower Rock Creek/ Tualatin R):		Creek at Brookwood					E.Coli, **Phos**, Temp)	
(4-4) HUC 170900100404 (Davis Creek/ Tualatin River):	Butternut Creek, David Creek, Tualatin River	Tualatin River at Farmington	33.3	No	No	Yes	TUALATIN RIVER (RM 0-44.7: Ammonia, Temp; RM 0-10.5: Algae; RM 0-69.9: **Chlorophyll a**, Phos; RM 0-80.67: Iron, manganese); BUTTERNUT CREEK (RM 0-5.3: DO,FC, Phos, Temp).	
(4-5) HUC 170900100405 (Mcfee Creek):	Baker, Heaton, Jaquith & Mcfee creeks	McFee Creek at HWY 219	1	Yes	No	No	McFee CREEK (RM 0-8.3: DO, FC, **Phos**); HEATON CREEK (RM 0-5.2: FC, **Phos**).	
(4-6) HUC 170900100406 (Christensen Creek/ Tualatin River):	Jackson Reservoir, Lower-Middle Tualatin River and Christensen and Burris creeks	Tualatin River at Scholls	27.1	Yes	Yes	Yes	TUALATIN RIVER (RM 0-44.7: Ammonia, Temp, RM 0-10.5: Algae; RM 0-69.9: **Chlorophyll a, Phos**; RM 0-80.67: Iron, manganese); BURRIS CREEK (RM 0-6: **Chlorophyll a**, DO, **Fecal Coliform, Phos**); CHRISTENSEN CREEK (RM 0-6.4: DO, **Phos, Fecal Col)**	

Table A-2. Summary of Tualatin River HUC-12 watersheds, impairments listed as of 2002, representative monitoring sites, and significant improvements in water quality. The 20 HUC-12 watersheds highlighted in green qualify under SP-12 (significant improvements in one or more pollutants causing impairment).

Tualatin River's HUC-12 watersheds	Drainages within each HUC-12 watershed	Applicable Monitoring Site	River Mile	TP	*E. coli*	Chlor	Listed Impairments (as of 2002)[1]	Notes
				Significant Improvement?				
5. Tualatin River/Fanno Creek								
(5-1) HUC 170900100501 (Chicken Creek):	Chicken & Cedar creeks	Chicken Creek at @ Scholls Sherwood	2	No	Yes	No	CHICKEN CR (RM 0-7: Ammonia, DO, **E. Coli,** Phos); CEDAR CREEK (RM 0-6.8: Chlorophyll a, **Fecal Coliform**, Phos, Temp)	
(5-2) HUC 170900100502 (Fanno Creek):	Ash, Summer and Fanno creeks	Fanno Creek at Durham	1.2	No	Yes	Yes	FANNO CREEK (RM 0-13.9: Ammonia, Dieldrin, DO, **E. Coli**, Phos, Temp); SUMMER CREEK (RM 0-4: DO, **Fecal Coliform**, Phos, Temp); ASH CREEK (RM 0-3.7: DO, **Fecal Coliform**, Phos, Temp)	
(5-3) HUC 170900100503 (Rock Cr south/ Lower Tualatin):	Lower Tualatin/Scholls, Lower Tualatin-King City, and Rock Creek (south)	Tualatin River at Boones Ferry	8.7	Yes	Yes	Yes	TUALATIN RIVER (RM 0-44.7: Ammonia, Temp, RM 0-10.5: Algae; RM 0-69.9: **Chlorophyll a, Phos**; RM 0-80.67: Iron, manganese)	
(5-4) HUC 170900100504 (Lower Tualatin/ Saum Creek):	Tualatin mouth, Lower Tualatin/Oswego Canal, Hedges & Saum creeks.	Tualatin River at Weiss	0.2	Yes	Yes	Yes	TUALATIN RIVER (RM 0-44.7: Ammonia, Temp, RM 0-10.5: Algae; RM 0-69.9: **Chlorophyll a, Phos**; RM 0-80.67: Iron, manganese); HEDGES CREEK: DO, **E.Coli, Phos**, Temp)	

decreasing trends in pollutants that have been identified as sources of impairments within that watershed are highlighted in green. This distinction has been made on Table A-2 to highlight those trends that fall under the SP-12 criteria. The SP-12 criteria distinguish watersheds that have documented impairments based on the state's list of impaired waterbodies (these are waterbodies that are either on the Clean Water Act section 303(d) list or classified as impaired but with the TMDL in place). Not all Tualatin River watersheds were listed as impaired as of Oregon's 2002 Integrated Report; thus, not all are eligible as SP-12 watersheds. However, the improvements seen across many of the Tualatin River watersheds highlight the extent of the widespread water quality improvements that have taken place throughout the watershed.

