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Water Quality Improvement Report

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Cover photo: Touchet River at Luckenbill Road (Ecology staff photo)

Walla Walla River Basin pH and Dissolved Oxygen Total Maximum Daily Load

Water Quality Improvement Report

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Waterbody Numbers: See Table 1

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Abstract

Several stream reaches in the Walla Walla River basin were listed on the 303(d) list for non-attainment of pH criteria by Washington State. Salmon and bull trout are potentially affected by the poor water quality. The federal Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for each waterbody on the 303(d) list to identify how much pollution needs to be eliminated to achieve clean water.

During 2002 and 2003, the Washington State Department of Ecology found pH and dissolved oxygen (DO) problems in the basin from May through October in the Walla Walla River and several tributaries. Of 54 sites monitored, 34 did not meet pH criteria and 17 did not meet DO criteria. The headwaters of the Touchet River and Mill Creek had relatively high levels of soluble reactive phosphorus (40 – 60 µg/L) and elevated pH (> 7.5).

Nitrogen is currently the limiting nutrient throughout most of the area. Excessive nutrients from point (discrete) and nonpoint (diffuse) sources, low streamflow in the summer and fall, and exposure to the sun cause excessive primary productivity. This causes the diel (24-hour) minimum DO and maximum pH values to be out of compliance with criteria.

pH and DO conditions can be improved by shading the streams more, decreasing point and nonpoint nutrient loads, and increasing streamflows. However, water quality modeling results suggest that even with these improvements, some stream reaches would still not meet Washington State water quality criteria, especially for pH.

This TMDL recommends seasonal nutrient wasteload allocations for the Dayton Wastewater Treatment Plant (WWTP). The College Place and Walla Walla WWTPs should continue their seasonal removal of effluent from Garrison and Mill Creeks during the May-October growing season. Subsurface transport from the Waitsburg WWTP wetland and nearby nonpoint sources need to be investigated as potential nutrient sources. The strategy to reduce nutrients from nonpoint sources consists of educating watershed residents and implementing best management practices.

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Executive Summary

The Walla Walla and Touchet Rivers and Mill Creek were on Washington State's 303(d) list (1996, 1998 and 2004) of impaired waterbodies for not meeting pH and dissolved oxygen (DO) water quality standards. The federal Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for each of the waterbodies on the 303(d) list.

This TMDL report identifies how much pollution needs to be reduced or eliminated to achieve clean water and meet state water quality standards. The *Implementation Strategy* section of the report provides a plan for activities that should bring these waterbodies back into compliance with standards.

The Walla Walla basin contains federally designated critical habitat for bull trout, a threatened species protected under the Endangered Species Act (USFWS, 2004). Most spawning habitat is in the upper reaches of the Walla Walla River, upper forks of the Touchet River, and upper Mill Creek, while the lower reaches of the Touchet and Walla Walla Rivers are mainly used for fish migration. Other important salmon species are also present in the basin or are in the process of being reintroduced. All aquatic species would benefit from improved oxygen concentrations and lower pH values.

From June 2002 to June 2003, the Washington State Department of Ecology (Ecology) made additional pH and DO measurements and collected other water quality samples from sites along the Walla Walla River, Touchet River, Mill Creek, and in several other tributaries in the basin. The pH and DO study was part of a larger Ecology TMDL effort that included temperature, bacteria, PCBs, and pesticides evaluations.

The pH and DO monitoring goals were to:

- Calculate the loading capacity for pH in Mill Creek, the Walla Walla River, and other areas in the Walla Walla basin as appropriate. Set load allocations for various tributaries and stream reaches using one or more parameters (e.g., limiting nutrient, temperature, or light).
- Determine if there is a DO or nutrient/primary productivity problem in the mainstem Walla Walla River, Touchet River, and Mill Creek. If necessary, calculate the seasonal loading capacity for limiting nutrient(s) and oxygen-demanding substances in portions of the Walla Walla River, Touchet River, or Mill Creek to meet the DO criterion. Set seasonal load allocations and wasteload allocations for pollutant sources.

The Walla Walla River basin is located in the southeast corner of Washington State. Two ecoregional divisions are present in the study area: the Blue Mountains and the Columbia Basin. The Walla Walla River extends 61 river miles (RM) from the headwaters of its north fork in Oregon to its confluence with the Columbia River in Washington. The drainage basin covers approximately 1,760 square miles. Two-thirds of the Walla Walla drainage basin and the last 40 miles of the mainstem lie within Washington. Major tributaries in Washington include the Touchet River, Mill Creek, Dry Creek, and Pine Creek.

The study area is Washington's Water Resource Inventory Area (WRIA) 32 (Figure E1). The Walla Walla River was examined from the Oregon border at river mile (RM) 36.9 to Pierce's Recreational Vehicle Park at RM 9.3. The Touchet River was evaluated from the confluence of the North Fork and South Fork upstream of the City of Dayton at RM 51.8 to the river's confluence with the Walla Walla River. Mill Creek was assessed from the City of Walla Walla waterworks dam at RM 24.7 to the creek's confluence with the Walla Walla River. Included were the Mill Creek distributaries, Yellowhawk Creek and Garrison Creek.

The study found that pH and DO problems are widespread in the basin. Of 54 sites monitored, 34 did not meet pH criteria and 17 did not meet DO criteria. The problems are most severe from June through September, but problems exist in some areas from May through October. The data show that several factors contribute to DO and pH problems in the Walla Walla basin. These were identified as:

- Naturally high phosphorus concentrations in the headwaters (>40 µg/L soluble reactive phosphorus)
- Naturally elevated pH (> 7.5)
- Diversion of water out of river channels
- Wide, shallow reaches that have very little riparian shade that (1) raise instream temperatures, and (2) provide light exposure for excessive algae growth on the channel bottoms
- Excessive nutrient loading from point (discrete) and nonpoint (diffuse) sources

Many of these factors cannot be controlled or easily alleviated. For example, the high background (natural) phosphorus and pH values are outcomes of geology rather than anthropogenic (human-caused) sources. Also, maximum potential riparian shade in the Columbia Basin Ecoregion is not adequate to cool the wide reaches of the lower Touchet and Walla Walla Rivers. Flood control structures on Mill Creek cannot easily be adapted to provide more shade. Water rights control where and when water is diverted in the basin. As a result, some areas are unlikely to fully meet their assigned numeric criteria even after the TMDL is completely implemented.

Nitrogen appears to be the limiting nutrient during the critical months (May-October) in most of the basin, but both nitrogen and phosphorus should be controlled. This report proposes nutrient reductions from point and nonpoint sources to stream reaches and whole tributaries where appropriate. Decreasing water temperatures by increasing instream water volumes and riparian shading is also recommended to decrease physical and biological factors contributing to the DO and pH problems. Nonpoint sources of nutrients in the upper Touchet River watershed above Dayton need to be reduced by one third as well.

Seasonal nutrient wasteload allocations based on background receiving water concentrations are recommended for effluent from the Dayton Wastewater Treatment Plant (WWTP). Model simulations of the Touchet River indicated that Dayton WWTP effluent causes downstream DO and pH criteria violations even when water volumes and river shading were increased and nutrients upstream were reduced to background levels. No net loss of DO or increase in pH is expected if nutrient concentrations in the effluent are equal to the background concentrations after upstream nonpoint sources of nutrients are reduced.

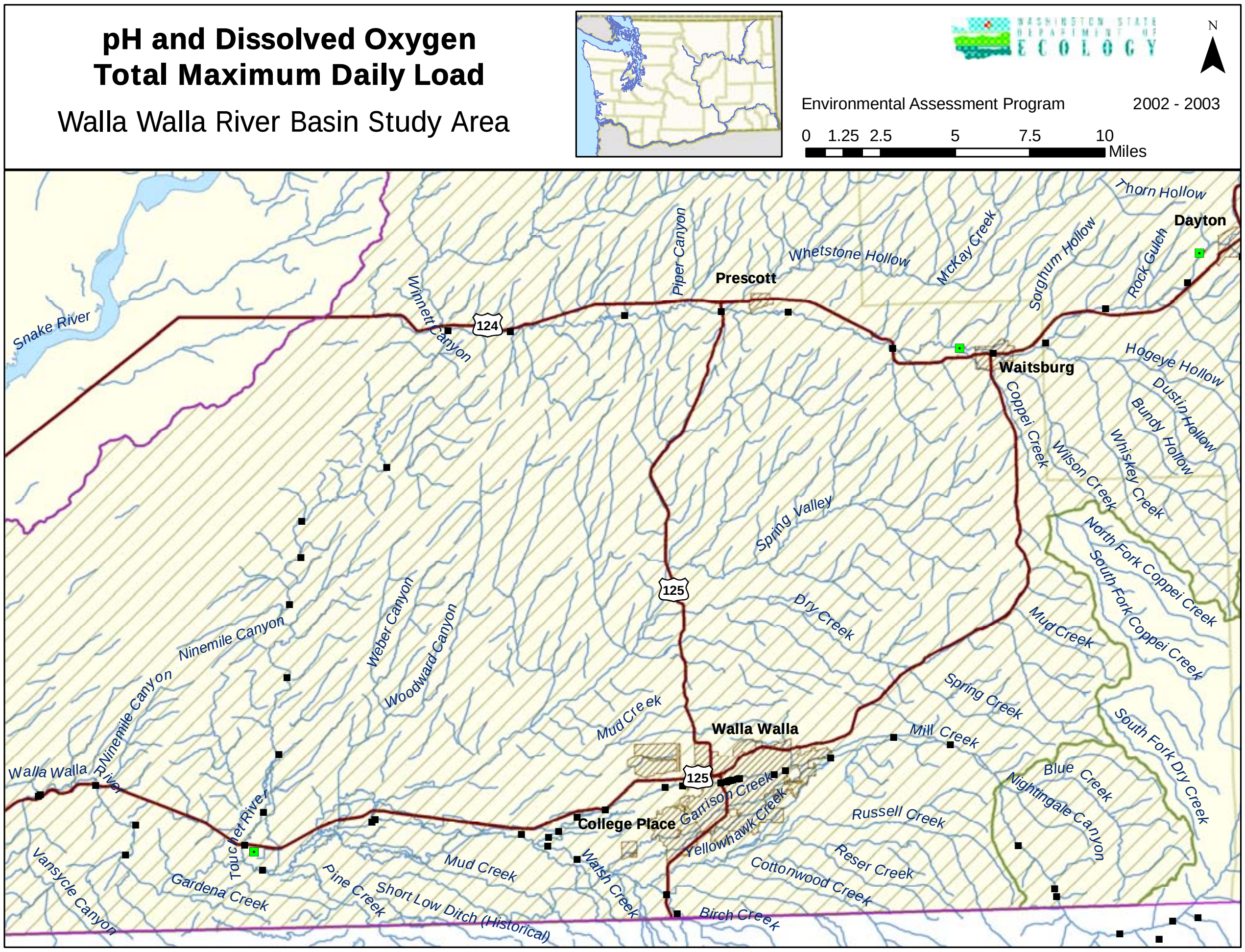

Figure E1. Walla Walla River basin study area for the 2002 -2003 Total Maximum Daily Load surveys.

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The Waitsburg WWTP uses an infiltration wetland on the banks of the Touchet River. Nutrient increases observed downstream of Waitsburg require reduction, and further investigations are necessary to determine if the facility is a source of subsurface nutrient loading.

Water right claims may complicate partial or full effluent diversion efforts on the Touchet River, but regional water authorities need to work with municipalities to reach legal and economical solutions to prevent further water quality impairment.

Seasonal effluent wasteload allocations for the City of Walla Walla and Waitsburg WWTPs are zero, although these WWTPs do not directly discharge to surface water under current permits. They are working toward reuse systems during the critical period (May-October). Walla Walla currently diverts effluent to the Gose-Blalock Irrigation Districts from May through October, but the effluent's fate in the irrigation system is uncertain. The effluent may be directed to Mill Creek at times and requires possible permitting by Ecology's Water Quality Program.

Load allocations for the rivers and tributaries in the basin are based on maintaining near background concentrations of nutrients. The complexities of the ecoregional characteristics make it difficult to determine, with great certainty, the appropriate background nutrient concentrations. However, nonpoint source loads to surface and groundwater need to be reduced. For example, fertilizers for agriculture and residential purposes require better control, on-site septic systems need to be maintained, and livestock and pet manures need to be managed.

Reducing nutrient loads to rivers and tributaries in the basin should increase the number of stream reaches in compliance with Class A and B water quality criteria for pH and DO, or meet the best potential conditions for pH and DO. Long-term efforts at increasing riparian shade and seasonal instream water volumes will help as well. The overall effect will promote healthy aquatic habitats and provide better conditions for salmon rearing and migration. Headwater nutrient, temperature, and streamflow controls will also help protect salmon spawning habitat.

Implementation Strategy

Achieving water quality standards within ten years after completion of the *Water Quality Implementation Plan* is the goal of this TMDL. The basic implementation strategy to reach this goal consists of identifying sources, prioritizing sites for implementation, finding funding, educating watershed residents, and implementing best management practices. Specifically, the implementation strategy calls for riparian corridor restoration to filter overland flow and nutrient management methods such as composting and spreading manure at agronomic rates.

The implementation strategy also includes (1) a monitoring plan to evaluate progress, (2) reasonable assurances that the strategy will be followed, and (3) an adaptive management strategy in case the goals are not being met.

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What is a Total Maximum Daily Load (TMDL)?

Federal Clean Water Act requirements

The Clean Water Act established a process to identify and clean up polluted waters. Under the Clean Water Act, each state is required to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses for protection, such as cold water biota and drinking water supply, as well as criteria, usually numeric criteria, to achieve those uses.

Every two years, states are required to prepare a list of waterbodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list. To develop the list, Ecology compiles its own water quality data along with data submitted by local state and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed to ensure that they were collected using appropriate scientific methods before the data are used to develop the 303(d) list. The 303(d) list is part of the larger Water Quality Assessment.

The Water Quality Assessment is a list that tells a more complete story about the condition of Washington's water. This list divides waterbodies into one of five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested

Category 2 – Waters of concern

Category 3 – Waters with no data available

Category 4 – Polluted waters that do not require a TMDL because:

- 4a. – Has a TMDL approved and its being implemented
- 4b. – Has a pollution control program in place that should solve the problem
- 4c. – Impaired by a non-pollutant such as low water flow, dams, culverts

Category 5 – Polluted waters that require a TMDL – or the 303d list.

TMDL process overview

The Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for each of the waterbodies on the 303(d) list. The TMDL identifies pollution problems in the watershed and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop an overall approach to control the pollution, called the *Implementation Strategy*, and a monitoring plan to assess effectiveness of the water quality improvement activities. Once the TMDL has been approved by EPA, a *Water Quality Implementation Plan* must be developed within one year. This Plan identifies specific tasks, responsible parties, and timelines for achieving clean water.

Elements required in a TMDL

The goal of a TMDL is to ensure the impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of a given pollutant that can be discharged to the waterbody and still meet standards (the loading capacity) and allocates that load among the various sources.

If the pollutant comes from a discrete source (referred to as a point source) such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. If it comes from a set of diffuse sources (referred to as a nonpoint source) such as general urban, residential, or farm runoff, the cumulative share is called a load allocation.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A reserve capacity for future loads from growth pressures is sometimes included as well. The sum of the wasteload and load allocations, the margin of safety and any reserve capacity must be equal to or less than the loading capacity.

Identification of the contaminant loading capacity for a waterbody is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a waterbody can receive without violating water quality standards" (EPA, 2001). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a waterbody into compliance with standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity.

TMDL = Loading Capacity = sum of all Wasteload Allocations + sum of all Load Allocations + Margin of Safety

What Part of the Process Are We In?

We are in the part of the process where the technical assessment and implementation strategy are combined into the *Water Quality Improvement Report*. The implementation strategy is intended to describe the general framework for improving water quality in the watershed. It describes the roles of organizations with responsibility to improve water quality and describes the means through which they will address the water quality issues.

The *Water Quality Improvement Report* will be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. Once all the TMDLs for the Walla Walla watershed have been approved, interested and responsible parties will then work to develop a *Water Quality Implementation Plan*. That plan will describe and prioritize specific actions planned to improve water quality.

Why is Ecology Conducting a TMDL Study in This Watershed?

Overview

The Walla Walla and Touchet Rivers and Mill Creek have been placed on Washington State's 303(d) lists (1996, 1998, 2004) of impaired waterbodies for not meeting pH and dissolved oxygen (DO) water quality standards (Table 1). The watershed contains important bull trout and salmon populations with further potential for habitat restoration. The federal Clean Water Act of 1972 requires the state to develop a cleanup plan (a TMDL) and to implement activities in the plan to bring these waterbodies back into compliance with standards.

Table 1. Walla Walla River basin waterbodies on the 1996, 1998, and 2004 303(d) lists for dissolved oxygen (DO), pH, nitrogen (Total N), ammonia, and phosphorus (Total P).

The waterbody identification numbers (ID) are shown; old IDs were used in the 1996 303(d) list and new IDs were used in the 1998 and 2004 lists.

Name		Old ID	New ID	Parameter	1996	1998	2004
Walla Walla River	(RM 15.3)	WA-32-1010	QE90PI	pH	Y	Y	N
	(RM 15.3, 38.7)		QE90PI	DO	N	N	Y
	(RM 9.3)		QE90PI	pH, Ammonia[1]	N	N	Y
Touchet River	(RM 53.3)	WA-32-1020	LV94PX	pH	Y	N	N
	(RM 0.5)	WA-32-1020	LV94PX	pH	Y	N	Y
	(RM 0.5, 2.0)		LV94PX	DO	N	N	Y
	(RM 2.0, 7.0, 14.2, 17.8, 25, 34.2, 40.5, 44.2, 46.2, 48.4, 51.1)		LV94PX	pH	N	N	Y
Touchet River, North Fork		WA-32-1025	EQ96XO	DO	N	N	Y
Mill Creek	(RM 4.8)	WA-32-1060	SS77BG	DO	Y	N	N
			SS77BG	pH	N	N	Y
				Total P, Total N	Y	N	N
	(RM 11.5)	WA-32-1070	SS77BG	pH	Y	Y	Y
				DO	Y	N	Y
	(RM 6.7)		SS77BG	pH	N	N	Y
	(RM 0.5)			DO	N	N	Y
Dry Creek		WA-32-1040	OT03FJ	DO	N	N	Y
Garrison Creek		WA-32-2000	DH35GB	DO, Ammonia	N	N	Y

[1] Ammonia listing is in error. Criteria were not properly calculated (Ecology 2006).

The Walla Walla River basin was slated to be the focus of TMDL technical studies from 2000 through 2004 in both Oregon and Washington State. The Oregon Department of Environmental Quality (ODEQ) conducted a Walla Walla River temperature TMDL study on 70 miles of river from Skiphorton Creek on the South Fork Walla Walla River in Oregon, to the Columbia River in Washington (ODEQ, 2005). The Washington State Department of Ecology (Ecology) conducted TMDL studies in Washington State waters for the following:

- Chlorinated pesticides and PCBs in the Walla Walla River and tributaries (Johnson, Era-Miller, Coots, and Golding, 2004)
- Fecal coliform bacteria in the Walla Walla River and tributaries (Joy et al., 2006)
- Temperature in Mill Creek and the Touchet River (Stohr et al., 2007)
- pH and dissolved oxygen in the Walla Walla River, Mill Creek, and Touchet River

This TMDL report addresses the results of the pH and DO studies. It describes many physical, biological, and chemical parameters (especially nutrients) influencing pH and DO changes in the aquatic environment. It is the technical document for the cleanup plan. The report forms the scientific basis for a set of instream targets to meet pH and DO water quality standards. The report also (1) allocates nutrient loads to sources in Washington State's Walla Walla River basin that will not exceed load capacities of the waterbodies, and (2) makes other recommendations that may help meet pH and DO standards.

The study was conducted by the Department of Ecology (Ecology) Environmental Assessment (EA) Program, Water Quality Studies Unit. A quality assurance (QA) project plan was prepared, reviewed, and approved in 2002 (Swanson and Joy, 2002). Data assessed in this report have been previously published (Swanson, 2005) and are also available on the Ecology website through the Environmental Information Management System (Study Name = Walla Walla Bacteria and pH TMDL) at www.ecy.wa.gov/eim/. The TMDL process includes public discussion of these data, the recommended targets in this report, and the resulting implementation strategy.

Study Area

The study area included the lower reaches of Water Resources Inventory Area (WRIA) 32, the Walla Walla basin (Figure 1). The Walla Walla River was examined from the Oregon border at river mile (RM) 36.9 to Pierce's Recreational Vehicle Park at RM 9.3. The Touchet River was evaluated from the confluence of the North Fork and South Fork upstream of the City of Dayton at RM 51.8 to the river's confluence with the Walla Walla River. Mill Creek was assessed from the City of Walla Walla waterworks dam at RM 24.7 to the creek's confluence with the Walla Walla River. Also included were the Mill Creek distributaries, Yellowhawk Creek and Garrison Creek.

Monitoring data collected from tributaries and wastewater treatment plant (WWTP) effluents to these main waterbodies were also evaluated. The tributaries were usually monitored as close as possible to their mouth and included Dry Creek, Pine Creek, Mud Creek, West Fork of the Little Walla Walla River, Coppei Creek, Patit Creek, Cottonwood Creek, and Russell Creek. Dayton, College Place, and the City of Walla Walla WWTPs were monitored as part of the study as well.

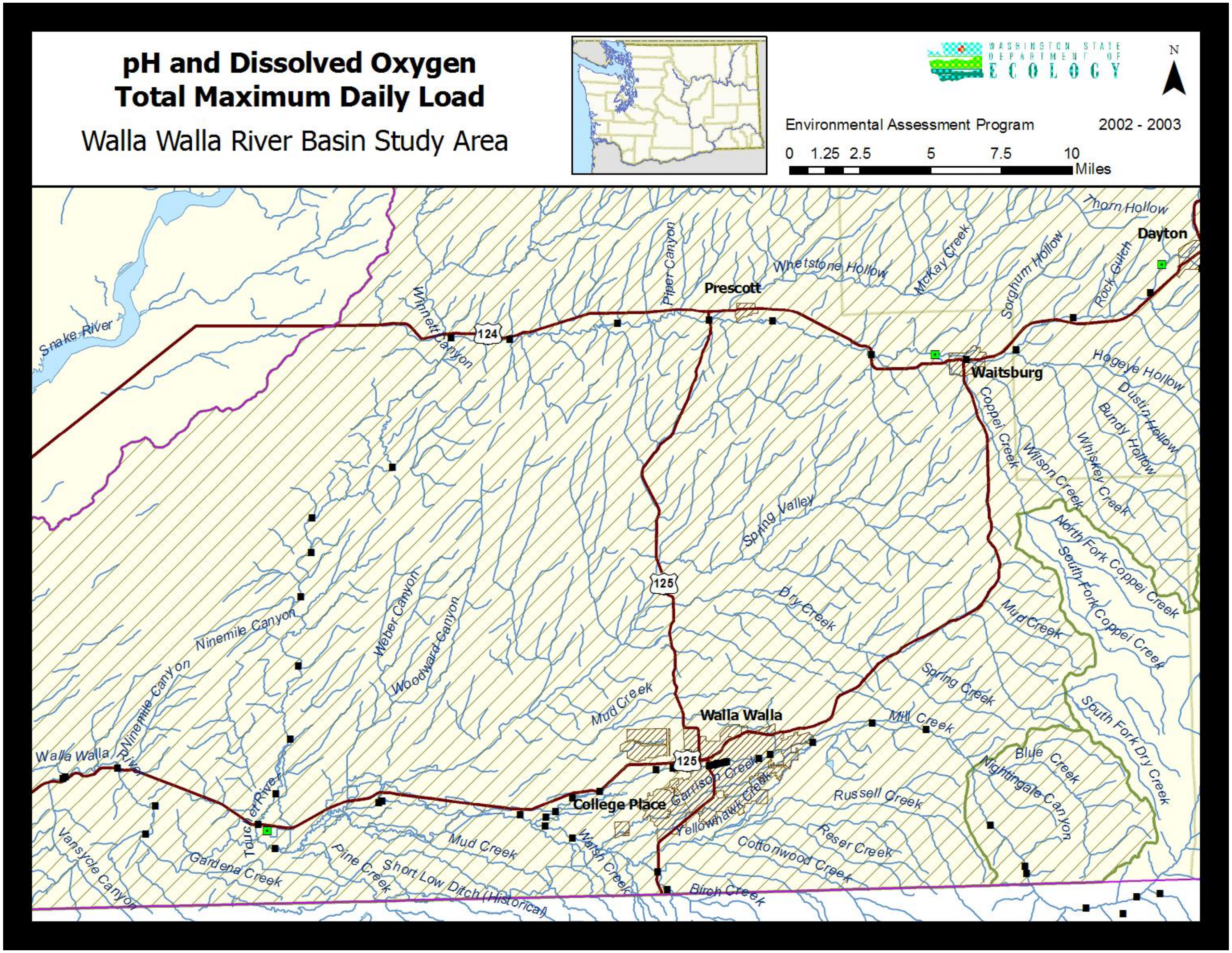

Figure 1. Map of the study area for the Walla Walla River basin pH and dissolved oxygen Total Maximum Daily Load study in 2002 and 2003. Monitoring sites are indicated by the symbol ■.

Stream Processes Affecting Dissolved Oxygen and pH

Dissolved Oxygen in Freshwater Systems

Oxygen physically enters surface water from the atmosphere through diffusion and reaeration processes. The amount of oxygen entering the water is determined by temperature, atmospheric pressure, and the amount of dissolved materials in the water column. For a given set of water temperatures, pressures, and dissolved solids concentrations, water will have a known dissolved oxygen (DO) saturation concentration under equilibrium conditions.

As natural combinations of temperature, pressure, and dissolved solids vary along a river or over the day, the DO saturation concentrations will vary as well. For example, higher water temperatures increase diffusion rates with the atmosphere, but they also lower the amount of oxygen the water can hold (i.e., higher water temperatures have lower DO saturation concentrations). Lower atmospheric pressures at higher altitudes will decrease DO saturation concentrations compared to lower altitudes with a similar water temperature. Turbulent water increases reaeration rates that generally help to bring the entire water column to DO saturation concentrations.

pH in Freshwater Systems

The pH value is a measure of hydrogen ions in the water. The pH value (0 to 14) represents the negative logarithm of the hydrogen ion concentration. When hydrogen ions are neither dominant nor deficient, a neutral pH of 7 is present. A low pH value (0 to 7) is actually a high concentration of hydrogen ions and an acidic condition is present. A high pH (7 to 14) is a low concentration of hydrogen ions and is a basic condition. Since the pH scale is logarithmic, a water sample with a pH of 6 has ten times more hydrogen ions than one with a pH of 7.

The carbon dioxide (CO_2) concentration in freshwater directly affects its pH value. As with oxygen, CO_2 from the atmosphere enters surface water through diffusion and reaeration processes. Temperature, atmospheric pressure, the initial CO_2 concentration in the water, as well as water depth and turbulence, all affect the resultant CO_2 concentration. For example, CO_2 will be released from the water when there is surplus CO_2 in the water relative to the temperature and pressure determined saturation concentration.

Once in the water column, CO_2 is quickly chemically regulated by a balance with bicarbonate and carbonate ions. In turn, the balance between these chemicals influences the pH of the stream as hydrogen ions are released to make more CO_2 (low pH – acidic conditions), or bound to make more carbonate (high pH – basic conditions). Also involved is the water's alkalinity, a measurement of the water's capacity to neutralize acid and resist changes in pH. Usually this balance of ions results in a pH around 7 unless large amounts of inorganic carbonate are available from geologic sources, or unless organic processes such as bacterial decomposition or accelerated plant growth are present.

Most aquatic macroinvertebrates and fish prefer pH values in the range of 6.5 to 8.5. When pH values get beyond that range for prolonged periods, they may affect the productivity of some fish species (Committee on Water Quality Criteria, 1972). In addition, the pH action on the toxicity of contaminants to aquatic organisms becomes more profound outside the preferred pH range. For example, dissolved metals become more toxic at low pH, and ammonia becomes more toxic at high pH.

Primary Producers, Decomposers, and Nutrients

Primary Producers and Decomposers

Biological processes also influence the amount of DO and pH in freshwater. During the day, plants as primary producers combine sunlight with dissolved carbon, nitrogen, and phosphorus in the water (or from sediment if they are rooted plants) to create chlorophyll and oxygen as they grow. At night, oxygen is consumed out of the water column by the plants, and CO_2 and nutrients are released. The plants are present as water column algae, rooted plants, and algae attached to rocks and other stationary features in the stream channel. The attached algae and associated organisms are called periphyton.

Bacteria and other microorganisms decompose organic materials in the water column, on the channel bed, and under it. Decomposition takes place day and night, and these processes consume oxygen and create dissolved carbon and CO_2. Dead plants, periphyton, macroinvertebrates, and fish are recycled into usable nutrients by the work of these microorganisms. Organic materials from riparian areas, and discharges from permitted and illegal sources, also are broken down by these aquatic microorganisms.

The productivity of algae, rooted plant, or periphyton biomass in rivers and streams is dependent on light, temperature, substrate, nutrients, water velocities, and predation. Streams and rivers with a healthy biotic structure have a proper balance of these factors so that plant biomass is neither over-productive nor under-productive.

When the primary producers in the system are in balance, DO and pH stay within limits that are beneficial to macroinvertebrates, fish, and other organisms in the aquatic community. Excessive natural or anthropogenic (human-caused) sources of nutrients can cause an overabundance of aquatic plants, algae, and periphyton that create large diel fluctuations in DO and pH. Diel refers to a 24-hr period. Excessive nutrients and biomass, and large diel chemical fluctuations, are characteristic of a eutrophic condition.

Algae and plant productivity augments the DO concentration during the daytime while their respiration and bacterial decomposition processes deplete DO. Daytime oxygen levels in a eutrophic system can exceed oxygen saturation levels, and at night respiration processes may drop DO concentrations to levels unacceptable for sustaining a healthy aquatic community. The diel DO fluctuations in eutrophic reaches of rivers and streams can affect downstream reaches at other times of the day if physical or biological conditions cannot overcome the upstream influences.

Likewise, if the plant and algal biomass grows and consumes more CO_2 from the water and overcomes the water's alkalinity, the reactions push the pH to 8, 9, or 10 – to the detriment of other aquatic organisms that rely on the pH remaining closer to 7. Organic decomposition creates excess CO_2 that can result in pH values below 6. Often wetlands and pools with a high seasonal load of decaying organic matter will have pH values as low as 5 or 6.

Light, stream hydrology, and channel features affect primary producer habitat and can be limiting factors for productivity, as well. Algae, periphyton, and aquatic plants have specific requirements for light intensity and duration, water velocity, and depth. Free-floating algae are less likely to proliferate in short, fast-moving streams than in large, slow-moving rivers. Periphyton prefer cobble and larger substrate in stable current conditions, whereas rooted plants thrive in fine-grained sand or silt, especially in pools and along slower or shallower areas along the sides of the channel. For either type of primary producer, shaded channels can limit aquatic growth by moderating daily light intensity and duration.

Nutrients

Nutrients play an essential role in primary productivity and influence DO and pH. Nitrogen and phosphorus are present from natural geologic or organic sources, and they also are present in wastewater, fertilizers, and other organic residues.

Carbon (C), nitrogen (N) and phosphorus (P) concentrations in aquatic algae are roughly present in a C:N:P ratio of 40:7.2:1. This ratio is used to estimate which available nutrient in the water column is most likely to become depleted first and therefore limit the growth of the plants and algae. Nitrogen and phosphorus are usually considered more limiting to plant growth than inorganic carbon because CO_2 from the atmosphere is readily available in the water. The dissolved fractions of these nutrients are more available, so the ratio is usually developed on dissolved nutrient concentrations.

The N:P ratio provides a helpful clue for determining nutrient dynamics. Values of dissolved inorganic nitrogen (DIN) to soluble reactive phosphorus (SRP) below 7 suggest growth limitation by DIN; values above 7 suggest growth limitation by SRP. However, since the ratios of nitrogen and phosphorus required by various algae and periphyton differ, often the phosphorus-limited boundary is set at 20 and the nitrogen-limited boundary is at 5. This leaves a ratio range of 5 to 20 that may be less definitive for establishing the limiting nutrient.

Groundwater and Hyporheic Influences

In many streams, groundwater plays an important role for nutrient interactions, as well as DO and pH patterns. Groundwater and surface water interactions vary seasonally and also spatially along the length of a stream. Groundwater entering the stream can carry nutrient loads and have different DO and pH concentrations than the stream. The loads can be carried from geologic or anthropogenic (human) sources. Surface water in the stream channel can also flow into the aquifer, leaving some channel reaches nearly dry. Reduced streamflow can exacerbate pH and DO problems in the remaining surface water.

The interface of the stream and groundwater in the channel bed is called the hyporheic zone (Figure 2). The hyporheic zone contains heterotrophic bacteria communities capable of using oxygen to decompose organic materials, much like a trickling filter in a wastewater treatment plant. As the bacteria break down the organic material, they release carbon, nitrogen, and phosphorus in the dissolved inorganic form. Anaerobic conditions can also exist where other biochemical reactions can take place, e.g., denitrification of nitrite to free nitrogen (Figure 3).

The nutrients released from the hyporheic zone into the surface water are readily available to the autotrophic organisms such as algae and periphyton. The dynamic exchange occurring between the hyporheic zone and the surface water assists in nutrient spiraling and can dominate nutrient dynamics in some reaches.

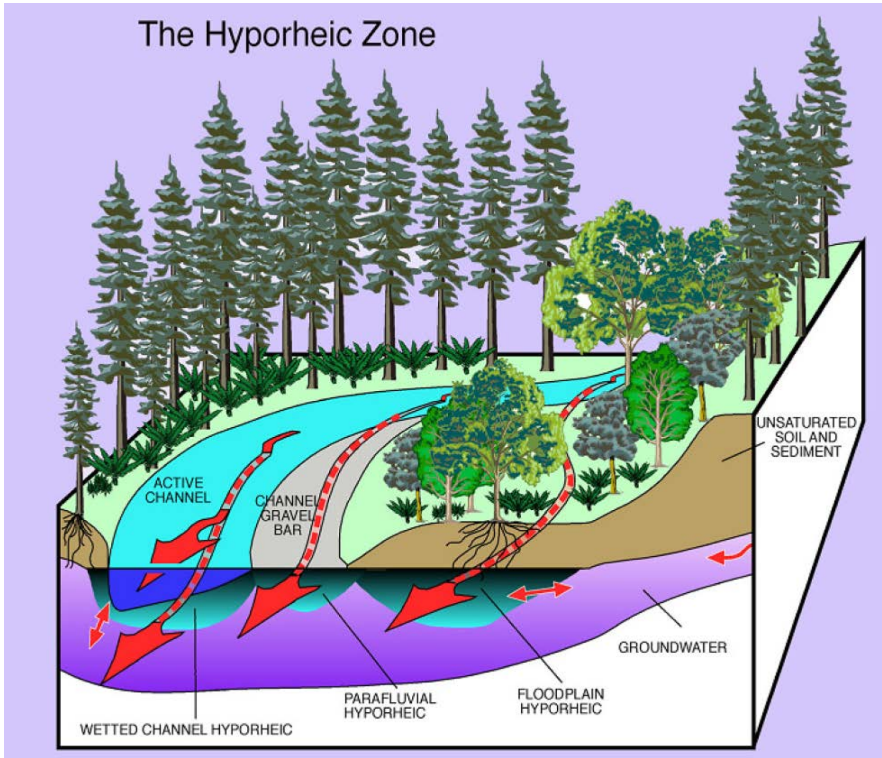

Figure 2. Surface water and groundwater interaction illustrated and various hyporheic zones identified (Naiman, 2003).

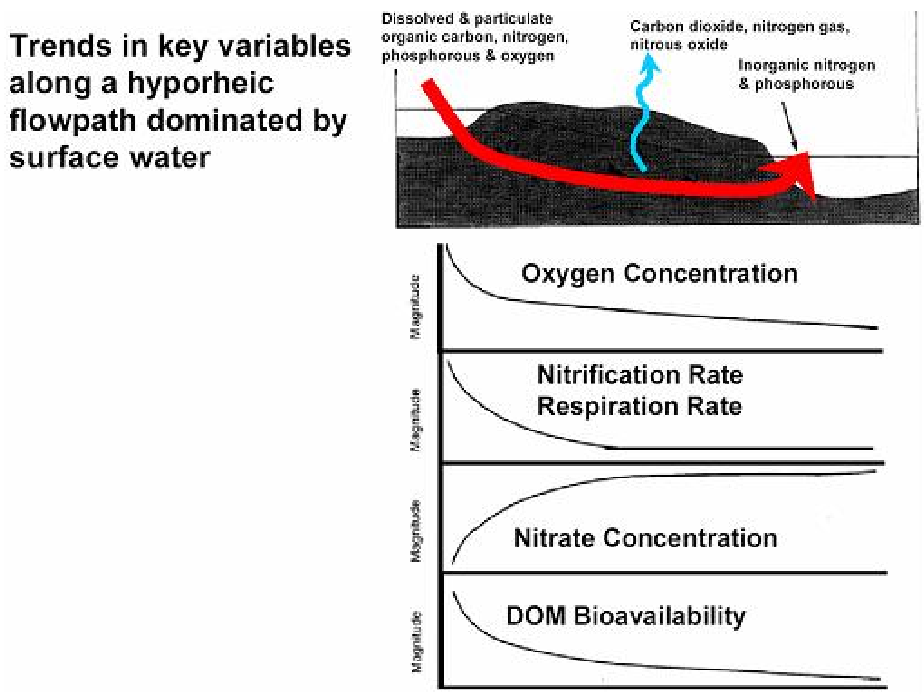

Figure 3. Nutrient transformations commonly occurring through the hyporheic zone (Naiman, 2003). (DOM = dissolved organic matter)

Impaired Beneficial Uses and Waterbodies on Ecology's 303(d) List of Impaired Waters

The main beneficial use to be protected by this TMDL is aquatic community health, especially endangered and threatened salmon populations. Mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*), and rainbow/steelhead trout (*Oncorhynchus mykiss*) are native salmonid species in the basin. Spring chinook salmon (*Oncorhynchus tshawytscha*) were historically present, and efforts are underway to reintroduce them (Mendel et al., 2004). Most spawning habitat is in the upper reaches, while the lower reaches of the Touchet and Walla Walla Rivers are mainly used for fish migration and limited juvenile rearing.

A few reaches of the Walla Walla River, Touchet River, and Mill Creek failed to meet pH and dissolved oxygen (DO) criteria in 1996 and 1998 303(d) assessments (Table 1). The Walla Walla River at RM 15.3, Touchet River (RM 0.5), and Mill Creek (RM 10) were on the 1996 or 1998 303(d) lists for not meeting pH criteria based on previous monitoring work. Dissolved oxygen (DO) has only been a listed parameter for lower Mill Creek in 1996.

Aquatic organisms, including fish and the food they eat, are exposed to high pH levels in some parts of the Walla Walla basin. High pH stresses aquatic organisms by impairing their osmoregulatory processes, and increasing the toxicity of some contaminants. Anadromous (sea-run) species of fish encounter this stress in their adult upstream migration, and as juveniles in rearing areas and during downstream migration.

Many more pH and DO listings were added to the 2004 303(d) list, especially for the Touchet River (Table 2). Diel monitoring conducted in 2002 and 2003 for this TMDL provided most of the data used to place more waterbodies on the list. Since Washington State does not have nutrient criteria, there are no 303(d) listings for excessive nitrogen or phosphorus that may be the cause of the pH and DO listings.

Because we studied this watershed more thoroughly, we found other impaired waterbodies for pH and DO, but the data did not meet the requirements for Category 5 of the 303(d) report. Many more waterbodies also were placed in Category 2, Waters of Concern, of the 2004 list for DO concentrations and pH values not in compliance with criteria (Ecology, 2005).

Ammonia, a nitrogen species with properties toxic to aquatic life, was also detected. However, the listings for ammonia based on samples collected during the 2002 and 2003 surveys are in error. The toxicity of some samples was calculated incorrectly during the 2004 review (Ecology, 2006). The chronic toxicity criterion to protect aquatic life was exceeded only once, and at only one site. None of the samples exceeded the acute toxicity criterion to protect aquatic life.

Table 2. Study area waterbodies on the 2004 303(d) list for pH and dissolved oxygen (DO).

Waterbody	Parameter	Listing ID	Township	Range	Section
Walla Walla River	pH	41191	07N	32E	21
	Dissolved Oxygen	11113	07N	32E	35
	Dissolved Oxygen	41374	06N	35E	11
Touchet River	pH	11096	07N	33E	33
	pH	41177	07N	33E	27
	pH	41178	07N	33E	02
	pH	41179	08N	33E	02
	pH	41180	09N	34E	32
	pH	41181	09N	34E	02
	pH	41183	09N	36E	05
	pH	41185	09N	37E	07
	pH	41186	09N	37E	11
	pH	41187	09N	38E	07
	pH	41188	09N	38E	04
	pH	41189	10N	38E	35
	Dissolved Oxygen	11099	07N	33E	33
	Dissolved Oxygen	41352	07N	33E	27
Touchet River, N.F. (E.F.)*	Dissolved Oxygen	41444	10N	39E	32
Mill Creek	pH	11119	07N	36E	23
	pH	41164	07N	36E	19
	pH	41329	07N	35E	24
	Dissolved Oxygen	41441	07N	36E	23
	Dissolved Oxygen	41469	07N	35E	38
Dry Creek	Dissolved Oxygen	41337	07N	34E	29
Garrison Creek	Dissolved Oxygen	41338	06N	35E	03

* The North Fork Touchet River was formerly known as the East Fork.

Why Are We Doing This TMDL Now?

In addition to fulfilling the requirements of the Clean Water Act, there are several opportunities to coordinate TMDL-related activities with other ongoing efforts in the watershed. Information collected as part of the TMDL process could be useful to these other plans. In addition, implementing the TMDL could benefit the goals of the other processes.

The primary planning processes in the basin that may be connected with the TMDL effort are:

- Walla Walla Watershed Planning
- Walla Walla Water Management Initiative
- Walla Walla Subbasin Planning
- Bi-State Habitat Conservation Plan
- Comprehensive Irrigation District Management Plan for Gardena Farms

There is much interest in the Walla Walla River and watershed. Several public and private organizations have established programs for monitoring, protection, and restoration. This continuing voluntary support for maintaining water quality is vital to the success of the TMDL.

Water Quality Standards and Beneficial Uses

Revisions to the Washington State water quality standards are under review by EPA, and the proposed changes in applying temperature, pH and dissolved oxygen (DO) criteria have not been accepted (as of September 2006). The revised criteria support aquatic life use categories that would be more specifically designated. For example, the pH and DO criteria minima in the Walla Walla basin will be determined by the presence and life-stage activity (spawning, rearing, migration) of char (bull trout) and other salmon species (Ecology, 2004). Temperature criteria would also have seasonally adjusted criteria to protect spawning and rearing.

The current standards and criteria, and the most recent iteration of the proposed revisions, are presented below. The data in this TMDL project are being measured against the current standards and criteria. There have been several changes in the revisions as negotiations at all levels of government continue, so the final details of the geographical, seasonal, numerical limits remain to be seen. Future adaptations of this TMDL may invoke the new criteria, so it is important to be aware of the direction of the revisions.

Dissolved Oxygen

As described earlier, aquatic organisms are very sensitive to reductions in dissolved oxygen levels in water. The health of fish and other aquatic species depends on maintaining an adequate supply of oxygen dissolved in the water. Growth rates, swimming ability, susceptibility to disease, and the relative ability to endure other environmental stressors and pollutants are all affected by oxygen levels. While direct mortality due to inadequate oxygen can occur, the state's criteria are designed to maintain conditions that support healthy populations of fish and other aquatic life in the most sensitive life stages.

Oxygen levels can fluctuate over the day and night in response to changes in climatic conditions as well as the respiratory requirements of aquatic plants and algae. Since the health of aquatic species is tied predominantly to the pattern of daily minimum oxygen concentrations, the criteria are expressed as the lowest 1-day minimum oxygen concentration that occurs in a waterbody. However, the site for measuring compliance must be representative of the waterbody in question, not a side channel or backwater.

Freshwaters: Current Standards and Definitions

Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC) include numeric criteria for each classification and general narrative criteria for all classifications (Appendix A, Table A-1). The numeric dissolved oxygen criteria currently (May 2006) applicable to this study are listed in Table 3.

Table 3. Water quality criteria for pH and dissolved oxygen currently applicable to the Walla Walla basin study.

Parameter	Criteria Category	Statistic	Criterion
pH	Freshwater	Minimum	6.5 units
		Maximum	8.5 units
		Human-caused variation[1]	0.5 units
Dissolved Oxygen	Class AA Freshwater	Minimum	9.5 mg/L
	Class A Freshwater	Minimum	8.0 mg/L
	Class B Freshwater	Minimum	6.5 mg/L
	Class B Freshwater – Special Condition[2]	Minimum	5.0 mg/L

[1] Allowed when pH is between 6.5 and 8.5 units for Class A and B waters
[2] Lower 6.4 mi. of Mill Creek special condition.

Table 4 shows that rivers and streams in the Walla Walla watershed are a mix of Class AA (extraordinary), A (excellent), and B (good) as defined by the 1997 Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC). All segments and tributaries to Class AA waters are Class AA as well. All other tributaries in the basin not specifically designated are considered Class A waters. Special conditions for the Walla Walla River and Mill Creek are variations of the class criteria written in the standards.

Table 4. Water quality classifications for the Walla Walla River, North Fork Touchet River, and Mill Creek in the Walla Walla basin.

Waterbody	Location	Special Conditions	Class
Walla Walla River	Mouth to Dry Creek. (RM 27.2)	NA	B
	Lowden (Dry Creek at RM 27.2) to Oregon border (RM 40)	Temperature shall not exceed 20.0 C due to human activities. When natural conditions exceed 20.0 C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3 C.	A
NF Touchet River	At Dayton water intake structure (RM 3.0) to headwaters	NA	AA
Mill Creek	Mouth to 13th St. Bridge (RM 6.4)	Dissolved oxygen concentration shall exceed 5.0 mg/L	B
	13th St. Bridge to Walla Walla waterworks dam (RM 11.5)	NA	A
	City of Walla Walla waterworks dam (RM 21.6) to headwaters	No waste discharge will be permitted	AA

NA – not applicable

Good water quality is essential in the Walla Walla River basin to support a variety of beneficial uses:

- *Recreation:* Fishing and swimming in Class A and AA waters; fishing and secondary contact (e.g., wading and boating) in Class B waters.
- *Fish:* All waters shall support salmonid migration, rearing, and harvesting. Class A and AA waters shall support salmonid spawning. Salmonid species include summer steelhead/rainbow trout, bull trout, and mountain whitefish. Steelhead are the only anadromous species presently available to sport anglers. Introduced species include smallmouth and largemouth bass, bluegill, carp, brown trout, channel catfish, bullheads, and tadpole madtom.
- *Water Supply and Stock Watering:* Shall support permitted domestic, industrial, and agricultural uses for Class A and AA, and industrial and agricultural uses for Class B waters.

Freshwaters: Proposed Standards and Definitions

In 2003, Ecology made significant revisions to the state's water quality standards (Chapter 173-201A WAC). Instead of a general classification system (e.g., Class A, B), numeric criteria are keyed to freshwater aquatic life uses by sensitive or endangered species such as char (bull trout), and chinook and steelhead salmon. Until the EPA approves these use-based standards and criteria for temperature, pH, and DO, the older classification-based standards are in force. The following are the most recent DO criteria (as of July 2006) for designated aquatic life uses in the Walla Walla basin (WRIA 32) with salmonid use and spawning maps available at http://yosemite.epa.gov/R10/WATER.NSF/1507773cf7ca99a7882569ed007349b5/5a8440cd8b259abd882571390071ef4d!OpenDocument:

1. To protect the designated aquatic life use of "Char Spawning," the lowest 1-day minimum oxygen level must not fall below 9.5 mg/l more than once every ten years on average.
2. To protect the designated aquatic life use of "Core Summer Salmonid Habitat," the lowest 1-day minimum oxygen level must not fall below 9.5 mg/l more than once every ten years on average.
3. To protect the designated aquatic life use of "Salmon and Trout Spawning and Migration," the lowest 1-day minimum oxygen level must not fall below 8.0 mg/l more than once every ten years on average.
4. To protect the designated aquatic life use of "Non-anadromous Interior Redband Trout," the lowest 1-day minimum oxygen level must not fall below 8.0 mg/l more than once every ten years on average.
5. To protect the designated aquatic life use of "Salmonid Migration Only," the lowest 1-day minimum oxygen level must not fall below 6.5 mg/l more than once every ten years on average.
6. To protect the designated aquatic life use of "Indigenous Warm Water Species," the lowest 1-day minimum oxygen level must not fall below 6.5 mg/l more than once every ten years on average.

The criteria described above are used to ensure that where a waterbody is naturally capable of providing full support for its designated aquatic life uses, that condition will be maintained. The standards recognize, however, that not all waters are naturally capable of staying above the fully protective dissolved oxygen criteria. When a waterbody is naturally lower in oxygen than the criteria, an additional allowance is provided for further depression of oxygen conditions due to human activities. In this case, the combined effects of all human activities must not cause more than a 0.2 mg/l decrease below that naturally lower (inferior) oxygen condition.

While the numeric criteria generally apply throughout a waterbody, the criteria are not intended to apply to discretely anomalous areas such as in shallow stagnant eddy pools where natural features unrelated to human influences are the cause of not meeting the criteria. For this reason, the standards direct that measurements be taken from well-mixed portions of rivers and streams. For similar reasons, samples should not be taken from anomalously oxygen rich areas. For example, in a slow moving stream, focusing sampling on surface areas within a uniquely turbulent area would provide data that are erroneous for comparing to the criteria.

pH

The pH of natural waters is a measure of acid-base equilibrium achieved by the various dissolved compounds, salts, and gases. pH is an important factor in the chemical and biological systems of natural waters. pH both directly and indirectly affects the ability of waters to have healthy populations of fish and other aquatic species.

The degree of dissociation of weak acids or bases is affected by changes in pH. This effect is important because the toxicity of many compounds is affected by the degree of dissociation. While some compounds (e.g., cyanide) increase in toxicity at lower pH, others (e.g., ammonia) increase in toxicity at higher pH.

Aquatic organisms, including fish and the food they eat, are exposed to high pH levels in some parts of the Walla Walla basin. High pH stresses aquatic organisms by impairing their osmoregulatory processes, and increasing the toxicity of some contaminants. Anadromous species of fish encounter this stress in their adult upstream migration, and as juveniles in rearing areas and during downstream migration.

While there is no definite pH range within which aquatic life is unharmed and outside which it is damaged, there is a gradual deterioration as the pH values are further removed from the normal range. However, at pH extremes, lethal conditions can develop. For example, extremely low pH values (<5.0) may liberate sufficient carbon dioxide from bicarbonate in the water to be directly lethal to fish.

Freshwaters: Current Standards and Definitions

Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC) include numeric criteria for each classification and general narrative criteria for all classifications (Appendix A, Table A-1). The numeric pH criteria currently (May 2006) applicable to this study are listed in Table 3.

Freshwaters: Proposed Standards and Definitions

In the 2003 revision of the state's water quality standards, two pH criteria are established to protect six categories of aquatic communities [WAC 173-201A-200; 2003 edition]:

1. To protect the designated aquatic life uses of "Char Spawning" and "Core Summer Salmonid Habitat," pH must be kept within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units.

2. To protect the designated aquatic life uses of "Salmon Spawning, Rearing, and Migration," "Salmonid Rearing and Migration Only," "Non-anadromous Interior Redband Trout," and "Indigenous Warm Water Species," pH must be kept within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.5 units.

Note that neither the current nor the revised standards contains language allowing any human-caused variation when the pH is not within standards. Natural conditions of pH levels above or below criteria would be considered subject to anti-degradation language in the current and revised standards.

Ammonia

Ammonia toxicity criteria are set to protect aquatic organisms against acute and chronic exposures (Chapter 173-201A WAC). Ammonia is a byproduct of organic decomposition, and it can be a contaminant in some types of run-off or discharges. Aquatic systems often have low concentrations of ammonia from instream microbial activity.

Too much un-ionized ammonia (NH_3) is toxic to aquatic invertebrates and fish. The concentration of the NH_3 is determined by the temperature and pH of the water. For example, a four-day average concentration of 1 mg/L total ammonia (NH_3-N) at temperatures over 19º C with pH values over 8 can be toxic to aquatic organisms; a 1-hour average concentration of 5.6 mg/L NH_3-N would be acutely toxic.

Pollutants and Surrogate Measures

The criteria for pH are minimum and maximum values, and dissolved oxygen (DO) criteria are a minimum concentration to protect aquatic organisms. Nutrient criteria in the state standards are limited to lake environments. The EPA criteria for ammonia, nitrates, nitrites, and phosphorus are only set to limit human health or direct aquatic toxicity effects, not to prevent eutrophication that cause pH and DO criteria violations.

Washington State water quality standards do not have numeric nutrient (nitrogen and phosphorus) criteria for streams. However, the 2003 standards [Chapter 173-201A-240 (1) WAC] contain a narrative criterion applicable to nutrients as toxic substances that states the following:

"Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department."

Nutrients can create nuisance conditions in streams either by creating DO and pH criteria violations, or by choking streams with excessive macrophyte and algae growth that degrade the aquatic community or interfere with fishing, swimming, and boating.

Target pollutant reductions may be expressed as loads, concentrations, or other appropriate measures [40 CFR 130.2(I)]. Limits on surrogates are allowed in TMDLs to prevent degradation of beneficial uses when a direct connection can be shown in the data. Nutrient load allocations are used in this report since nutrients are identified as the primary controllable factor for pH and DO.

Recommendations for increased shading, water cooling, and seasonal instream flows are also examined as measures to help pH and DO criteria compliance. These factors require long-term political and biological implementation. However, dissolved oxygen concentrations and pH values that meet water quality standards are the compliance criteria to be met in the future after TMDL implementation measures are in place.

Oregon Standards and Listings for the Walla Walla Basin

Waters of the Walla Walla River basin that flow through Oregon are subject to slightly different water quality criteria than those in Washington. The Oregon Department of Environmental Quality (ODEQ) water quality standards are specific for the Walla Walla basin, and are based on their beneficial uses.

pH: pH is a core indicator driven by fish health. The pH criterion is 6.5-8.7 standard units, or up to 9.0 if it can be shown to be non-anthropogenic.

Nutrients: Typically, nutrient TMDLs are generated when modeling shows that eutrophic conditions from excessive nutrient loading cause a pH exceedance. In the neighboring Umatilla basin, however, modeling showed that temperature TMDL attainment through shading would alleviate pH criteria violations by limiting light to the stream, so the ODEQ did not allocate nutrient loads (Butcher, personal communication).

Dissolved Oxygen: Oregon's dissolved oxygen standards are statewide and consist of cold, cool, and warm water criteria (Appendix D) (ODEQ, 2001). Some implementation of intergravel DO criteria has occurred as well.

Temperature: The temperature standard is narrative, with numeric values of 50º Fahrenheit (F) (Bull Trout), 55º F (salmonid spawning), and 64º F (everywhere else) as triggers for "no human caused temperature increase" (Butcher, personal communication). For easier comparison to Washington State criteria: 50º F = 10º C; 55º F = 12.8º C; and 64º F = 17.8º C.

The only 303(d) listings for the Walla Walla River in Oregon are for temperature and flow. The EPA approved a temperature TMDL conducted by Oregon for the Walla Walla River in September 2005. The TMDL technical evaluation includes the Walla Walla River in Oregon and Washington, but Washington will need to evaluate how to integrate Oregon's work into its Walla Walla cleanup plan.

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Basin Description

Geographic Setting

The Walla Walla River basin is located in the southeast corner of Washington State (Figure 4). The Walla Walla River extends 61 river miles (RM) from the headwaters of its north fork in Oregon to its confluence with the Columbia River in Washington. The drainage basin covers approximately 1,760 square miles and portions of four counties: Umatilla and Wallowa Counties in Oregon, and Columbia and Walla Walla Counties in Washington. Two-thirds of the Walla Walla drainage basin and the last 40 miles of the mainstem lie within Washington. Major tributaries in Washington include the Touchet River, Mill Creek, Dry Creek, and Pine Creek.

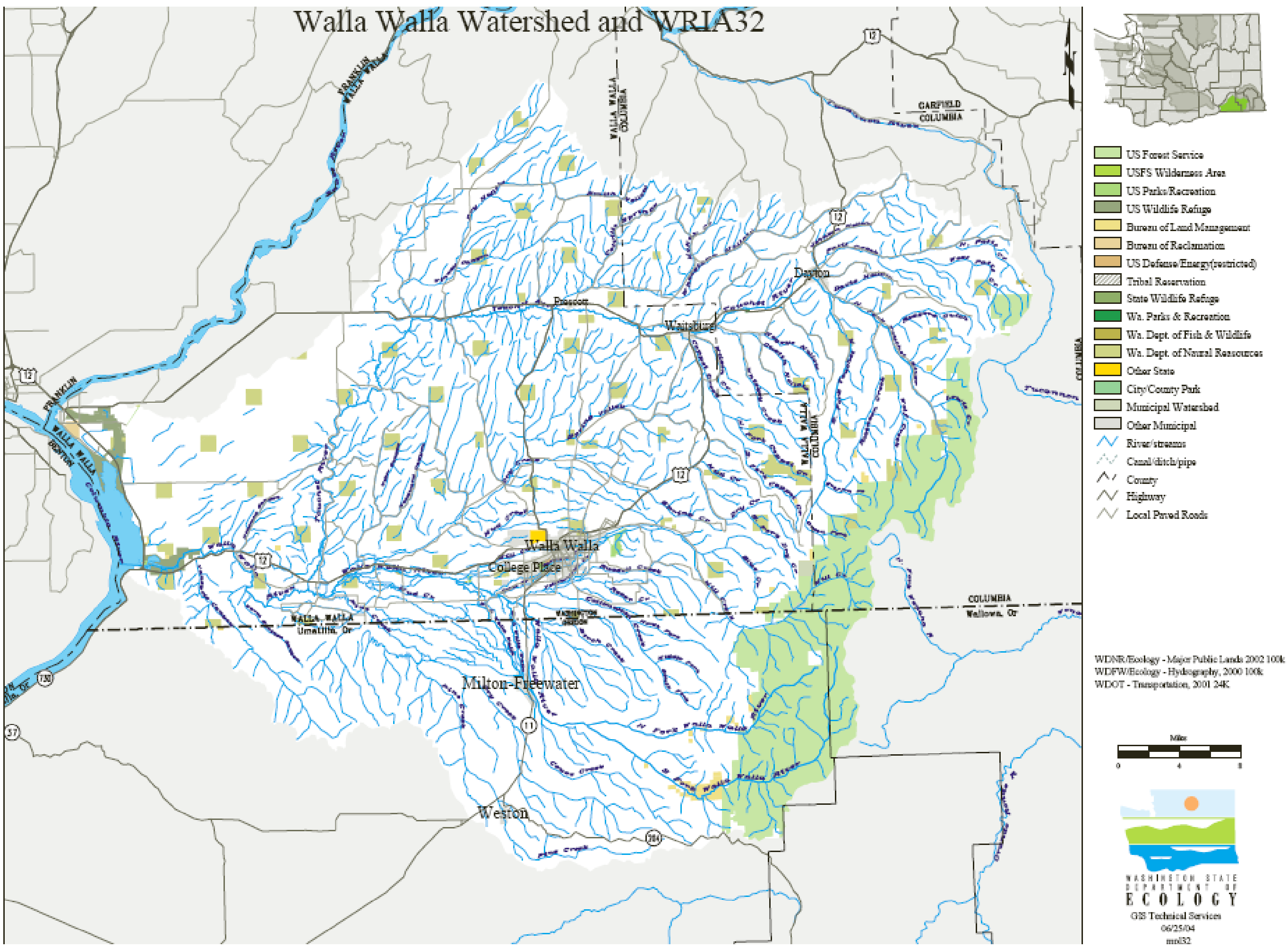

Figure 4. The Walla Walla watershed with reference to the Washington State Water Resources Inventory Area (WRIA) 32 boundaries, political boundaries and public land ownership.

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Two Level 3 ecoregions are present in the Walla Walla watershed: the Blue Mountains and the Columbia Basin (EPA, 2003). Several Level 4 sub-regions are also represented. The watershed is at the upper northern extension of the Blue Mountains of Oregon. The Blue Mountains are a tilted, folded, and faulted uplift of the Columbia River basalt. The Columbia Basin is characterized with rolling, uplands of fine, deep windblown soils over the same but previously eroded Columbia River basalt (Harrison et al., 1964).

Soils in the Blue Mountains Ecoregion are fairly shallow loess and weathered basalt overlying basalt bedrock. They tend to be well-drained and slightly acidic to neutral. They support growths of fir and pine forests, and can be used for grazing if carefully managed.

Columbia Basin Ecoregion soils on the uplands are primarily deep loess silt loams of the Palouse Formation. They cover approximately 55% of the Walla Walla basin at 1 foot to 100 feet in thickness (Mapes, 1969). The pH of some of these soils varies with depth because of an interlaid lime layer at a depth of 3 to 5 feet that can increase pH values to 8.5 or 9. The soils are naturally rich in most minerals except nitrogen (Harrison et al., 1964; Harrison et al., 1973). Wheat, peas, garbanzo beans, and other small grains are grown on these soils.

The valleys of the Columbia Basin Ecoregion have well-drained alluvial soils originating from loess overlying basalt, outburst flood and older Pleistocene deposit gravels, fine silt, and fine sand. The well-drained alluvial soils are suitable for small grains and other crops. The Touchet beds beneath the alluvial deposits create terraces west of the city of Walla Walla. When they are near the surface, they may be a source of salts in the Walla Walla Valley soils that are calcareous with pH greater than 8. These soils require leaching away salts before the soils can be used for alfalfa, row crops, or hay.

The four primary forks of the Touchet River – Robinson Creek, Wolf Creek, North Fork Touchet, and South Fork Touchet – originate in the Blue Mountains at an elevation of 6,074 feet. The four forks are mainly located in forested areas of the Blue Mountain Ecoregion with some small farms in the valleys. As the forks converge just above the city of Dayton to form the mainstem Touchet River, the river enters the Columbia Basin Ecoregion. The Touchet River flows through the cities of Dayton, Waitsburg, and Prescott reaching its confluence with the Walla Walla River by the town of Touchet at an elevation of 469 feet. Land use in the Touchet basin from Dayton to the confluence of the Walla Walla River is predominantly agricultural, with both irrigated and non-irrigated crops.

Dry Creek drains a 239 square mile watershed with elevations from 460 feet at the confluence with the Walla Walla River near Lowden to 4,600 feet in the Blue Mountains. Dry Creek's watershed is mainly used for non-irrigated small grains and legumes (peas, garbanzo beans, lentils) with sparse forests in the headwaters.

Pine Creek makes up about 10% of the Walla Walla River basin. Most of the 168 square miles of the watershed is in Oregon and drains the southern part of the basin (Figure 4). Land use in the basin is farming and livestock grazing. The Weston wastewater treatment plant discharges to Pine Creek close to the Blue Mountains and several miles from the Oregon/Washington line.

Mill Creek flows from headwater streams in the Blue Mountains of Washington and Oregon. The City of Walla Walla's drinking water comes from the 36-square-mile managed and protected portion of upper Mill Creek into Oregon. At RM 25.2, the City of Walla Walla waterworks dam provides diversion of consumptive drinking water, and non-consumptive water for hydroelectric generation off-site near the airport. Water used for the generators is returned at RM 11. The dam regulates streamflows to the mid-reaches of Mill Creek that flows through agricultural and urban/residential areas until the U.S. Army Corps of Engineers operations at RM 11.5.

The diversion and division structures on Mill Creek at RM 11.5 and 10.5 are used for flood control and irrigation operations. During the winter and spring, floodwaters are routed off-channel to Bennington Lake by a dam and canal at RM 11.5. Water in Mill Creek flowing over the dam or through the fish ladder goes through a mile of constructed channel with artificial gabion falls every 50 feet. At RM 10.5, Mill Creek is routed through other structures where most of the water is diverted to Yellowhawk and Garrison Creeks from May through October.

The Mill Creek armored or concrete channel continues from RM 10.5 to RM 4.5 for continued flood control. Portions of the creek that are not entirely concrete have revetments to stabilize the banks and a rubble bottom. Below RM 4.5, the creek flows in an unarmored channel through the western part of the City of Walla Walla and agricultural areas to the confluence with the Walla Walla River.

Drinking water for the City of Walla Walla is supplemented by groundwater from a deep basalt aquifer. A relatively dynamic, shallower gravel aquifer is used by residents around Walla Walla, mainly for irrigation. Over 2000 wells have been drilled into this aquifer (Marti, 2005). Recent studies identified nitrate and coliform bacteria contamination of the gravel aquifer near Walla Walla (Pacific Groundwater Group, 1995).

Springs supply baseflow to surface waters year-round. Infrequent storm events during the winter months sometimes cause severe flooding from heavy rainfall and rapid snowmelt. Seasonal snowmelt and runoff in the spring increase river discharge volumes. Rivers and streams in the basin experience greatly reduced flows in the summer from a combination of reduced supply and diversion for irrigation. For example, the Walla Walla River has often gone dry at the Oregon-Washington border, and Mill Creek usually has little to no flow between points of irrigation withdrawals and returns.

Streamflow conditions have improved in the mainstem Walla Walla River as a result of a settlement agreement between the U.S. Fish and Wildlife Service and irrigation districts in Oregon and Washington in 2000. Farmers gradually began diverting less water in response to salmonid Endangered Species Act listing requirements. Irrigation season streamflows near the state line that were near zero now exceed 13 cubic feet per second (cfs), and exceed 10 cfs below Burlingame Dam at RM 36.7 (Mendel et al., 2004).

Land Use

The Walla Walla basin is predominantly rural with few urban areas (Figure 5). The major towns are Walla Walla and College Place, with a combined population of approximately 40,000. Smaller towns of Dayton (est. population 2,700), Waitsburg (est. population 1,200), and Milton-Freewater, Oregon (est. population 6,500) support surrounding agriculture.

In 2002, Walla Walla County had 568 farms (USDA, 2002). Approximately 50% of the farms were less than 100 acres while 30% had greater than 1000 acres. Currently, winter and spring wheat,

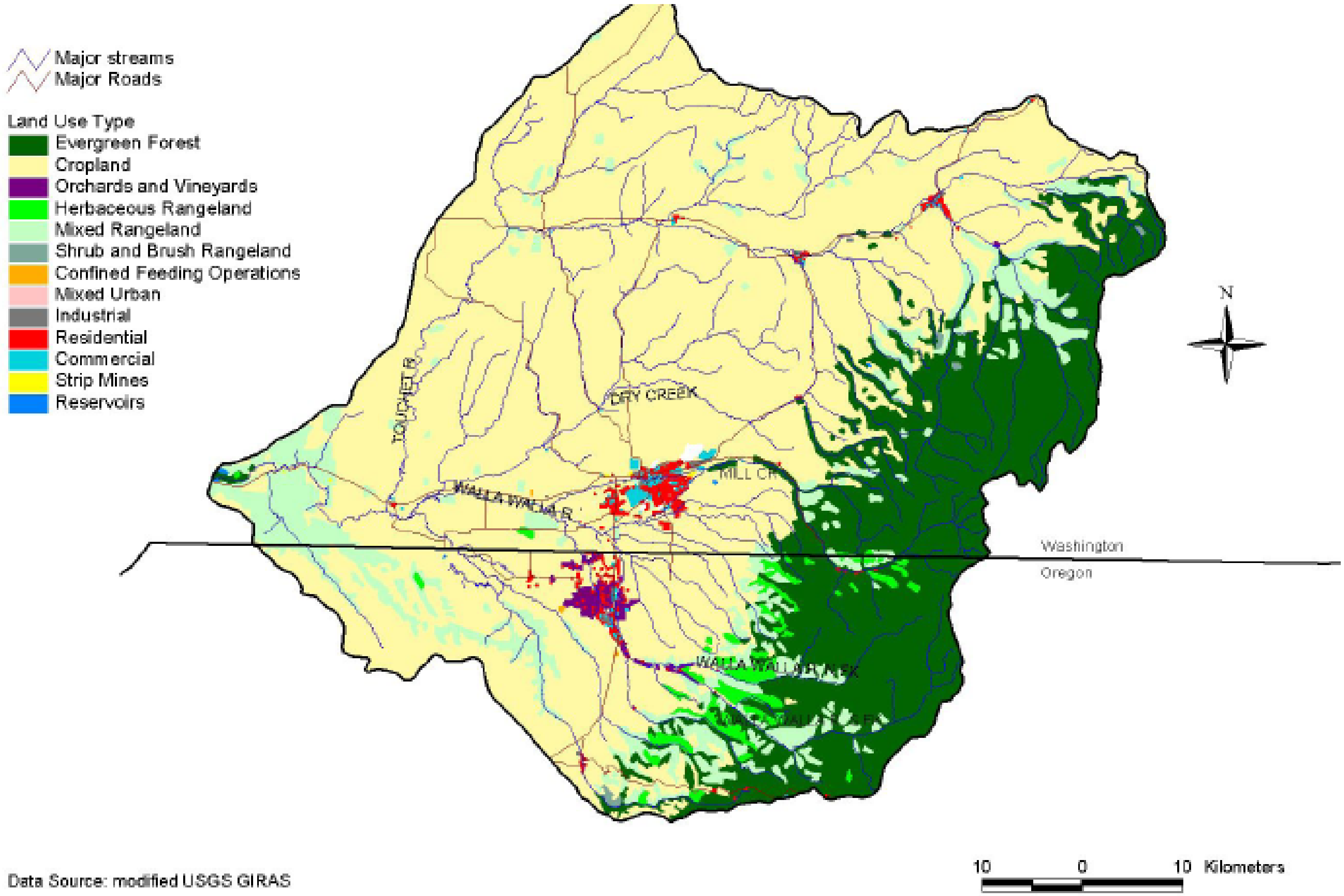

Figure 5. Land use in the Walla Walla River basin (Walla Walla Basin Watershed Council, 2004).

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alfalfa seed, hay, and peas are the largest percentage of the crops. Other crops include grapes, apples, asparagus, barley, legumes, and onions. Walla Walla County has 115,000 acres of irrigated farmland, with 90% of it as cropland and 10% as pasture.

Headwaters are mostly forest and rangeland managed by the U.S. Forest Service. Some Confederated Tribes of the Umatilla Indian Reservation (CTUIR) lands are located in and near the upper Walla Walla watershed. The CTUIR has expressed interest in this project. Their biologists are actively involved with salmon and steelhead production and habitat restoration in the Walla Walla River basin.

Salmon Populations and Listings

Mendel et al. (2003) of the Washington Department of Fish and Wildlife (WDFW) surveyed the fish populations within the Walla Walla basin, finding the highest abundances of salmonid species in upper Mill Creek and the North and Wolf Forks of the Touchet River. Native salmonid species identified were mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*), and rainbow/steelhead trout (*Oncorhynchus mykiss*). Most spawning habitat was found in the upper reaches, while the lower reaches of the Touchet and Walla Walla Rivers are mainly used for fish migration with little rearing capability.

Spring chinook salmon (*Oncorhynchus tshawytscha*) were historically present in the Walla Walla basin but were extirpated in the 1950s (Van Cleve and Ting, 1960). A few chinook salmon were observed in the late 1990s by the WDFW (Walla Walla Basin Watershed Council, 2004). In August 2000, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) released about 200 pair of sexually mature spring chinook from the Ringold Hatchery into the upper Walla Walla River in Oregon in hopes of establishing a naturally spawning population (Kuttel, 2001).

Since 2001, more chinook adults and juveniles have been observed in the upper Touchet River basin, upper Mill Creek, Yellowhawk Creek, and the Walla Walla River near the state line (Mendel et al., 2002; 2003). Adult spring chinook return to the Walla Walla basin in May to June and spawn in August through September (Walla Walla Watershed Planning Council, 2004). The fingerlings emerge in February and March, and the juveniles overwinter in local streams to migrate the next spring.

Changes in flow regime, water quality, riparian conditions, water temperatures, substrate, and passage impediments have affected steelhead salmon runs as well (Kuttel, 2001). Steelhead salmon in this system were listed as threatened under the Endangered Species Act in March 1999. Adult steelhead salmon enter the Walla Walla system generally by September or October, but usually must hold in the Columbia River for long periods of time until streamflow conditions are more favorable. They then spawn in March and April. Fingerling emergence is thought to occur as late as June and July. Fingerlings spend one to three years in the basin before migrating out in the spring.

The Walla Walla basin contains federally designated critical habitat for bull trout, a threatened species protected under the Endangered Species Act (USFWS, 2004). Dams, diversions, and high water temperatures have disrupted the historic bull trout migrations throughout the basin. The North and South Forks of the Walla Walla River, upper Mill Creek, North Fork Touchet River, Wolf Fork, and South Fork Touchet River support bull trout, but they are isolated populations. The U.S. Fish and Wildlife Service (USFWS) listed bull trout as a threatened species in June 1998.

Resident bull trout spend most of their time in cooler waters in the upper watershed. Migratory stocks may move into the lower reaches of Mill Creek, the Touchet River, the Walla Walla River, and perhaps the Columbia River (Walla Walla Watershed Planning Council, 2004). Adults and juveniles migrate in the fall through late spring. Adult spawning occurs from late August through October. Because of cool water temperatures, the fry emerge from redds in June or later. In 2002, WDFW staff counted 161 redds in Mill Creek, 29 redds in the North Fork Touchet River, and 92 redds in the Wolf Fork Touchet River (Mendel et al., 2004).

Made up of county elected officials, citizens, tribes, and a regional technical team, the Snake River Salmon Recovery Board is working to restore native salmonids in the Walla Walla watershed. The Board finalized and submitted an Endangered Species Act recovery plan for listed steelhead, bull trout, and salmon to the National Marine Fisheries Service. The plan presents priority areas for protection and restoration as well as identifies significant limiting factors that need to be addressed.

Water Resources

In general, the low-flow issues of most streams in the Walla Walla watershed profoundly affect water quality. Many reaches are dry or a series of shallow pools for several months in the summer and early fall. Some of the dry reaches are a result of legal and illegal diversions and withdrawals. Many water rights in the Walla Walla basin have very early priority dates (dates of origin), dating back to the mid to late 1800s. Agencies and local groups have been working to improve instream water volumes during critical life-stage periods of endangered fish species. However, water rights issues are not in the scope of this TMDL.

The TMDL does require an evaluation of critical conditions (see *Results and Discussion: Seasonal Variation and Critical Conditions*). One variable in the critical condition evaluations is water volume. As will be described, the seven-day average low flow with a probability of occurring once every 10 years (7Q10) is used for most aquatic life assessments.

The evaluation of critical streamflows also will consider the new appropriation flow (NAF) recommendations for four management points in the Walla Walla River basin (HDR/EES, 2005) (Figure 6):

- Management Point 1 – Mill Creek just downstream of the Oregon/Washington border (at Kooskooskie)
- Management Point 6a – North Fork Touchet just upstream of the South Fork confluence
- Management Point 11 – Touchet River near the county line (river mile 40.5 at Bolles).
- Management Point 5a – Walla Walla River at Detour Road Bridge.

The NAF recommendations were made by the Instream Flow Subcommittee of the WRIA 32 Basin Planning Unit and approved by the Planning Unit in May 2005 for inclusion in the final *Walla Walla Watershed Plan* (HDR/EES, 2005). The recommendations are based on the best hydrologic, biologic, and water-use data available, but professional judgment was used in each of the NAF recommendations (Appendix G, Tables G1 – G4). The NAF values are the minimum monthly flows that, when reached, would allow new consumptive out-of-stream uses and withdrawals. The NAF instream flow levels do not affect existing water rights.

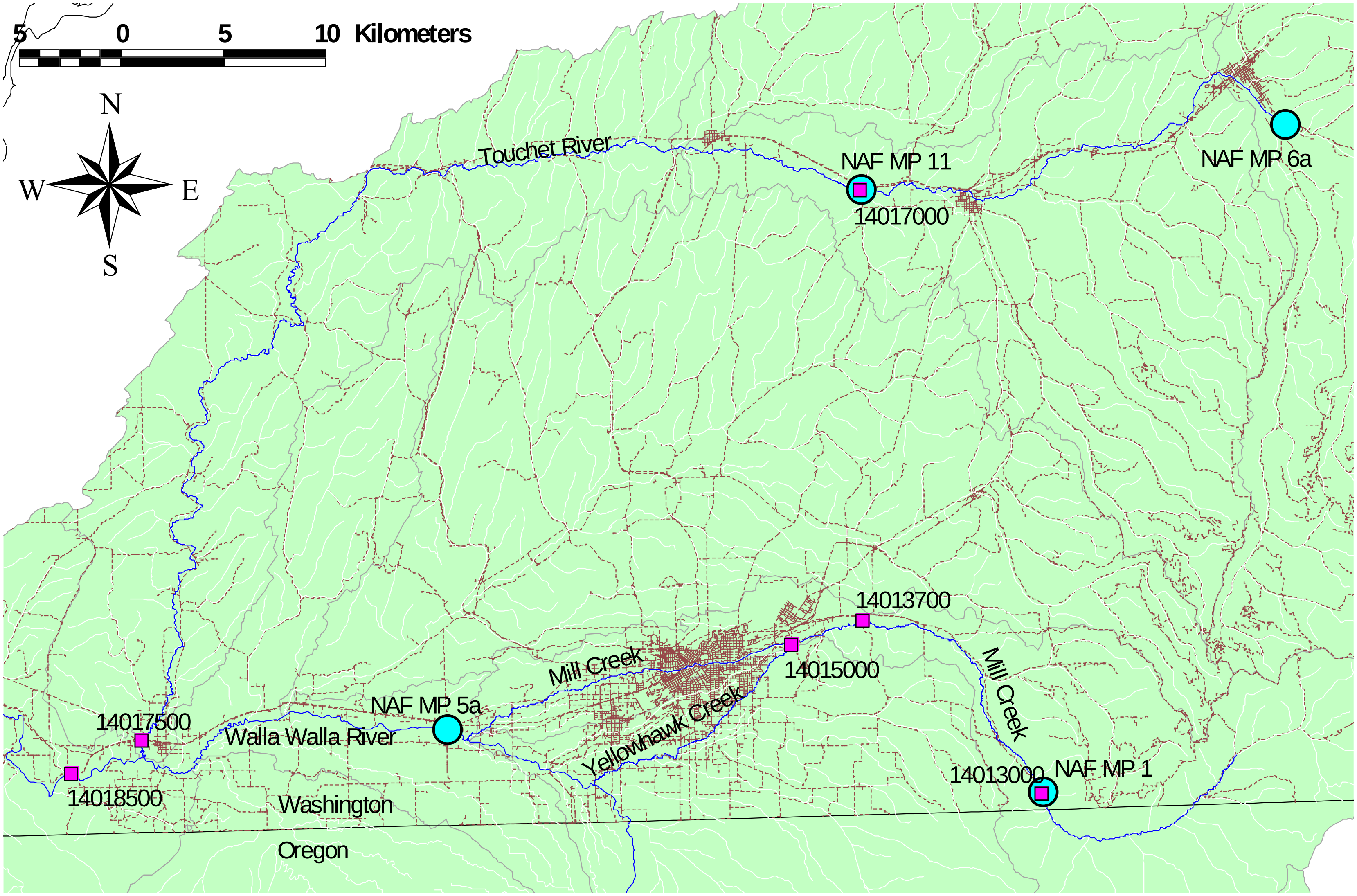

Figure 6. USGS flow stations and WRIA 32 Planning Unit new appropriation flow management points (NAF MP).

The *Walla Walla Watershed Plan* has been included in the Snake River Region Salmon Recovery and *Walla Walla Watershed Detailed Implementation Plan* (HDR, 2006). The detailed implementation plan outlines how the watershed and salmon recovery plans meet requirements of both sets of planning legislation. Once the implementation plan is approved, requests for funding and actions on priority tasks can take place.

Possible Pollution Sources

Much of the past water quality monitoring in the Walla Walla basin was conducted on the lower 10.5 miles of Mill Creek around the City of Walla Walla, the Touchet River near Waitsburg and Dayton, and the lower reaches of Garrison Creek. These studies have focused on the effects of the wastewater treatment plants (WWTPs) serving urban communities. Other possible sources in and near the urban environment have not been examined (e.g., stormwater, on-site sewage systems, and residential nonpoint contaminants).

Most reaches of the Walla Walla River in Washington, the Touchet River from RM 0.5 to RM 40, and Mill Creek above RM 11.5 have not been characterized for water quality, although problems have been suggested. For example, the 303(d) pH listing on Mill Creek is above the city at RM 10.5; therefore, high pH is a problem even before additional nutrient loading from urban and WWTP sources. Recreational homes, livestock, and cropland are present in this area, and these nonpoint sources are likely contributors of high nutrient and oxygen-demanding contaminants in rural areas of the basin.

But soils and geology may play an important role in pH and nutrient concentrations in the basin. Lime layers and alkaline conditions in soils may affect the pH of subsurface and groundwater moving into surface waters. Many of the soils in the basin are also naturally depleted of nitrogen and high in phosphorus (USDA, 1964).

In general, managing the low-flow and high-flow issues of most streams in the Walla Walla watershed profoundly affect water quality. Historically, integrating water quality and water quantity issues have not been carefully considered. For example, ways need to be found to prevent damage during floods, but also to allow adequately shaded and deep channels for fish passage. Although specific water rights decisions are not in the scope of this TMDL, the management of water quantities will be examined.

The Walla Walla WWTP discharges into Mill Creek from December 1 through April 30 of each year, subject to NPDES permit conditions (Appendix A, Table A-3). The WWTP discharges at RM 5.4. An upstream diversion on Mill Creek diverts nearly all instream flows above the WWTP discharge from May through October to Garrison and Yellowhawk Creeks for irrigation purposes.

Most of the City of Walla Walla’s effluent to Mill Creek is available for irrigation use from April 15 through December 15. Irrigation flows are then returned to the creek downstream of the diversion stretch. The major suspected causes of pollution in Mill Creek may be nonpoint sources such as agriculture, livestock management practices, and re-used city wastewater returned to Mill Creek from the irrigation system. Effluent discharged directly into Mill Creek from December through April is not expected to cause a water quality problem.

In 2000, the College Place WWTP discharged from May through October through wetlands prior to discharging into Garrison Creek (Appendix A, Table A-3). The effluent is discharged November through April directly to Garrison Creek. The College Place WWTP outfall is less than 1 mile from where Garrison Creek joins the Walla Walla River at RM 36.7, upstream of the confluence with Mill Creek.

Dayton WWTP may have an impact on biochemical oxygen demand (BOD) and nutrient loads since effluent is discharged to the Touchet River throughout the year. Currently, the impacts of wastewater discharges from the Waitsburg and Touchet WWTPs on nutrient and BOD loads in the Touchet River are not known because those facilities do not have surface water discharges (Appendix A, Table A-3). Subsurface leaching of contaminants from these facilities has not been studied.

The Waitsburg WWTP has trickling filters that discharge to infiltration basins with a contiguous groundwater connection to the hyporheic zone of the Touchet River (Appendix A, Table A-3). The proposed plant upgrade is an activated sludge oxidation ditch with extended aeration. The infiltration basins pose a risk of transmitting highly mobile nitrates to the river. Overloading can also result in phosphorus migration through the hyporheic zone.

Tributaries with heavy urban, point-source, or agricultural contaminant loads have an impact on the Walla Walla River. The nutrient and BOD contributions from Mill Creek, the Touchet River, and other tributaries may also contribute to the criteria violations noted in the lower Walla Walla River. Additional sources of nutrients and oxygen demand from Oregon and irrigation withdrawals all along the mainstem may exacerbate water quality degradation.

Previous Monitoring Activities

As shown in Figure 7, Ecology's Environmental Assessment (EA) Program has monitored nine sites in the basin. These sites have been monitored at monthly intervals but during various years between 1989 and the present (Table 5). The two Ecology stations in the basin with the longest monitoring records have been the Walla Walla River near Touchet (32A070) and the Touchet River at Touchet (32B070).

The cities of Walla Walla, Dayton, Waitsburg, and College Place have been the subjects of EA Program WWTP inspections and receiving water surveys (Hoyle-Dodson, 1997; Chase and Cunningham, 1981; Joy, 1987; Heffner, 1988). Additionally, Ecology conducted receiving water surveys for Mill and Garrison Creeks, and the Touchet River (Joy, 1986; 1987; White et al., 1998).

Table 5. Ecology ambient water quality monitoring sites in the Walla Walla basin.