Some headwater tributaries do not have monitoring sites in the proximity of the mouth of the HUC-12 watersheds. In two cases, because the HUC-12 watersheds immediately downstream show significantly improving water quality thanks to watershed-wide restoration efforts, we assumed similar improvements in the upstream HUC-12 watersheds. These include (1) HUC 170900100101 (Upper Gales Creek) and (2) HUC 170900100304 (Upper East Fork Dairy Creek).

In two tributary sub-basins that are part of this SP-12 submission, data show an increasing trend in one or two pollutants. These trends are specific to the individual sub-watershed (e.g., they do not extend above or below that individual sub-watersheds) and are considered anomalies caused by a specific source or sources above the monitoring station. These increasing trends include:

(1) HUC 170900100103 (Lower Gales Creek): Data show that this watershed has significantly increasing levels of *E. coli*. However, the watershed just upstream (HUC 170900100102, Middle Gales Creek) shows significantly decreasing levels of *E. coli*. The watershed immediately downstream (HUC 170900100206, City of Forest Grove/Tualatin River) shows no significant trends in E. coli. DEQ will investigate the possible sources of E. coli impacting this watershed. This sub-basin shows significantly decreasing levels of phosphorus, as is seen elsewhere in the Tualatin River watershed, so this sub-basin is included in the SP-12 submission for phosphorus.

(2) HUC 170900100402 (Upper Rock Creek/Tualatin R): Data show increasing trends in both *E. coli* and chlorophyll *a*. However, data also show that chlorophyll *a* is significantly decreasing in the subwatersheds just upstream (HUC 170900100401, Beaverton Cr) AND downstream (HUC 170900100403, Lower Rock Creek/Tualatin R). Data show no trends in *E. coli* either upstream or downstream. DEQ will investigate the possible pollutant sources leading to these anomalous increasing trends within this subwatershed. This sub-basin shows significantly decreasing levels of phosphorus, as is seen elsewhere in the Tualatin River watershed, so this sub-basin is included in the SP-12 submission for phosphorus.

A.5. Summary

Thanks to a concerted, watershed-wide effort, water quality conditions in the Tualatin River watershed have improved since the adoption of the first TMDLs in 1988. The incidence of algae blooms in the lower river has decreased, as demonstrated by lower chlorophyll *a* concentrations, no pH violations, higher minimum dissolved oxygen levels, and fewer hours when dissolved oxygen is supersaturated. These improvements coincide with lower total phosphorus concentrations that now meet the 2001 TMDL phosphorus targets in the mainstem Tualatin River. This success suggests that the TMDL target for total phosphorus should remain in place to maintain water quality. Efforts to control urban stormwater and agricultural runoff are also helping to reduce bacteria levels in several areas, especially in the lower Tualatin River watershed. These efforts will continue and should generate additional improvements in the near future.

A TMDL for temperature was issued in 2001. No data have been collected that demonstrate lower water temperatures; however, more than 35 miles of streams and creeks have been planted with shade trees—some on creeks sufficiently narrow that the stream is fully shaded after less than 10 years of growth. Additional riparian planting and continued growth of the reaches already planted are expected to improve water temperatures in the future. Flow augmentation from Henry Hagg Lake and Barney Reservoir have also lowered summertime Tualatin River water temperatures and improved water quality. Many of the tributaries of the Tualatin River do not have adequate water. CWS is augmenting stream flows by releasing its stored water in several tributaries of the Tualatin River during the dry season. Data have shown that the flow restoration program has resulted in lower temperatures, higher dissolved oxygen levels and overall improved water quality in the tributaries. CWS plans to expand the tributary augmentation program in the future.