ID	Station Name	River Mile	Monitoring Years Since 1989
32A070	Walla Walla R. near Touchet	15.3	1989-present
32A100	Walla Walla R. at East Detour Rd. Br.	32.8	1999
32B070	Touchet River at Touchet	0.5	1989-1992; 1996-97
32B080	Touchet River at Sims Road	9	1999
32B100	Touchet River at Bolles	40.4	1999
32B130	Touchet River at Dayton	53.3	1991-92
32B140	Touchet River above Dayton	53.7	1996-97
32C110	Mill Creek at Tausick Way	10	1992-93

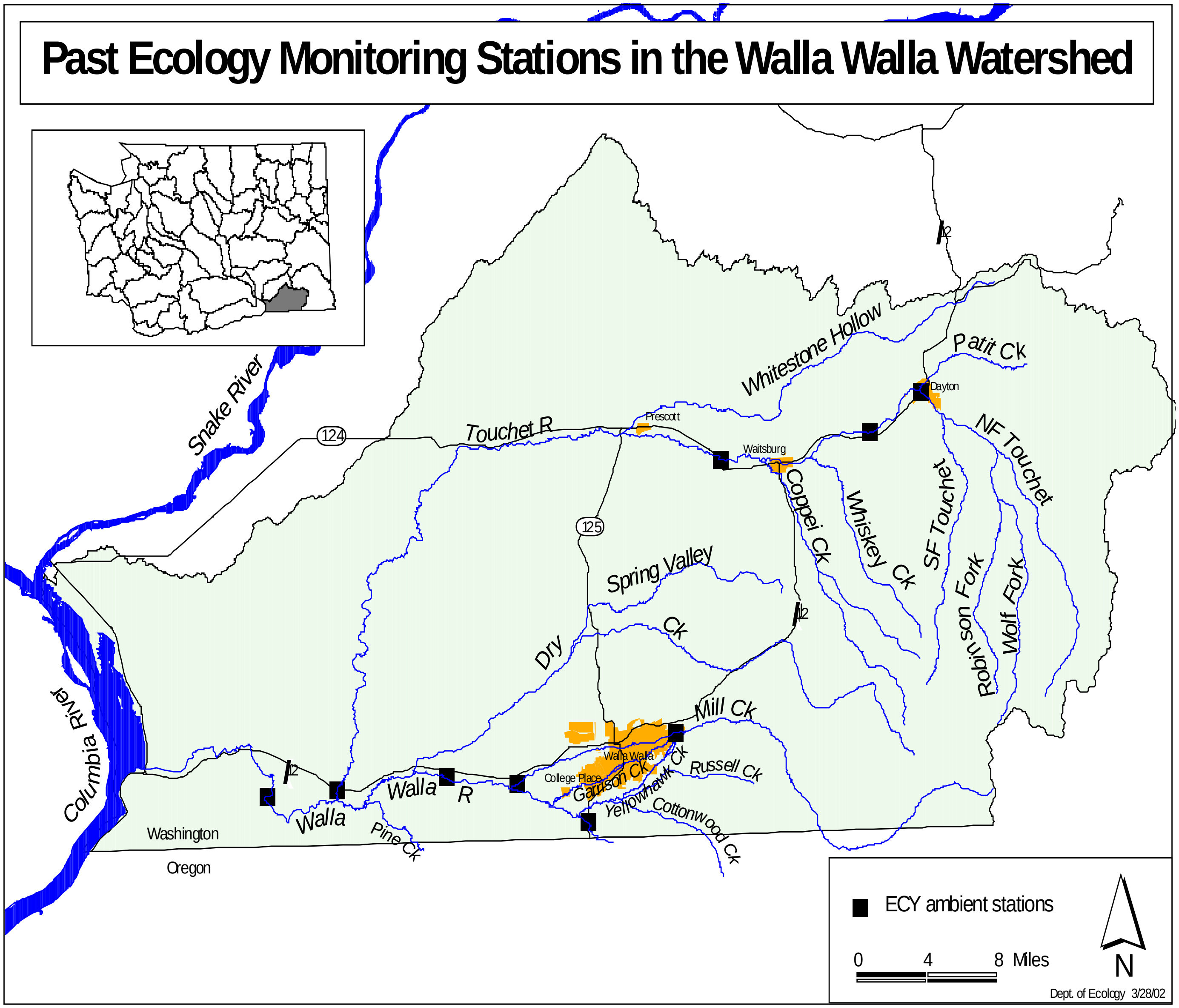

Figure 7. Ecology's historical ambient monitoring stations in the Walla Walla watershed.

Oregon's Department of Environmental Quality (ODEQ) performed a temperature TMDL on the mainstem Walla Walla River in Oregon and Washington (ODEQ, 2005). The ODEQ also included channel morphology and streamside vegetation data in their temperature TMDL analysis. No conventional parameters' samples were taken; however, some historical ODEQ data have been collected for selected conventional parameters in the Walla Walla River and Pine Creek (Table 6).

Table 6. ODEQ ambient water quality monitoring sites in the Walla Walla River basin.

ID	Stream Name	Site Location	Lat./Lon.	Monitoring Years
10712	Walla Walla River	Milton-Freewater	45.9038/118.3675	1967-75
10713	Pine Creek	Pine Creek Near Umapine	45.9681/118.5296	1967 and 1968

Based on studies conducted in 1982 and 1986 on Mill Creek by Ecology, a TMDL for ammonia was developed and approved by the EPA in February 1993. CH2M Hill performed a year-long evaluation of Mill Creek in 1997–1998 to modify the terms of the original TMDL (CH2M Hill, 1998). CH2M Hill studied many conventional parameters, including diurnal DO and pH, and most nutrients under contract for the City of Walla Walla. A final evaluation of the data has not been completed.

The Washington Department of Fish and Wildlife (WDFW) has performed assessments of salmonids and their habitat in the Walla Walla River basin since 1999 (Mendel et al., 1999; 2000; 2003; 2004). The primary objectives of the WDFW studies have been to collect and assess biological and habitat data. Streamflow volumes, temperature data, and summertime pH and conductivity data have been recorded for the Touchet and Walla Walla Rivers and several of their tributaries.

The Washington State Conservation Commission performed a salmonid habitat limiting factors study in the Walla Walla basin in 2000 (Kuttle Jr., 2001). Its focus was on factors limiting salmonid migration and overall survival. Water quality data included total suspended solids (TSS) and temperature. Temperature was listed as a limiting factor, and TSS was mentioned as having adverse impacts on salmonid habitat in several streams (e.g., Patit Creek, Touchet River, and the lower Walla Walla River).

The Washington State University (WSU) Center for Environmental Education also conducted water quality monitoring in the Columbia County portion of the Touchet River watershed (Krause et al., 2001). Temperature, TSS, fecal coliform (FC), ammonia, nitrate, total Kjeldahl nitrogen (TKN), total phosphorous (TP), and flow were monitored at nine sites. Sites were located on the North and South Forks, the mainstem Touchet River, and Patit Creek.

Historical Data Assessment

Historical monitoring data provide a description of water quality problems in the Walla Walla basin. Ecology ambient monitoring data and some ODEQ data were analyzed to determine general seasonal characteristics, criteria violation frequency, and long-term trends. The graphs generated from Ecology's ambient data are in Appendix B. These data analyses focused on monitoring conducted from 1980 to 2000.

pH

Previous Ecology monitoring data in the Walla Walla and Touchet Rivers indicate seasonal variation of pH. Although the data are from instantaneous samples only, pH tended to increase in the spring and summer, peak in mid- to late summer, and declined again in the fall and to the lowest relative values in winter (Figure 8). The data also show that reported pH values rarely dropped below 7 at any time of the year, and that all but one monthly average values were greater than 7.5.

The seasonal pH pattern, especially in the Touchet River, is typical of the influence of plants and decreasing streamflows over the March to October growing season (Appendix, Figure B-6). High pH in the summer could be due to low streamflows with a higher contribution of subsurface water, combined with the influence of benthic or macrophyte productivity (due to high light and high temperatures). The latter may indicate nutrient enrichment problems. The pH 303(d) listings are often seen by Ecology staff as indicators of possible eutrophication and nutrient problems.

Mill Creek, the Touchet River, and the Walla Walla River were all listed for pH violations in 1996. Mill Creek and the lower mainstem Walla Walla River continued to be on the 1998 303(d) list for high pH. Ecology's monitoring data showed that the Touchet River near the mouth did not have any pH criteria violations. Diel (24-hour) pH monitoring has not been conducted at any of the Ecology sites.

Water quality data collected by WDFW in 1999 showed pH criteria violations. Four of the six samples taken in late June and early July on the Walla Walla River at RM 29.3, 32.9, 34.0, 36.5, and 39.6 exceeded water quality standards (Mendel et al., 2000). Mendel et al. (2000) also sampled the Touchet River during this time at RM 1.5, 11.3, 40.5, and 53.5 and found three of the six total samples taken there were above the pH 8.5 criterion. The single pH sample taken in early June on Pine Creek at RM 1.3 also exceeded the criterion.

No pH violations were detected at other Ecology stations; however, many other streams in the basin have elevated pH values during the growing season that approach the pH criterion of 8.5. For example, CH2M Hill (1998) recorded pH values greater than (>) 8.5 standard units (s.u.) in Mill Creek. In the afternoon and evening hours during their July and August diel surveys, pH values of 9.12 and 8.94 were recorded below the city of Walla Walla at river miles 5.5 and 4.8, respectively. July and August are months when most streamflow is diverted to Yellowhawk Creek at RM 10.5, and the Walla Walla WWTP is not directly discharging to the lower Mill Creek channel.

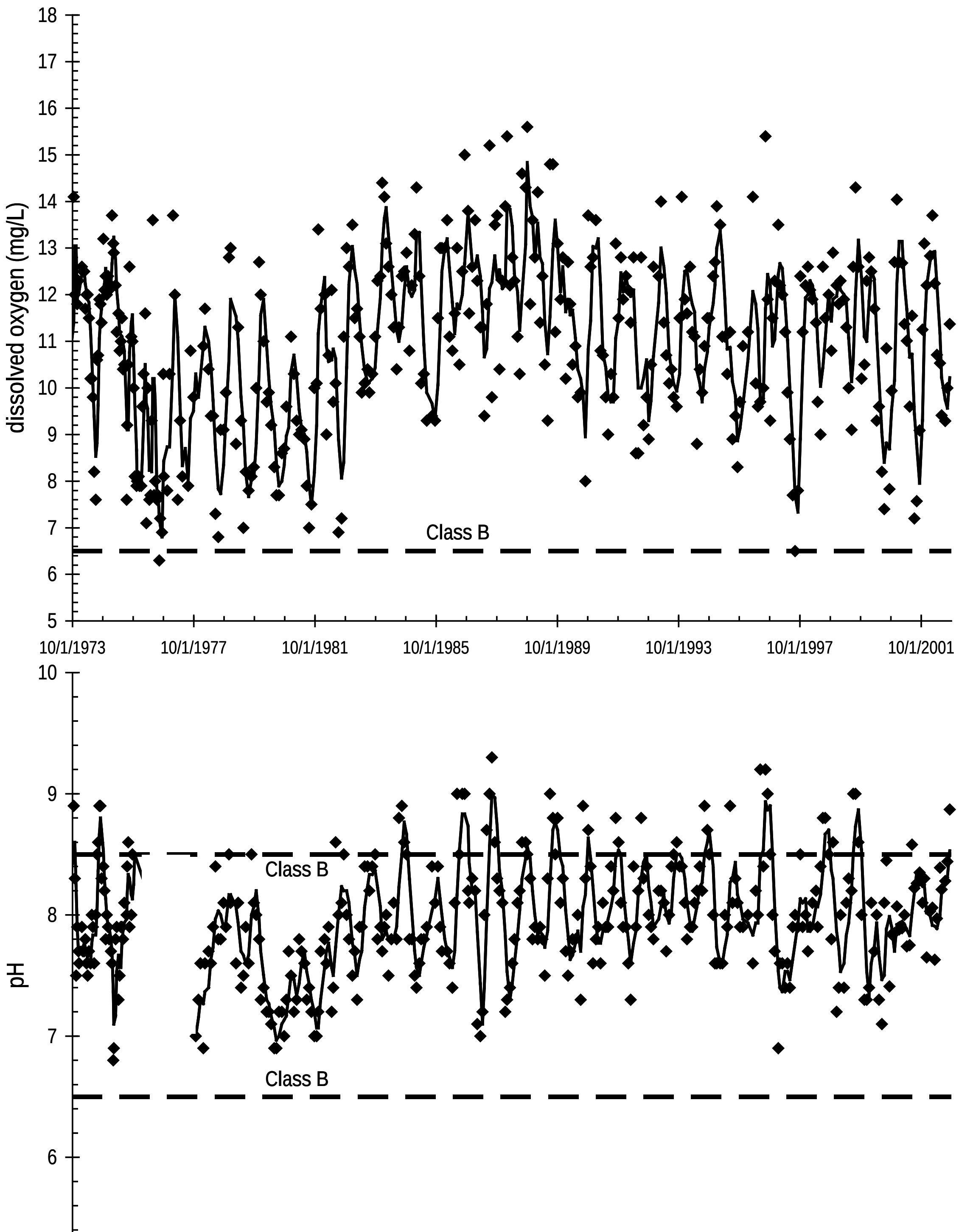

Figure 8. Dissolved oxygen and pH in the Walla Walla River near Touchet, 1973-2002 (Ecology station 32A070). Lines show 3-month moving averages.

CH2M Hill also found pH values > 8.5 at other sample sites in Mill Creek during their regularly scheduled monitoring. The data were not reported for the 305(b) assessment, but the data indicate that pH problems extend downstream of the 303(d) listed area on Mill Creek at RM 10.5.

Dissolved Oxygen

Dissolved oxygen (DO) data from Ecology's long-term ambient monitoring station 32A070 are presented in Figure 8. Based on grab samples, DO usually appeared to meet the 6.5 mg/L water quality standard. Grab samples for the site were most often taken after sunrise, so usually minimum DO concentrations were not observed.

CH2M Hill performed a diurnal DO monitoring survey on lower Mill Creek in July and August 1997 (CH2M Hill, 1998). Although the study reported major diurnal changes in DO concentrations (e.g., from 5.8 mg/L in early morning up to 13.4 mg/L during the afternoon), DO did not fall below the special condition criteria of 5.0 mg/L for Mill Creek below RM 6.4. High diurnal variations, together with more extensive sampling, might show that a DO problem exists in Mill Creek.

Diurnal changes in DO concentrations on the mainstem Walla Walla River near Touchet were not well understood because of the lack of continuous, 24-hour sampling. The widest range of concentrations is presumably in July and August when temperatures and primary productivity are at their highest and flows at their lowest.

According to Ecology's ambient monitoring data, the closest to a violation of the 6.5 mg/L DO criterion for Class B streams occurred in August 1997 (6.5 mg/L DO) (Figure 8). Sampling time changes over the years limit the usefulness of these data for yearly trend analysis. Dissolved oxygen saturation maxima occur in the daytime in August, and minima in January and May. Summer supersaturated conditions suggest upstream benthic or macrophyte productivity and the possibility of nutrient enrichment problems.

Ecology's monthly data for the Touchet River near Touchet and Mill Creek at Tausick Way were very similar for seasonal DO trends. The Touchet River had 4 violations out of 35 samples taken monthly in 1990, 1991, 1992, 1996, and 1997, with 3 violations in the summer of 1997. This was not enough to include the Touchet River on the 1998 303(d) list for DO. Ecology's Mill Creek monitoring data from October 1992 through September 1993 show similar seasonal trends, but no criteria violations were recorded for that period.

Nutrients

Nutrients affect the health of the aquatic system directly and indirectly. Ammonia can be a toxicant at high concentrations or when pH and temperature conditions are elevated. Organic nitrogen and ammonia can also exert an oxygen demand as the aquatic community converts them to nitrite and nitrate. Nitrogen and phosphorus are essential for a healthy community, but they can over-stimulate aquatic growth and cause DO and pH problems in the water column.

There are no nutrients on the 1998 303(d) list for the Walla Walla basin because Washington does not have nutrient criteria for streams and rivers. However, total phosphorus, total nitrogen, and ammonia were listed on the 1996 303(d) list as potential contributors to the low DO conditions in Mill Creek and to ammonia toxicity. Although not recognized by EPA Region 10 as a nutrient TMDL, the Mill Creek TMDL submitted in 1992 limited nutrients and ammonia by limiting Walla Walla WWTP effluent discharge to Mill Creek from May to November.

Ecology's ambient data for the lower Touchet River (32B070) and the lower Walla Walla River (32A070) showed relative increases in nitrite-nitrate and total phosphorous concentrations during late winter and early spring in the lower portions of both rivers. Soluble reactive phosphorus (SRP) concentrations were measurable throughout the year. Not enough data were collected to determine trends in Mill Creek's (32C110) monthly nutrient concentrations.

The concentrations of dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP), and the ratios of DIN:SRP at ambient monitoring station 32A070, are shown in Figures 9 and 10, respectively. The DIN:SRP ratios suggest that DIN is often limiting to growth in the growing season of June to October, and that the lower Walla Walla River tends to be phosphorus-limited other times of the year (Figure 10).

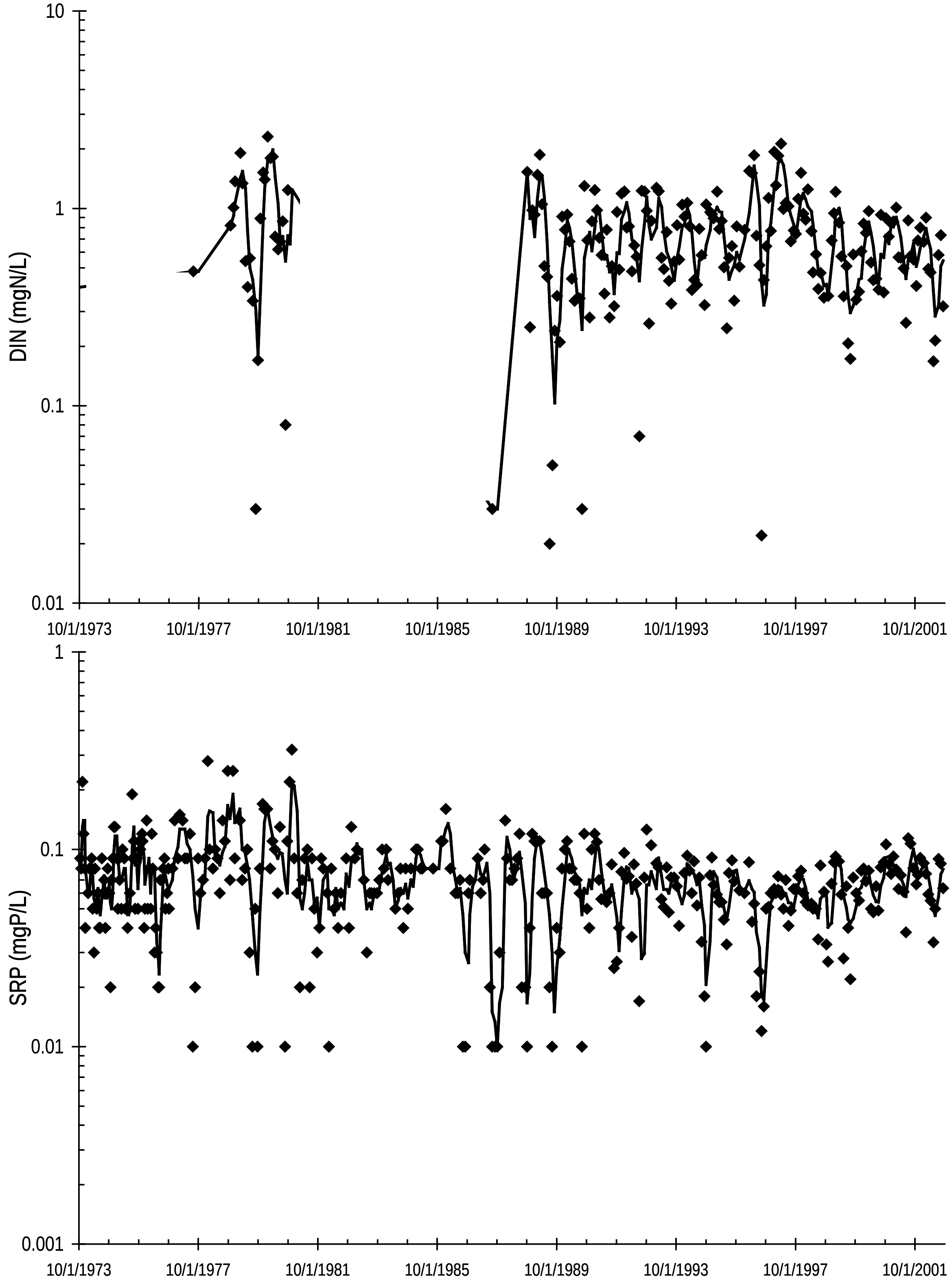

Figure 9. Dissolved inorganic nitrogen and soluble reactive phosphorus in the Walla Walla River near Touchet, 1973-2002 (Ecology station 32A070). Lines show 3-month moving averages.

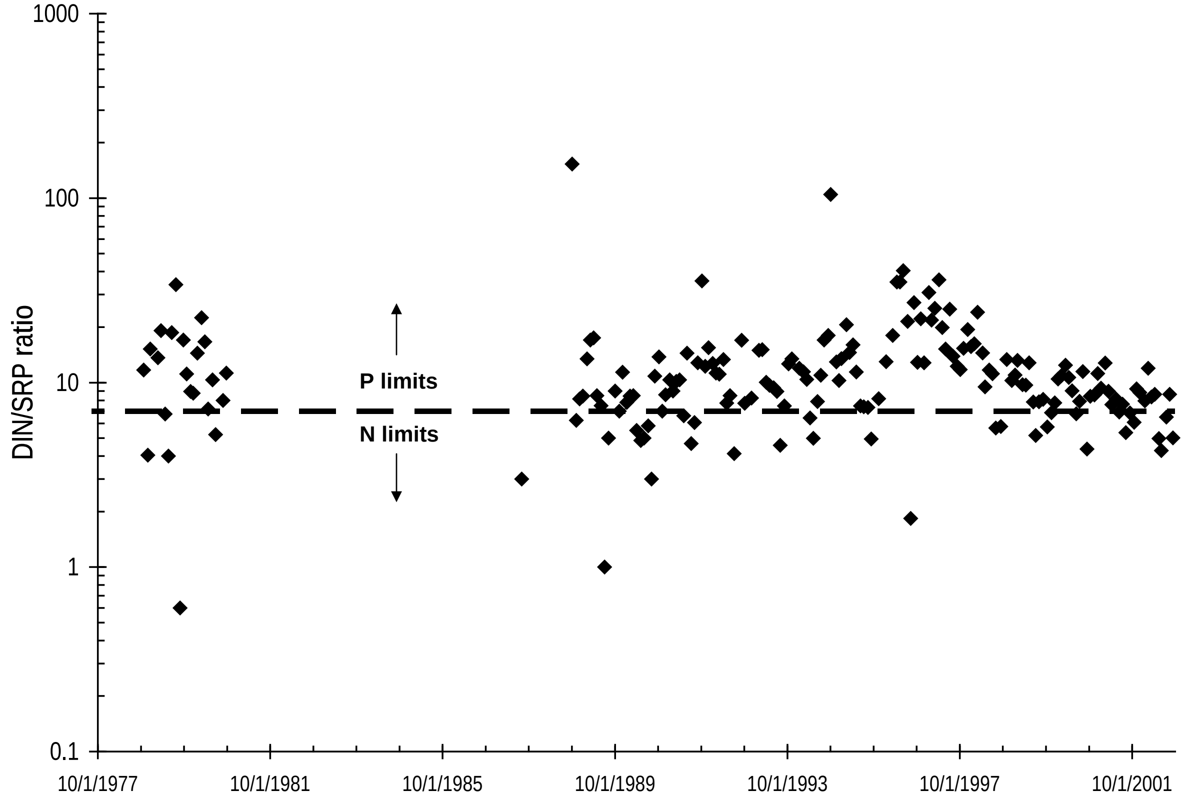

Figure 10. Ratios of dissolved inorganic nitrogen to soluble reactive phosphorus in the Walla Walla River near Touchet, 1973-2002 (Ecology station 32A070).

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TMDL Goals and Objectives

Goals

The Total Maximum Daily Load (TMDL) goal of meeting state pH water quality standards was expanded to include dissolved oxygen (DO) and nutrients, after reviewing historical data. Ecology staff recognized that the pH and DO problems were more widespread than the 303(d) listings suggested, and that the problems were likely associated with excessive nutrient stimulation of primary productivity, exacerbated by low streamflows and high temperature. In addition, any pH and DO problems would have a direct effect on fish and Endangered Species Act issues in the basin.

As with all TMDLs in Washington, there are two primary components to operating within the TMDL framework. One is conducting a technical assessment of the water quality, and the other is implementing the actions to improve water quality. The components are worked concurrently, as communication and community participation are essential for assessment and implementation.

The pH, DO, and nutrient technical assessment goals were to:

- Calculate the loading capacity for pH in Mill Creek, the Walla Walla River, and other areas in the Walla Walla basin, as appropriate. Set load allocations for various tributaries and reaches using one or more appropriate parameters (e.g., limiting nutrient, temperature, or light).
- Determine if there is a DO or nutrient/primary productivity problem in the mainstem Walla Walla River, Touchet River, and Mill Creek. If necessary, calculate the seasonal loading capacity for limiting nutrient(s) and oxygen-demanding substances in portions of the Walla Walla River, Touchet River, or Mill Creek to meet the DO criterion. Set seasonal load allocations and wasteload allocations for pollution sources.

Objectives

Several objectives were set for attaining the project goals. These involved both technical analysis and the implementation process. The technical analysis is led by the Ecology Environmental Assessment (EA) Program project manager and field lead. The implementation process is led by the Ecology Eastern Regional Office (ERO) Water Quality Program TMDL lead.

Objectives for the technical analysis included the following:

- Review background information and historical water quality data to:
  - Understand geology, hydrology, climate, land use, and political influences on the water quality problem
  - Evaluate additional data needs
  - Help determine the seasonal and geographical limits to the problem
  - Determine trends
  - Focus investigations on potential sources

- Engage local agencies for additional data, expertise, and experience.
- Focus the goals of the TMDL to meet the needs of the ERO Water Quality Program and the local community, and to meet the requirements of the Clean Water Act.
- Write and attain approval for a quality assurance (QA) project plan covering the 2002-03 surveys. The QA project plan is needed to ensure that:
    - Credible environmental data were collected
    - Useful data for modeling and statistical analysis were collected
    - Potential sources to the water quality problem were addressed
    - Redundancy in field and data analysis was reduced
- Integrate Ecology field work with work performed by other agencies in the Walla Walla River basin for efficient use of resources.
- Cooperate with other TMDL water quality modelers and project managers for efficient and consistent approaches to interpreting water quality data.
- Stay informed on emerging issues in the basin to focus the TMDL results in the most helpful way.

Objectives for achieving water quality through implementation activities include the following:

- Introduce the community to the TMDL process.
- Meet water quality standards by following a locally developed plan.
- Gather input from local residents to create a plan with strategies shown to improve water quality.
- Provide a clear communication link between all Ecology staff.
- Create and maintain communication with the public and representatives of the various planning processes.
- Partner with local groups to apply best management practices that improve water quality.
- Provide technical and financial assistance when possible.

Study Methods

Data Collection Activities

The study was conducted under a quality assurance (QA) project plan that was reviewed by Ecology, EPA Region 10, the Confederated Tribes of the Umatilla Reservation, and local stakeholders. The QA project plan was approved after incorporating reviewer's comments in August 2002 (Swanson and Joy, 2002). A brief description of the 2002-03 TMDL survey data collection and analysis activities is presented here.

Water Quality Data Network

Water quality and streamflow data were collected from monitoring sites distributed throughout the basin within Washington (Appendix D, Table D-1 and Figures D-1 to D-3). Instantaneous measurements of pH and DO were taken at 58 sites in the basin:

- 25 core sites were sampled 16 times over 13 months. The core sites were set at known or suspected areas of pH and DO problems based on the water-quality-impaired 303(d) list, at the mouths of major tributaries, bracketing cities or where changes in land use occur, and at convenient intervals in larger river systems.
- 33 expanded sites, including the three municipal wastewater treatment plants (WWTPs), were sampled six or fewer times during expanded surveys. Expanded sites were used to monitor minor tributaries, provide quality assurance data generated under WWTP self-monitoring, and better define water quality between larger monitored reaches.

Sites were distributed in the basin as shown in Table 7.

Table 7. The distribution of sampling sites among various subwatersheds for the 2002-03 Walla Walla River basin monitoring study. See text for explanation of Core and Expanded sites.

Subwatershed or Source	Core	Expanded	Total
Touchet River	10	9	19
Mill Creek	6	10	16
Yellowhawk/Garrison Creeks	2	3	5
Walla Walla River	7	3	10
Minor tributaries to the Walla Walla River	-	4	4
Municipal WWTPs*	-	4	4
Total	25	33	58

* Walla Walla, 2 sites in College Place, and Dayton

Two other monitoring techniques were used. Hydrolab DataSonde® multi-probe meters were deployed at 11 sites to continuously monitor DO, pH, temperature, and conductivity over two or three consecutive days in July, August, and September 2002 and May and June 2003 (Appendix H). The continuous meter monitoring data provide diel maximum and minimum values. An additional set of intensive surveys of upper Mill Creek and Yellowhawk Creek was conducted August 31 through September 1, 2004 to follow nutrient and chemical changes in a single block of water as it travels downstream.

Nutrient samples were collected at fewer sites and at a lower frequency. All of the core sites were monitored for nitrogen, phosphorus, and organic carbon on at least nine occasions (Swanson, 2005). Walla Walla, College Place, and Dayton WWTPs were monitored on at least seven occasions. One or more nutrient samples were collected at 13 sites of the expanded network.

Periphyton samples were collected and analyzed for chlorophyll *a* content at six sites: Walla Walla River at RM 15.6 and RM 38.7; Mill Creek at RM 21.1 and RM 0.5; and Touchet River at RM 2.0, and at the mouth of the North Fork Touchet. Samples were collected on two occasions, once in July and once in August in 2002.

Wiseman, LeMoine, and Diamond (in press) collected and evaluated benthic macroinvertebrate samples in the fall of 2002 from six reaches of the Touchet River. Washington State field protocols were followed (Plotnikoff and Wiseman, 2001). In addition, data on channel, substrate, and riparian habitat characteristics for the Walla Walla River basin temperature TMDL (LeMoine and Stohr, 2002) were used in the evaluation.

A few groundwater samples were collected and analyzed for nutrients at four sites (Marti, 2005). Groundwater levels were also recorded and compared to surface water elevations. Three sites were along the mainstem Walla Walla River near McDonald Road, Lowden Road, and Gardena Farms Road. One site was located near Cummins Road along the Touchet River. Samples were collected once each in August and October 2002 and analyzed for nitrate-nitrite, total persulfate nitrogen, ammonia, total phosphorus, orthophosphate, and organic carbon (Appendix B, Table B4).

The paucity of historical pH, DO, and nutrient data in much of the basin, as well as the finite resources available to cover a large geographic and hydrologic complex basin, limited the scope of the study to general problem assessment. The study was designed to provide Ecology and local water quality managers with a broad overview of the DO and pH problems in the basin, on which better monitoring and implementation resource allocation decisions can be made. Other than WWTP evaluations, the study was not designed to assess or identify individual sources of nutrient enrichment or oxygen demand, especially nonpoint sources.

Data Analyses Methods

Data Compilation and Quality Assurance

Swanson (2005) previously published the 2002–2003 Ecology TMDL survey-generated data summary. These data are also in Ecology's Environmental Information Management (EIM) system under the study name, Walla Walla Bacteria and pH TMDL. The EIM system can be accessed on the internet at www.ecy.wa.gov/eim/.

Nutrient, temperature, DO, and pH data collected by the Ecology Freshwater Monitoring Unit at four stations were also used for this project (Ecology, 2005). These are provided in Appendix B, Table B1-B3. Groundwater data analyzed by Marti (2005) are in the EIM system [SW/GW interactions – Walla Walla R. watershed (WRIA 32)].

Additional streamflow data measured by the following were also used:

- Washington State Department of Fish and Wildlife (Mendel et al., 2004),
- U.S. Geological Survey - http://waterdata.usgs.gov/wa/nwis
- U.S. Army Corp of Engineers
- Ecology Walla Walla Watermaster (Neve, 2004)
- Stream Hydrology Unit - https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp?region=4

Data Assessment Methods

The general approach used to assess pH and dissolved oxygen (DO) consisted of first examining the historical and TMDL survey data and then identifying areas not meeting water quality criteria. Areas meeting criteria, but barely so, were also identified. Probable causes for pH and DO problems were identified after examining nutrient data and considering potential sources of contaminants upstream of the problem area. For example, were DO deficits in the reach more likely the result of BOD loads or of nutrient loads stimulating biomass productivity?

The next steps toward assessing pH and DO involved establishing seasonal background concentrations, evaluating reaeration and physical processes, and then evaluating deoxygenation and eutrophication. Developing loading capacities for nutrients followed, and consisted of three main elements:

1. Data from historical ambient monitoring and the 2002-03 surveys were summarized to describe seasonal and spatial variability of concentrations of dissolved oxygen, pH, and nutrients.
2. Ratios of dissolved inorganic N (DIN) to soluble reactive phosphorus (SRP) were evaluated to determine which nutrient was most likely to be limiting growth of periphyton in the streams.
3. Where sufficient synoptic data were available (Mill-Yellowhawk Creek and Touchet River), a numerical model (QUAL2Kw) was calibrated and used to estimate the (1) loading capacity and predict the response to load allocations for nonpoint sources and (2) wasteload allocations for point sources.

Nutrients (nitrogen and phosphorus) are necessary for growth of periphyton, and phosphorus is often the most limiting nutrient for algal growth in natural freshwater (Wetzel, 1983). This is particularly true if the DIN to SRP ratio is greater than approximately 7 (Reynolds, 1984). Ratios below 7 indicate a nitrogen limitation. Nitrogen limitation is not as common in freshwater systems because some algae and bacteria can fix atmospheric nitrogen. Nitrogen limitation can occur in rivers and streams with a high proportion of wastewater.

Critical streamflows for the TMDL were evaluated as the lowest 7-day average flows with a 10-year recurrence interval (7Q10). The 7Q10 streamflow is defined in Washington State standards (Chapter 173-201A WAC) as the critical condition for steady-state discharges in riverine systems. Lowest flows typically occur in August or September. The 7-day average flow with a 2-year recurrence interval (7Q2) is another useful indication of the lowest flow that would occur in a typical year. Flow regimes were not examined during the spring and fall months of salmon rearing and spawning that are identified in the proposed standards.

The 7Q10 and July-August 7Q2 low-flows at USGS gaging stations and the new appropriation flow (NAF) recommendations for the WRIA 32 management points are presented in Table 8. In general the 7Q10 and 7Q2 flows are much lower than the NAF values. The NAF values reflect the minimum flow for allowing new consumptive out of stream uses and groundwater withdrawals and are not intended to represent the lowest flows that are likely to occur in the basin.

Table 8. Summary of lowest 7-day average flows with 10-year recurrence (7Q10) during July-August and WRIA 32 Planning Unit NAF values.

Location	WRIA 32 planning unit Management Point number	Period of record	7-day-10-year low flow during July-August (7Q10, cfs)	7-day-2-year low flow during July-August (7Q2, cfs)	WRIA 32 minimum monthly NAF (cfs)
Mill Creek near Walla Walla	1	1914-17, 1938-2002	21.7	28.4	41
Mill Creek at Walla Walla	--	1941-2002	0	0.85	--
Touchet River at Bolles	11	1924-29, 1951-1989	14.1	29.7	48
Touchet River at Bolles	11	1951-1989	21.9	31.3	48
Touchet River near Touchet	--	1941-1955	11.4	20.3	--
Walla Walla River near Touchet	--	1952-2002	2.8	8.1	--
Walla Walla River at Detour Rd bridge	5a	--	--	--	closed
North Fork Touchet River	6a	1941-1968	31.6	39.9	51

NAF data source: HDR/EES, 2005

Modeling Dissolved Oxygen and pH

There are several important concepts for modeling the effect of primary productivity on DO and pH in running waters. Among the most important are:

1. Only one nutrient can limit algal growth at a time. The limiting nutrient will be the least available relative to its demand.
2. For river modeling, it is important to limit the growth rate to control the algal biomass yield. The growth rate is only limited by the concentration of the most limiting nutrient (i.e., the supply rate of the limiting nutrient), or by temperature and light restrictions.
3. It is appropriate to use the dissolved-fraction concentration of the limiting nutrient such as soluble reactive phosphorus (SRP) and dissolved inorganic nitrogen (DIN) as the basis for modeling periphyton growth. This is because the nutrient must be in a readily-available form for biological uptake and growth to occur during steady-state solute transport (Welch and Jacoby, 2004).
4. Total phosphorus and nitrogen are important to model since the particulate and organic fractions can be transformed into the dissolved fractions through various instream and hyporheic conditions.

Modeling pH and DO to check compliance with water quality standards also requires estimates of maximum or minimum daily concentrations, not just daily averages. The current Washington State criteria are based on pH values and DO concentrations not to be exceeded at any time. Therefore, the model needs to be at least quasi-dynamic to simulate the highest and lowest daily fluctuations of nutrients, light, biomass, DO, and pH.

Study Quality Assurance Evaluation

Field and Laboratory Data

Ecology developed a quality assurance (QA) project plan for the fecal coliform bacteria and pH Total Maximum Daily Load (TMDL) study in 2002 (Swanson and Joy, 2002). The project plan, which was approved, provides background information and a detailed description of monitoring and sample processing activities. The plan is available at www.ecy.wa.gov/biblio/0203076.html.

Swanson (2005) wrote a data summary that includes the quality assurance evaluations for all field and laboratory generated data collected by Ecology's Water Quality Studies Unit for this TMDL. The data summary is available at www.ecy.wa.gov/biblio/0503003.html. Field and laboratory replicate samples were collected and analyzed. Statistical analyses were conducted on these data and evaluated against the data quality objectives set in the QA project plan (Swanson and Joy, 2002). All data met the objectives. The statistical results from the data summary are shown in Appendix C, Tables C-1 and C-2.

Data from other Ecology sources have undergone quality assurance evaluation by their authors (Marti, 2005; Stohr et al., 2007 in press; Hallock and Ehinger, 2003; Springer, 2005). We cannot vouch for the quality of meteorological, hydrologic, or biological data collected by other agencies and groups. We did not contact them to obtain quality assurance data, but we believe the data are credible.

Model Calibration Procedures

The root mean squared error (RMSE) was used as a measure of the goodness-of-fit of the model predictions compared with the observed water quality at all sites during the synoptic surveys. Nitrogen, phosphorus, DO, pH, discharge volume, temperature, chloride, and biomass were the key parameters monitored for calibration. Model calibration was achieved by minimizing the overall RMSE of all parameters of interest. The best goodness-of-fit may not result in all model-generated data precisely fitting the field data.

Dissolved oxygen and pH predictions were compared with Hydrolab DataSonde® measurements of daily minimum and maximum values. Daily water temperature data were also continuously monitored at several sites so that maximum and minimum values could be compared to model output. The major nutrient forms of nitrate+nitrite, soluble reactive phosphorus, and most other chemical parameters were calibrated, observed values from single samples or sets of samples taken at different times during one day.

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Results and Discussion

Hydrology and Climate

Streamflows in the Walla Walla basin in 2002 and 2003 were near average compared to the last 20 years (Figures 11 and 12). The average monthly flows during the low-flow period, July through September, were slightly lower than normal. However, none were near the minimum average monthly flows on record for the two USGS gaging stations in the basin. Interagency and irrigation company agreements have helped to increase summer minimum flows in Mill Creek and the Walla Walla River in recent years.

Air temperatures during the 2002-03 TMDL survey period were near normal in the Walla Walla Valley at the Whitman Mission and in the upper Touchet River watershed at Dayton. Monthly average maximum daily air temperatures in 2002 and 2003 closely followed the historical averages (Figures 13 and 14).

Monthly precipitation totals during the TMDL survey period were normal early in 2002, but were below average during May through December 2002 (Figures 13 and 14). In 2003, January through March monthly precipitation totals were higher than average.

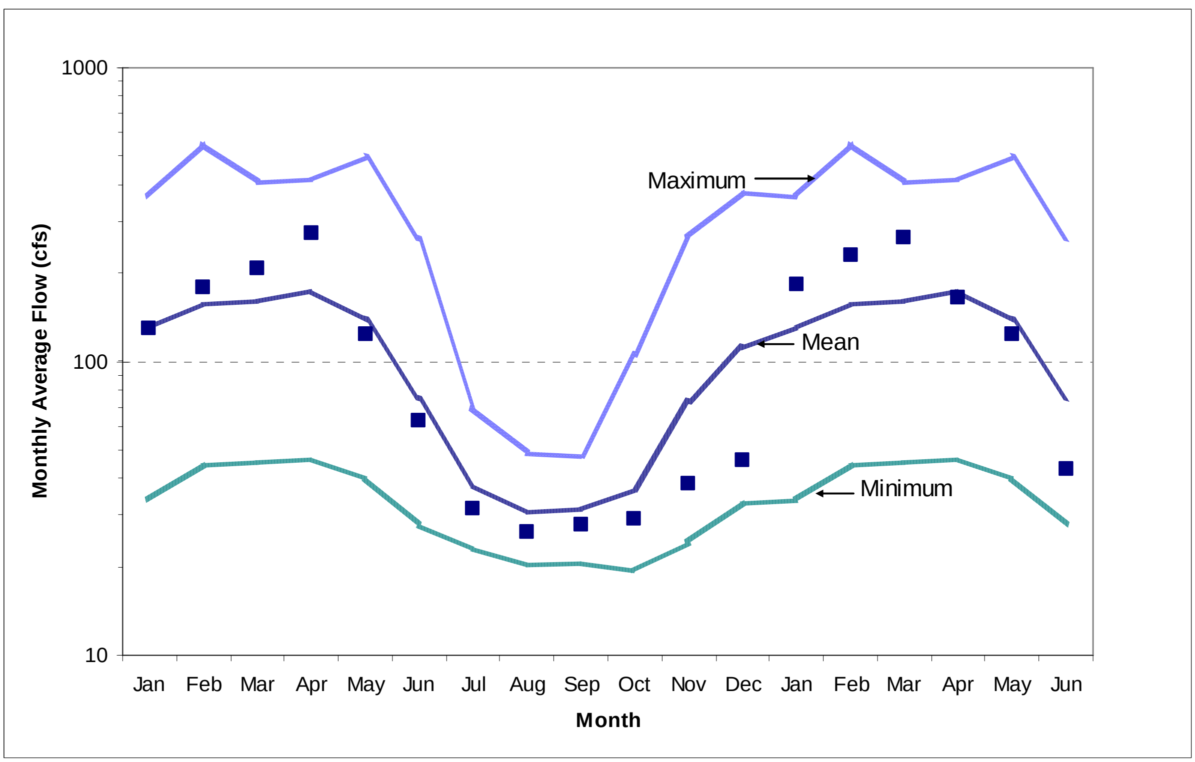


Figure 11. The 20-year historical mean, maximum, and minimum average monthly flows at USGS Station 14013000 Mill Creek near Walla Walla compared to the June 2002 to June 2003 TMDL survey period flows (■).

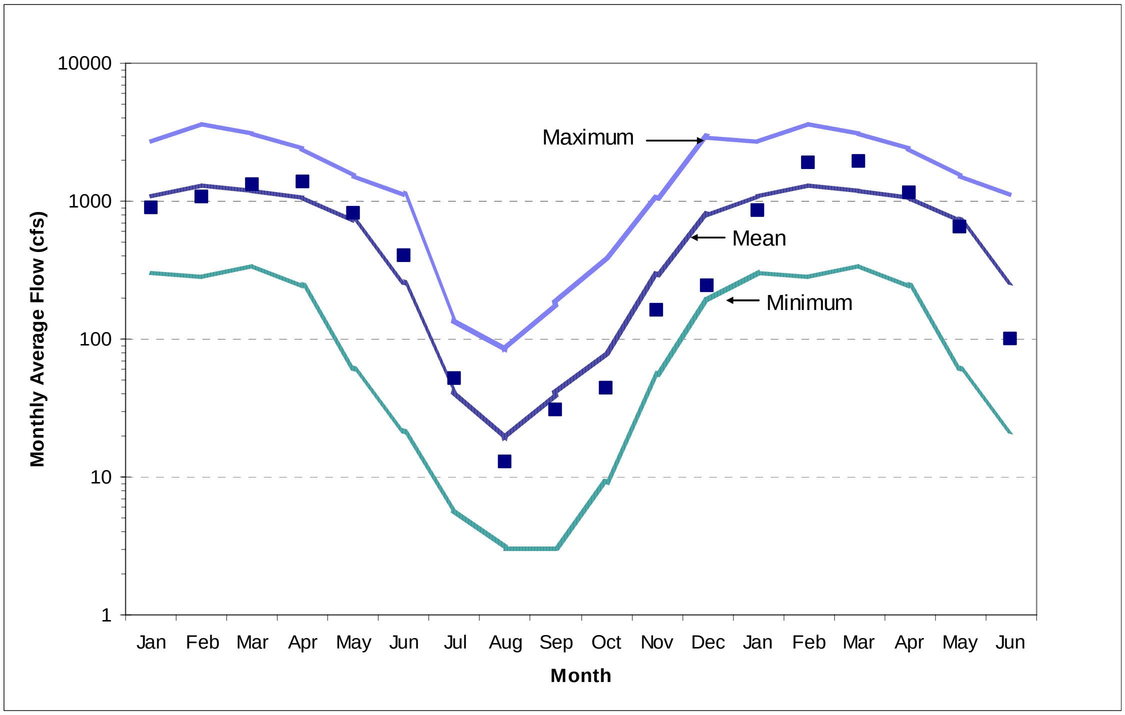


Figure 12. The 20-year historical mean, maximum, and minimum monthly flows at USGS Station 14018500 Walla Walla River near Touchet compared to the June 2002 to June 2003 TMDL survey period flows (■).

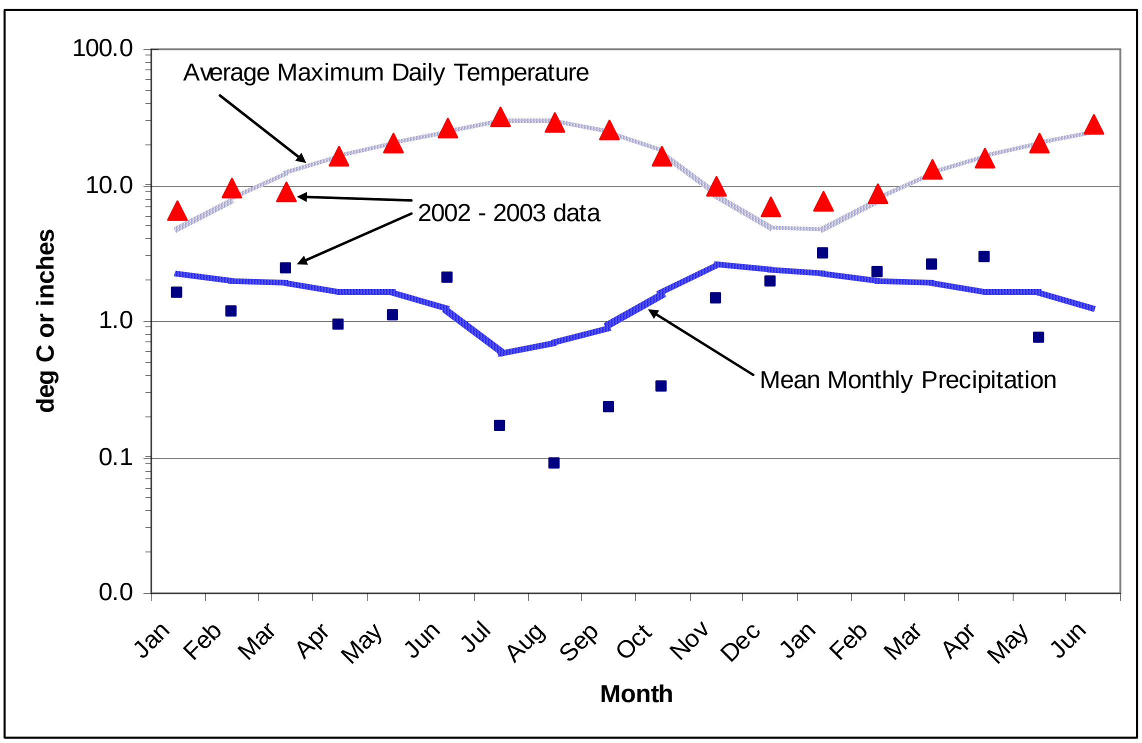


Figure 13. Monthly average maximum air temperatures (▲) and monthly total precipitation (■) in the June 2002 to June 2003 period at Dayton (452030) compared to historical averages (1971-2000).

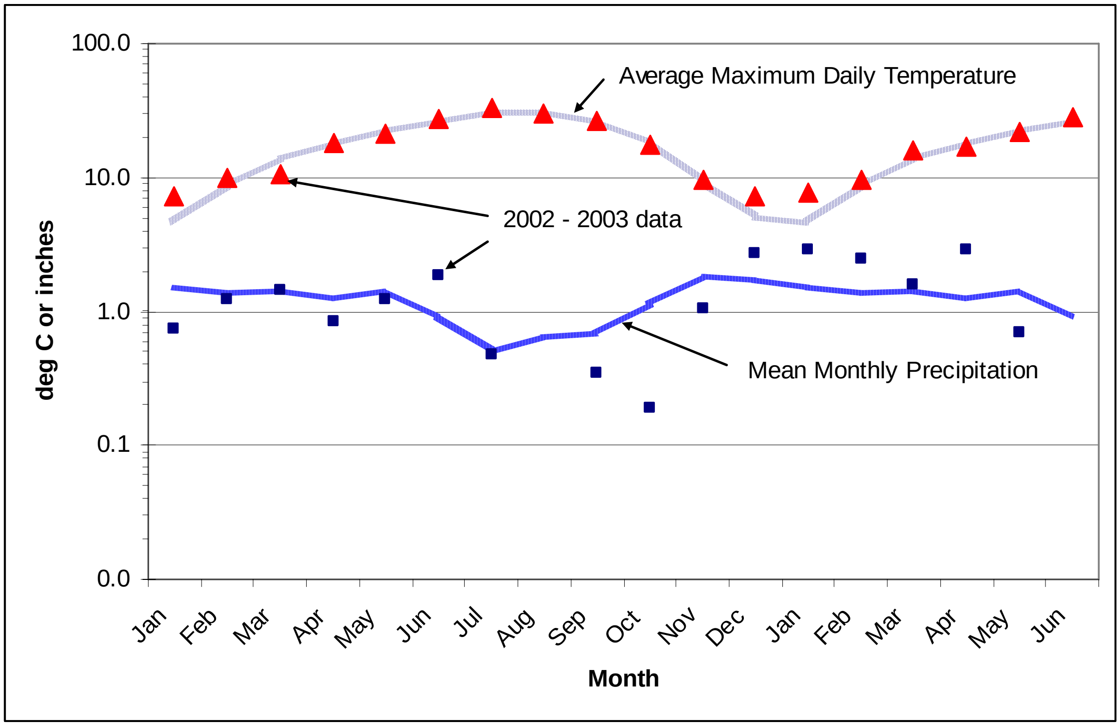


Figure 14. Monthly average maximum air temperatures (▲) and monthly total precipitation (■) in 2002 and 2003 at Whitman Mission (459200) compared to historical averages (1971-2000).

Areas of Concern – Dissolved Oxygen and pH

Dissolved oxygen (DO) concentrations and pH were out of compliance with Washington State water quality criteria at several sites in the basin during the 2002-03 TMDL survey period. Wherever continuous recording probes were placed and previous grab samples had indicated a pH compliance problem, a DO problem was also found by diel monitoring (Appendix H). In Table 9, 38 sites are listed where monitoring data did not meet criteria on one or more occasions.

Continuously recorded data at several of the sites had diel DO ranges > 3 mg/L (Appendix H). Diel DO ranges in the upper Touchet and Mill Creek watersheds were usually < 1.5 mg/L. A 12 mg/L diel range was recorded in the Walla Walla River at McDonald Road in June 2003. The maximum DO at the site was 16 mg/L during the day, and the minimum was 4 mg/L at night (Appendix H).

Several of these sites may not have met DO criteria because of elevated temperatures (i.e., the equivalent percent saturation values would have met the DO criteria if the temperature criteria had been met). Dissolved oxygen saturation values based on grab sample concentrations and selected values from the continuous data recorders are compared to DO criteria percent saturation levels when temperature criteria are met (Figure 15). At many Class A Touchet River and Walla Walla River sites, adequate oxygen saturation for the corresponding temperature (saturation greater than 80%) was present, but the concentration was below the Class A criterion of 8 mg/L.

Table 9. Monitoring sites that reported pH and dissolved oxygen (DO) criteria violations during the 2002-03 Walla Walla basin TMDL study. Instantaneous grab sample results (X) and diel continuously monitored (15-minute) data (C) are indicated.

Site	River Mile	pH	DO	Criteria
Coppei Creek at Hwy 124	0.5	X		Class A
Cottonwood Creek	1.0	X	X	Class A
Dry Creek at Hwy 12	0.5		X	Class A
Garrison Creek at Mission St	0.5		X	Class A
Mill Creek at Swegle Rd	0.5	X	C	Special Class B
Mill Creek at Wallula Ave	2.8	X		Special Class B
Mill Creek at Gose St	4.8	X		Special Class B
Mill Creek at 9th St	6.7	X		Class A
Mill Creek at Roosevelt St	8.5	X	X	Class A
Mill Creek at Wilbur St	8.9		X	Class A
Mill Creek at Reservoir Rd	11.5	XC	C	Class A
Mill Creek at Five Mile Rd	12.8	X		Class A
Mud Creek at Borgen Rd	0.5	X		Class A
Pine Creek at Sand Pit Rd	1.4	X		Class A
Russell Creek at Plaza Way	0.1		X	Class A
Touchet R at Hwy 12	0.5	X	X	Class A
Touchet R at Cummins Rd	2.0	XC	XC	Class A
Touchet R above Hofer Diversion	7.0	X		Class A
Touchet R at North Touchet Rd	14.2	X		Class A
Touchet R at Luckenbill Rd	17.8	XC	C	Class A
Touchet R off Lamar Rd	25.0	X		Class A
Touchet R at Pettyjohn Rd	30.6	X		Class A
Touchet R at Hwy 125	34.2	X		Class A
Touchet R at Hart Rd	36.6	X		Class A
Touchet R at Hwy 124	40.5	X		Class A
Touchet R at Hwy 12 (Waitsburg)	44.2	X		Class A
Touchet R at Lower Hogeye Rd	46.2	X		Class A
Touchet R at Lewis & Clark St. Pk	48.4	X		Class A
Touchet R at Ward Rd	51.2	X		Class A
Touchet R at Dayton City Park	53.9	X		Class A
North Fork Touchet R	0.0	XC	C	Class A
South Fork Touchet R	0.0	X		Class A
Patit Creek at Front St	0.1	X	X	Class A
Walla Walla R at Pierce's RV Park	9.3	XC	C	Class B
Walla Walla R at Cummins Rd	15.6	X		Class B
Walla Walla R at Lowden Rd	27.4	XC	XC	Special Class A
Walla Walla R at McDonald Rd	29.3	XC	C	Special Class A
Walla Walla R at Hwy 125	38.7	XC	XC	Special Class A

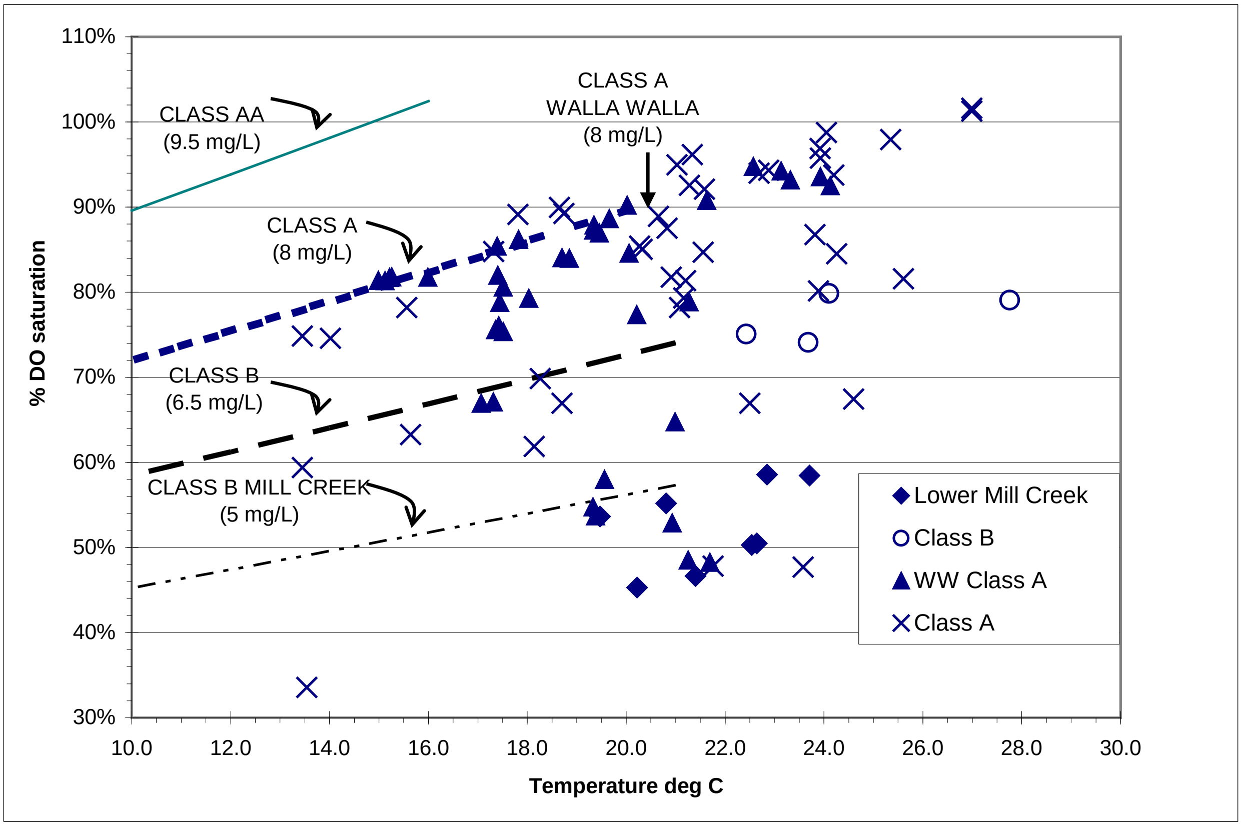


Figure 15. Oxygen saturation values of samples that did not meet dissolved oxygen (DO) concentration criteria in the Walla Walla basin compared to the saturation values expected for DO concentrations meeting criteria at a range of temperatures of the same water quality classification.

Dissolved oxygen samples collected from some areas appeared to be affected by other factors. Lower Mill Creek concentrations often were lower than the special Class B limit of 5 mg/L. Oxygen saturation levels for these samples were less than 50%, suggesting significant oxygen demand and depletion. North Fork Touchet River samples appeared to be affected by both temperature and by altitude. Some concentrations below 8 mg/L at this site had oxygen saturation levels of 95%.

The pH measurements taken at all the sites in the basin were generally greater than 7 standard units (s.u.); none were below the lower criterion of 6.5. All 35 sites listed above had pH values greater than the upper criterion of 8.5 s.u., including 19 sites on the Touchet River and half of the sites on Mill Creek and the Walla Walla River. Diel pH ranges varied from 0.5 s.u. in headwater areas to 2 s.u. in highly productive reaches (Appendix H).

Seasonal Variation and Critical Conditions

The federal Clean Water Act Section 303(d)(1) requires that TMDLs "*be established at the level necessary to implement the applicable water quality standards with seasonal variations*". The implementing regulations also state that determination of "*TMDLs shall take into account critical conditions for streamflow, loading, and water quality parameters*" [40 CFR 130.7(c)(1)]. Finally, Section 303(d)(1)(D) suggests consideration of normal conditions, flows, and dissipative capacity.

Existing water quality conditions reflect seasonal variation. Figures 16, 17, and 18 show the seasonal patterns of pH and DO in the Walla Walla River, Mill Creek, and Touchet River during the 2002-03 survey season (Swanson, 2005). Data are from instantaneous samples collected at various times of the day and represent a 'snapshot' of conditions in these waterbodies, not necessarily the daily maximum or minimum value.

The lowest dissolved oxygen levels and highest pH occur from May through October, with the worst conditions typically in late June to early September. For example, extreme diel ranges of pH and DO occurred in the Walla Walla River at McDonald Road in June 2003 (Appendix H). The May to October timeframe is used as the critical period for development of the TMDL. Seasonal estimates for streamflow, meteorology, and loading for the TMDL are taken into account to develop critical conditions for the TMDL model. The lowest streamflows and highest temperatures occur in these months, and they greatly influence the pH and DO extremes.

If the proposed Washington State water quality standards for temperature and DO are approved, seasonal limits for salmonid spawning and rearing may define additional critical conditions other than the low flow summer period. These conditions may require additional data collection and analysis to better evaluate water quality during those periods.

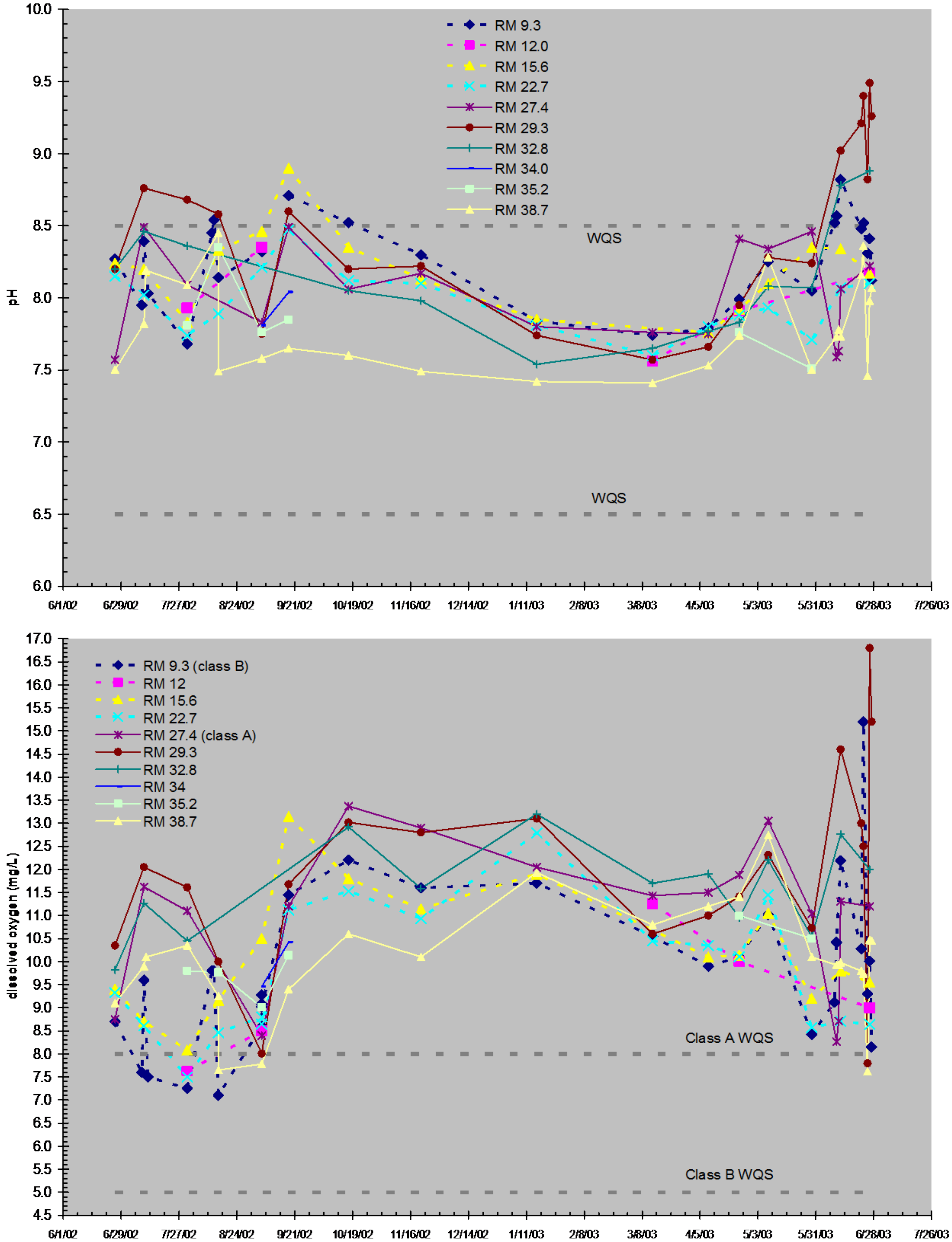


Figure 16. Instantaneous pH and dissolved oxygen measurements taken at ten sites in the Walla Walla River from June 2002 through June 2003. RM = river mile WQS = water quality standard.

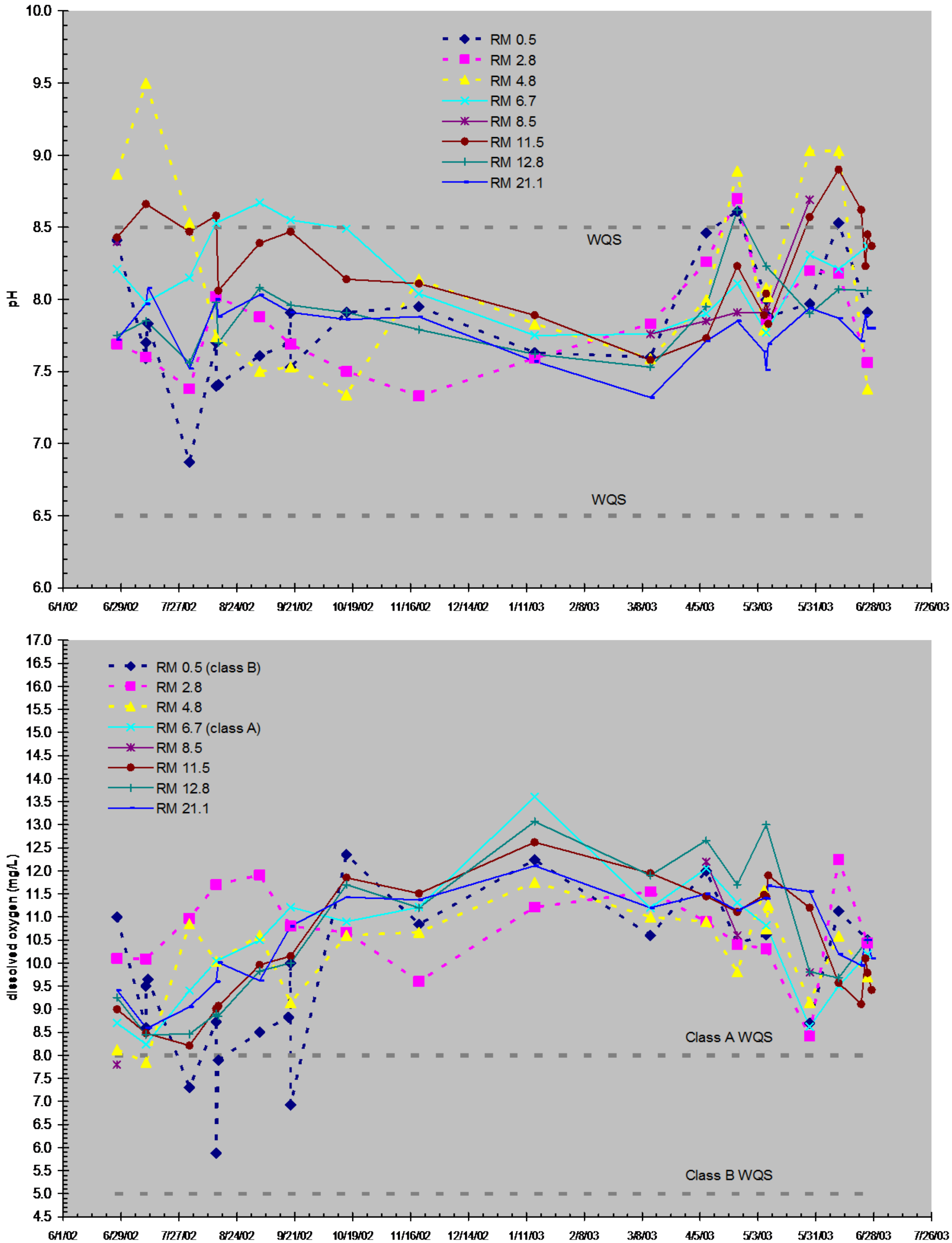
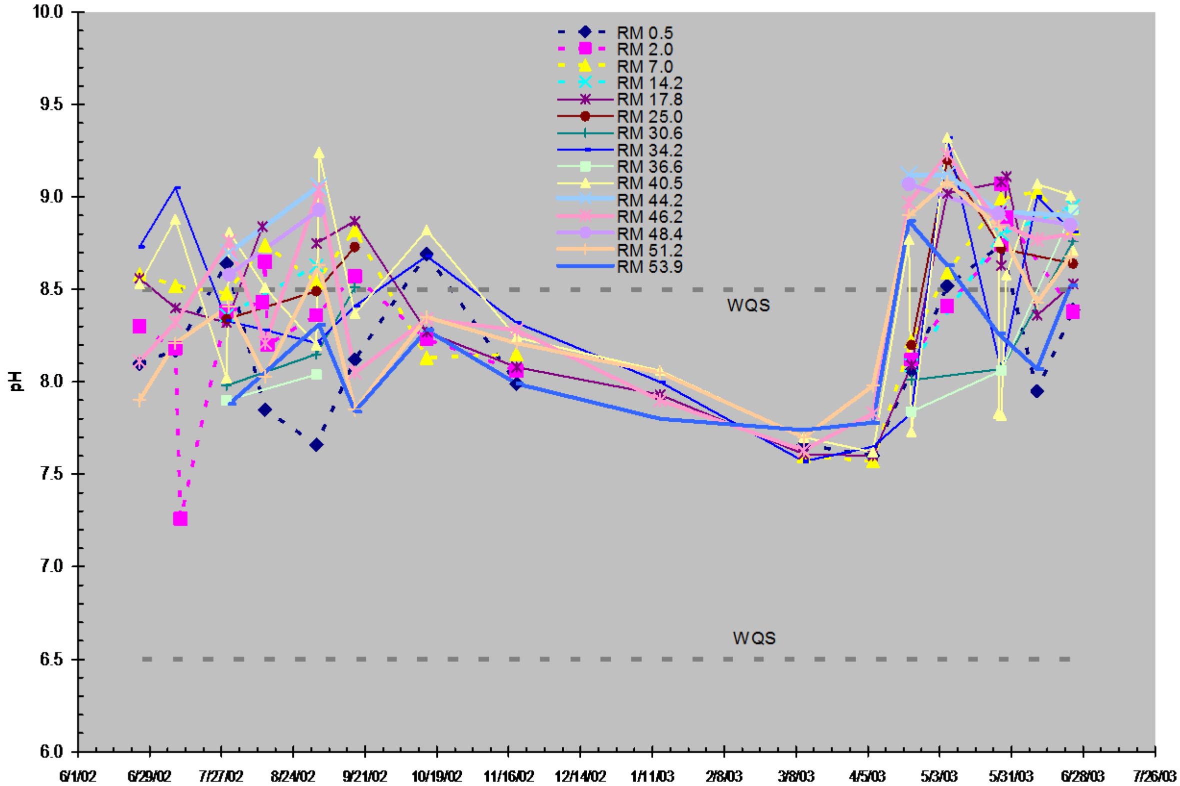


Figure 17. Instantaneous pH and dissolved oxygen measurements taken at eight sites in Mill Creek from June 2002 through June 2003. RM = river mile WQS = water quality standard.



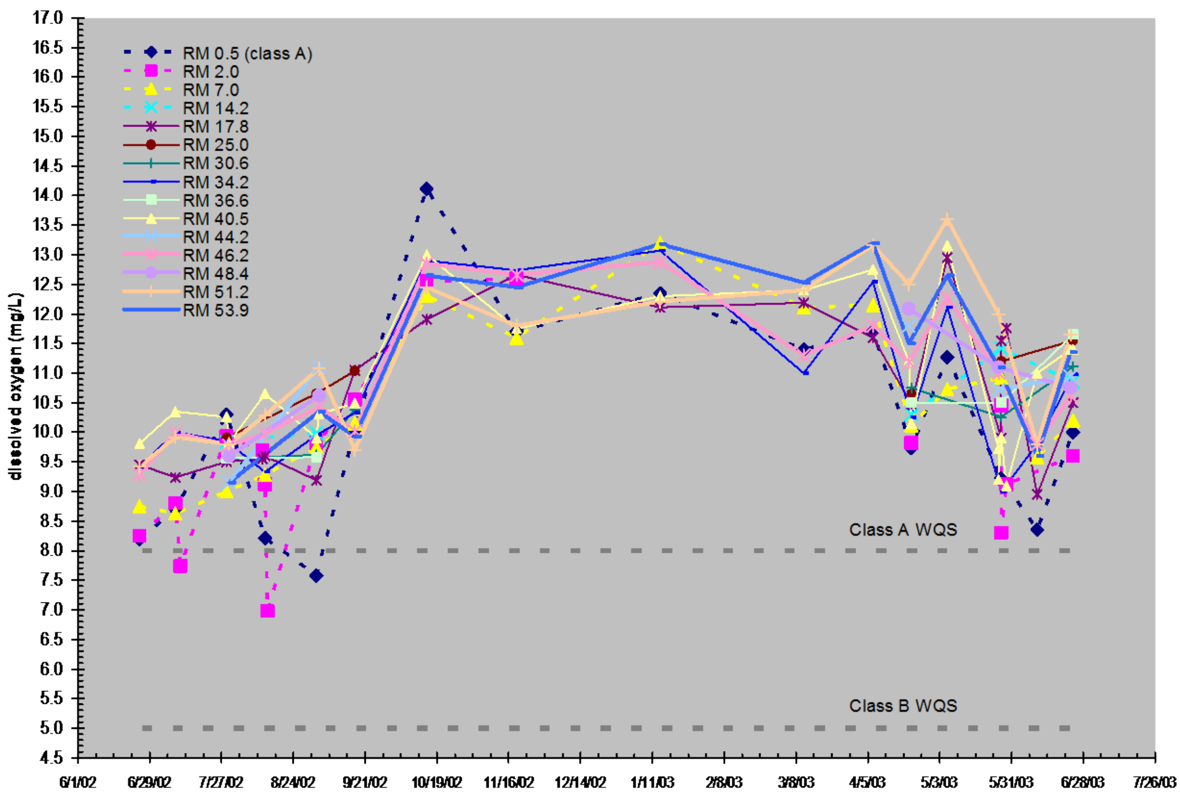


Figure 18. Instantaneous pH and dissolved oxygen measurement taken at 15 sites in the Touchet River from June 2002 through June 2003. RM = river mile WQS = water quality standard.

Nutrient Limitations

As discussed earlier (see *Producers, Decomposers and Nutrients*), the nitrogen:phosphorus (N:P) ratio provides a helpful clue for determining nutrient dynamics. Values of dissolved inorganic nitrogen (DIN) to soluble reactive phosphorus (SRP) below 7 suggest growth limitation by DIN; values above 7 suggest growth limitation by SRP. However, since the ratios of nitrogen and phosphorus required by various algae and periphyton differ, often the phosphorus-limited boundary is set at 20 and the nitrogen-limited boundary is at 5. This leaves a ratio range of 5 to 20 that may be less definitive for establishing the limiting nutrient.

During the low-flow period (late May through October), much of the Touchet River and Mill Creek appear to be nitrogen-limited from the headwaters to the mouth (Yellowhawk branch for Mill Creek) (Figures 19 and 20). The nitrogen limitation is less apparent during the higher flow periods of December through April.

Some reaches of the Walla Walla River and the lower reaches of the Mill Creek/Yellowhawk Creek system exhibit less tendency towards a nitrogen limitation (Figure 19 and 21). Subsurface nitrate loading and cumulative tributary nitrogen loads from WWTPs and agriculture are suspected sources.

Natural concentrations in soils or other geologic formations are the suspected sources of phosphorus in the Touchet River and Mill Creek. Phosphorus concentrations are similar to the undeveloped headwaters of nearby basins [e.g., the Grande Ronde (ODEQ, 2000) and the Palouse River (Greene et al., 1997)]. A clear relationship of increasing total phosphorus with increasing total suspended solids was evident during periods of sediment movement in the Touchet River (Figure 22). Biomass sloughing could also be contributing phosphorus during higher flows.

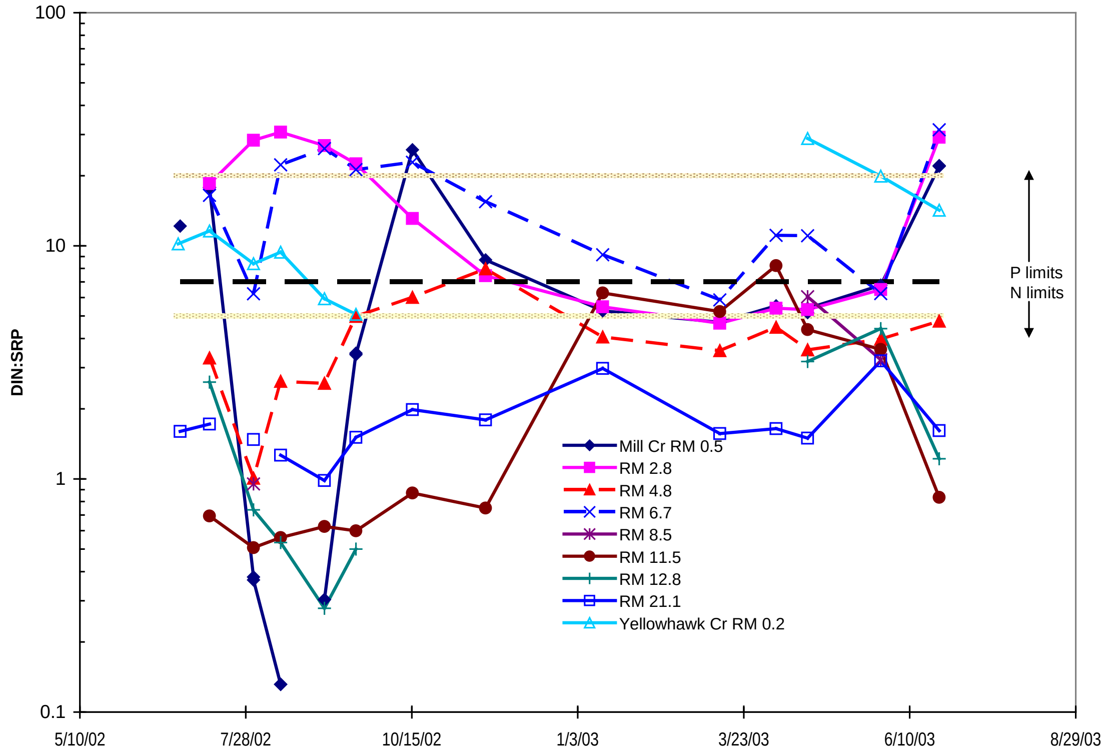


Figure 19. Ratios of DIN:SRP in Mill Creek and Yellowhawk Creek from June 2002 through June 2003. Values of DIN:SRP below 7 suggest growth limitation by DIN; values above 7 suggest growth limitation by SRP.

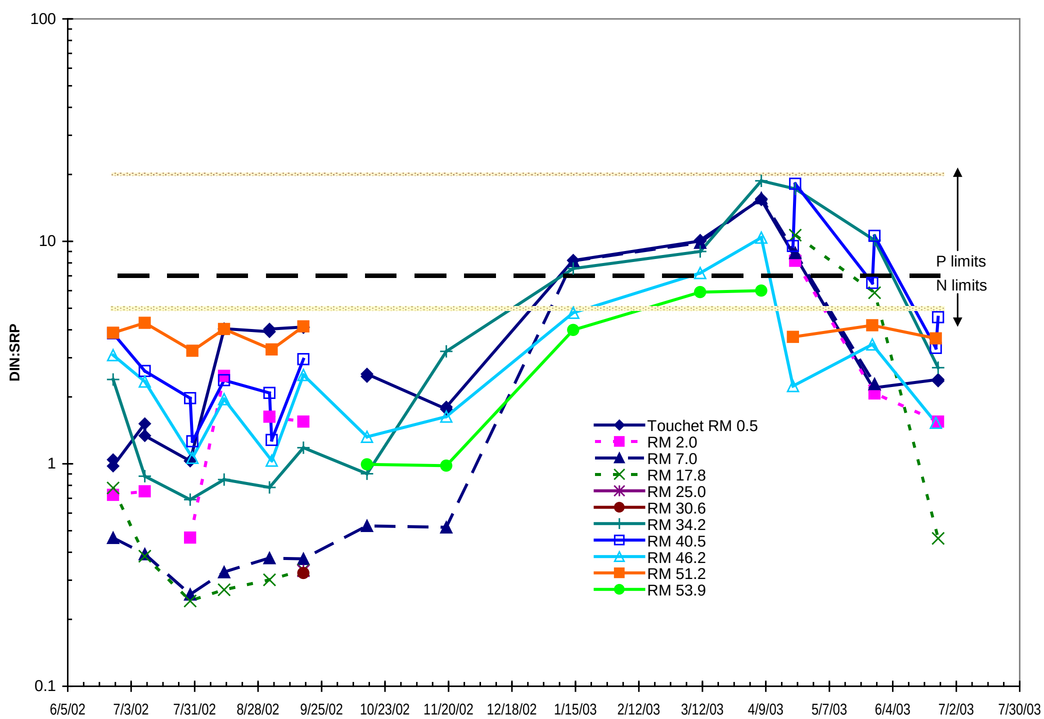


Figure 20. Ratios of DIN:SRP in the Touchet River from June 2002 through June 2003. Values of DIN: SRP below 7 suggest growth limitation by DIN; values above 7 suggest growth limitation by SRP.

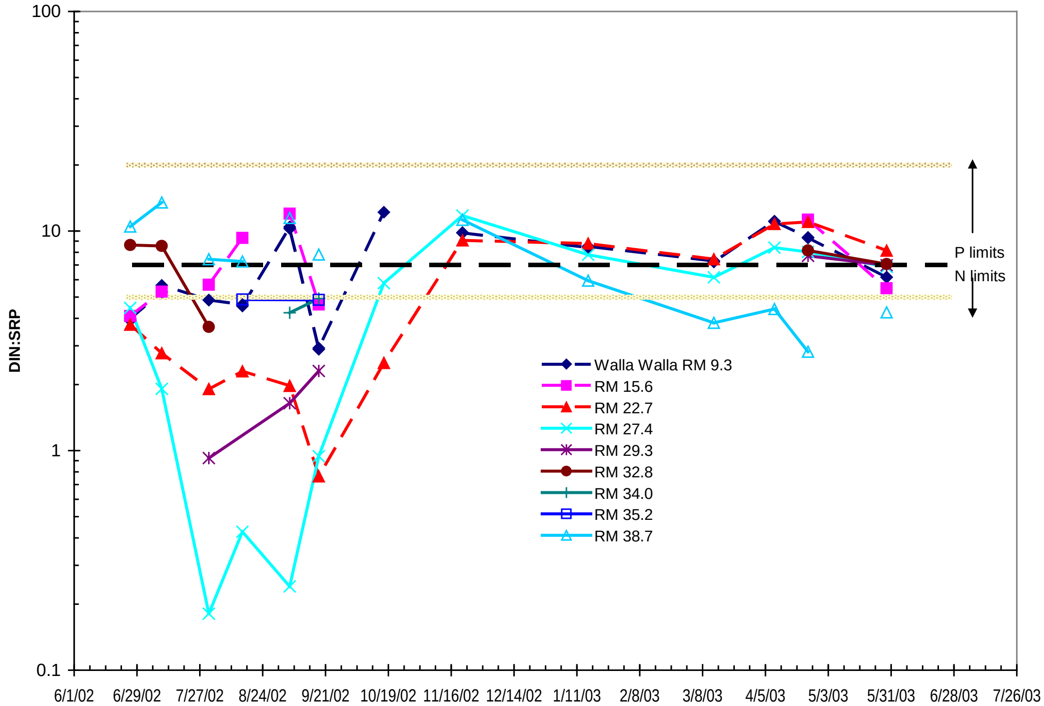


Figure 21. Ratios of DIN:SRP in the Walla Walla River from June 2002 through June 2003. Values of DIN:SRP below 7 suggest growth limitation by DIN; values above 7 suggest growth limitation by SRP.

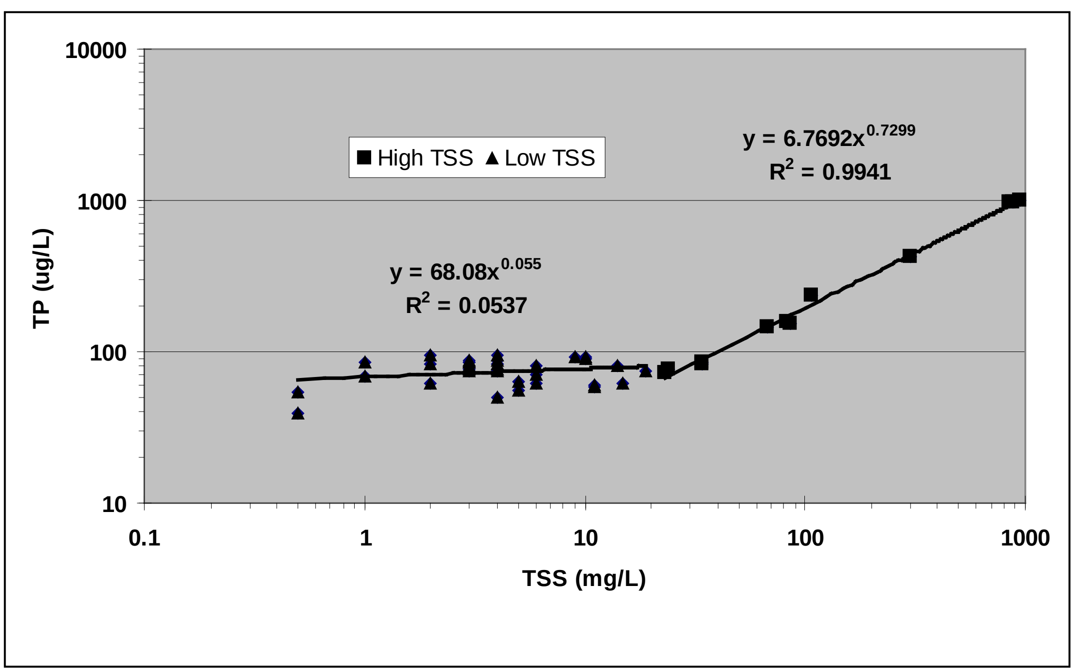


Figure 22. The correlation of increasing total phosphorus (TP) with increasing total suspended solids (TSS) observed in samples collected from the Touchet River during the 2002-03 TMDL surveys.

The EPA ecoregional nutrient approach recommended two methods for calculating a reference conditions (EPA, 2000a,b). One uses the lower 25th percentile concentrations of all streams in the ecoregion as reference data when reference sites were not available. The other method uses the 75th percentile of reference streams in the ecoregion of interest. Unfortunately the data in Oregon, Washington, and Idaho for these two Level III ecoregions are lacking, and no reference sites are indicated.

Although there are many technical criticisms to this approach, it provides a general idea of nutrient availability on a regional scale. The summer Blue Mountain and Columbia Plateau ecoregional 25th percentile values for various nutrients are compared to the 75th percentile summer concentrations in the headwaters of Mill Creek (32MIL-24.7 and 32MIL-21.1) and the least developed site on the Touchet River (32NFT-00.05) in Table 10. The North Fork Touchet is the closest to a reference condition as could be identified among the Touchet River watershed sites.