This report shows improvements in water quality for at least one of three parameters across 21 of the 27 small watersheds that make up the Tualatin River Watershed. The report also touches on the many efforts that have caused these widespread improvements. Declining water quality in a few small watersheds, along with the need to maintain the TMDL pollutant targets in order to maintain the improved water quality indicate that the TMDL is working, and should remain in place. The extensive number of projects and stakeholders working to improve water quality in the Tualatin ensure that conditions will continue to improve.

Attachment B

Oregon's Tualatin River Watershed
Statistical Analyses

SP-12 Submission Option 2a, Supporting Documentation

B.1. Seasonal Kendall Test Results

Clean Water Services (CWS) performed statistical analyses on Tualatin River basin data to identify significant trends in water quality between 1992 and 2010. CWS analyzed data for chlorophyll *a*, total phosphorus, and *E. coli* on both the mainstem Tualatin River and many Tualatin tributaries. More than half of all results showed significant improvements in water quality (see green highlighted cells in Table B-1 to Table B-6). In 20 HUC-12 watersheds these results indicate significant improvements in pollutants that were listed as sources of impairment on Oregon's 2002 list of impaired waters. Significant improvements are also seen in pollutants not listed as causing impairments. For information on the results relative to specific subwatersheds and their listed impairments, see Table A-2 in Attachment A.

Please note that at four tributary stream sites, trend results showed significantly increases in pollutants (see red text in Tables B-4 to B-6); three of these instances occur within two watersheds that qualify for SP-12. These trends are specific to the individual sub-watershed (e.g., they do not extend above or below that individual sub-watersheds) and are considered anomalies caused by a specific source or sources above the monitoring station. See Attachment A, Section A-4 for more information.

Table B-1. Summary of Seasonal Kendall tests for Total Phosphorus at river sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Tualtin River at Cherry Grove	71.5	3701715	TR @ CHER GR	114	123	0.120	2.5076	0.01215	0.0250	0.000000	Yes
Tualatin River at Springhill	61.2	3701612	TR @ SPRNGHL	114	-311	-0.303	-4.6324	0.00000	0.0534	-0.000001	Yes
Tualatin River at Golf Course	52.8	3701528	TR @ GOLF CR	114	-345	-0.336	-4.9330	0.00000	0.1155	-0.000002	Yes
Tualatin River at HWY 219	45.0	3701450	TR @ HWY 219	114	-150	-0.146	-2.1303	0.03315	0.1163	-0.000001	Yes
Tualatin River at Farmington	33.3	3701333	TR @ FARMNGT	96	23	0.032	0.4040	0.68619	0.0692	0.000001	No
Tualatin River at Scholls	27.1	3701271	TR @ SCHOLLS	114	-152	-0.148	-2.1605	0.03073	0.1517	-0.000002	Yes
Tualatin River at Boones Ferry	8.7	3701087	TR @ BOONES	114	-127	-0.124	-1.8013	0.07166	0.1330	-0.000001	Yes
Tualatin River at Weiss	0.2	3701002	TR @ WEISS B	114	-238	-0.232	-3.3908	0.00070	0.1704	-0.000002	Yes

Table B-2. Summary of Seasonal Kendall tests for *E. Coli* at river sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Tualtin River at Cherry Grove	71.5	3701715	TR @ CHER GR	107	-187	-0.208	-2.9204	0.00350	111.26	-0.0023	Yes
Tualatin River at Springhill	61.2	3701612	TR @ SPRNGHL	106	-133	-0.150	-2.1007	0.03567	237.51	-0.0040	Yes
Tualatin River at Golf Course	52.8	3701528	TR @ GOLF CR	106	-3	-0.003	-0.0318	0.97464	120.25	0.0000	No
Tualatin River at HWY 219	45.0	3701450	TR @ HWY 219	106	6	0.007	0.0795	0.93666	148.75	0.0000	No
Tualatin River at Farmington	33.3	3701333	TR @ FARMNGT	91	18	0.028	0.3346	0.73796	74.12	0.0005	No
Tualatin River at Scholls	27.1	3701271	TR @ SCHOLLS	106	-149	-0.169	-2.3508	0.01873	163.98	-0.0027	Yes
Tualatin River at Boones Ferry	8.7	3701087	TR @ BOONES	106	-140	-0.158	-2.2113	0.02702	148.58	-0.0025	Yes
Tualatin River at Weiss	0.2	3701002	TR @ WEISS B	106	-409	-0.463	-6.4838	0.00000	349.48	-0.0082	Yes