Table 10. EPA 25th percentile nutrient concentrations for the Blue Mountains and Columbia Basin Ecoregions compared to the 75th percentile of concentrations taken in upper Mill Creek and the North Fork Touchet River from 2002 to 2004.

Nutrient	Blue Mountains	Columbia Basin	Mill Creek	North Fork Touchet
Total phosphorus	30 µg/L	30 µg/L	57 µg/L	67 µg/L
SRP	5 µg/L	5 µg/L	48 µg/L	40 µg/L
Total nitrogen	140 µg/L	280 µg/L	120 µg/L	140 µg/L
Nitrate-nitrite	10 µg/L	50 µg/L	99 µg/L	77 µg/L
DIN:SRP*	2:1	10:1	2.1:1	1.9:1

Nitrate-nitrite is used as the dissolved inorganic nitrogen (DIN) concentration in these calculations
SRP - soluble reactive phosphorus

The inorganic nutrient ratios (2:1 and 10:1) of the nitrate-nitrite to soluble reactive phosphorus suggest that the Blue Mountain areas are seasonally nitrogen-limited while the Columbia Basin areas are possibly phosphorus-limited. The Mill Creek and North Fork Touchet River DIN:SRP ratios are surprisingly consistent with the EPA Blue Mountain ecoregional 25th percentile ratios, although the concentrations are twice to ten times greater. The large surplus of phosphorus in Mill Creek and the Touchet River suggests they are also nitrogen-limited.

The headwater sites have a few potential anthropogenic (human-caused) sources upstream (e.g., the city waterworks and rural development on Mill Creek, and rural residences and farms up the North Fork Touchet). These may contribute nonpoint nutrient loads, especially for the North Fork Touchet site, but these sources would tend to increase nitrogen more than phosphorus concentrations.

The watersheds may have different geologic and vegetation sources of the nutrients compared to other areas of the ecoregions that have been monitored. As mentioned earlier, phosphorus concentrations are similar to the undeveloped headwaters of nearby basins [e.g., the Grande Ronde (ODEQ, 2000) and the Palouse River (Greene et al., 1997)]. Those studies indicated seasonally nitrogen-limited systems, also. Wind-blown deposition of dirt from lowland Columbia Basin areas could also be a source of nutrients in the upper watershed, but research on this transport mechanism is lacking.

The EPA data, other studies, and the 2002-03 TMDL survey data suggest that these ecoregions are characterized as having nitrogen-limited systems. Nitrogen will be a key factor in the loading capacity and load allocation analyses of the TMDL. Background nutrient concentrations will be further discussed as potential nutrient-load reductions from various sources are examined.

Ammonia Toxicity

Two potential sources of ammonia in the Walla Walla basin are fertilizers and wastewater treatment plant (WWTP) discharges. Ammonia is used as a soil amendment for crops. It is injected into the soil where it is quickly taken-up by plants or converted to nitrate by soil organisms.

Over-application or poor operating practices can lead to ammonia transport to waterbodies. Effluent from secondary WWTPs can contain a relatively high concentration of ammonia. Additional processes or in-plant procedures are necessary to oxidize the ammonia to nitrate, or to denitrify it to nitrogen gas.

The toxic component of ammonia is especially active at elevated temperatures and with pH values greater than 8 s.u. Although elevated pH and temperature conditions were present in several reaches of the basin, only one sample, collected from the mouth of Garrison Creek (GAR-00.5), exceeded the four-day chronic toxicity criterion. Although NPDES permit limits are written to ensure adequate dilution of ammonia in the receiving waters, the Garrison Creek sample may have been a case where effluent from the College Place WWTP was inadequately diluted or poorly treated.

The data collected during the 2002-03 TMDL surveys were used in the 2004 statewide water quality assessment. Unfortunately, the 303(d) listings for ammonia toxicity were based on incorrectly calculated criteria and are in error. One of these erroneous listings, the Walla Walla River at RM 9.3, will be placed in Category 1, *Meets Standards*. The Garrison Creek listing will be placed in Category 2, *Waters of Concern*, because two or more violating concentrations collected from a site are required for a Category 5, *303(d) listing*. Based on these factors, ammonia will not be addressed in this TMDL with load or wasteload allocations.

Mill Creek, Yellowhawk Creek, and Garrison Creek

Hydrologic Characteristics

Water flowing through the Mill Creek watershed is highly manipulated; the primary structures in the watershed have been described previously (see *Basin Description*). During the irrigation season, the majority of water is diverted down Yellowhawk Creek at RM 10.5. Since the pH and DO problems observed fall primarily within the irrigation season, understanding and modeling water and nutrient transport during this period is important. Mill Creek below RM 10.5 relies on small subsurface seeps, springs, and irrigation returns during the irrigation season, and was not part of the modeled reaches.

Hydrologic data were developed to populate the QUAL2Kw model framework. The hydrology is the foundation for accurately simulating the chemical and biological interactions of the creek. The relationship between flow, width, velocity, and depth was analyzed using cross-section measurements by the Department of Ecology and other agencies. Linear regression analysis was used to determine the parameters of power curves for the hydraulic geometry relationships with flow. Appendix E, Table E1, shows a summary of the hydraulic geometry relationships for Mill Creek, Yellowhawk Creek, and Garrison Creek.

A dye study of Mill Creek was conducted in July 2004. Dye was injected at various locations and then measured downstream to determine the time of travel between locations. The study demonstrated that when 40 cfs is discharged near Kooskooskie, it takes 31 hours (1.3 days) to reach the mouth of Yellowhawk Creek (Appendix E, Table E3). The slowest section of the creek (0.22 ft/sec) is between Bennington Dam and the diversion structure, through the energy dissipation structures. The fastest section (1.4 ft/sec) is in the upper reach of Yellowhawk Creek and the upper reach of Mill Creek above Blue Creek.

Flow measurements during the 2004 synoptic surveys were used to determine the flow budget from all the various sources in the system. Table 11 presents the flow budget typical for late in the irrigation season (September) for the Mill Creek watershed.

Nutrients, pH, and Dissolved Oxygen

Dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) concentrations in Mill, Yellowhawk, and Garrison Creeks are shown in Figure 23. In general, the DIN and SRP concentrations in lower Mill Creek and Garrison Creek were highest compared with other surface waters in the study area. Upper Mill Creek and the upper reaches of Yellowhawk Creek had substantially lower DIN and SRP (Figure 23).

As discussed earlier (see *Nutrient Limitations*), concentrations of DIN and SRP at RM 24.7 and 21.1 of Mill Creek are representative of nearly natural background conditions. Only the city waterworks, with a protected watershed for drinking water, is upstream of the monitoring site at RM 24.7. Periphyton growth at RM 21.1 was low (~ 22 mg chlorophyll a/m^2), and all other indicators (low chloride, TSS, and E. coli) suggested high quality water. Diel pH and DO remained within the Class A criteria.

The SRP remained relatively constant from the headwaters of Mill Creek to the mouth of Yellowhawk Creek. DIN decreased proceeding from the headwaters of Mill Creek to the diversion dam at the head of Yellowhawk Creek, and then showed an increase in concentration in Yellowhawk Creek compared with upper Mill Creek. Total nitrogen decreased in a similar pattern, but never became completely depleted as DIN had.

The range of diel pH and DO maxima and minima increased from the headwaters to the diversion dam as well. Excursions over the pH criterion were first observed at Five-Mile Bridge (RM 12.8), and pH and DO criteria excursions were recorded at the diversion structure in June 2003 (Appendix H, Figure H10). The one-mile, slow, shallow, flood-control reach between Bennington Dam (RM 11.5) and the diversion structures elevated temperatures and provided an ideal environment for periphyton growth.

Table 11. Flow measurements and budget for the synoptic survey of Mill Creek and Yellowhawk Creek on August 31-September 1, 2004. Flows are in cubic feet per second.

Upper Mill-Yellowhawk River (Km)	River Mile	Stream/ Location Name	Location ID	Measured Discharge (ft3/s)	Tributary/ Irrigation Return	Diversion	Computed Gain (+) Loss (-)
RM 24.7 Mill Creek in Oregon to RM 11.5 near Reservoir Rd.							
39.0	24.7	Mill Creek	32MIL-24.7	22.32			
33.8	21.1	Mill Creek	32MIL-21.1	30.62			8.31
33.7		32KKT-00.1	32KKT-00.1		0.01		
26.4		Blue Creek	32BLU-00.2		0.88		
22.6	14.8	Mill Creek	32MIL-14.8	27.60			-3.91
19.0	12.8	Mill Creek	32MIL-12.8	26.62			-0.98
14.9	11.5	Mill Creek	32MIL-11.5	27.93			1.32
RM 11.5 Mill Creek near Reservoir Rd. to RM 00.5 near the confluence with the Walla Walla River (September 1-2 2004)							
	11.5	Mill Creek	32MIL-11.5	24.91			
	6.7	Mill Creek	32MIL-06.7				
	4.8	Mill Creek	32MIL-04.8	1.4			
	2.8	Mill Creek	32MIL-02.8				
	0.5	Mill Creek	32MIL-00.5	6.64			
Garrison Creek at diversion							
		Garrison Creek	32GAR-DIVE			3.55	
Garrison Creek downstream of diversion to RM 00.5 near its mouth							
		College Place WWTP	32COL-WWTP				
	0.5	Garrison Creek	32GAR-00.5				
RM 05.0 Yellowhawk Creek @ Cottonwood Rd. to RM 00.2 near its mouth							
8.5	5	Yellowhawk Creek	32YEL-05.0	22.70			-5.24
7.1		Coldwell Creek	32CAL-00.1		0.15		
	3.5	Yellowhawk Creek	32YEL-03.5				
6.1		Russell Creek	32RUS-00.1		0.15		
4.0		Cottonwood Creek	32COT-01.0		0.35		
0.4	0.2	Yellowhawk Creek	32YEL-00.2	20.90			-2.44
Flow budget inputs for QUAL2Kw							
	Headwater	Mill Creek	32MIL-24.7	22.32			
33.7	Tribs/diversion	32KKT-00.1	32KKT-00.1		0.01		
26.4		Blue Creek	32BLU-00.2		0.88		
14.85		Lower Mill Cr diversion				1.69	
14.65		Garrison Cr diversion				3.55	
7.1		Coldwell Creek	32CAL-00.1		0.15		
6.1		Russell Creek	32RUS-00.1		0.145		
4.0		Cottonwood Creek	32COT-01.0		0.345		
39.0-33.8	Diffuse flows	RM 24.7-21.1					8.31
33.8-22.6		RM 21.1-14.8					-3.91
22.6-19.0		RM 14.8-12.8					-0.98
19.0-14.9		RM 12.8-11.5					1.32
14.9-8.5		RM 11.5- YH5.0					0
8.5-0.4		RM YH5.0-YH0.2					-2.44

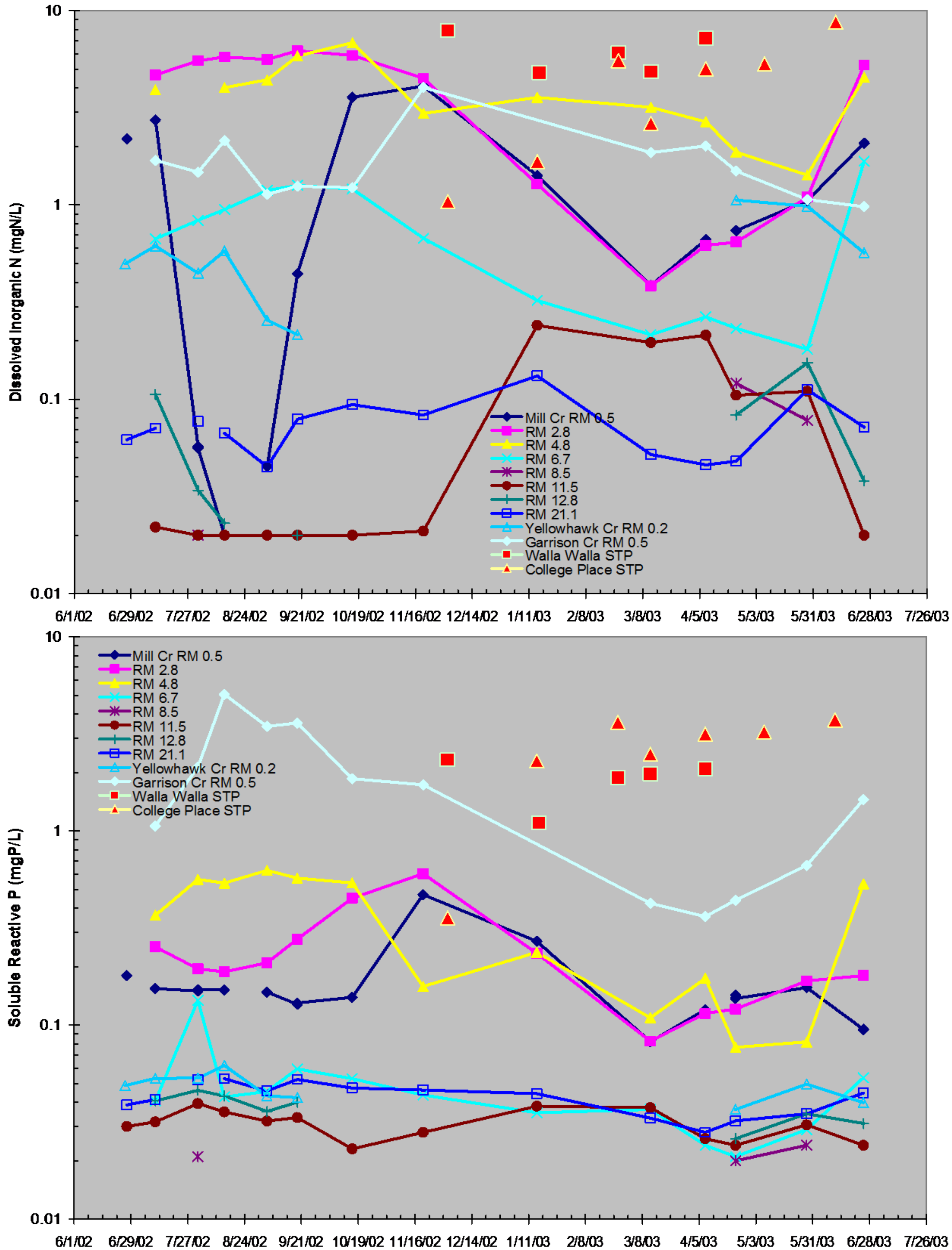


Figure 23. Dissolved inorganic nitrogen and soluble reactive phosphorus in Mill Creek, Yellowhawk Creek, Garrison Creek, and point sources from June 2002 through June 2003.

Changes in nutrient ratios in the Mill Creek system became apparent during the surveys. The ratios of DIN:SRP suggest that nitrogen is the limiting nutrient for growth of periphyton in upper Mill Creek (Figure 19). The DIN:SRP in Yellowhawk Creek suggests a tendency toward limitation by SRP, although DIN may also be limiting at times. Groundwater and nonpoint sources along Yellowhawk Creek may have significant nitrogen loads since Cottonwood Creek and Russell Creek loads appear to be minor during the irrigation season.

The pH and DO along Yellowhawk Creek remained within criteria. Shaded riparian areas, swifter water, and groundwater exchange may help to limit primary productivity. Russell Creek and Cottonwood Creek DO measurements were lower than the Class A criterion once in each creek, and a few Cottonwood Creek pH values were greater than 8.5. The pH and DO in these tributaries had negligible effect on Yellowhawk Creek values.

Lower Mill Creek and Garrison Creek have reduced seasonal flows below the diversion dam. Lower Mill Creek (below RM 4.8) and the mouth of Garrison Creek had nutrient concentrations sometimes approaching those of wastewater effluent. College Place WWTP effluent strongly influenced lower Garrison Creek because of problems with the facility during the 2002-03 surveys. Walla Walla WWTP effluent is diverted to irrigation systems. Several irrigation return sites are present, but a specific return site of effluent to Mill Creek was not observed. Livestock and septic systems also may be contributing nutrients to Garrison and Mill Creeks.

The DO and pH in the lower reaches of Mill Creek and Garrison Creek appeared to be influenced by decomposition processes, wastewater effluent, or groundwater. DO concentrations taken at Mill Creek at Swegle Road could not always meet the Class B Special Condition of 5 mg/L, but only one Mill Creek pH value was greater than 8.5. Garrison Creek DO was consistently below 8 mg/L from June through November 2002 at midday when maximum DO concentrations would be expected. The midday pH measurements taken at Garrison Creek were not typical for the basin; pH values were never above 7.8.

Touchet River

Hydraulic Geometry

Water flowing through the Touchet River watershed is less manipulated than Mill Creek. However, irrigation withdrawals have a significant seasonal impact on the river, and dikes and other channel work have changed the hydrology of the river. The study area for the 2002-03 pH and dissolved oxygen (DO) surveys began at the confluence of the North and South Forks of the Touchet River above the city of Dayton (RM 51.8). The North Fork supplies water throughout the year while the South Fork goes nearly dry in the late summer.

As with Mill Creek, all the hydrologic data were developed to populate the QUAL2Kw model framework. Discharge coefficients were determined for individual flow measurement sites by fitting power curves to data collected for instantaneous discharge measurements. The curves are used to estimate width and depth for flow regimes not specifically measured (e.g., 7Q2 or 7Q10). Appendix E, Table E2, summarizes these equations. Coefficients for stream segments that were not located at a flow site were calculated using linear interpolation between the upstream and downstream flow measurement sites.

July and August flow budgets for the Touchet River were constructed from 2002 surface water synoptic survey data, gaging information, and groundwater estimates for losing and gaining reaches (Stohr et al., 2007; Mendel et al., 2003; Marti, 2005). The flow budget for July 7-11, 2002 is summarized in Table 12. Residual water losses and gains were calculated between gaging points with the help of data from groundwater (Appendix B, Table B4).

Table 12. Touchet River flow budget and QUAL2Kw model flow budget.

River Km	River Mile	Name	ID	Measured Flow	Tributary	Diversion	Gain (+) Loss (-)
				cfs	cfs	cfs	cfs
Measured and Estimated Surface Water Flow Budget for the Touchet River: July 7- 11, 2002							
88.2	54.8	North & South Fork	32NFT; 32SFT	70			
		Irrigation Diversion	24*			2	
86.7	53.9	Touchet River	32TOU-53.9	67.89			-0.11
		Irrigation Diversion	23*			9.5	
85.6	53.2	Patit Creek	32PAT-00.1		1.43		
83.8	52.1	Dayton WWTP	32DAY-WWTP		0.52		
73.9	45.9	Whiskey Creek	WC-1**		0.47		
69.2	43.0	Coppei Creek	32COP-00.5		1.76		
65.2	40.5	Touchet River	32TOU-40.5	63.57			-8.5
		Irrigation Diversion	20 - 22*			17.69	
28.6	17.8	Touchet River	32TOU-17.8	45.89			0.01
6.6	4.1	Hofer Diversion	19*			17.4	
3.2	2.0	Touchet River	32TOU-2.0	33.1			4.61
Flow Budget for QUAL2Kw Calibration Run							**Flow Balancing**
86.7	53.9	Headwater	32TOU-53.9	67.9			
		Irrigation Diversion	23*			9.5	
		Groundwater					1.5
85.6	53.2	Patit Creek	32PAT-00.1		1.4		
83.8	52.1	Dayton WWTP	32DAY-WWTP		0.5		
73.9	45.9	Whiskey Creek	WC-1**		0.5		
69.5	43.2	Waitsburg WWTP					0.04
69.2	43.0	Coppei Creek	32COP-00.5		1.8		
65.2	40.5	Touchet River	32TOU-40.5	63.6			
		Irrigation Diversion	20 - 22*			17.7	
59.5	37.0	Nonpoint Source					0.18
		Groundwater					7.1
		Loss to Groundwater					-7.1
28.6	17.8	Touchet River	32TOU-17.8	45.9			
6.6	4.1	Hofer Diversion	19*			17.4	
		Groundwater					4.6
4.0	2.5	Nonpoint Source					0.04
3.2	2.0	Touchet River	32TOU-2.0	33.1			

* From Neve, 2004

** From Mendel et al., 2003

QUAL2Kw model chemistry results for these areas were analyzed, and the best plausible factors explaining the gains or losses were included in the model [e.g., groundwater, hyporheic exchange, or nonpoint sources (Table 12)]. Groundwater values from samples collected by Marti (2005) were used where appropriate (Appendix B, Table B4).

Nutrients, pH, and Dissolved Oxygen

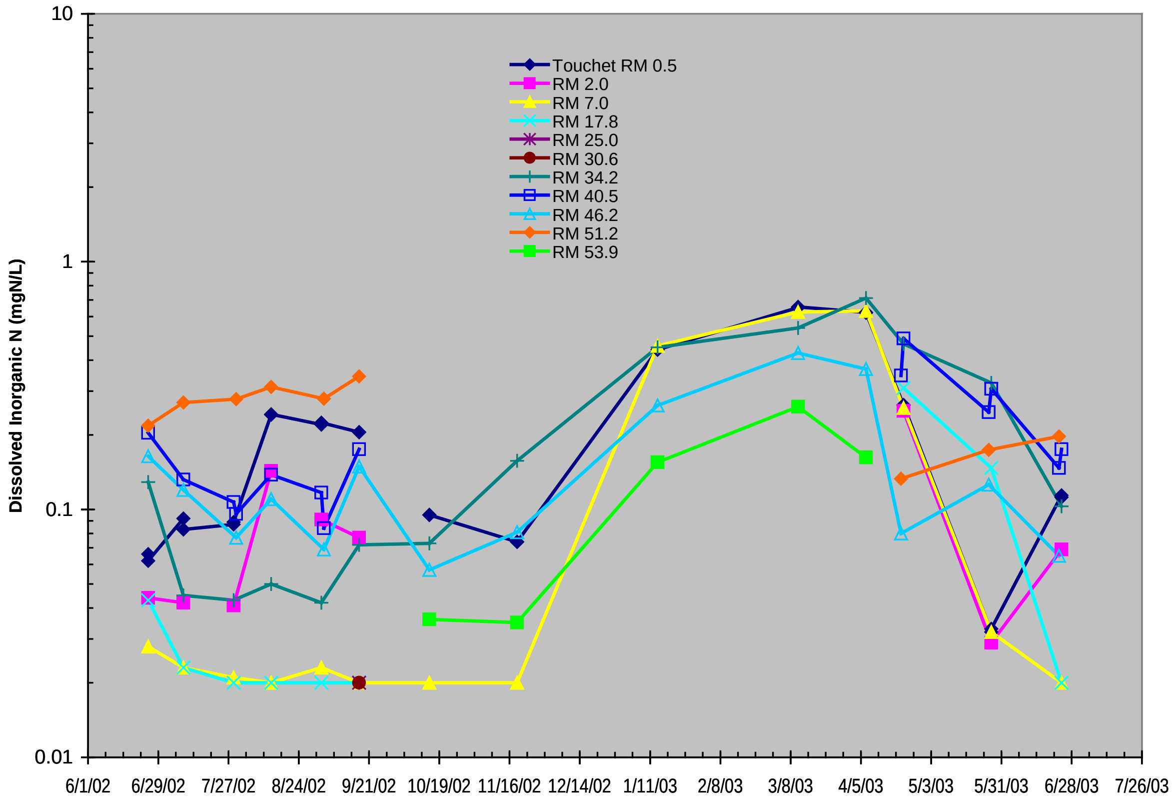
Phosphorus was elevated in the North and South Forks of the Touchet River (relative to nitrogen) and concentrations did not appear to dissipate appreciably downstream during the low-flow season (Figure 24). The summer average phosphorus concentration (40 µg/L) was elevated in comparison to other background conditions in other parts of the state, but the concentration was between the spring and summer 25^{th} percentile values found for the Blue Mountain Ecoregion (EPA, 2000a,b; ODEQ, 2006).

During the 2002 and 2003 surveys, the South Fork Touchet had five times the average nitrate concentration compared to the North Fork Touchet. Dissolved inorganic nitrogen (DIN) concentrations in the two forks were higher than Blue Mountain Ecoregion (Table 10) summer 25^{th} percentile concentrations (10 µg/L). These DIN concentrations were more similar to the median to 75^{th} percentile values of 30 – 50 µg/L nitrate-nitrite nitrogen (EPA, 2000a,b). Rural development upstream of the two sites are suspected of increasing DIN and SRP over a background concentration, although the concentrations are lower than measured in the undeveloped Mill Creek headwaters.

The DIN concentrations were low in the summer and fall, but rose above 100 µg/L in the winter and early spring (Figure 24). Soluble phosphorus concentrations remained relatively stable through the year. Nitrogen:phosphorus (N:P) ratios suggest that the Touchet River is nitrogen-limited during the growing season (Figure 20). Therefore, nitrogen sources become the dominant stimulus of primary productivity. Along the Touchet River, several reaches were identified with significant pulses of nitrogen. The primary productivity created by these pulses may cause daily swings in pH and DO that violate Washington State criteria.

Immediately below the confluence of the two forks, Patit Creek and the Dayton WWTP provided pulses of nutrients (RM 51.2), especially nitrogen (Figure 25). The Dayton WWTP doubled the instream phosphorus loads (total phosphorus and SRP), and tripled the nitrogen loads (total nitrogen and DIN) during the low-flow season (Figure 26). Dayton WWTP effluent DIN had 10 – 20 mg/L and 2.5 – 4 mg/L phosphorus (note that the units are milligrams not micrograms). Patit Creek typically had 1 – 4 mg/L DIN and 0.05 – 0.16 mg/L phosphorus. Samples collected at RM 51.2, below Dayton, consistently showed instream nutrient loading (Figure 26).

Grab samples were collected mid-morning below Dayton (Swanson, 2005). Diel results (Appendix H) upstream from the North Fork and downstream at Luckenbill Road (RM 17.8) demonstrated that early morning DO and late afternoon pH values did not meet standards (Table 9). If grab samples were collected at a different time, it would not be unusual that only one pH measurements at RM 51.2 was reported as greater than 8.5. The pH and DO measurements below Dayton were probably out of compliance more often than recorded by the grab samples. The nutrient loads and channel characteristics were ideal for stimulating instream primary productivity during the entire growing season.



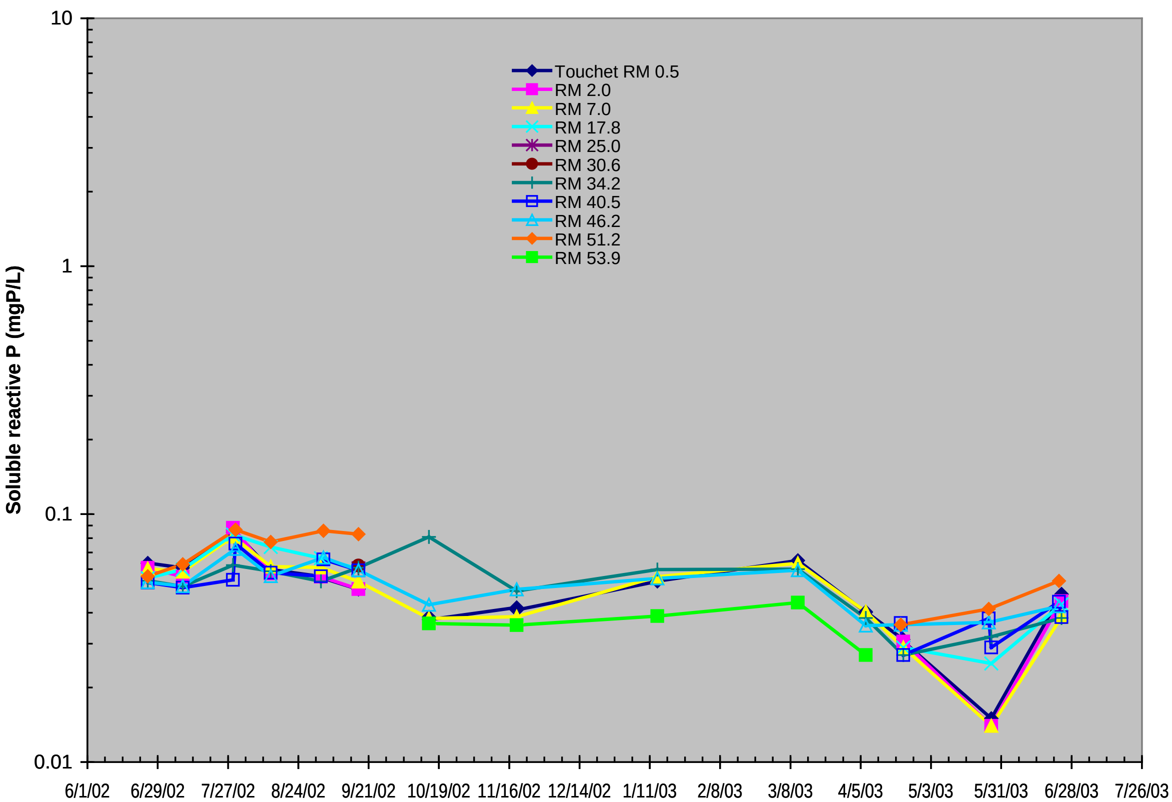


Figure 24. Dissolved inorganic nitrogen and soluble reactive phosphorus in the Touchet River from June 2002 through June 2003.

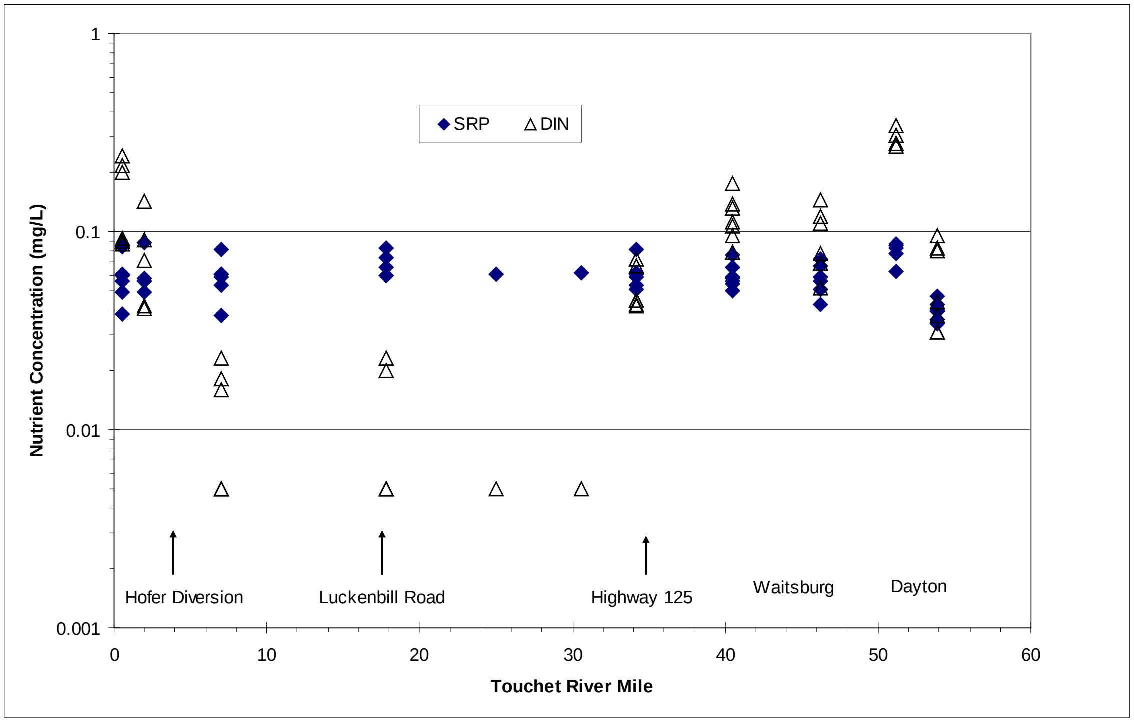


Figure 25. Soluble reactive phosphorus (SRP) and dissolved inorganic nitrogen (DIN = nitrate+ nitrite+ ammonia as N) concentrations from July through October 2002 along the Touchet River. DIN values below 0.01 mg/L represent non-detectable concentrations.

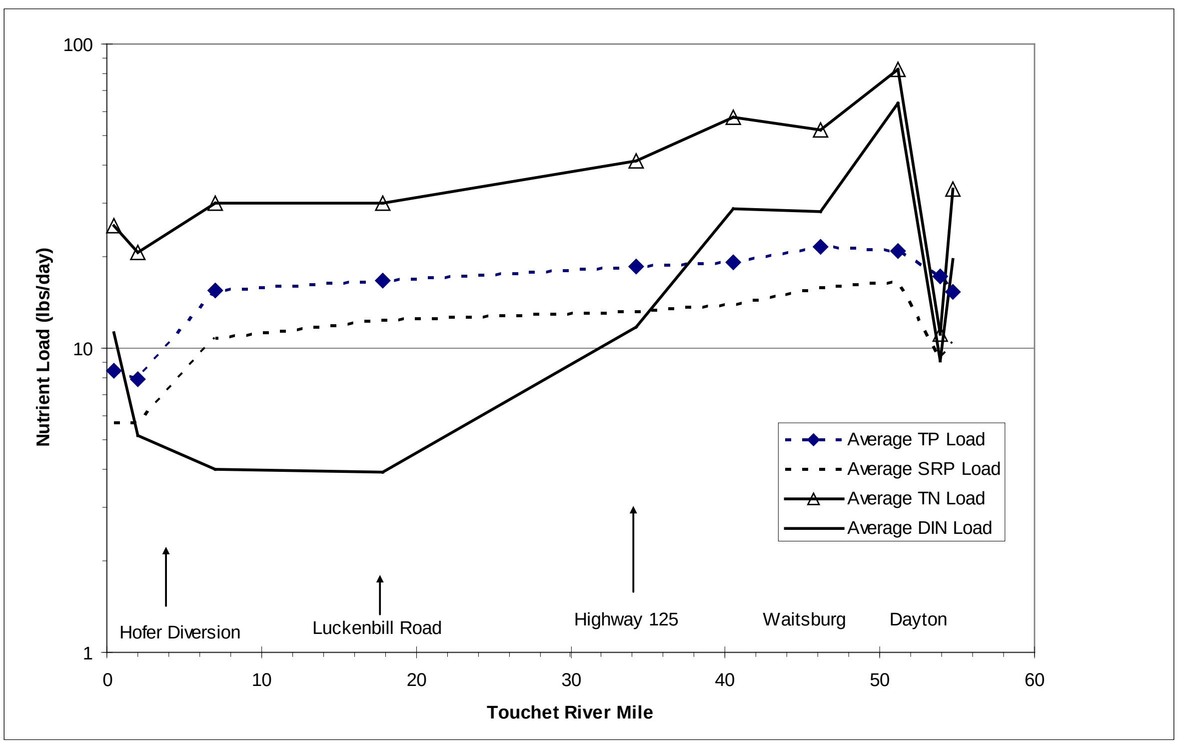


Figure 26. Estimated average total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), and dissolved inorganic nitrogen (DIN) loads from July through October 2002 along the Touchet River.

While total phosphorus loads stay fairly stable, total nitrogen, DIN, and SRP loads appeared to rapidly diminish downstream (RM 46.2), and then increased again after the Waitsburg area (RM 40.5) (Figure 26). Nutrients, chloride, and alkalinity increased downstream of Waitsburg greater than could be accounted for by Coppei Creek inputs alone. This suggested sources within the city limits, nonpoint sources near the city, or leaching from the Waitsburg WWTP infiltration lagoon. Grab measurements of pH from the reach were often not in compliance with the Class A criterion.

Low-flow SRP and total phosphorus concentrations continued to be 50 – 90 µg/L to Luckenbill Road Bridge (RM 17.8), but DIN concentrations dropped below the 10 µg/L detection limit (Figure 25). Total nitrogen concentrations remained at 140 – 200 µg/L with only minor losses in total nitrogen loads. Diel DO and pH measurements taken at Luckenbill Road in August 2002 and late May 2003 were not in compliance with Class A criteria despite the lack of DIN (Appendix H, Figures H4 and H8). Diel ranges of pH and DO suggested a high degree of primary productivity, and elevated stream temperatures (greater than 20º C).

At the North Touchet Road Bridge (RM 7.0), all nutrient concentrations and loads during the low-flow period were similar to those 10 miles upstream at Luckenbill Road. Measurements of pH suggested conditions were similar at the two sites. Without a notable loss of instream nutrients between the two sites, additional nutrients to sustain periphyton biomass may have been from heterotrophic bacteria decomposition of organic nitrogen in the hyporheic zone, groundwater, or nonpoint sources.

The Hofer Diversion greatly reduced Touchet River instream flows to the Walla Walla River during the irrigation season. The reach upstream of Cummins Road (RM 2.0) and above Highway 12 (RM 0.5) appeared to have received additional DIN and SRP, chloride, and slightly lower water temperatures from groundwater and/or nonpoint sources below Hofer Diversion (Figure 26). Grab pH and DO measurements taken at both sites (Table 9) and diel measurements at Cummins Road did not meet Class A criteria on a few occasions (Appendix H, Figure H3 and H4).

Walla Walla River

Hydrologic Characteristics

The Walla Walla River was undergoing new instream flow management operations during the 2002-03 TMDL surveys. The 2000 U.S. Fish and Wildlife Service agreement with the irrigation districts had increased minimum summer flows in the Walla Walla River across the state line from 3 - 4 cfs in 2000, and then to 13 - 25 cfs in 2002 (Mendel et al., 2003). Also, the Gardena Farms Irrigation District increased flows across the Burlingame Dam at RM 36.7 (downstream of Yellowhawk Creek and the East Little Walla Walla River) from 10 cfs in 2000 to 18 cfs in 2002 (Mendel et al., 2003).

Withdrawals or other losses still had a significant seasonal impact on instream flows between Detour Road (RM 32.8) and McDonald Road (RM 29.4) in 2002 (Mendel et al., 2003). An average of 25 cfs was lost in that 3.4-mile reach in July through September, essentially reducing the instream flows to state-line volumes.

As discussed earlier, the 2002 and 2003 monthly flows in the Walla Walla River recorded at the USGS gage near Touchet (RM 18.4) were near the historical averages (Figure 11). The new instream management may have played a role in sustaining flows despite lower than normal September and October rainfall. However, water metering in Washington may have resulted in more water being removed, or 'used', from the stream channels than was needed for irrigation. An assessment of this phenomenon was not conducted.

Discharge measurement in July and August were collected at several sites by several groups from 2000 to 2002 (Butcher and Bower, 2005). An August flow budget for the Walla Walla River and South Fork Walla Walla River was constructed from 2002 surface water synoptic survey data, gaging information, and groundwater estimates for losing and gaining reaches (Appendix E, Figure E1).

Nutrients, pH, and Dissolved Oxygen

Dissolved inorganic nitrogen and SRP at Walla Walla River sites during 2002 and 2003 are presented in Figure 27. The nitrogen:phosphorus ratios were presented earlier in Figure 21. Both DIN and SRP appear to increase in a downstream direction from the state line. Growth limitation by DIN is suggested by the DIN:SRP ratios at most locations during the June-October period.

The average annual nutrient loads along the river for the June 2002 to June 2003 TMDL survey period are shown in Figure 28. Increased loads were observed downstream of the major tributaries (e.g., Yellowhawk Creek, Garrison Creek, Mill Creek, and the Touchet River. Nutrient loads did not appreciably reduce along the course of the mainstem despite obvious uptake by primary producers).

Irrigation returns and groundwater may be contributing additional loads of nutrients. The biomass generated in the mainstem is a nutrient sink, but this was not evaluated. The effects of the biomass were evident from the pH and DO measurements taken during the TMDL surveys.

Grab sample DO and pH results at all stations during 2002 and 2003 were presented in Figure 16. These data suggest daytime DO at stations in the Class A section of the river occasionally dips below the water quality criterion, and pH is frequently higher than the water quality criterion at several stations. The results are consistent with historical grab sampling results (Figure 8).

Continuous diel DO and pH measurements taken at Pepper Road (RM 39.6), McDonald Road (RM 29.3), Lowden Road (RM 27.4), and Pierce's RV Park (RM 9.3) are shown in Appendix H, Figures H5, H6, and H8 - H10. The DO concentrations did not meet the appropriate Class A and Class B DO criteria at times. The pH criterion at all sites was not always met either. The diel monitoring results suggest that it is unlikely that any reach of the Walla Walla River met designated pH and DO criteria during low-flow conditions in the 2002-03 TMDL survey period.

The diel patterns of DO and pH indicate that these variables are strongly influenced by photosynthesis, mainly by periphyton and, to a lesser extent, by phytoplankton in the river. Reductions of DIN and SRP from tributary and nonpoint sources would be expected to reduce the diel maximum pH and increase the diel minimum DO.

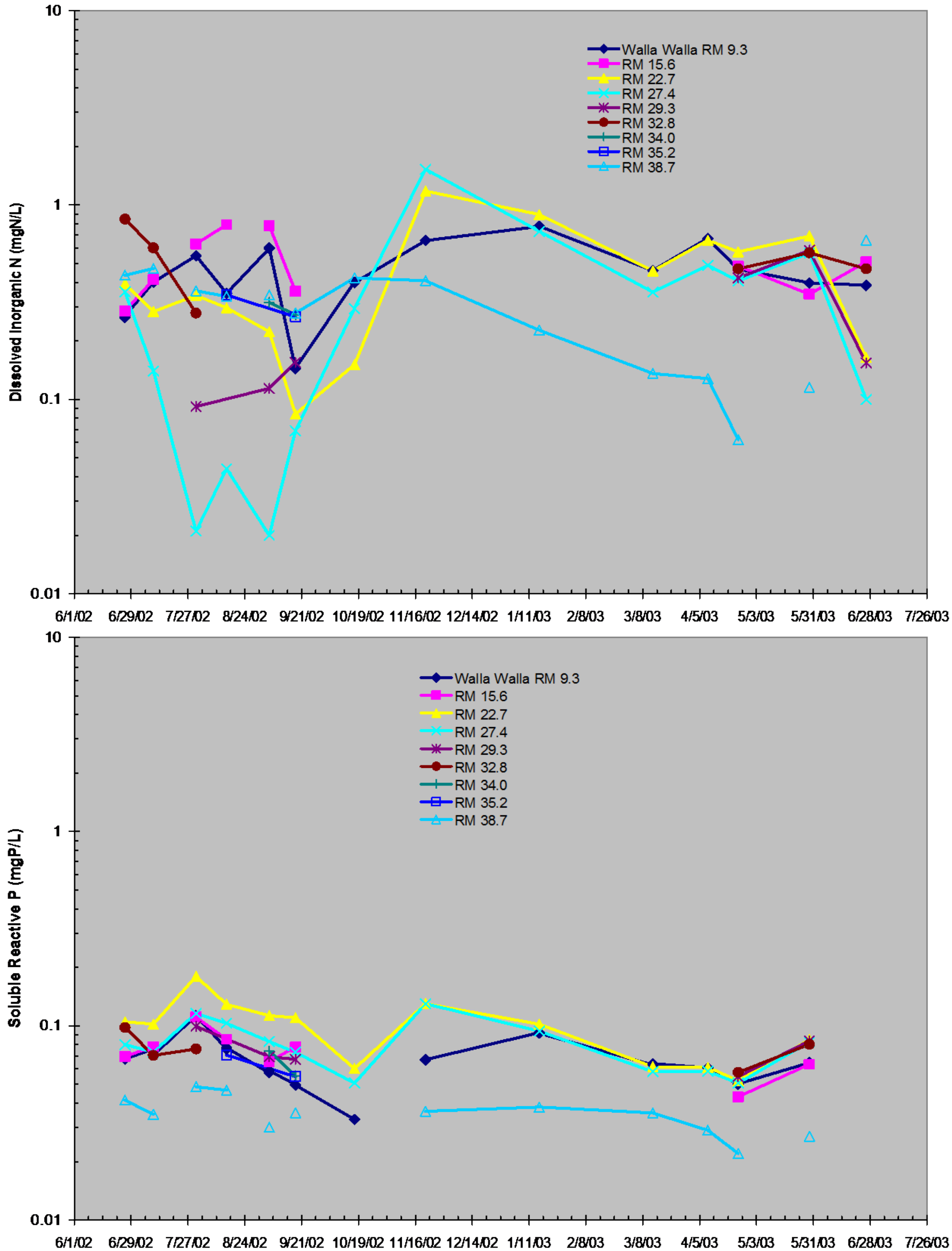


Figure 27. Dissolved inorganic nitrogen and soluble reactive phosphorus in the Walla Walla River from June 2002 through June 2003.

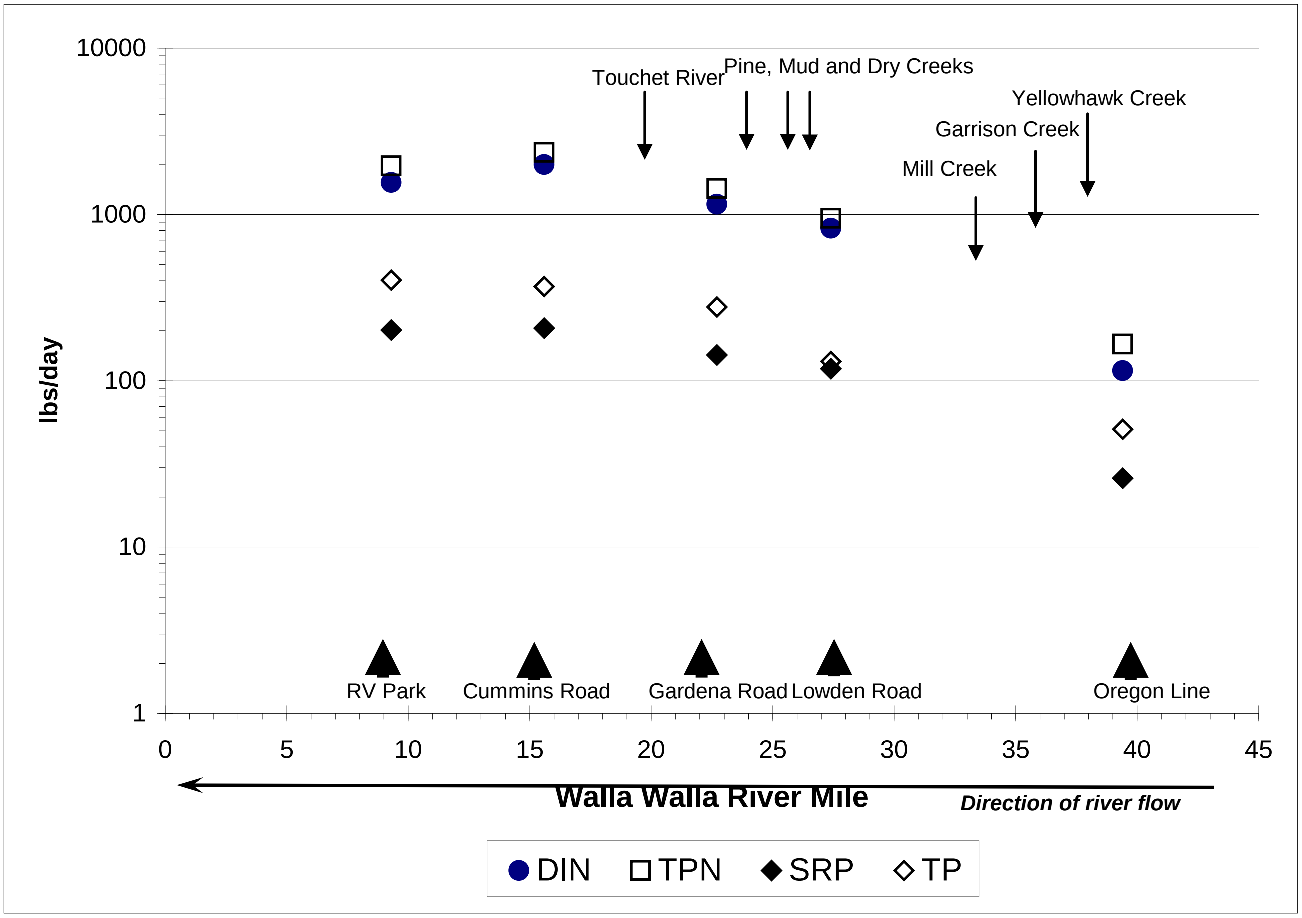


Figure 28. Average dissolved inorganic nitrogen (DIN), total nitrogen (TPN), soluble reactive phosphorus (SRP), and total phosphorus (TP) loads for five sites monitored along the Walla Walla River from June 2002 to June 2003.

TMDL Analyses

Analytical Framework

QUAL2Kw Water Quality Model

QUAL2Kw is a one-dimensional, steady-flow numerical model capable of simulating a variety of conservative and non-conservative water quality parameters (Chapra et al., 2005). QUAL2Kw assumes steady-state flow and hydraulics; however, the heat budget and temperature are simulated on a daily time scale. Diel variations in all water quality variables are simulated as well. The model was used to evaluate the influence of nutrient and benthic biomass on pH and DO concentrations in Mill Creek and the Touchet River during the steady-state, critical, low-flow season.

The QUAL2Kw model requires an accurate characterization of hydrology. The relationship between streamflow and width, velocity, and depth was analyzed using cross-section measurements by the Department of Ecology (Stohr et al., 2007, in press) and other agencies. Linear regression analysis was used to determine the parameters of power curves for the hydraulic geometry relationships with flow.

QUAL2Kw simulates diel variations in water quality variables for a steady flow condition. QUAL2Kw is applied by assuming that flow remains constant for a given condition such as a 7-day or 1-day period, but key variables change over the course of a day in response to changes in the heat budget and biological processes such as photosynthesis of periphyton. For example, for temperature simulation, the solar radiation, air temperature, relative humidity, headwater temperature, and tributary water temperatures were specified or simulated as diel functions (changing over the course of a day).

The water quality model was calibrated to instream data along the mainstem of the Touchet River from the confluence of the North and South Forks above the city of Dayton to the confluence with the Walla Walla River. Mill Creek was modeled from Kooskooskie at the Oregon state line to the U.S. Army Corps of Engineers diversion above the city of Walla Walla, and then from Yellowhawk Creek to the confluence with the Walla Walla River.

The calibrated QUAL2Kw model was used to evaluate the effect of various flow, shade, and nutrient loading scenarios on daily minimum DO and daily maximum pH in these areas. Since the amount of water volume is a controlling factor for biological and chemical processes, critical and non-critical flow conditions were simulated. The following scenarios were evaluated for instream flows:

- The average 7-day low-flow with a 10-year recurrence interval (7Q10).
- The average 7-day low-flow with a 2-year recurrence interval (7Q2).
- The proposed new appropriation flow (NAF) recommendations by the Walla Walla Watershed Planning Committee under the 1998 Comprehensive Watershed Planning Act (Section 6 of HDR/EES, 2005).

The 7Q10 low-flow is used as the critical streamflow condition in river systems unless the pollutant of concern has the most potential for adverse effects at another time (WAC 173-201-020). It also is the river flow statistic used for wastewater treatment effluent dilution design. The July-August 7Q2 low-flow provides an estimate of average conditions during the low-flow season. As explained earlier, the NAF values are the minimum monthly flows that, when reached, would allow new consumptive out-of-stream uses and withdrawals. The NAF instream flow levels do not affect existing water rights (HDR/EES, 2005).

As mentioned earlier, the proposed changes in the Washington State standards could require future assessment of other seasonal flow, temperature, and chemical characteristics as critical conditions. For example, designated salmon and trout spawning areas would require evaluations for the February to June and September to June periods in the Walla Walla basin according to EPA maps http://yosemite.epa.gov/R10/WATER.NSF/1507773cf7ca99a7882569ed007349b5/5a8440cd8b259abd882571390071ef4d!OpenDocument.

Once the model water balance was calibrated for the flow scenario by adjusting groundwater and withdrawal volumes, several applicable loading scenarios were run. The scenarios systematically varied the heat (adjusted shade through riparian vegetation) and nutrient loads (point and nonpoint sources and headwater phosphorus, nitrogen, and carbon inputs) in the model.

A potential 'natural background condition' was run where human-caused heat and nutrient inputs were reduced to pre-development levels. The scenario lacked major modification to pre-development channel conditions (i.e., any extensive valley braiding and complexity that may have been present was not added to the model). An appropriate reference watershed to estimate these channel conditions was not identified. Scenarios to reduce temperatures would be considered long-term, post-implementation conditions because of the time required for full potential vegetation growth.

The same set of simulations was not run for Mill Creek and the Touchet River. The presence of the WWTPs and development at the headwaters of the Touchet River required a focused evaluation of 7Q10 conditions. Mill Creek has a protected and undeveloped headwater and no point sources along the reaches were modeled, so the effects of 7Q10, 7Q2, and NAF flows on nonpoint sources were evaluated.

Mass Balance Equation

A simple mass balance approach was used to evaluate nutrient loads on the Walla Walla River. A Beales ratio estimator formula (Dolan et al., 1981) was used to calculate the annual nutrient loads at sites with adequate nutrient and streamflow data (Appendix F). The Beales formula provides a better annual or seasonal estimate of pollutant loads compared to the average instantaneous load obtained from a few sampling events.

pH and Dissolved Oxygen Model Calibrations

Mill Creek and Yellowhawk Creek

The QUAL2Kw model (Chapra et al., 2005) was used to simulate water quality in Mill Creek during the low-flow irrigation period. The water quality model was calibrated to instream data along the mainstem of Mill Creek from the waterworks dam at RM 25.2 to the division structure at RM 10.5, and down Yellowhawk Creek to the mouth. The September 2004 synoptic survey was used for calibration. Garrison Creek and Mill Creek below the division structure were not modeled. As described earlier, the majority of Mill Creek flows are routed down Yellowhawk Creek during the irrigation season.

The root mean squared error (RMSE) was used as a measure of the goodness-of-fit of the model predictions compared with the observed water quality during the synoptic survey (Appendix E, Table E4). Calibration of the model was achieved by minimizing the overall RMSE. Dissolved oxygen and pH predictions were calibrated within a RMSE of 0.23 mg/L and 0.23 pH units, respectively, compared with Hydrolab measurements of daily minimum and maximum values. The major nutrient forms of nitrate+nitrite and soluble reactive phosphorus were calibrated within a RMSE of 20% and 4% of the observed values, respectively.

A comparison of predicted and observed profiles of daily minima and maxima dissolved oxygen (DO) and pH is presented in Figure 29. The diel patterns of predicted and observed pH and DO at the location of highest pH and low DO (above the diversion to lower Mill Creek at the headwaters of Yellowhawk Creek) are presented in Figure 30. In general, the model did a good job of representing the longitudinal profiles and the diel patterns compared with the data from the synoptic survey.

Calibration results for DIN and SRP are shown in Figure 31. Growth of periphyton was found to be limited by nitrogen. The model predictions accurately represented the uptake of DIN and SRP by periphyton which caused the concentrations to decrease between the headwaters of Mill Creek and the headwaters of Yellowhawk Creek to levels of about 50 ugN/L and 30 ugP/L for DIN and SRP, respectively.

Both DIN and SRP concentrations increased significantly proceeding downstream in Yellowhawk Creek. Nonpoint (diffuse) inflows and tributary loads were used in the model to increase the nitrogen and phosphorus concentrations in Yellowhawk Creek. Hyporheic exchange may be involved since there is a net loss of water through the creek.

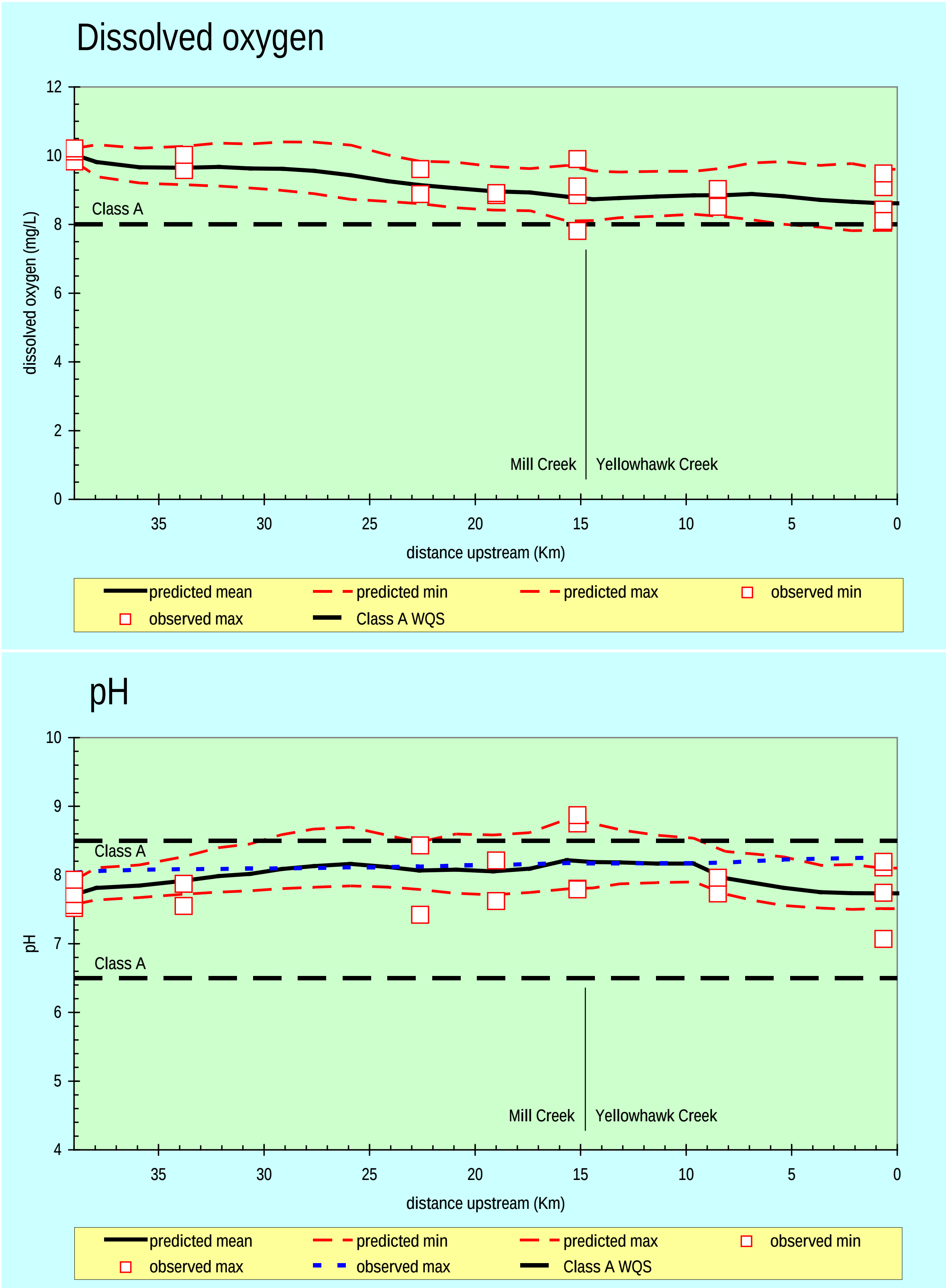


Figure 29. Predicted and observed dissolved oxygen and pH on 8/31/2004 – 9/1/2004 in Mill Creek above the diversion dam and in Yellowhawk Creek.

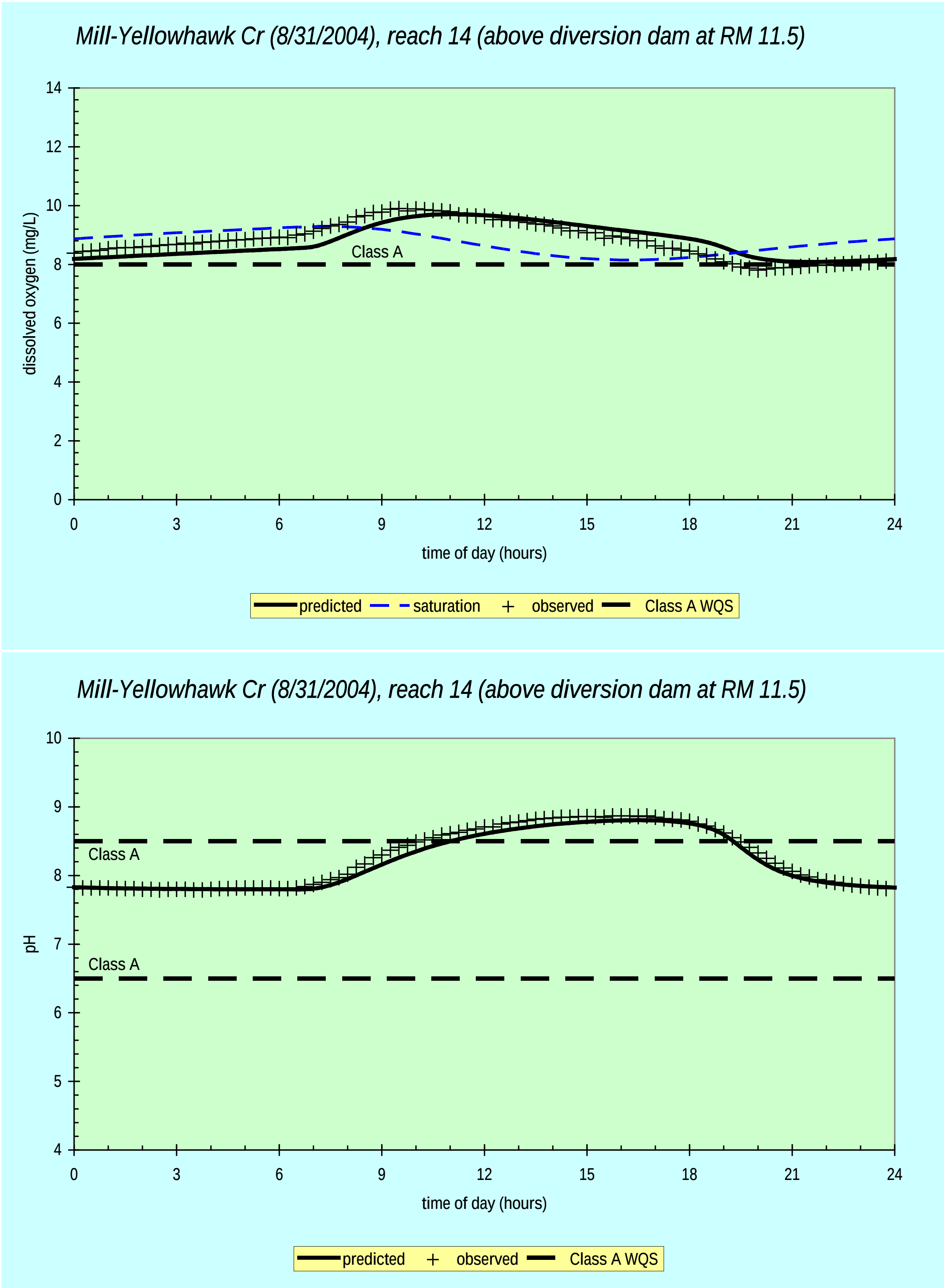


Figure 30. Predicted and observed dissolved oxygen and pH on 8/31/2004 – 9/1/2004 in Mill Creek above the diversion dam at RM 11.5 (32MIL-11.5) above the start of Yellowhawk Creek.

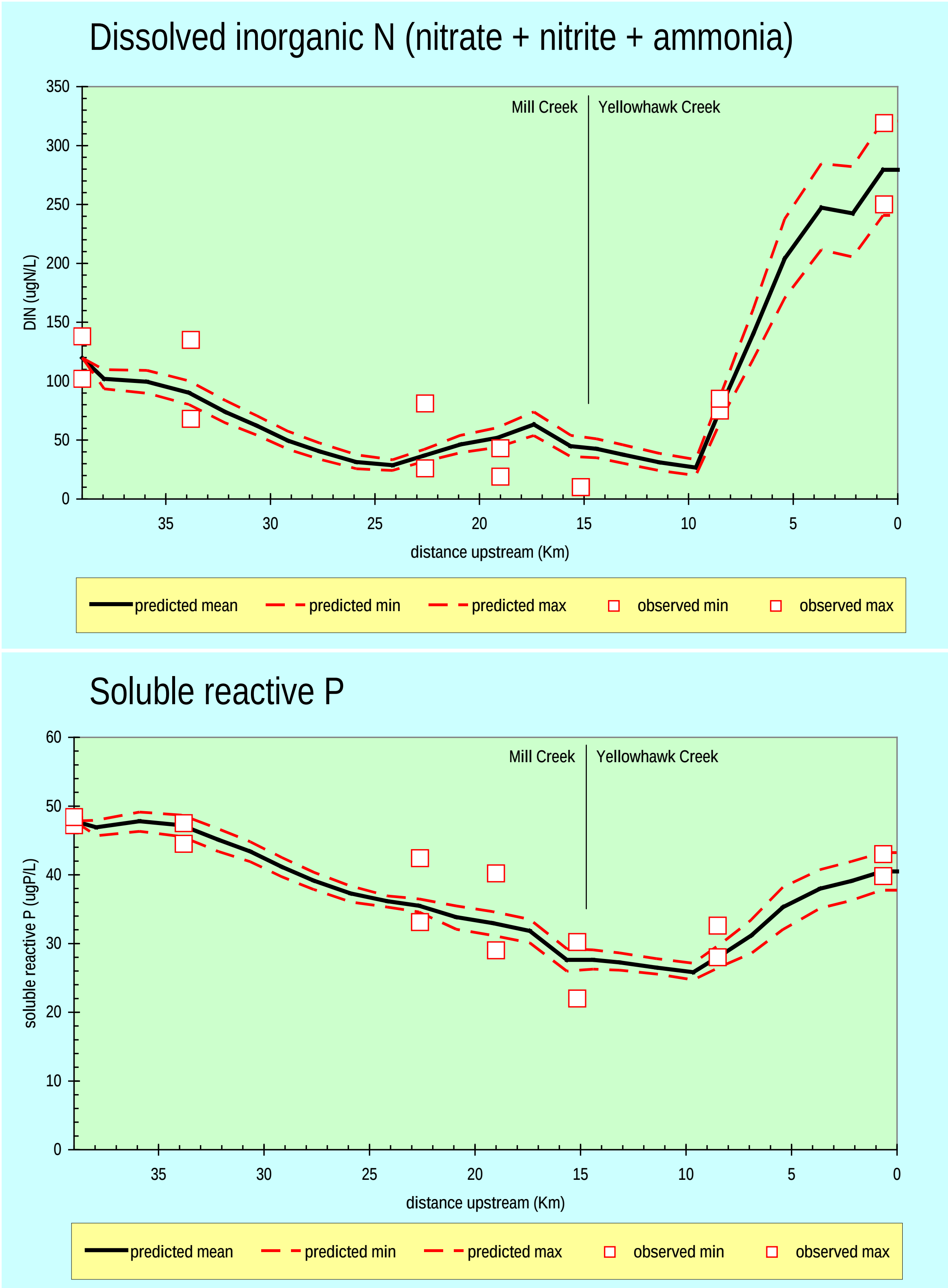


Figure 31. Predicted and observed dissolved inorganic nitrogen and soluble reactive phosphorus on 8/31/2004 – 9/1/2004 in Mill Creek above the diversion dam and Yellowhawk Creek.

Touchet River

A set of QUAL2Kw models (Chapra et al., 2005) was populated for the Touchet River from the confluence of the North and South Forks to the mouth. The models address simulations within all of the areas with pH and DO 303(d) listings in the Touchet River sub-basin; all were in the Class A designated areas, and none were in the Class AA reaches of the North Fork Touchet River.

Only the low-flow conditions were simulated in the QUAL2Kw model. Even so, difficulties were encountered using global reaction coefficients during nutrient calibration of the QUAL2Kw temperature model framework by Stohr et al. (2007). A better modeling solution was obtained by splitting the river into two separate models at river mile (RM) 34.2, the Highway 125 Bridge below Prescott. Output from the upper river (RM 54 to RM 33) model provided the headwater input for the lower river (RM 35 to RM 0.1) model. More recent versions of the QUAL2Kw model allow reach-specific rates
(Pelletier, 2007).

A significant change in the aquatic environment sometimes requires a new set of relationships between chemical, physical, and biological parameters. The river transverses from the Loess Island (10b) to the Pleistocene Lake Basin (10e) Level 4 ecoregions in that vicinity (EPA, 2003). The reaches downstream and upstream of RM 34 may be influenced by differences in upland and alluvial soil types (USDA, 1964) and underlying geology, as well as riparian vegetation and shade (Stohr et al., 2007). The downstream orientation of the river also changes from westerly to southerly.

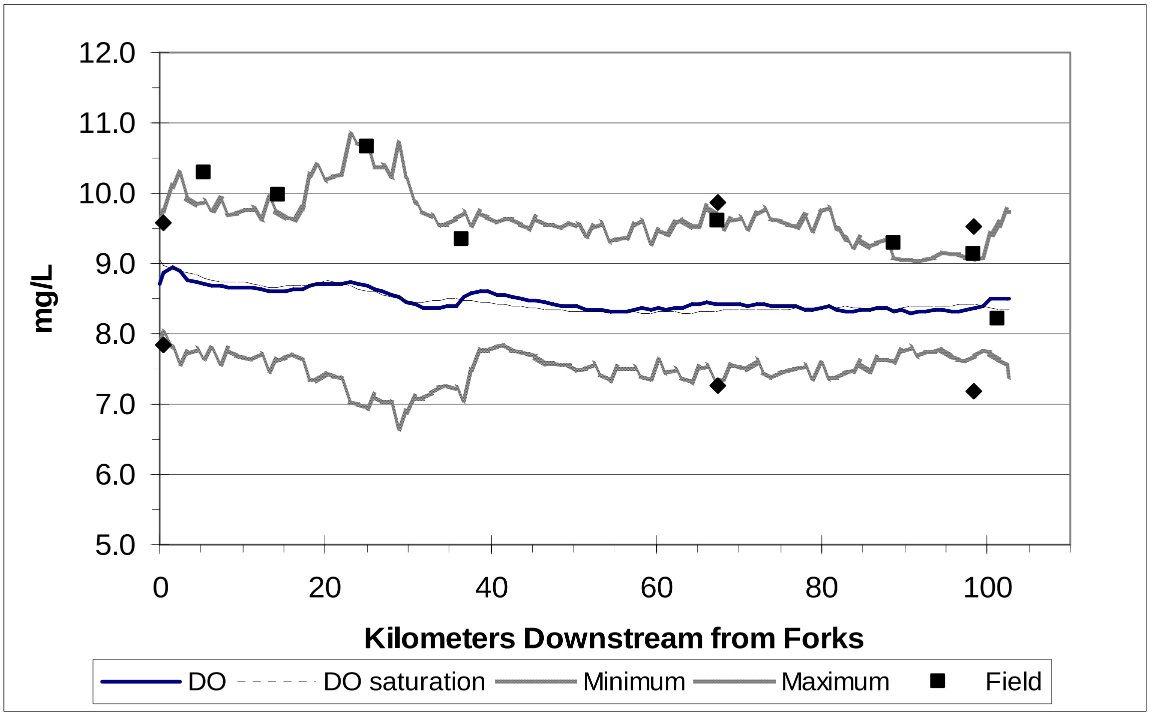
The QUAL2Kw model was used to simulate physical, chemical, and biological interactions focusing on nutrients, DO, and pH changes during the low-flow season. The water quality model was calibrated to instream data collected during July and August 2002 along the Touchet River from the confluence of the forks to the mouth. Hydrologic conditions in Table 12 were used. Patit Creek, Coppei Creek, Whiskey Creek, Dayton WWTP, Waitsburg WWTP, and two unidentified discrete sources (RM 3.0 and RM 37) loads were modeled as point source inputs. Groundwater, small diversions, hyporheic exchange, and other diffuse source inputs were entered as nonpoint sources.

The root mean squared error (RMSE) was used as a measure of the goodness-of-fit of the model predictions compared with the observed water quality during the August 2002 survey (Appendix E, Table E5). Calibration of the model was achieved by minimizing the overall RMSE. Dissolved oxygen and pH predictions were calibrated within a RMSE of 0.3 mg/L and 0.2 pH units, respectively, compared with instantaneous measurements and Hydrolab measurements of daily minimum and maximum values. The major nutrient forms of dissolved inorganic nitrogen (DIN) and soluble reactive phosphorous (SRP) were calibrated within a RMSE of 14% and 12% of the observed values, respectively.

A comparison of predicted and observed August 2002 profiles of daily minima and maxima DO and pH is presented in Figure 32. In general, the model represented the longitudinal profiles and diel ranges compared with the pH and DO data from the August survey. Diel data for the Touchet River were available for few sites; this limited evaluation of reach-specific diel ranges, especially pH. Touchet River grab samples were collected upstream to downstream from the morning to early afternoon. For calibrating the model, grab DO measurements were considered to be near maxima, and pH measurements were considered to be near the mean because of the collection times.

Calibration results for DIN and SRP are shown in Figures 33. Calibrating DO and pH data was difficult because of longitudinal changes in the inorganic nutrient fractions relative to total nutrient concentrations. As suggested by the field data, the model predicted that periphyton growth was limited by available nitrogen from Highway 125 (RM 34.2) to North Touchet Road above the Hofer Diversion (RM 7). However, the total nitrogen concentration in the water column, primarily as an organic fraction, remained greater than 200 µg/L. Between the Hofer Diversion and Cummins Road (RM 2), groundwater, hyporheic processes, or nonpoint sources raised instream DIN concentrations again.

The model predictions represented the uptake of DIN and SRP by periphyton, and the resulting changes in pH and DO, fairly accurately. Groundwater, hyporheic exchange, and point and nonpoint source inputs were somewhat difficult to calibrate between the July and August 2002 surveys because of water balance changes. The basic longitudinal chloride, DO, pH, and nutrient patterns in both surveys indicated influences from the Dayton WWTP, the Waitsburg area, and a combination of nonpoint and groundwater sources between the Hofer Diversion and the town of Touchet.



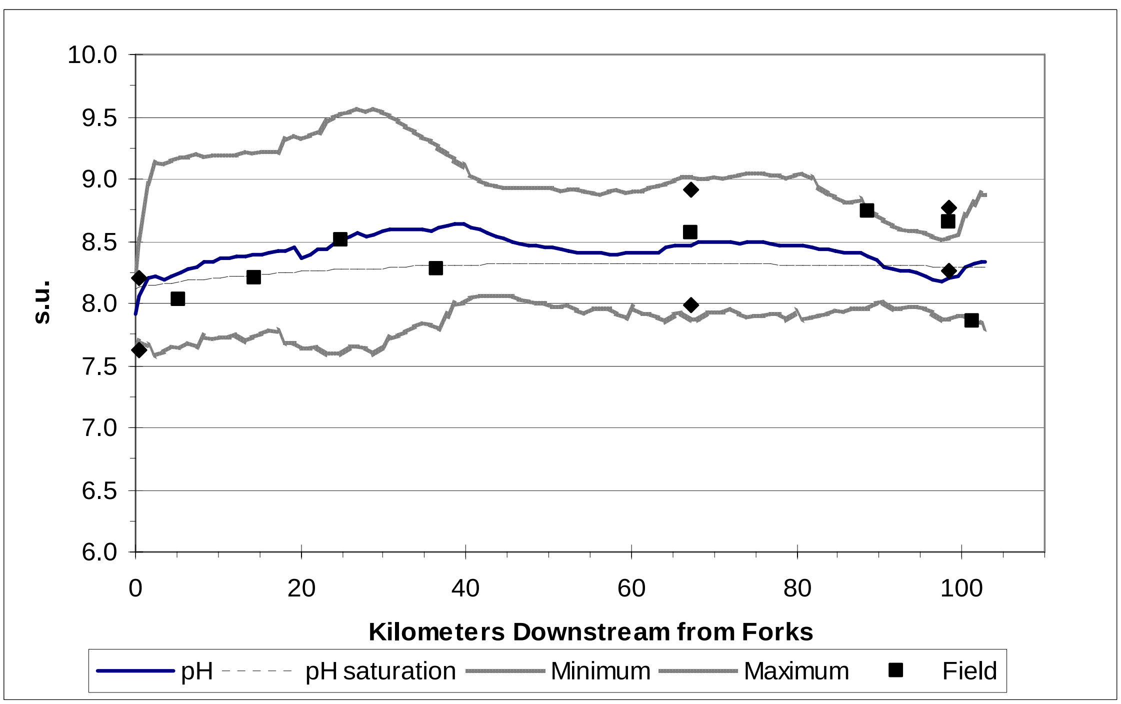
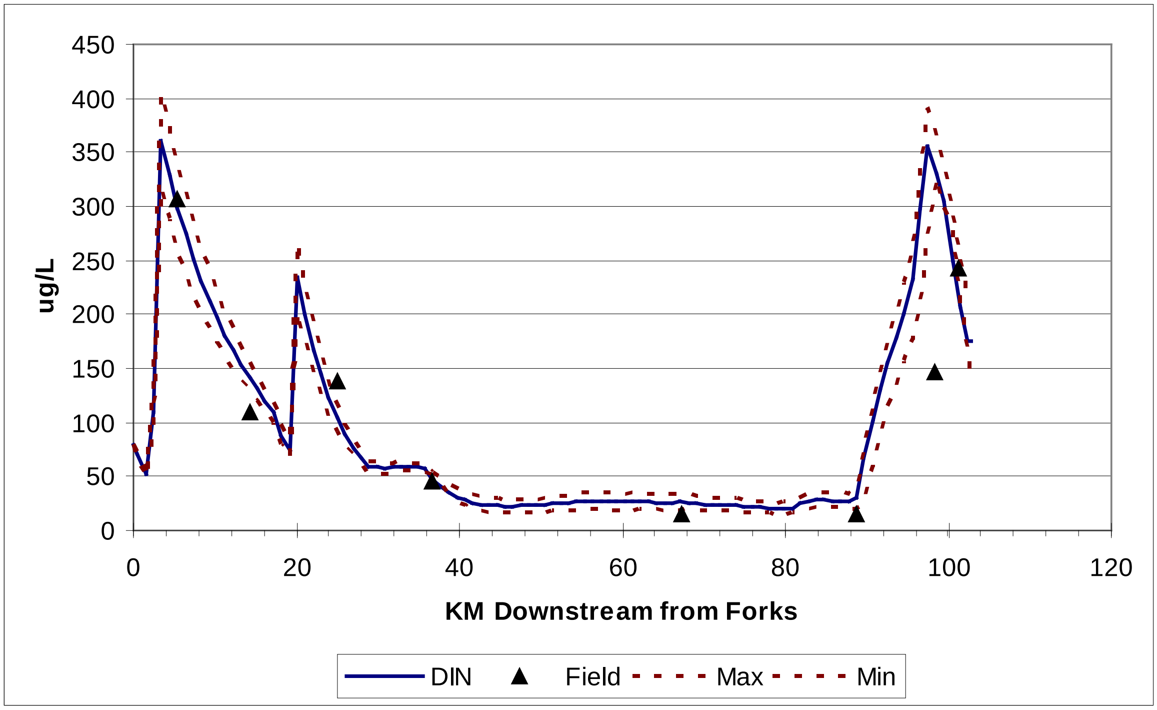


Figure 32. The QUAL2Kw Touchet River model dissolved oxygen (DO) and pH calibration to grab (■) and diel (♦) field data collected August 13, 2002.



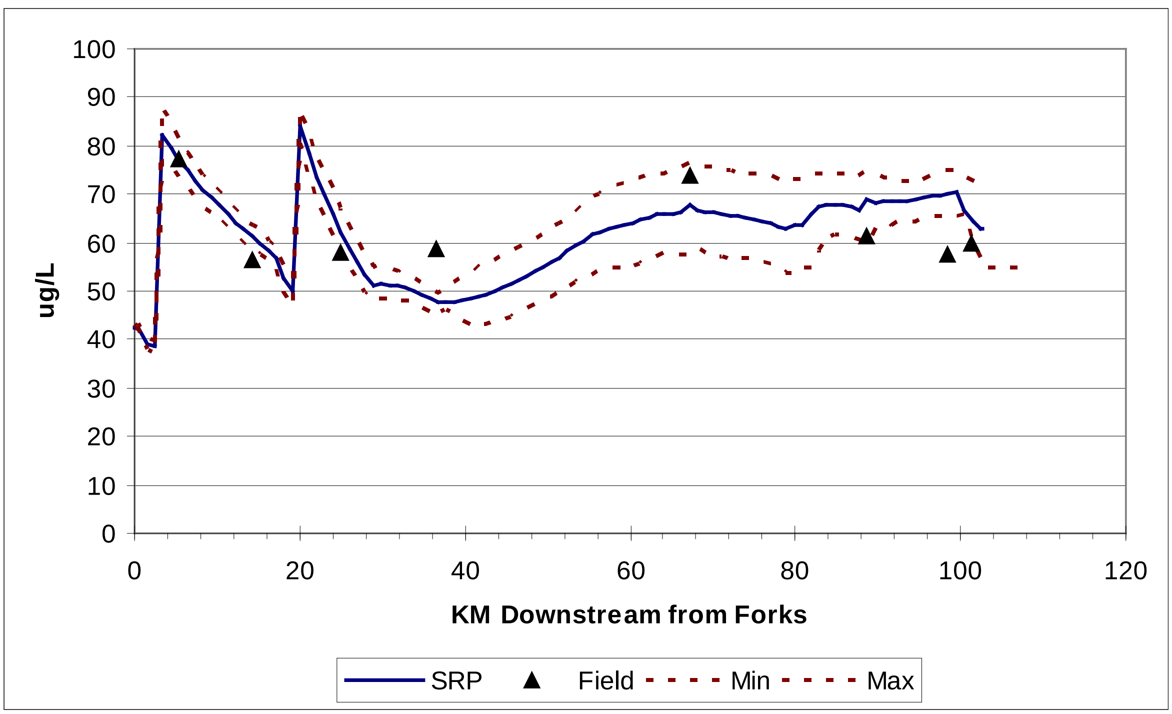


Figure 33. The QUAL2Kw Touchet River model dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) calibrations to field data collected August 13, 2002.

Walla Walla River

The SRP and DIN data in the upper mainstem reaches of the Walla Walla River from the state line at RM 38.7 to Detour Road (RM 32.8) were examined to determine the effect of the tributary loads (Figure 34). The May to October season loads and the annual loads were estimated from the monitoring data collected from Mill Creek, Garrison Creek, and Yellowhawk Creek. Data were not adequate to include distributaries of the Little Walla Walla River, Stone Creek and irrigation returns.

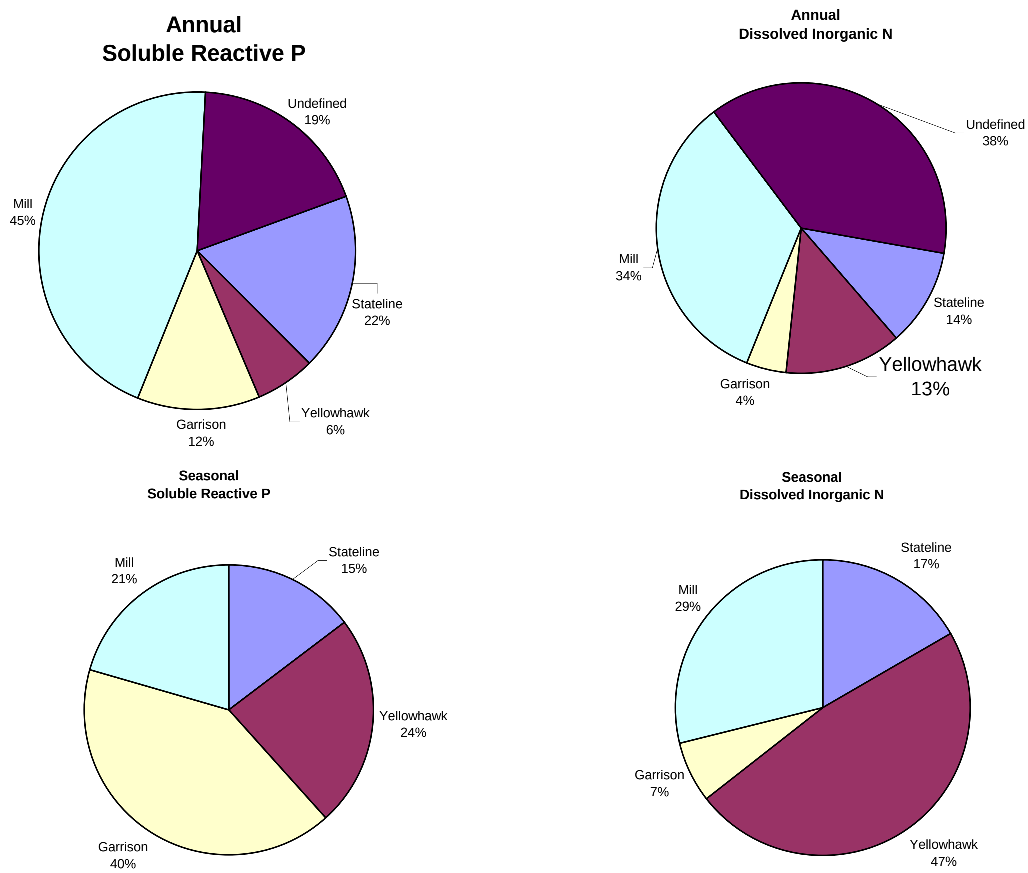


Figure 34. Estimated annual and seasonal (May – October) contributions of soluble reactive phosphorus (SRP) and dissolved inorganic nitrogen (DIN) loads from tributaries, the Walla Walla River upstream at river mile 38.7 (state line), and unidentified sources to the Walla Walla River at Detour Road (river mile 32.8).

Annual and growing season (May through October) loading estimates were calculated based on 2002 and 2003 data. Nutrient loads from Oregon (state line) appear to be fairly consistent. Unidentified nutrient loads at Detour Road in the annual data analyses suggest significant contributions probably from groundwater (Marti, 2005), but also from the unmonitored tributaries or local nonpoint source. Based on 2002 and 2003 data collected from May through October, the estimated average daily DIN and SRP loads increased 4.5 times in the Walla Walla River at Detour Road compared to the Oregon/ Washington border. The average daily discharge only increased from 36 to 52 cfs.

During the growing season, the sum of the tributary and upstream DIN and SRP loads are greater than the instream load estimated at Detour Road, even if a large margin of error is assumed in the estimates. Irrigation withdrawals are another component of the reduced load. One possible 'sink' for these nutrients during the growing period is primary production: periphyton, macrophytes, and algae.

The loading estimates also show a shift in relative importance between the tributaries, much of which can be explained by irrigation management operations. Mill Creek's relative seasonal contribution of DIN and SRP is much less than its annual contribution (Figure 34); streamflows and effluent are diverted away from lower Mill Creek from May through October. Garrison Creek's seasonal SRP loading increases substantially, as does Yellowhawk Creek's DIN load contribution. College Place WWTP is the primary source of SRP in Garrison Creek.