Table B-3. Summary of Seasonal Kendall tests for Chlorophyll-*a* at river sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Tualtin River at Cherry Grove	71.5	3701715	TR @ CHER GR	26	-11	-0.250	-1.2217	0.22182	9.84	-0.0003	No
Tualatin River at Springhill	61.2	3701612	TR @ SPRNGHL	37	18	0.188	1.2465	0.21258	-4.39	0.0002	No
Tualatin River at Golf Course	52.8	3701528	TR @ GOLF CR	37	2	0.021	0.0733	0.94155	-1.32	0.0001	No
Tualatin River at HWY 219	45.0	3701450	TR @ HWY 219	43	19	0.143	1.0625	0.28801	-1.91	0.0002	No
Tualatin River at Farmington	33.3	3701333	TR @ FARMNGT	95	-322	-0.457	-5.9877	0.00000	17.42	-0.0004	Yes
Tualatin River at Scholls	27.1	3701271	TR @ SCHOLLS	114	-526	-0.513	-7.5015	0.00000	22.91	-0.0005	Yes
Tualatin River at Boones Ferry	8.7	3701087	TR @ BOONES	114	-540	-0.526	-7.6984	0.00000	89.51	-0.0022	Yes
Tualatin River at Weiss	0.2	3701002	TR @ WEISS B	114	-639	-0.623	-9.1152	0.00000	144.50	-0.0036	Yes

Significantly decreasing values

Table B-4. Summary of Seasonal Kendall tests for Total Phosphorus at tributary sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Beaverton Cr at Cornelius Pass Rd, Beaverton Cr at Guston	1.2 0.8	3821012 3821008	BVTN @ CNLUS PASS-GUSTON	113	-34	-0.034	-0.4773	0.63314	0.2254	-0.000001	No
Chicken Creek at @ Scholls Sherwood	2	3835020	CHICKEN @ SCH-SHER	110	-90	-0.094	-1.3406	0.18005	0.1474	-0.000001	No
Dairy Creek at HWY 8	2.1	3815021	DAIRY @ HWY 8	114	161	0.157	2.2878	0.02215	0.0571	0.000002	Yes
Fanno Creek at Durham	1.2	3840012	FANNO @ DURHAM	110	3	0.003	0.0301	0.97596	0.1455	0.000000	No
Gales Creek at HWY 47	1.5	3810015	GALES @ NEW HWY 47	114	-242	-0.236	-3.4478	0.00057	0.0910	-0.000001	Yes
McFee Creek at HWY 219	1	3811010	MCFEE @ HWY 219	40	-40	-0.351	-2.5495	0.01079	0.2855	-0.000005	Yes
McKay @ Hornecker	2	3816020	MCKAY @ HORN	96	15	0.021	0.2575	0.79676	0.0953	0.000000	No
Rock Creek at HWY 8 Rock Creek at Brookwood	1.2 2.2	3820012 3820022	ROCK @ HWY 8-BROOK	114	-199	-0.194	-2.8300	0.00465	0.3312	-0.000003	Yes
Rock Creek at Quatama	4.7	3820047	ROCK @ QUATAMA	100	-175	-0.223	-3.0112	0.00260	0.3214	-0.000004	Yes
Scoggins Creek at HWY 47	1.7	3805017	SCOGGINS @ 47	114	-216	-0.211	-3.4878	0.00049	0.0250	0.000000	Yes
Dairy Creek at Susbauer	5.8	3815058	DAIRY @ SUSB	30	-12	-0.200	-1.1000	0.27133	0.3306	-0.000006	No
E. Fork Dairy Creek Harrington Rd	3.2	3818032	EFD HARRINGTON RD	22	-16	-0.533	-2.3146	0.02064	0.3935	-0.000009	Yes
Gales Creek at Stringtown	7	3810070	GALES @ STRINGTOWN	30	-13	-0.217	-1.2061	0.22780	0.0855	-0.000001	No
McKay Creek at Sunset	8	3816080	MCKAY @ SUNS	22	-14	-0.467	-2.0059	0.04486	0.8211	-0.000019	Yes