As a result of the excessive nutrient loading, sites on the Walla Walla River downstream of these tributaries have very poor water quality. For example, extreme swings in DO and pH were recorded in June 2003 farther downstream at Lowden Road at RM 27.4 (Figure 35). Aquatic organisms experienced a 7.5 mg/L diel DO range with minima at 5 mg/L, and pH maxima to 9 at temperatures greater than 25º C (77º F) – a serious physical-chemical block to salmonid migration or survival. The situation was aggravated by upstream withdrawals that left less than 10 cfs in the river at this location.

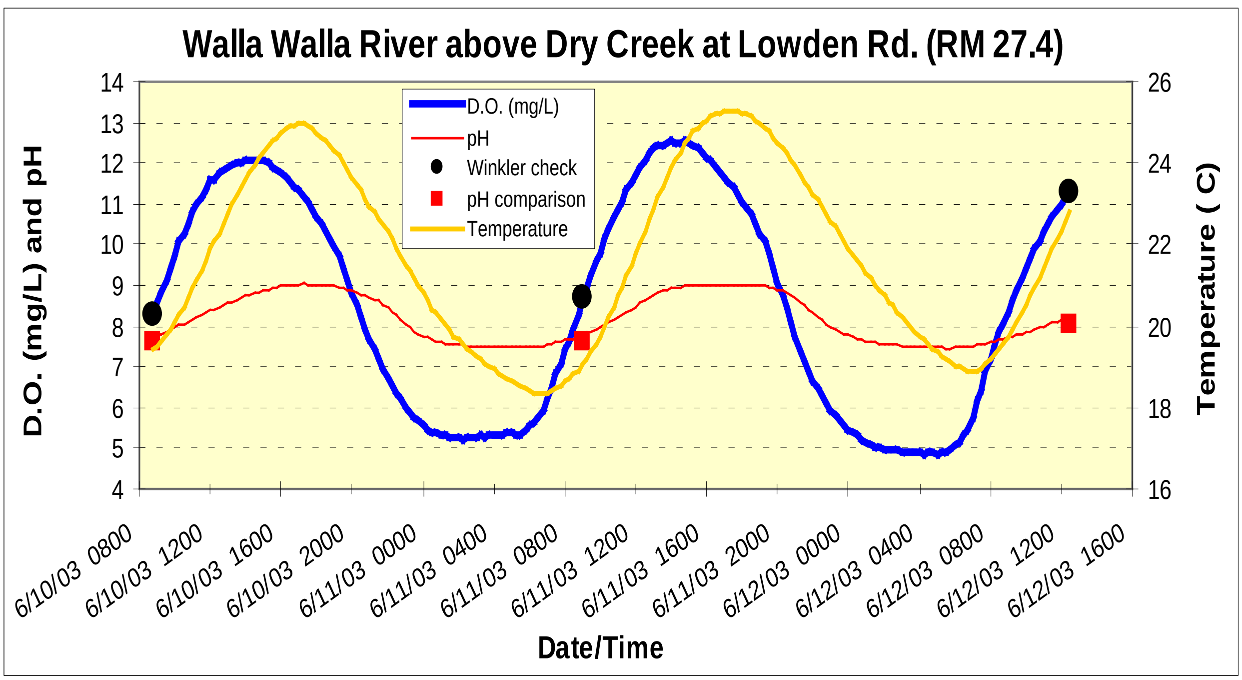


Figure 35. Temperature, dissolved oxygen (DO), and pH data recorded every 15 minutes at the Walla Walla River at Lowden Road from June 10 – 12, 2003.

The Beales mass balance estimates for DIN and SRP loads in the Walla Walla River were previously shown in Figure 28. The loading analysis indicated the all tributary loads, including the Touchet River, may account for approximately 80% of the annual DIN and total nitrogen loads, and 90% of the annual SRP and total phosphorus loads, to the Walla Walla River.

These mainstem pH and DO data are examples of the response of instream primary producers in the Walla Walla River to excessive nutrient loads, lack of riparian shading, elevated temperatures, and low streamflows.

Loading Capacity

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. EPA's current regulation defines loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards" (40 CFR §130.2(f)). Loading capacity analyses are conducted for critical conditions with maximum permit limit loadings from point (discrete) sources, and worst-case nonpoint (diffuse) source loadings. Because pH and DO loading capacities are related to primary productivity during the growing season, nutrient loads are considered the controllable stimulating agents for productivity. Shade is also considered.

Upper Mill Creek and Yellowhawk Creek

The calibrated QUAL2Kw model was used to determine the loading capacity for Mill Creek from RM 24.7 to RM 10.5 and down through Yellowhawk Creek. The critical season for pH and DO along this route occurs from May through October. The loading capacity was determined based on predictions of water quality under critical conditions within the May to October season. The lowest 7-day average flow with a 10-year recurrence interval (7Q10) and 2-year recurrence interval (7Q2) were selected to represent reasonable worst-case and typical conditions, respectively. In addition the proposed NAF management flow scenario was evaluated.

Meteorological conditions were evaluated for the 50th percentile (for 7Q2 and NAF flow scenarios) and 90th percentile (for 7Q10 scenarios) annual probability of the hottest week, based on the Washington State University's Public Agricultural Weather System (PAWS) station near Walla Walla. These statistics were developed for the Walla Walla basin temperature TMDL (Stohr et al., 2007).

Critical conditions for shade from riparian vegetation ranged between current conditions and potential maximum mature vegetation. Various scenarios of nutrient loading from tributaries and nonpoint (diffuse) inflows were evaluated to determine the loading capacity. No point source loads were present along the route. The approximate natural condition of nutrient loading was estimated based on headwater and estimated concentrations of diffuse sources in the upper watershed (Table 13).

The combined effect from increasing flow, increasing shade, and keeping nutrient loading at approximately natural conditions along the length of the creek is expected to significantly reduce the daily maximum pH, especially in Yellowhawk Creek (Figure 36). Mill Creek reaches from the waterworks dam to the Bennington Lake diversion (kilometer 39 to kilometer 18.5 in Figure 36) are predicted to have fewer daily maximum pH values in excess of the Class A criterion of 8.5 under all flow, shade, and nutrient loading scenarios.

The currently undisturbed conditions of the headwaters of Mill Creek, with relatively high nutrient load, appear to be sufficient to cause portions of Mill Creek to be out of compliance with the Class A pH criterion. Based on the pH model results, there does not appear to be assimilative capacity for additional nutrient loading to these waterbodies, especially during the growing season of May through October.

Dissolved oxygen conditions in Mill Creek and Yellowhawk Creek also improved with increased flows and shade (Figure 37). Under 7Q10 conditions, DO minima did not meet the 8 mg/L criterion in Mill Creek at the diversion structure. Yellowhawk Creek DO concentrations met the criterion when maximum shade and reduced nutrient loads were in place.

As with pH, DO concentrations improved in critical areas with increased shade, increased flows, and decreased nutrient loads (Figure 37). However, there does not appear to be assimilative capacity for additional nutrient loading to these waterbodies, especially during the growing season of May through October.

The model results for the various scenarios can be summarized as follows:

- **Flow:** Streamflows have a significant effect on dissolved oxygen (DO) and pH. The lowest DO and highest pH are expected when flows are lowest seasonally during summer and for extended periods in drought years. The proposed NAF management flows, if actually realized in the stream, are predicted to increase the daily minimum DO and decrease the daily maximum pH.
- **Shade.** Increasing shade from riparian vegetation is predicted to significantly increase the daily minimum DO, and to a lesser degree, decrease the daily maximum pH.
- **Nutrient loading.** Holding headwater nutrient concentrations at current levels (Table 13 and 14), and decreasing the loading of nutrients from nonpoint sources, is expected to increase the daily minimum DO and decrease the daily maximum pH. Reducing the diffuse inflow concentrations along the entire length of the creek to those estimated for headwater reaches above Kooskooskie (Table 13) would be necessary.
- **Combined effect on improving DO.** The combined effect of increasing flow, increasing shade, and decreasing nutrient loading is predicted to result in daily minimum DO in compliance with the Class A criterion of 8 mg/L throughout the length of upper Mill Creek and Yellowhawk Creek.
- **Combined effect on improving pH.** The combined effect of increasing flow, increasing shade, and decreasing nutrient loading is expected to significantly reduce the daily maximum pH, especially in Yellowhawk Creek and the lower portion of upper Mill Creek. The middle portion of upper Mill Creek is predicted to exhibit a decrease in the spatial extent of daily maximum pH out of compliance with the Class A criterion of 8.5. Natural conditions of relatively high nutrient loading from the headwaters of Mill Creek appear to prevent portions of Mill Creek from meeting the Class A pH criterion.

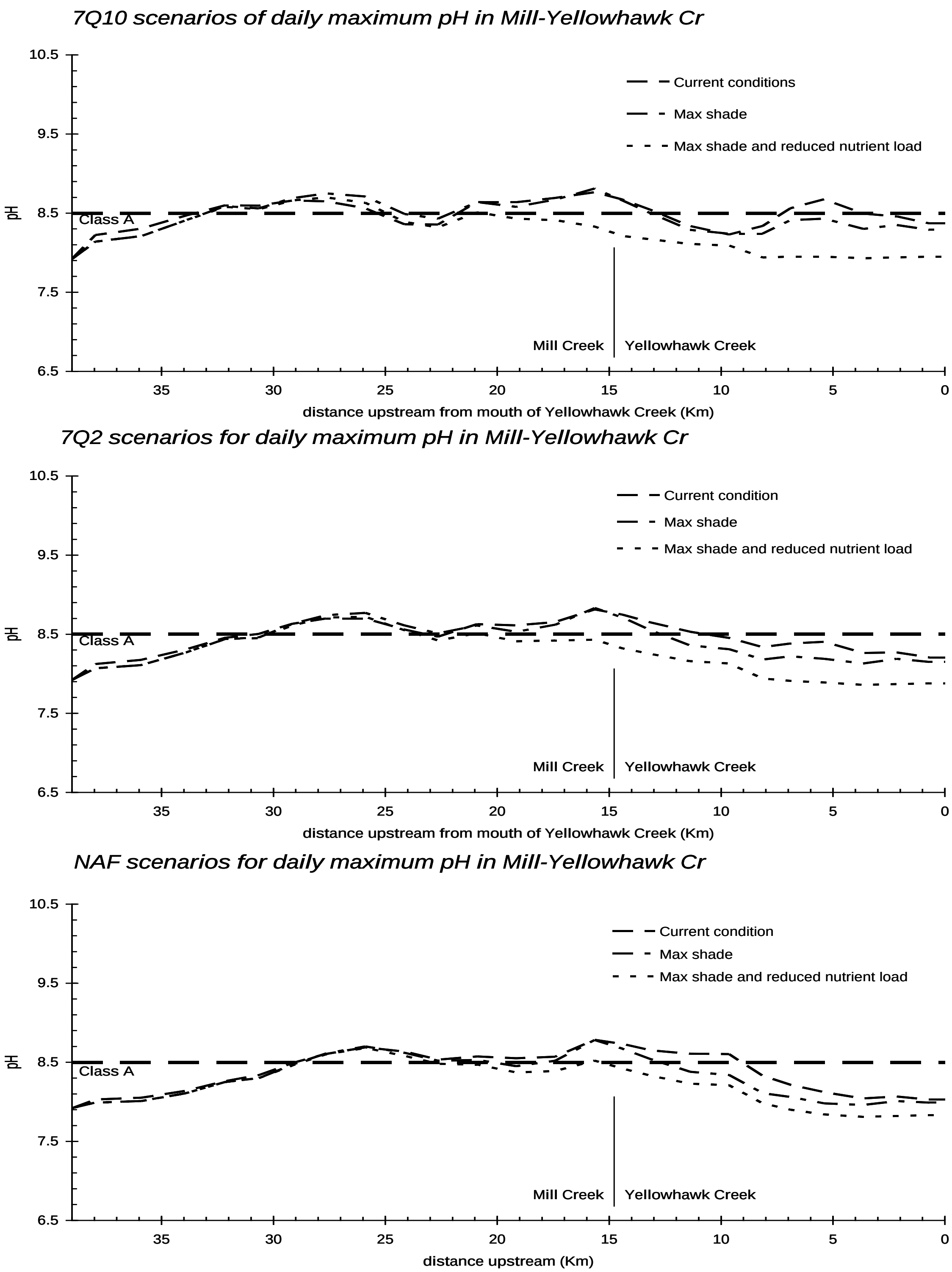


Figure 36. Predicted daily maximum pH in Mill and Yellowhawk Creeks with various management scenarios for shade, nutrient loading, and flow.

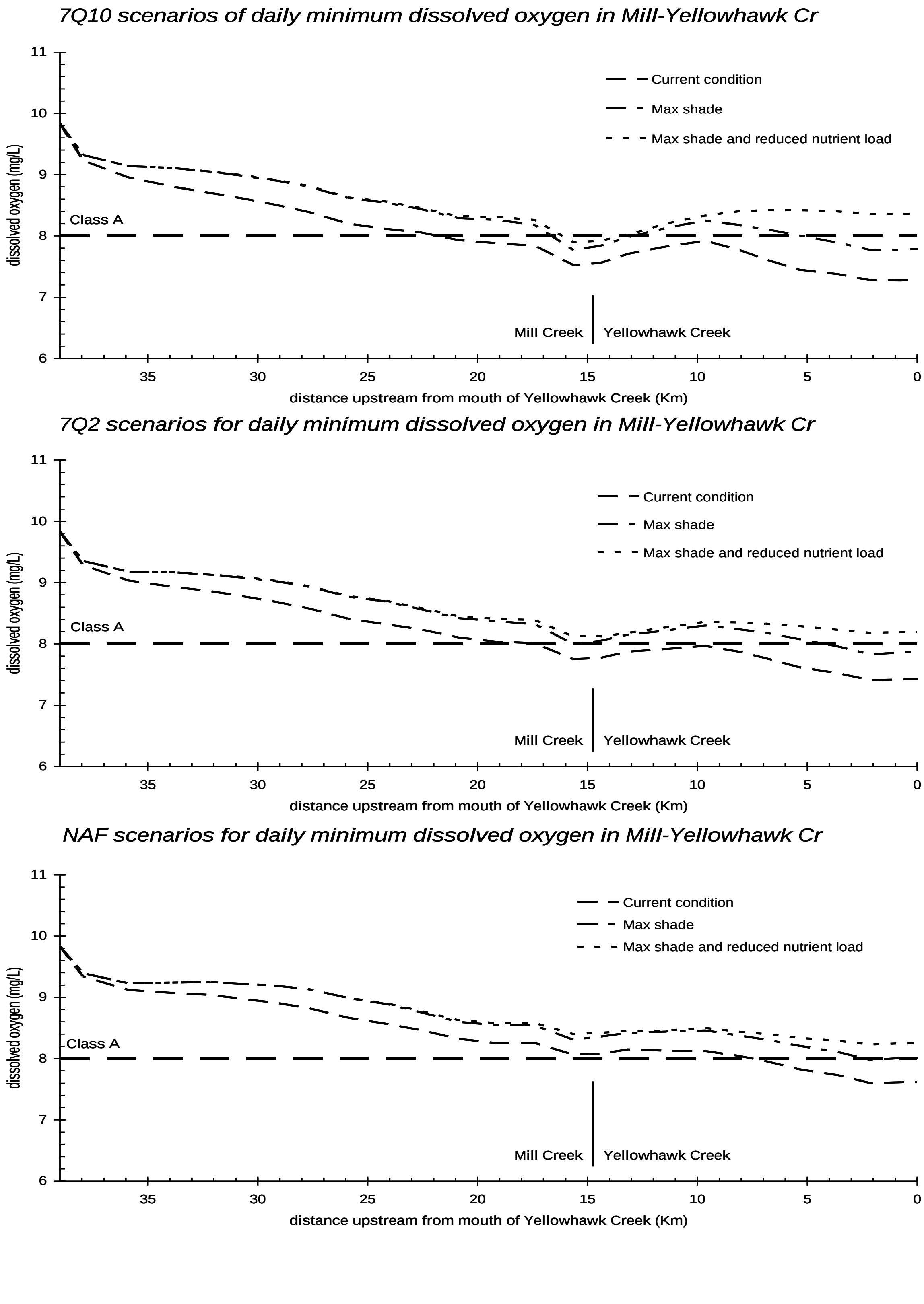


Figure 37. Predicted daily minimum dissolved oxygen (DO) in Mill and Yellowhawk Creeks with various management scenarios for shade, nutrient loading, and flow.

Lower Mill Creek and Garrison Creek

In general, the DIN and SRP concentrations in lower Mill Creek and Garrison Creek were the highest compared with other surface waters in the basin. Sometimes instream concentrations approached those found in wastewater effluent (Figure 23). Considering the advanced state of enrichment of nutrients in these waterbodies, substantial reductions would be required to improve water quality to conditions approaching natural background. Enrichment was exacerbated by extremely low flows from water management operations.

If sources of nutrient concentrations in lower Mill Creek and Garrison Creek are reduced to natural background levels (e.g., levels approaching headwater and estimated upper watershed diffuse source concentrations shown in Table 13) and flows are increased, then DO and pH may be expected to respond similarly to Yellowhawk Creek (Figures 36 and 37). Reductions in nutrient loading would be expected to reduce the daily maximum pH and increase the daily minimum DO. There is no assimilative capacity for additional nutrient loading to these waterbodies especially during the growing season of May through October.

Table 13. Measured headwater and estimated diffuse (nonpoint) inflow nutrient concentrations in upper Mill Creek and Yellowhawk Creek (8/31/04 – 9/1/04).

Reach name	Start of reach (km)	End of reach (km)	Organic N (ugN/L)	NH3-N (ugN/L)	NO3-N (ugN/L)	DIN (ugN/L)	Organic P (ugP/L)	SRP (ugP/L)
Headwater								
(above Kooskooskie)			8	5	132	137	0	48
			18	5	97	102	0	48
			13	5	117	122	0	47
			1	5	106	111	1	48
Diffuse Sources								
Headwater to Kooskooskie	39.0	33.8	8	74	313	387	29	85
Kooskooskie to 7-mile	33.8	22.6	8	74	560	634	29	99
7-mile to 5-mile	22.6	19.0	8	74	431	505	29	66
5-mile to YH div	19.0	14.9	8	74	992	1065	29	74
YH div to YHRM 5.0	14.9	8.5	14	95	1482	1577	21	332
RM 5.0 to RM 0.2	8.5	0.4	14	95	2782	2877	21	170
RM 0.2 to mouth	0.4	0.0	14	95	4467	4562	21	93

Table 14. Nutrient concentrations in Mill Creek at Kooskooskie during 2002-03.

Date	Time	Organic Nitrogen (ugN/L)	NH3-N (ugN/L)	Nitrate + Nitrite (ugN/L)	DIN (ugN/L)	Organic Phosphorus (ugP/L)	SRP (ugP/L)
6/27/02	9:30 AM	54	5	52	57	17	39
7/11/02	1:10 PM	33	11	60	71	14	41
8/1/02	7:10 PM	29	5	67	72	11	52
8/14/02	11:10 AM	15	5	57	62	7	53
9/4/02	9:30 AM	5	5	35	40	20	46
9/19/02	10:15 AM	19	5	69	74	24	52
10/16/02	9:20 AM	12	5	84	89	34	47
11/20/02	10:15 AM	17	5	73	78	22	46
1/15/03	9:15 AM	38	5	122	127	18	44
3/12/03	9:10 AM	49	5	42	47	39	33
4/8/03	9:45 AM	35	5	36	41	33	28
4/23/03	8:55 AM	21	5	38	43	24	32
5/28/03	10:30 AM	72	5	102	107	37	35
6/25/03	9:26 AM	5	5	62	67	11	45
8/31/04	6:45 AM	5	13	122	135	5	44
8/31/04	3:10 PM	26	5	63	68	1	48
9/1/04	6:55 AM	17	5	88	93	1	43
9/1/04	3:45 PM	34	5	76	81	2	44
Annual summary statistics							
Minimum		5	5	35	40	1	28
25th percentile		16	5	53	58	8	32
Average		27	6	69	75	18	42
75th percentile		35	5	82	87	24	47
Maximum		72	13	122	135	39	53
June-October summary statistics							
Minimum		5	5	35	40	1	39
25th percentile		10	5	59	66	4	41
Average		21	6	70	76	12	47
75th percentile		30	5	78	83	18	49
Maximum		54	13	122	135	34	53

Touchet River

The calibrated QUAL2Kw model was used to determine the loading capacity for the Touchet River from the confluence of the North and South Forks to the mouth. Loading capacity was determined based on prediction of water quality under critical conditions. The critical season for pH and DO in the Touchet River occurs from April through October. The lowest 7-day average flow with a 10-year recurrence interval (7Q10) was selected to represent reasonable worst-case conditions since Dayton and Waitsburg WWTPs NPDES permit limits are based on this flow statistic. In addition, the proposed NAF management flow scenario was evaluated.

Meteorological conditions were evaluated for the 90th percentile annual probability of the hottest week, based on the Washington State University Public Agricultural Weather System (PAWS) station near Walla Walla and Dayton. Critical conditions for shade from riparian vegetation used current conditions evaluated in the temperature TMDL by Stohr et al. (2007).

Model scenarios required nutrient estimates from tributaries and diffuse inflows. Reference conditions for these inputs also were required for the loading capacity analysis. The nutrient reference concentrations for undeveloped headwaters above Dayton were estimated from the monitoring data summarized in Table 15.

Development and nonpoint sources may be contributing as much as one-third of the current nutrient load above Dayton. Reducing the May to October 75th percentile concentrations in Table 15 by one-third gives an estimated reference concentration of 25 µg/L for SRP, 18 µg/L for organic phosphorus, 55 µg/L for DIN, and 39 µg/L for organic nitrogen. Reducing the seasonal 75th percentile is in keeping with EPA ecoregional approach (EPA, 2000a; 2000b). These concentrations were used only for the scenarios simulating reduced nutrient loading (e.g., ‘No sources + Maximum shade’ in Figures 38 and 39).

The diffuse (nonpoint) groundwater and nonpoint inflow concentrations were based on groundwater data (Marti, 2005) and estimates from the calibrated model. They were calculated residual terms, so they may contain a large error. Based on the available data, DIN and SRP near Dayton are 205 and 50 µg/L, respectively. Groundwater nutrients are different in the lower watershed. Although SRP concentrations are similar to upstream values, DIN concentrations during the critical season appear to be up to 25 times higher (5000 µg/L), and total phosphorus concentrations are closer to 70 µg/L (Appendix B, Table B-4).

The elevated nutrient concentrations may be influenced by the geology and soils in Level 4 Pleistocene Lake Basin Ecoregion, or a legacy build-up from years of application of nutrients in the watershed. The lack of development in the valley precludes active and identifiable nonpoint sources of this magnitude.

Table 15. Estimated nutrient concentrations in the Touchet River at the confluence of the North and South Forks during 2002-03.

Date	Organic N (ugN/L)	Ammonia (ugN/L)	Nitrate+Nitrite (ugN/L)	Dissolved Inorganic Nitrogen (ugN/L)	Organic Phosphorus (ugP/L)	Soluble Reactive Phosphorus (ugP/L)
6/25/02	62	7	68	75	10	32
7/9/02	57	11	83	95	14	34
7/30/02	47	5	77	82	13	47
8/13/02	43	5	75	80	18	43
9/3/02	21	5	39	44	23	40
9/17/02		5	33	38	27	40
10/13/02	13	5	26	31	32	36
11/19/02	29	5	25	30	25	36
1/14/03	50	5	145	150	21	39
3/11/03	91	5	250	255	96	44
4/7/03	63	5	152	157	42	27
4/21/03	43	5	17	22	28	27
5/26/03	63	5	118	123	44	28
6/23/03	46	5	67	72	12	35
Annual Summary Statistics						
Minimum	13	5	17	22	10	27
10th percentile	23	5	25	30	12	27
Average	48	6	84	90	29	36
90th percentile	63	7	150	155	44	44
Maximum	91	11	250	255	96	47
May - October Summary Statistics						
Minimum	13	5	26	31	10	28
10th percentile	19	5	31	36	12	31
Average	44	6	65	71	22	37
90th percentile	62	8	90	100	34	43
Maximum	63	11	118	123	44	47
75th percentile	58	5	77	82	27	40

The future nutrient loads, as maximum loading, for the Dayton WWTP were estimated using the field data and the NPDES permit design capacity. The capacity of the plant is 0.75 million gallons per day (mgd). Future maximum effluent flows during the critical season were estimated to be 81% of the plant capacity during the peak month, or 0.61 mgd. Effluent characteristics were chosen from the highest values from samples collected during the critical season of the 2002-03 surveys (Swanson, 2005). An exception was the DO concentration which was the lowest concentration observed:

- Temperature 19.5º C
- DO 5.2 mg/L
- pH 6.7
- Ammonia (NH_3-N) 0.5 mg/L
- Nitrite and Nitrate (NO2 + NO3-N) 20.4 mg/L
- Organic Nitrogen 0.02 mg/L
- Soluble Reactive Phosphorus (SRP) 3.75 mg/L
- Organic Phosphorus 0.09 mg/L
- Biochemical Oxygen Demand (BOD_5) 14.0 mg/L

The Waitsburg WWTP was not directly monitored, but 2002-03 survey data suggest it may be a contributor to the nutrient loading in the reach below Waitsburg through subsurface routes. Potential nonpoint sources are present near the WWTP (e.g., an inactive, buried landfill and noncommercial ranches lie close to the river). In Waitsburg, a cannery had been identified as a past source (Joy, 1986), but it now has been closed for several years. The estimate of the source characteristics to this reach were made for the QUAL2Kw model calibration. Future monitoring will be necessary to evaluate the sources in the reach.

A discharge volume of 0.46 mgd and the following characteristics were called 'Waitsburg WWTP' for convenience and applied to the reach:

- Temperature 17.0º C
- DO 5.0 mg/L
- pH 6.8
- Ammonia (NH_3-N) 0.04 mg/L
- Nitrite and Nitrate (NO2 + NO3-N) 20.0 mg/L
- Soluble Reactive Phosphorus (SRP) 1.0 mg/L

The minimum DO concentrations and maximum pH values predicted by the model for a 7Q10 flow volume, with maximum permitted point source and current nonpoint source nutrient loading conditions, are shown in Figures 38 and 39. The 8 mg/L DO criterion was not met anywhere along the river. The 8.5 maximum pH criterion was not met but for a brief reach just above the Hofer Diversion. The simulations demonstrate that nutrient loading to the river from point and nonpoint sources is exceeded, causing extensive pH and DO criteria violations.

Stohr et al. (2007) also demonstrated that 7Q10 flow temperatures would exceed 30º C, far beyond the 18º C temperature criterion and salmon lethality limit of 23º C. As explained earlier, higher temperatures drive DO concentrations down by reducing saturation concentrations.

The combined effect on DO minima from increased shade and decreased nutrient loading was modeled under 7Q10 flow conditions (Figure 38). The effect on water rights of reducing flows from point sources was not considered. Increasing riparian shade to full-potential vegetation significantly increased the daily minimum DO, especially between Dayton and Waitsburg and in the middle reaches of the river below Highway 125 to Luckenbill Road. However, DO minimum concentrations would continue to drop below criteria in reaches between Luckenbill Road and the mouth of the river.

Daily maximum pH values were reduced with increased shading and decreased loading, but the change did not significantly bring more of the river into compliance with the criterion (Figure 39). Shading appeared to have less of an effect on pH maxima than on DO minima. Reducing nutrient loads caused nitrogen limitation to occur downstream of Highway 125, so biomass-induced pH maxima were suppressed.

Increased flows to the NAF targets only slightly improved DO and pH (Figures 38 and 39). The improvement appeared to be limited to the reaches above Highway 125. If the increased flows accompanied lower water temperatures, more improvement would have been observed. However, the NAF flows were run with 7Q10 air and headwater temperatures. The apparent worsening of DO and pH conditions downstream of Highway 125 may be the result of increased headwater and groundwater nutrient loads accompanying the increased flows.

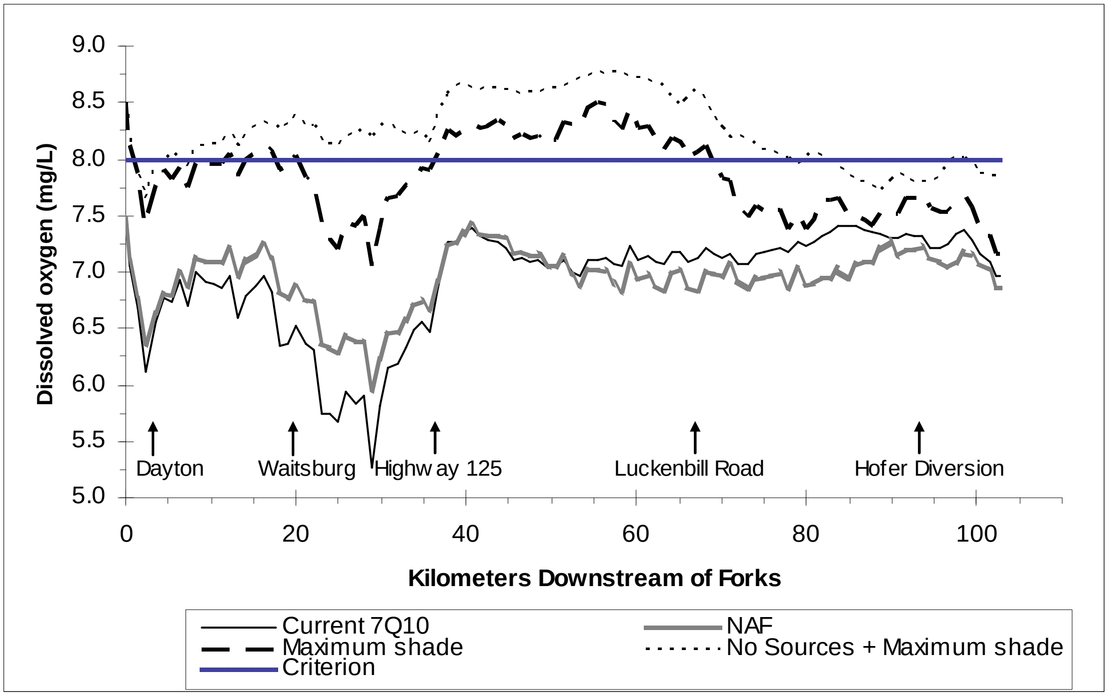


Figure 38. Predicted daily minimum dissolved oxygen values in the Touchet River with current potential nutrient loading under critical 7-day, 10-year low-flow (7Q10) conditions, and various management scenarios for shade, reduced nutrient loading, and new appropriation flows (NAF).

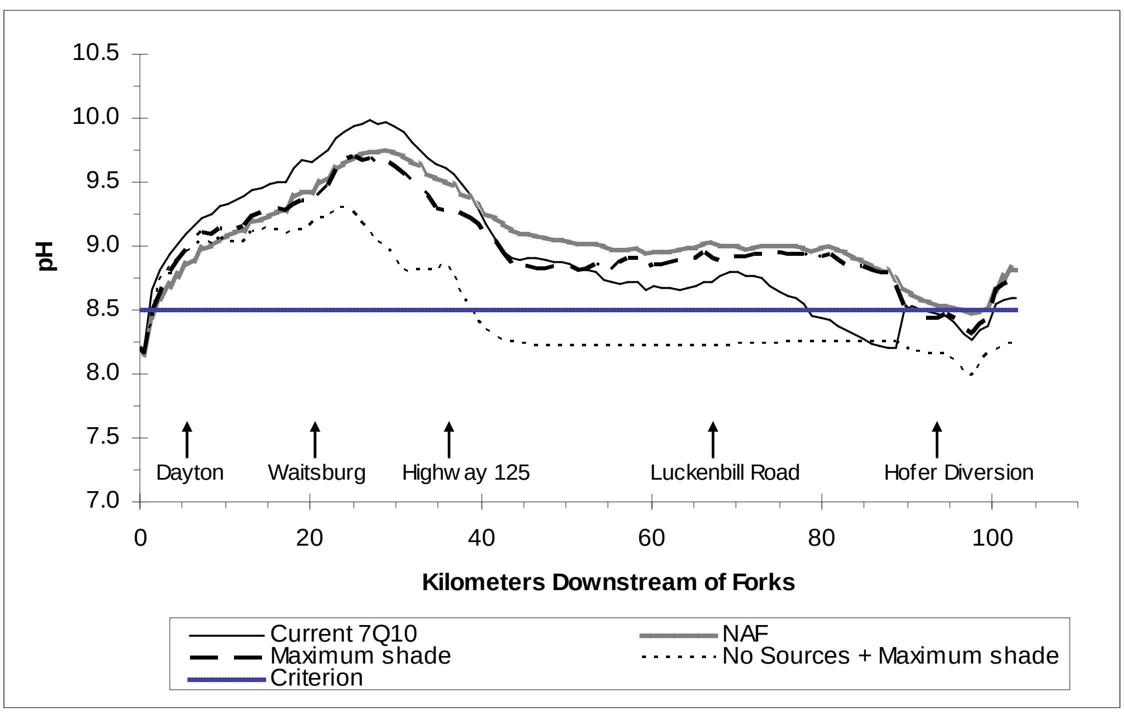


Figure 39. Predicted daily maximum pH values in the Touchet River with current potential nutrient loading under critical 7-day, 10-year low-flow (7Q10) conditions, and various management scenarios for shade, reduced nutrient loading, and new appropriation flows (NAF).

The Touchet River currently exhibits excessive nutrient loading from the confluence of the North and South Forks to the mouth. Relatively high nutrient loading above the forks prevents upper reaches of the Touchet River from meeting the pH and DO Class A criteria, even when loading above the forks is reduced by one-third to simulate reference conditions. There is no assimilative capacity for the additional or existing human-caused nutrient loads to the Touchet River during the growing season. Nutrient loads from nonpoint sources in the headwaters, and point and nonpoint sources along the river, also must be reduced to improve DO and pH conditions.

As mentioned previously in the *Results and Discussion* section, the Dayton WWTP doubles the instream phosphorus loads and triples the nitrogen loads during the low-flow season. The calibrated QUAL2Kw model results indicate Dayton WWTP effluent had a small, but measurable, effect on instream DO and pH downstream of the outfall during August 2002 (Figure 40).

However, the Clean Water Act requires critical condition loading estimates at maximum permit limits for point sources. The loading capacity modeling results confirm that current nutrient concentrations with design flows allowed under the current NPDES permit for Dayton WWTP exceed the capacity of the river to meet pH and DO criteria, especially during critical conditions (Figures 38 and 39). Model simulations indicate that effluent nutrient concentrations would need to be as low as background concentrations to have no net effect on Touchet River DO and pH levels.

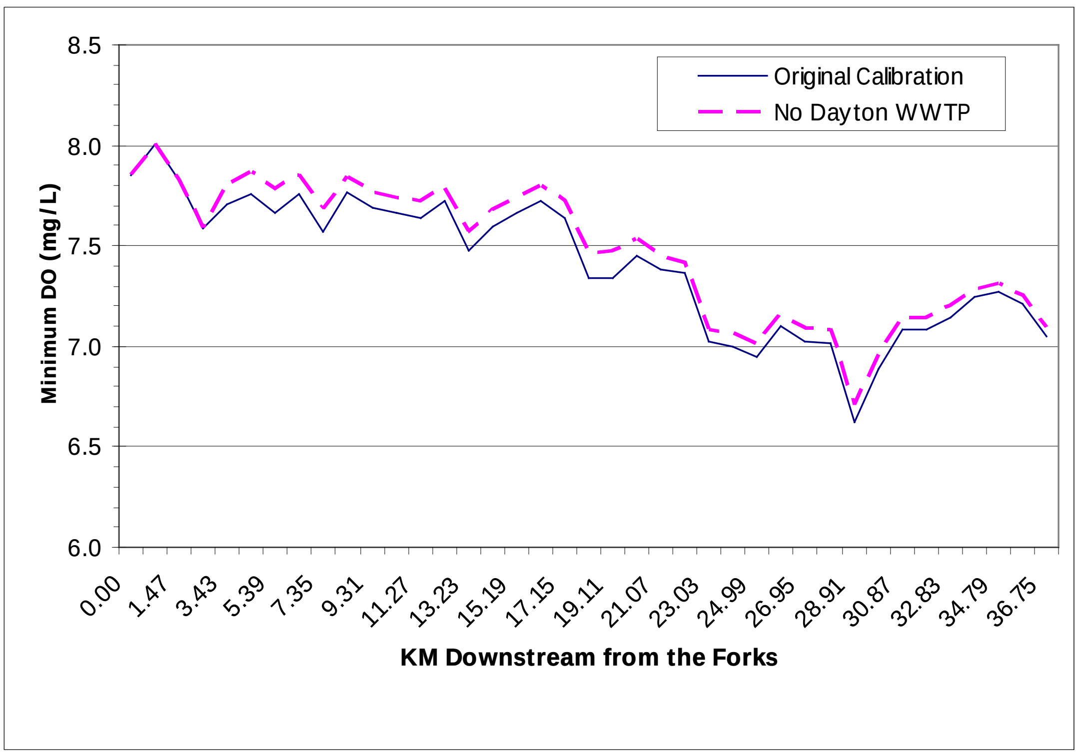


Figure 40a. The QUAL2Kw Touchet River model minimum daily dissolved oxygen (DO) concentrations for conditions on August 13, 2002 compared to estimates in a scenario without the presence of the Dayton WWTP effluent.

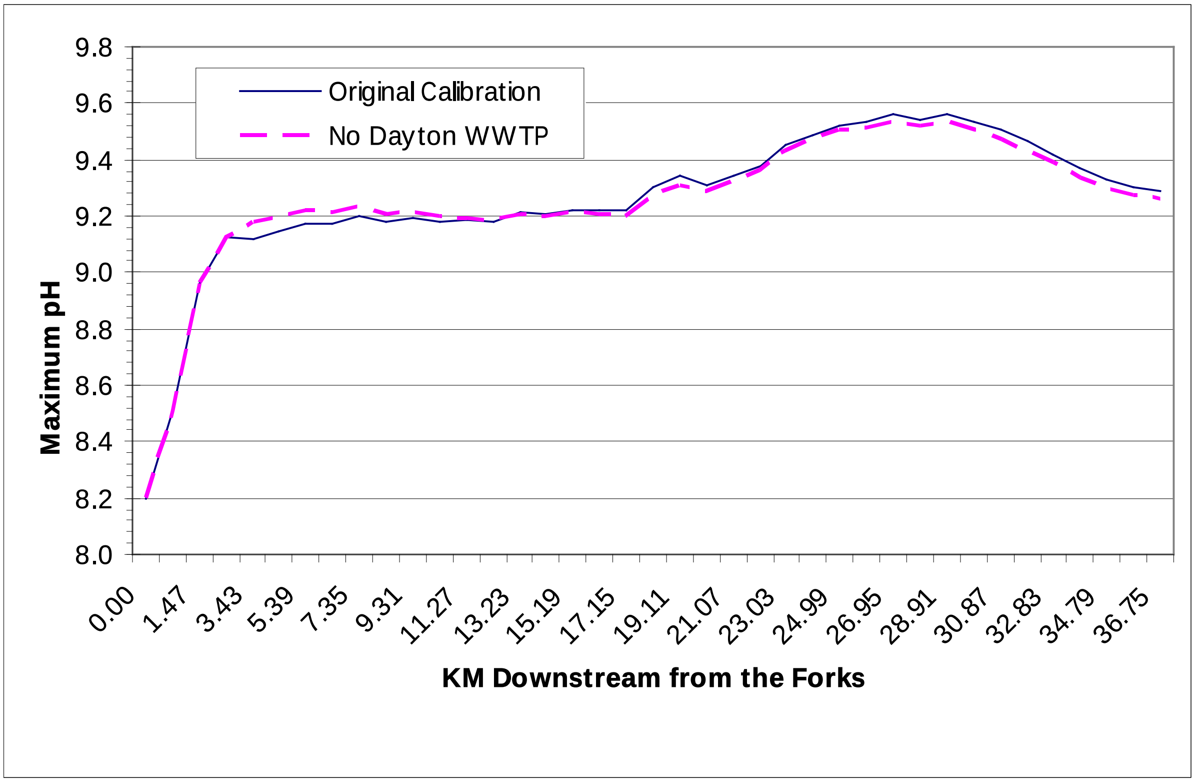


Figure 40b. The QUAL2Kw Touchet River model minimum daily and maximum pH values for conditions on August 13, 2002 compared to estimates in a scenario without the presence of the Dayton WWTP effluent.

The model results for the various scenarios suggest the following:

- **Flow.** Slightly increased streamflows have an effect on dissolved oxygen and pH, but not substantially so. The 7Q10 flow results in the lowest DO and highest pH. The proposed NAF management flows do not improve daily minimum DO and the daily maximum pH much, unless accompanied by lower water temperatures.
- **Shade.** As with Mill Creek, increasing shade from riparian vegetation is predicted to significantly increase the daily minimum DO, but to a lesser degree, decrease the daily maximum pH.
- **Nutrient loading.** Decreasing nutrient loads from point and nonpoint sources during the biomass growing period is expected to increase the daily minimum DO and decrease the daily maximum pH. Included in the scenarios is reducing by one-third the nutrient loads in the North Fork and South Fork above Dayton.
- **Combined effect on improving DO.** The combined effect of increasing shade and decreasing nutrient loading is predicted to result in daily minimum DO compliance with the Class A criterion of 8 mg/L in about 80% of the river.

- **Combined effect on improving pH.** The combined effect of increasing shade and decreasing nutrient loading is expected to significantly increase compliance with pH standards in about 60% of the river. Relatively high nutrient loading above the North and South Forks appears to be sufficient to keep the upper reaches of the Touchet River from meeting the 8.5 Class A pH criterion.

None of the model scenarios demonstrated a situation where pH and DO criteria would be met in all reaches of the river. There is no nutrient load capacity for Dayton WWTP effluent in the river from May through October with its current NPDES permit limits and design capacity. Sources in the Waitsburg reach are suspected of increasing nutrients. If further investigation shows this is from the WWTP wetlands, Waitsburg will need to eliminate subsurface nutrient transport to the river.

Nonpoint sources and point-source load controls will bring more reaches of the river into compliance with standards, especially if lower temperatures and increased flows can be realized. It appears unlikely that DIN and phosphorus concentrations of groundwater can be reduced much in the lower reaches of the Touchet River (from RM 34 to the confluence with the Walla Walla River). Those reaches may continue to be out of compliance with DO criteria after identified sources are controlled.

Walla Walla River

The estimated nutrient loads and physical factors create conditions beyond the capacity of the Walla Walla River's ability to meet Class A pH and DO criteria. In general, the DIN and SRP concentrations in the Walla Walla River are elevated from tributary, groundwater, and nonpoint source loads. Reducing these nutrient loads is required to improve pH and DO water quality approaching the best potential conditions for the mainstem. Water withdrawals, poor riparian shading, and sluggish channel conditions are obstacles as well.

The average concentration of DIN in the Walla Walla River at the state line (313 ± 167 ugN/L) is elevated compared with the headwater DIN of Mill Creek at Kooskooskie (75 ± 25 ugN/L), while SRP concentrations are similar. The Walla Walla River lies within the Columbia Plateau and the Level 4 Pleistocene Lake Basin Ecoregion at this point. The state line site also is located below residential and commercial areas of Milton-Freewater as well as returns from surrounding agricultural areas (Figure 5).