Table B-5. Summary of Seasonal Kendall tests for *E. Coli* at tributary sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Beaverton Cr at Cornelius Pass Rd, Beaverton Cr at Guston	1.2 0.8	3821012 3821008	BVTN @ CNLUS PASS-GUSTON	106	-104	-0.118	-1.6366	0.10171	689.86	-0.0109	No
Chicken Creek at @ Scholls Sherwood	2	3835020	CHICKEN @ SCH-SHER	103	-253	-0.303	-4.1698	0.00003	1257.70	-0.0272	Yes
Dairy Creek at HWY 8	2.1	3815021	DAIRY @ HWY 8	107	60	0.067	0.9249	0.35502	14.35	0.0058	No
Fanno Creek at Durham	1.2	3840012	FANNO @ DURHAM	103	-176	-0.211	-2.9011	0.00372	1192.42	-0.0225	Yes
Gales Creek at HWY 47	1.5	3810015	GALES @ NEW HWY 47	107	173	0.192	2.7004	0.00693	-220.44	0.0098	Yes
McFee Creek at HWY 219	1	3811010	MCFEE @ HWY 219	28	-1	-0.019	0.0000	1.00000	463.20	-0.0062	No
McKay @ Hornecker	2	3816020	MCKAY @ HORN	84	-49	-0.090	-1.0727	0.28341	434.83	-0.0061	No
Rock Creek at HWY 8 Rock Creek at Brookwood	1.2 2.2	3820012 3820022	ROCK @ HWY 8-BROOK	107	9	0.010	0.1257	0.90001	240.00	0.0000	No
Rock Creek at Quatama	4.7	3820047	ROCK @ QUATAMA	93	167	0.247	3.1941	0.00140	-814.17	0.0274	Yes
Scoggins Creek at HWY 47	1.7	3805017	SCOGGINS @ 47	107	-47	-0.052	-0.7214	0.47068	49.60	-0.0007	No
Dairy Creek at Susbauer	5.8	3815058	DAIRY @ SUSB	30	-8	-0.133	-0.7000	0.48393	1368.66	-0.0293	No
Gales Creek at Stringtown	7	3810070	GALES @ STRINGTOWN	30	-30	-0.500	-2.9000	0.00373	1763.05	-0.0415	Yes

Table B-6. Summary of Seasonal Kendall tests for Chlorophyll-*a* at tributary sites

Sample Site	River Mile	LOCCOD	Column Name	N	Seasonal Kendall Test						
					S_ALL	TAU_ALL	Z_ALL	PVAL_ALL	SEAINTER	SEASLOPE	Significant?
Beaverton Creek at Cornelius Pass Rd	1.2	3821012	BVTN @ CNLUS PASS	31	-21	-0.323	-1.8926	0.05841	83.52	-0.0022	Yes
Chicken Creek at @ Scholls Sherwood	2	3835020	CHICKEN @ SCH-SHER	104	6	0.007	0.0817	0.93490	1.85	0.0000	No
Dairy Creek at HWY 8	2.1	3815021	DAIRY @ HWY 8	99	-265	-0.345	-4.6330	0.00000	13.48	-0.0003	Yes
Fanno Creek at Durham	1.2	3840012	FANNO @ DURHAM	109	-225	-0.240	-3.4156	0.00064	12.62	-0.0003	Yes
Gales Creek at HWY 47	1.5	3810015	GALES @ NEW HWY 47	37	-18	-0.188	-1.2465	0.21258	6.88	-0.0002	No
McFee Creek at HWY 219	1	3811010	MCFEE @ HWY 219	12	Sample size too small to conduct seasonal Kendall test						
McKay @ Hornecker	2	3816020	MCKAY @ HORN	25	-2	-0.050	-0.1291	0.89728	6.47	-0.0001	No
Rock Creek at HWY 8 Rock Creek at Brookwood	1.2 2.2	3820012 3820022	ROCK @ HWY 8-BROOK	102	-318	-0.390	-5.3309	0.00000	20.68	-0.0005	Yes
Rock Creek at Quatama	4.7	3820047	ROCK @ QUATAMA	24	18	0.500	2.3575	0.01840	-147.79	0.0045	Yes
Scoggins Creek at HWY 47	1.7	3805017	SCOGGINS @ 47	26	-6	-0.136	-0.6063	0.54429	15.45	-0.0004	No

	Significantly decreasing values
####	Significantly increasing values