Both DIN and SRP continue to increase downstream from the Oregon border. In the absence of additional sources, the DIN and SRP concentrations would be expected to decrease downstream due to uptake by periphyton and other instream primary producers. Tributary and local nonpoint sources of DIN and SRP increase concentrations in the Walla Walla River. Groundwater leaching nutrients from soil and geologic formations, or transporting nutrients from years of fertilizer applications may be a source as well. Meanwhile DO and pH respond to excessive primary productivity and elevated temperatures.

If tributaries to the Walla Walla River reduce nutrient concentration to levels approaching Mill Creek and Touchet River headwaters (Tables 13 - 15), then DIN and SRP loads in the tributaries are estimated to decrease by 20% to 90% (Table 16). Even decreasing nutrient concentrations in Yellowhawk Creek, Garrison Creek, Mill Creek, and the Touchet River to levels currently coming from Oregon at the state line also would provide some improvement in the Walla Walla River (Table 16).

Table 16. Reductions estimated in annual soluble reactive phosphorus (SRP) and dissolved inorganic nitrogen (DIN) loads (lbs/day) from selected tributaries to the Walla Walla River if instream concentrations are reduced to headwater concentrations (Table 13 - 15) or those recorded at the Oregon border at site 32WAL-38.7 (state line).

Tributary	Headwater		State line	
	SRP	DIN	SRP	DIN
Yellowhawk Creek	22%	91%	22%	71%
Garrison Creek	94%	96%	94%	91%
Mill Creek	58%	99%	65%	79%
Touchet River	29%	61%	22%	54%

If tributary nutrient reductions were implemented to headwater levels, DO and pH may be expected to improve in a manner similar to the model simulations for Yellowhawk Creek or the Touchet River (Figures 36 to 39). However, the large groundwater component of DIN would continue to stimulate primary productivity so that pH and DO concentrations would still have wide diel ranges and would not be in compliance with applicable criteria. As observed in the lower Touchet River, the groundwater nutrient concentrations may be a function of the underlying geology and soils in the Level 4 Pleistocene Lake Basin Ecoregion.

Garrison Creek nutrient loads in 2002 and 2003 were often dominated by College Place WWTP effluent. The concentrations of SRP and DIN at site 32GAR-00.5 were indistinguishable from the effluent concentrations (Swanson, 2005). Garrison Creek was the largest SRP loading source to the ‘state line to Detour Road’ reach of the Walla Walla River from May to October (Figure 34). Eliminating the College Place WWTP nutrient load to Garrison Creek during this period would lower the excessive nutrient concentrations in the Walla Walla River and improve pH and DO.

None of the smaller tributaries was sampled for nutrients enough to quantitatively establish loading capacities. Groundwater and irrigation returns may be the primary sources of nutrients to other minor tributaries to the Walla Walla River. For example, Dry Creek was sampled only once and was flowing at 0.6 cfs, but the DIN and SRP concentrations were 3900 ugN/L and 128 ugP/L, respectively. The nutrients were associated with a 6.09 mg/L DO, 7.36 pH, and temperature of 13.4º C in September while nearby water temperatures were 20º C. Together they suggest a groundwater source. Mud Creek, the west Little Walla Walla River, and Pine Creek are similarly impaired and require nutrient reductions.

Dissolved oxygen minima and pH maxima would be closer to Class A or Class B criteria if reduced nutrient loading occurred with lower water temperatures and increased flows. As the Oregon temperature TMDL findings demonstrated, lack of instream flows and riparian shading seriously limit major water quality improvements during the irrigation season (Butcher and Bower, 2005). Similarly, DO and pH concentrations cannot meet criteria even if nutrient loads were reduced to headwater levels. To improve DO and pH in the river, river temperatures would need to be reduced and river shading increased.

Simulations of the temperature model for the Walla Walla River illustrated that only substantial instream flows (>100 cfs), coupled with increased riparian vegetation, would bring water temperatures below 25º C in Washington (Butcher and Bower, 2005). Potential vegetation in the lower reaches is not tall enough to significantly increase shading a river the width of the Walla Walla. Without reduced light, biomass will use any available nutrients and affect DO and pH. High temperatures will also cause lower DO saturation concentrations.

The current capacity of the Walla Walla River to carry nutrients without harming water quality is clearly being exceeded. The best potential pH and DO conditions cannot be determined at this time because of uncertainties about improvements in water temperature, water volume, and groundwater nutrient loads. Steps taken to decrease current surface water nutrient loads from point, tributary, and nonpoint sources will help improve pH and DO conditions. However, some reaches of the Walla Walla River are unlikely to meet applicable pH and DO numeric criteria even after nutrient reductions are made because of low flows, high light exposure, high water temperatures, and large groundwater DIN loads.

Load and Wasteload Allocations

Load Allocations

Dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) are the major controllable pollutants in the Walla Walla River basin that cause dissolved oxygen (DO) and pH criteria violations. Elevated phosphorus concentrations due to geologic and soil characteristics, as well as indigenous low-growing vegetation along river corridors, may be contributing to DO and pH criteria violations. To meet the best potential DO and pH conditions during the May–October critical period, human-caused nutrient sources must be reduced or controlled. Any improvement to lower instream temperatures, increase instream flows, and increase shading to reduce light exposure will improve DO and pH values as well.

The natural condition provision of the water quality standards is the basis of the load allocations in this TMDL (WAC 173-201A-070(2)):

"Whenever the natural conditions of said waters are of a lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria. Where water quality criteria are not met because of natural conditions, human actions are not allowed to further lower the water quality, except where explicitly allowed in this chapter."

Where possible, the natural condition was approximated by the system potential water quality, which was an evaluation of the combined effect of hypothetical critical conditions (including increases in riparian shading) and reductions in external nutrients loads to approximated natural background levels. The load allocations are expected to result in water quality that is equivalent to the system potential water quality. Therefore, the load allocations are expected to result in conditions that meet the water quality standard as stated in WAC 173-201A-070(2).

Mill Creek and Yellowhawk Creek

The load allocations for nutrients for all surface water and groundwater inflows in Mill Creek, Yellowhawk Creek, Garrison Creek, and the Walla Walla River are equivalent to natural background conditions estimated from the monitoring data as follows:

- All headwater and tributary surface water inputs are assigned a seasonal load allocation average DIN of 76 ugN/L and SRP of 47 ugP/L based on 2002-03 June-October averages from the headwaters of Mill Creek to Kooskooskie.
- All groundwater and diffuse (nonpoint) sources are assigned a load allocation average DIN of 387 ugN/L and SRP of 85 ugP/L based on estimated diffuse inflows from the Mill Creek headwaters to Kooskooskie.

In addition to load allocations for nutrient source concentrations, the load allocations for the temperature TMDL (Stohr et al., 2007) are also applicable to this TMDL for DO and pH.

The new appropriation flows (NAF) for increases in instream flows in Mill Creek would also achieve improvements in DO and pH if implemented.

Touchet River

The load allocations for nutrients for all surface water and diffuse (nonpoint) inflows to the Touchet River are equivalent to background conditions estimated from the monitoring data as follows:

- All headwater and tributary surface water inputs are assigned a seasonal load allocation average of 18 µg/L for organic phosphorus, 55 µg/L for DIN, 39 µg/L for organic nitrogen, and 25 ugP/L for SRP based on estimated reductions of diffuse sources in the North and South Fork Touchet River by one-third.
- Groundwater and diffuse sources from the North and South Fork to RM 34 are assigned a load allocation average of 205 ugN/L for DIN and 50 ugP/L for SRP based on estimated diffuse inflows to the Touchet River to the mouth. Diffuse and groundwater inflows to the reaches of the Touchet River below RM 34 should be reduced as much as possible after examining possible natural and legacy sources of the nutrient loads.

In addition to load allocations for nutrient source concentrations, the load allocations for the temperature TMDL (Stohr et al., 2007) are also applicable to this TMDL for DO and pH.

The new appropriation flows (NAF) recommended for the Touchet River will also be beneficial for attaining the best potential pH and DO conditions.

Walla Walla River and Minor Tributaries

Load allocations for nutrients in the Walla Walla River are the attainment of all the load allocations for Yellowhawk Creek, Garrison Creek, Mill Creek, and the Touchet River (Table 16). These major tributaries provide most of the nutrient load to the Walla Walla River during the critical season. In other words when load reductions in the tributaries are met, the Walla Walla River will meet load allocations and water quality standards. The expected result in the

Walla Walla River from reducing all these tributary loads will be approximately 40 ugP/L as SRP, and approximately 200 ugN/L DIN. The best potential DO and pH conditions in the Walla Walla River during critical conditions can be met when the following events occur:

- The major tributary nutrient loading sources are reduced to their load allocation or best potential levels.
- Instream flows are increased and stabilized through the entire lower Walla Walla River.
- Riparian shading is increased to the maximum potential.
- Nitrogen loads from sources in Oregon are reduced to maintain an instream concentration of 200 ugN/L DIN in the Walla Walla River at the state line. The SRP concentrations should be maintained at 38 ugP/L or less. If Oregon can determine nutrient background conditions for the Walla Walla River, further nutrient controls should be implemented.
- Diffuse and groundwater nutrient sources to minor tributaries like Dry Creek, Mud Creek, Pine Creek, and the west Little Walla Walla River are reduced to less than or equal to the state line concentrations (200 ugN/L DIN).

If load reductions in the tributaries do not result in the attainment of water quality standards in the Walla Walla River, adaptive management will be used to achieve standards.

Not enough nutrient and flow data were collected from the minor tributaries and groundwater in the Walla Walla River valley study area to clearly quantify nutrient loads. Indications are that groundwater sources of DIN and total phosphorus can be substantial and that surface-generated streamflows during the critical season are insignificant in this area. Geology, soils, or legacy applications of nutrients to agriculture lands may be partially contributing sources.

The expected result in the Walla Walla River will be approximately 40 ugP/L as SRP, and approximately 200 ugN/L DIN.

Wasteload Allocations

All of the assimilative capacities for nutrients in Mill Creek, Yellowhawk Creek, Garrison Creek, the Touchet River, and the Walla Walla River have been allocated to the background and current diffuse (nonpoint) sources from May through October. The current nutrient loads for the following National Pollutant Discharge Elimination System (NPDES) permitted point sources need to be diverted from the receiving waters during the May – October growing season:

- College Place WWTP (WA 002065-6).
- Gose and Blalock Irrigation District returns of Walla Walla WWTP (WA 002462-7) effluent.

The City of Walla Walla's WWTP NPDES permit only allows discharge from December 1 through April 30, and is therefore in compliance with this wasteload allocation. The College Place WWTP will have two permit cycles or up to ten years to remove their effluent from the receiving waters beginning in May and lasting through October.

The Dayton WWTP (WA 002072-9) nutrient wasteload allocations to the Touchet River from May through October are based on no net increase in pH downstream of the outfall and less than 0.2 mg/L decrease in DO after load allocations are met above Dayton. Modeled scenarios indicate that these wasteload allocations will have no effect under the current permit with a seasonal maximum discharge of 0.61 mgd and current upstream nutrient loads that have been reduced by one-third:

- 0.28 lb/day for DIN as nitrogen (sum of nitrate, nitrite, and ammonia as nitrogen).
- 0.20 lb/day for organic nitrogen as nitrogen.
- 0.13 lb/day for soluble reactive phosphorus as phosphorus.
- 0.09 lb/day for organic phosphorus as phosphorus.

Once the city's permit is to be reissued, they will have a 10-year compliance schedule to remove discharge or use a treatment that will result in nutrient loads being no greater than listed during the May through October critical period. As part of this effort, it will be important to coordinate with other planning groups and governmental entities so the impacts of this effluent diversion are widely understood. If cities go to *Water Reuse,* they may need to do a water right impairment analysis.

Sources in the Waitsburg reach of the Touchet River require further investigation. If the Waitsburg WWTP wetland system (WA 004555-1) is identified as a significant source of nutrients, preventing continuity between the wetland and river via groundwater will be necessary. There is no capacity in the Waitsburg reach from May through October for nutrients from the WWTP, abandoned landfill, or sources with an inactive permit.

Jurisdictions with municipal separate storm sewer systems (MS4s) under a NPDES permit need to evaluate nutrient loading from their systems to the Walla Walla River basin receiving waters. Although nutrient loading from events involving MS4s was not evaluated in this TMDL study, nutrient loading needs to be prevented by applying best management practices (BMPs). Stormwater is not considered a significant source of nutrients during the growing period, but nutrients delivered during the off-season could be retained in benthic or littoral sediments for later mobilization.

Margin of Safety

The federal Clean Water Act requires that TMDLs be established with margins of safety (MOS). The MOS accounts for uncertainty in the available data, or the unknown effectiveness of the water quality controls that are put in place. The MOS can be stated explicitly (e.g., a portion of the load capacity is set aside specifically for the MOS). But implicit expressions of the MOS are also allowed, such as conservative assumptions in the use of data, application of models, and the effectiveness of proposed management practices.

Implicit MOS elements were applied to analyses to provide a large MOS for the Walla Walla River basin pH and DO TMDL evaluation. The nutrient allocations are conservatively set to protect aquatic life and beneficial uses to the fullest extent. The following are conservative assumptions that contribute to the MOS.

- The lowest 7-day average flows during July-August with recurrence intervals of 10 years (7Q10) were used to evaluate reasonable worst-case conditions in the Touchet River and Mill Creek. Typical conditions were evaluated using the lowest 7-day average flows during July-August with recurrence intervals of 2 years (7Q2) in Mill Creek.

- Headwater concentrations of nutrients for background conditions were calculated from data collected in undeveloped watersheds (Mill Creek), or estimated by reducing the 75th percentile value by one-third to estimate the effect of minor development in the North Fork Touchet River. The 75th percentile is recommended as a reference condition by the EPA ecoregional approach.

- The maximum daily effluent discharge volume during the critical season (May-October) was estimated for the Dayton WWTP at twice the current seasonal average flow of the plant.

- The initial biomass and growth rates in the QUAL2Kw model were not reduced for scenarios with lower headwater or source nutrient inputs. One might expect the aquatic community to start with less biomass during late summer critical conditions when fewer nutrients have been available over the growing season. By assuming the biomass and growth rates are the same under background or reduced nutrient loading scenarios as current conditions, the simulations have an implicit margin of safety that requires more nutrient reduction than may be needed to meet pH and DO criteria.

- The 90th percentile of the highest 7-day averages of daily maximum air temperatures for each year of record at the Walla Walla Airport represents a reasonable worst-case condition for prediction of water temperatures in the Walla Walla River basin. These temperature conditions were not changed to evaluate background conditions or increased streamflow scenarios in the Touchet River, or for the 7Q10 scenarios in Mill Creek.

- The diffuse (nonpoint) source nutrient load allocations in all reaches of Mill Creek, Garrison Creek, Yellowhawk Creek, the Touchet River, and the Walla Walla River assume headwater land use and geologic conditions more typical of the Blue Mountains Ecoregion. The lower reaches of these waterbodies are in more developed valley areas in the Columbia Basin Ecoregion. The nutrient reference concentrations for the Columbia Basin are generally higher than for the Blue Mountains.

Conclusions

Following are conclusions based on the results of this study:

- Critical conditions for pH and dissolved oxygen (DO) in the Walla Walla River basin occur during the growing season of May through October. Two-thirds of the 54 sites monitored in this 2002-03 study did not comply with pH criteria, and one-third of the 54 sites did not comply with DO criteria.

- Nutrient stimulation of primary productivity creates conditions throughout the basin where pH and DO fail to comply with criteria.

- Phosphorus concentrations and pH values in the headwaters of the Touchet River and Mill Creek appear to be naturally elevated, so controlling nutrients to levels where pH and DO meet Class A and Class B criteria will not be possible at all sites in the basin.

- Low instream flows, high instream temperatures, and poorly-shaded stream reaches contribute to excessive instream primary productivity.

- The nutrient loading capacity of Mill Creek, Yellowhawk Creek, Garrison Creek, the Touchet River, and the Walla Walla River is exceeded during the May – October critical period.

- There is no capacity for nonpoint (diffuse) and point (discrete) source nutrient loads from May through October in any of the waterbodies evaluated.

- Nonpoint sources, groundwater sources, and sources along the Walla Walla River in Oregon require nutrient reductions as near to background levels as can be achieved.

- Nutrient reductions, increased streamflows, increased potential shade, and lower instream temperatures will all be necessary to achieve the best potential pH and DO conditions in the Walla Walla River basin. After these are accomplished, pH and DO in some reaches will still not meet Washington State Class A and B criteria.

Recommendations

Following are recommendations based on the result of this study:

- The Dayton Wastewater Treatment Plant (WWTP) needs to work towards reduction of its effluent nutrient loads to the Touchet River during the critical period, May through October. Water right claims may complicate partial or full effluent diversion efforts, if they are necessary, but regional water authorities need to work with municipalities to reach legal and economical solutions to prevent further water quality impairment.

- The Walla Walla WWTP and College Place WWTP are not directly discharging to waterbodies during the critical period, but they should be monitored so they do not indirectly contribute nutrient loads via irrigation returns (Walla Walla) or groundwater (College Place). The Gose and Blalock Irrigation Districts need to be involved in limiting nutrient loading to Mill Creek. Nutrient loading from the Walla Walla and College Place WWTPs needs to be investigated, then prevented or eliminated.

- The Waitsburg WWTP effluent may indirectly be contributing nutrient loads via sub-surface seepage. Other nonpoint (diffuse) sources may be contributing in the Waitsburg reach as well. These potential sources of nutrient loading need to be investigated, then prevented or eliminated.

- Temperature Total Maximum Daily Load (TMDL) recommendations for the Walla Walla River basin should be implemented.

- New appropriation flow (NAF) recommendations or any management strategy that substantially increases instream flows from May through October will help alleviate some pH and dissolved oxygen problems.

- The Walla Walla River loading capacity calculations and allocations should be revisited as benefits from tributary implementation measures are achieved.

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Implementation Strategy

Introduction

An implementation strategy is needed to meet the TMDL requirements as outlined in the 1997 Memorandum of Agreement between the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology). This implementation strategy is intended to describe the general framework for how to improve water quality. It describes the roles and responsibilities of cleanup partners (i.e., organizations with jurisdiction, authority, or direct responsibility for cleanup) and the programs or means through which they will address these water quality issues. This implementation strategy includes a:

- List of recommended actions to improve water quality.
- Description of implementation activities already underway.
- Strategy for monitoring progress and changes in water quality.
- Summary of public involvement methods.
- Description of potential funding sources to help implement the activities.

Following EPA approval of this TMDL, interested and responsible parties will work together to develop a *Water Quality Implementation Plan*. That plan will describe and prioritize specific actions planned to improve water quality and achieve water quality standards.

What Needs to be Done?

The Walla Walla Watershed Planning Unit's Water Quality Subcommittee is providing guidance, advice, and recommendations in the development of all the TMDLs in the Walla Walla watershed. The group's goal for the TMDLs is that area streams meet water quality standards while not impacting the area's economic viability.

Many Walla Walla watershed residents and local government agencies are involved with planning and implementation activities outside of the TMDL process to improve instream flow, bull trout and steelhead habitat, and water quality. These other planning efforts identified implementation activities which will help achieve the load allocations set by this TMDL. The following plans were consulted during the development of this implementation strategy:

- Bi-State Habitat Conservation Plan (HCP)
- Walla Walla Watershed Plan
- Walla Walla Subbasin Plan
- Snake River Salmon Recovery Plan
- Comprehensive Irrigation District Management Plan (CIDMP)

Bi-State Habitat Conservation Plan (HCP)

In June 2000, a settlement agreement led to the development of the HCP process. The goal of the HCP process is to increase conservation and habitat restoration measures while allowing residents to continue using surface water. The U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service will begin drafting an environmental impact statement (EIS) and other HCP documents in the spring of 2007. Stakeholders from Oregon (Walla Walla Basin Watershed Council) and Washington (Walla Walla Watershed Planning Unit) will work with representatives from these agencies to develop the documents. The product of the process is a document (called an HCP) that identifies actions people can take to minimize the potential of harming a threatened or endangered fish species. HCP documents will be attached to applications for an incidental take permit (Walla Walla Watershed Planning Web site 2007). For more information, see www.wallawallawatershed.org/hcp.html.

Walla Walla Watershed Plan

The *Walla Walla Watershed Plan* (HDR/EES, 2005) provides local guidance to identify, prioritize and develop solutions to water resource management issues. A group of local residents and groups partnered with local governments and tribes formed the Planning Unit in 2000 to develop the plan. In May 2005, the final *Walla Walla Watershed Plan* was adopted. The Plan includes strategies to improve water quantity, water quality and fish habitat.

Walla Walla Subbasin Plan

The *Walla Walla Subbasin Plan* is a locally developed amendment to the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program. The plan (Walla Walla Watershed Planning Unit & Walla Walla Basin Watershed Council, 2004) identified seven characteristics of watershed streams that limit habitat of threatened fish:

- Too much sediment.
- Lack of large woody debris.
- Lack of pools.
- Limited riparian function/confinement.
- High summer water temperature.
- Increased bed scour.
- Not enough streamflow.

The plan suggests several strategies to address these problems. Several strategies in the Subbasin plan call for improving riparian corridors and reducing sediment, which this TMDL also prescribes. Therefore, the strategies in the Subbasin plan may also be applied to this TMDL. Additional information about the Subbasin plan is available at www.wallawallawatershed.org/subbasin.html

Snake River Salmon Recovery Plan

The *Snake River Salmon Recovery Plan* identifies actions that will assist in the overall effort to restore salmon populations that are "biologically, culturally and economically viable" (Snake River Salmon Recovery Board, 2006). The Snake River Salmon Recovery Board (Board) finalized and submitted the recovery plan for listed steelhead, bull trout and salmon to the National Marine Fisheries Service. The Board is made up of county elected officials, citizens, tribes and a regional technical team, is working to restore native salmonids. As a subbasin of the Snake River, the plan includes several recommended actions for the Walla Walla watershed.

The *Snake River Salmon Recovery Plan* presents priority areas for protection and restoration as well as identifies significant limiting factors that need to be addressed. The objectives, strategies, and actions in the plan are based on assessments of fish and habitat reported in the various watershed plans and assessments. The plan addresses threats, limiting factors, cost, commitments, monitoring and adaptive management to recover these fish populations. This comprehensive plan has and will continue to be used to guide investments of public and private money and policy based on the information it provides. Implementation of many of the actions in the TMDL will likely occur through implementation of the actions called for in the plan. For more information on the plan, visit the Web site: www.snakeriverboard.org/resources/library.htm.

Comprehensive Irrigation District Management Plan (CIDMP)

The CIDMP is a planning process that allows landowners to construct and carry out a plan for their property that can (if the right programs are included) meet water quality and Endangered Species Act regulations. The Washington State Department of Agriculture provides funding for this process with local organizations providing technical assistance. The Gardena Farms Irrigation District completed a plan in 2004 which calls for piping open channels. For more information about CIDMP, visit www.wallawallawatershed.org/cidmp.html.

Since all these plans include actions to improve water quality in the Walla Walla watershed, those actions related to reducing nutrients are included in this implementation strategy. Table 17 provides a list of the actions or best management practices (BMPs) recommended by the Watershed, Subbasin, and Snake River Recovery plans that will also increase dissolved oxygen and reduce pH levels. The following paragraphs describe what actions should be performed to achieve dissolved oxygen and pH standards.

Table 17. Implementation actions from other watershed plans that will help achieve the TMDL targets.

TMDL Recommended Action	Walla Walla Watershed Plan Management Category	Walla Walla Subbasin Plan Strategy	Snake River Salmon Recovery Plan
Install, enhance, and protect riparian buffers	2d. Address Livestock Impacts 1b. Improve Timber Harvest Management 3c. Manage Urban Landscaping	• Improve the extent, structure & function of riparian buffers…through vegetation planting… (MC 1.1.1, MC 2.1.12, MC 3.1.6, MC 4.1.3, MC 5.1.1, MC 6.1.8, MC 7.1.1) • Increase density, maturity and appropriate species…of vegetation in riparian buffers (MC 2.1.2, MC 6.1.3) • Protect high quality riparian habitats… (MC 4.1.6) • Increase size & connectivity of existing patches of riparian habitat… (MC 4.1.10) • Protect wetland and riparian habitats… (MC 5.1.12) • Enhance extent & function of wetlands… (MC 5.1.13)	• Permanently protect riparian zone on… S.F. Coppei Cr. (action #'s:1, 16) • Use large woody debris to restructure eroding bank and provide fish habitat and plant riparian vegetation. (Action # 23, 50) • …planting 2,400 trees and shrubs in…riparian areas to reduce sediment input and stream temperature (Action #34) • Improve riparian conditions throughout urban area (Action # 57) • Enhance riparian buffer… (Action # 61) • Use CREP program to install riparian buffers (Action # 65) • Restore and increase riparian area along Yellowhawk and Caldwell creeks… (Action #'s 69, 70)
Apply livestock BMPs such as fencing, off-stream water, etc.	2d. Address Livestock Impacts	• Adjust seasonal timing of livestock grazing within riparian areas… (MC 4.1.5) • Improve the extent, structure & function of riparian buffers…through …selected livestock fencing… (MC 1.1.1, MC 2.1.12, MC 3.1.6, MC 4.1.3, MC 5.1.1, MC 6.1.8, MC 7.1.1) • Protect riparian vegetation through promotion of livestock BMPs… (MC 5.1.6)	

TMDL Recommended Action	Walla Walla Watershed Plan Management Category	Walla Walla Subbasin Plan Strategy	Snake River Salmon Recovery Plan
Follow road maintenance BMPs and consider alternatives such as relocation	1a. Improve Forest Road/Trail Management 2f. State, County, and City Road Maintenance Impacts	• Pave, decommission, or relocate roads near the stream…where possible (MC 1.1.5) • Use appropriate BMPs for road maintenance… (MC 1.1.6) • Implement BMPs for bridge design and maintenance activities to reduce buildup of sediment… (MC 1.1.18, MC 2.1.13) • Decommission, modify or relocate roads, low-priority dikes, bridges, culverts… (MC 2.1.8, MC 4.2.1, MC 5.1.5, MC 6.1.7)	• Protect…water quality by keeping vehicles from driving through SF Coppei Creek. (Action # 14) • …reconstruction of approximately 3 miles of drawbottom road [in the Upper Touchet]… (Acton # 34)
Control sediment from upland sources	1b. Improve Timber Harvest Management 2b. Improve Cropland Management	• Decrease sediment delivery from upland practices through expanded use of conservation tillage, sediment basins…vegetative buffers on road shoulders and other practices where possible. (MC 1.1.2) • Restore perennial vegetation in upland cultivated and non-cultivated areas with native species… (MC 1.1.3, MC 5.1.7, MC 7.1.2) • Reduce sediment inputs through implementation of forestry and agricultural BMPs (MC 1.1.10) • Implement upland BMPs… (MC 1.1.16) • Improve upland water infiltration… (MC 5.1.9, MC 6.1.6, MC 7.1.5)	• Convert canal systems to pipes. (Action #4) • Continue to replace earth-lined open ditches with closed-conduit gravity piping… (Action # 27, 29, 39, 47) • …plant adjacent acreage in native upland vegetation. (Action # 62)
Apply lawn, garden and agricultural fertilizers at agronomic rates	2c. Reduce Impacts of Agriculture Chemicals		

TMDL Recommended Action	Walla Walla Watershed Plan Management Category	Walla Walla Subbasin Plan Strategy	Snake River Salmon Recovery Plan
Stabilize streambanks using accepted bioengineering techniques / improve natural stream form & function (other than planting riparian vegetation)		• Improve bank stability through implementation of soft bank stabilization methods… (MC 1.1.7, MC 3.1.4) • Add LWD…rootwads, log jams, and similar designed structures… (MC 2.1.1, MC 6.1.2) • Where appropriate, improve natural stream form and function… (MC 2.1.4, MC 3.1.1, MC 7.1.7) • Maintain existing LWD… (MC 2.1.11, MC 3.1.3, MC 5.1.16) • Install properly designed instream structures… (MC 3.1.2) • Wherever feasible, use passive and active approaches to allow stream channels to develop and flood naturally… (MC 4.1.11, MC 4.2.5, MC 6.1.9) • Restore floodplain connectivity and decrease entrenchment…through natural or mechanical methods. (MC 4.1.12, MC 4.2.6) • Increase stream sinuosity and decrease entrenchment… (MC 6.1.1)	• Reestablish stream characteristics to Doane Creek… (Action # 1, 2, 45) • Restore historic channel meander, create pool and riffles…along McEvoy Creek. (Action 10) • Improve instream morphology of the middle Touchet River. (Action # 15) • Use LWD to restructure eroding bank… (Action # 23) • Restore natural river function by removing Hofer Dam structure (Action # 49) • Install LWD for…streambank stabilization… (Action # 50) • Enhance floodplain function by removing…gravel dike (Action # 59, 64) • Enhance riparian buffer, stabilize streambank… (Action # 61)
Control stormwater	3a. Plan/Implement Municipal Stormwater Runoff Control 3b. Plan/Implement Industrial Stormwater Runoff Control	• Improve municipal stormwater management… (MC 1.1.14, MC 7.1.17)	
Seek additional funding		• Seek additional funding sources consistent with current CRP and CREP guidelines… (MC 1.1.8, MC 3.1.7, MC 4.1.4)	

TMDL Recommended Action	Walla Walla Watershed Plan Management Category	Walla Walla Subbasin Plan Strategy	Snake River Salmon Recovery Plan
Monitor progress		• Develop and implement strategy for monitoring improvements… (MC 1.1.11, MC 2.1.5, MC 3.1.8) • Continue current data collection efforts and expand…to identify changes in flow… (MC 5.1.17)	
Uphold land use regulations		• Uphold existing land use regulations and instream work regulations…that limit channel, floodplain and riparian area impacts… (MC 1.1.12, MC 2.1.6, MC 4.1.1, MC 4.2.2, MC 5.1.3, MC 6.1.4, MC 7.1.3)	
Identify problem areas	4c. Plan/Implement Watershed Monitoring 1c. Other Watershed Actions	• Identify relative sediment inputs of tributaries… (MC 1.1.17) • Complete a detailed inventory of confinement… (MC 2.1.9, MC 4.2.4) • Assess and remedy significant sources of high temperature inputs to surface waters. (MC 5.1.15)	
Educate the public	4a. Water Quality Protection through Education and Enforcement 2e. Control Other Agricultural Impacts	• Increase landowner participation in…local programs that enhance watershed conditions… (MC 1.1.19, MC 2.1.15, MC 3.1.13) • Increase understanding of the importance of riparian habitat through education and outreach programs… (MC 4.1.7)	

Point Sources

TMDLs must allocate pollutant loads to point sources in the watershed. In the Walla Walla watershed, the point sources are the Dayton, College Place, and Walla Walla wastewater treatment plants. Point sources are addressed through the National Pollutant Discharge Elimination System (NPDES) permitting process. The wasteload allocations in this TMDL will be incorporated into the cities' future NPDES permits.

Once the City of Dayton's permit is reissued, they will have a 10-year compliance schedule to remove discharge or use a treatment that will result in nutrient loads being no greater than listed during this May-October critical period. As part of this effort, it will be important to coordinate with other planning groups and governmental entities so the impacts of this effluent diversion are widely understood. If cities go to *Water Reuse*, cities may need to do a water right impairment analysis.

The College Place and Walla Walla wastewater treatment plants should continue diverting their effluent from May through October. The City of Waitsburg lagoon discharges to a wetland. The City of Waitsburg should work to identify and reduce or eliminate sources of nutrients to the Touchet River within its city limits.

Stormwater runoff from developed and urban areas and industrial sites contains pollutants that impact receiving waters. Therefore, stormwater systems are additional sources and/or conveyances for nutrients in the Walla Walla watershed. Communities or entities with stormwater systems are responsible for reducing nutrients in their system and not discharging nutrients into surface water. State and regional guidelines exist [e.g., Stormwater Management Manual for Eastern Washington (Ecology, 2003)] to identify appropriate stormwater management practices. Future stormwater permits need plans and BMPs to meet the targets in this TMDL.

Nonpoint Sources

TMDLs must also assign pollutant loads to nonpoint sources in the watershed. Nonpoint sources are assigned load allocations which will be addressed using a variety of approaches to reduce nutrients which are discussed below. In addition, as stated in the *Load Allocation* section of this report, any improvement to lower stream temperatures, increase streamflows, and increase shading will help to improve dissolved oxygen and pH levels.

Apply best management practices (BMPs)

Implementation is needed to reduce nutrients and meet the standard for dissolved oxygen and pH. Although the watershed was found to have naturally high levels of phosphorus, any activities designed to reduce nutrients from these nonpoint sources are recommended:

- Over application of fertilizers (lawn, garden, and agricultural).
- Failed septic tanks.
- Allowing livestock to have unrestricted access to surface water.
- Failure to manage pet and livestock wastes correctly.
- Dumping lawn clippings and other organic matter into surface water.
- Erosion of sediment into surface water.
- Reduce impacts from recreational off road vehicles and four wheel drive trucks on muddy roads.
- Reduce sediment from roads and road cuts and ditches.

As with other TMDLs, establishing riparian buffers is one of the most important tools to reduce nutrients and improve water quality. The vegetation in the buffer acts as a filter that traps and uses nutrients in runoff. Riparian buffers also shade the streams so that aquatic plants do not have sunlight to grow. Stream shading also helps to keep the water cooler, which holds more dissolved oxygen.

Watershed residents should carefully follow directions on how to spread fertilizers on their lawns and gardens. Farmers should apply fertilizers at the correct rate, and extra care should be taken to make sure the applicators are working as designed. Also watershed farmers should take advantage of any new technology that would either reduce the amount of fertilizer needed or more precisely deliver the fertilizer to the soil.

Residents should also take measures to keep pet and livestock waste from entering surface water. All homeowners with septic tanks need to maintain and inspect them regularly to make sure they are working properly. Septic tanks should be pumped every three to five years, which may require some sort of a reminder system to be developed by septic tank pumpers, local health districts, or the homeowner. Table 18 provides a list of other recommended activities to reduce nutrients from potential sources.

In order to use limited funding efficiently and effectively, it is important to know where the problem areas are and the appropriate action to take. The TMDL study has indicated what the nutrient levels were at some locations. However, additional monitoring in small upstream increments is likely needed to locate some sources.

Time and available resources to achieve restoration goals are often limited. Under such circumstances, it is necessary to prioritize areas to concentrate resources. The TMDL advisory group will assist with further prioritization during the development of the *Water Quality Implementation Plan* (WQIP).

Table 18. Summary of implementation actions for the Walla Walla DO & pH TMDL.

Source	Recommended Actions
Reduce Livestock Impacts	• Obtain permits for dairies and confined animal feeding operations (CAFOs). • Provide technical assistance to ranchers and dairies and offer financial assistance to install BMPs. • Fence livestock away from streams and provide off-stream water or install water gaps. • Practice pasture rotation techniques. Closely monitor riparian pastures so that vegetation is not damaged. • Place salt in upland areas to draw cattle away from riparian corridor. • Establish riparian buffers along streams buffers. • Follow appropriate manure (nutrient) management techniques.
Address Septic Tank Impacts	• Identify areas with septic tank failure problems and prioritize. • Seek funding for septic tank replacement and/or repair. • Develop and implement education program targeting septic tank issues. • Coordinate efforts with other agencies and local health officials. • Institute county-wide maintenance reminder program.
Intensify Cropland Conservation	• Establish riparian buffers and tree plantings. • Develop educational and assistance programs for small farm/ranches. • Establish educational tours/demonstrations for farmers. • Ensure manure is spread at agronomic rates (nutrient management) at appropriate times of the year. • Ensure that fertilizers are applied at agronomic rates. • Continue testing soil nutrients.
Implement municipal, industrial, and construction Stormwater Runoff Controls	• Apply for and implement stormwater permits as required. • Follow stormwater runoff control guidelines. • Develop stormwater control plans. • Monitor stormwater for nutrients.
Reduce sediment from road construction, maintenance and use	• Establish and maintain roadside vegetative cover. • Mow road sides instead of spraying. • Ensure road cut and fill slopes are stable. • Enforce road closures during erosive time periods. • Manage sediment accumulations (from ditch maintenance, etc.) properly.

Perform Education/Outreach

Education/outreach is a significant component to the success of any TMDL project. Education efforts should focus not only on informing, but more importantly on behavior change, in order to reach water quality goals. For an educational strategy to change behaviors, surveys should be conducted to identify the reasons that residents do not apply the recommended BMPs. Once these reasons (or barriers) are identified, an educational strategy that promotes solutions to the barriers can be put into action. This educational approach is called social marketing. Appendix I of the *Walla Walla Watershed Plan* (HDR/EES, 2005) was prepared by Kooskooskie Commons and lays a foundation for effective outreach programs in the Walla Walla watershed. Groups interested in educating the public should consult this appendix before beginning work.

Social marketing strategies may be aimed at target audiences. However, a more widespread education campaign should be directed to all watershed residents since we all can impact the quality of the water within the watershed we live in. Education and outreach may be achieved through a variety of methods such as:

- workshops
- newsletters
- informational brochures
- public meetings
- tours
- demonstration projects
- one-on-one contact

Who Needs to Participate?

Many local interests in the Walla Walla basin are involved with TMDL planning and implementation. As discussed above, many others are involved in a variety of other planning and implementation processes. There is an excellent opportunity to dovetail the actions in this TMDL with these other related efforts. Coordinating efforts should help to achieve water quality improvements more efficiently and effectively. Ecology will continue to work closely with these basin interests to improve water quality in the Walla Walla watershed.

Table 19 lists the implementation actions people or groups may use to meet the targets in this TMDL. The information listed in the table will likely change as personnel and monetary resources are better defined during the development of the WQIP (see the *Glossary and Acronyms* section following the *References*). Organizations or agencies which can assist with actions to reduce nutrients are described below.

Table 19. Recommended actions individuals or groups can take to meet TMDL targets.

Individuals/Groups	Recommended Actions
Homeowners with waterfront property	• Avoid actions that will cause streambank erosion or help transport material containing fecal coliform bacteria to area waterways. • Maintain and ensure proper functioning of on-site septic systems if applicable.
Columbia Conservation District (CCD), and Walla Walla County Conservation District (WWCCD)	• Continue to fund BMP implementation and offer technical assistance. • Continue providing education to agricultural producers, streamside landowners and others in the watershed. • Continue to monitor water quality of the watershed's surface water (as funding is available).
NRCS, WSU Cooperative Extension, local health district and WWCC Water and Environmental Center	• Continue to fund BMP implementation and offer technical assistance. • Continue educational efforts to area residents, especially streamside landowners in the watershed.
Non-profit organizations such as Kooskooskie Commons and Tri-State Steelheaders	• Continue educational efforts to area residents.
Ranchers	• Implement livestock management BMPs to reduce or eliminate nutrient sources. • Maintain vegetation in riparian pastures. • Prevent streambank erosion.
Ecology	• Continue providing technical assistance, financial assistance, and educational opportunities. • Review progress of TMDL implementation with the Water Quality Subcommittee. • Perform effectiveness monitoring. • Evaluate if interim and final targets are being met. If targets are not met, work with Water Quality Subcommittee on Adaptive Management Strategy.
Cities, Walla Walla and Columbia county governments, and WSDOT	• Implement stormwater management plans or Permits per Ecology's Stormwater Management Manual for Eastern Washington. • Manage and maintain roads to reduce sediment.
Dayton, College Place, and Walla Walla WWTPs	• Monitor and maintain NPDES permit limits.
Agricultural producers	• Practice direct seeding and/or conservation tillage. • Apply BMPS to reduce nutrients and sediment erosion. • Better management of crop residues.

County and City Governments

Local regulatory programs involving land-use planning and permitting are expected to help reduce water temperatures in the Walla Walla watershed. Shorelines of streams with mean annual flows greater than 20 cubic feet per second (cfs) are protected under the Shoreline Management Act. (Larger rivers greater than 200 cfs east of the Cascade crest are defined as shorelines of statewide significance.) The counties as well as cities develop and manage plans for streams protected by the Shoreline Management Act. In addition, land management practices next to streams may be limited by cities or counties if there are local critical areas ordinances. These ordinances are established by cities and counties and typically prescribe buffer widths for streams or wetlands. County and city governments are tasked with protecting these buffer requirements while permitting activities. City and county governments must periodically update their Shoreline Management Plans and critical areas ordinances. Local governments in the Walla Walla watershed have agreed to consider the *Snake River Salmon Recovery Plan* when updating their plans and ordinances. Steps should be taken by local governments to encourage a proactive approach to protect water quality.

Columbia Conservation District

Conservation districts have authority under Chapter 89.08 of the Revised Code of Washington (RCW) to develop farm plans that protect water quality. Conservation districts also provide information, education, and technical assistance to residents on a voluntary basis. In 1988 Ecology signed a Memorandum of Agreement (MOA) with conservation districts. This MOA establishes a process for conservation districts to address and resolve agriculture-related water quality complaints received by Ecology.

The Columbia Conservation District offers a variety of technical and financial assistance programs to private landowners to address water quality and quantity issues within the Touchet River subbasin. The District has also worked cooperatively with Washington State University and the Washington Department of Fish and Wildlife to monitor and collect temperature data in the Touchet River Subbasin. The District is an active participant in the promotion and installation of the United States Department of Agriculture Farm Service Agency's Conservation Reserve Enhancement Program (CREP) which enhances riparian buffers. Currently there are 56 contracts in effect, encompassing 1007 acres and 50 stream miles. The District has provided technical and cost-share assistance funding in the past and continues to pursue grant funding for future programmatic needs. The District is also involved in:

- Irrigation efficiency projects.
- Irrigation diversion screens and metering.
- Upland sediment reduction projects.
- Livestock best management practice (BMP) projects to improve water quality.

Confederated Tribes of the Umatilla Indian Reservation

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) are made up of the Umatilla, Cayuse, and Walla Walla Tribes. The CTUIR have co-management responsibilities in the Walla Walla River basin. Some CTUIR lands are located in or near the upper Walla Walla watershed.

The CTUIR has expressed interest the Walla Walla watershed TMDLs and are concerned with salmon and steelhead production in the Walla Walla River basin. In 1995, the CTUIR wrote a Salmon Policy that includes a number of actions to improve water quality and enhance steelhead production (CTUIR, 1995). Some actions included in the plan include protecting floodplains and returning beaver to area rivers. CTUIR is currently involved with a number of habitat, hatchery, harvest, and hydrologic restoration actions. These efforts often help improve water quality. For more information, visit: www.umatilla.nsn.us.

Natural Resources Conservation Service (NRCS)

The United States Department of Agriculture (USDA) NRCS offers technical and financial assistance to landowners for water quality related projects through a variety of programs. One program seeks the input of a local work group to help NRCS establish priority conservation practices for Environmental Quality Improvement Program (EQIP) funding. For more information on the funding available through NRCS and other USDA programs, see the *Funding* section in this report.

Oregon Department of Environmental Quality (ODEQ)

Approximately a quarter of the Walla Walla basin lies in Oregon. ODEQ published the *Walla Walla Subbasin Stream Temperature Total Maximum Daily Load and Water Quality Management Plan* in August 2005 (Butcher & Bower, 2005). EPA approved this TMDL on September 29, 2005. ODEQ's TMDL includes several actions Oregon residents may use to reduce water temperature. Implementation work underway in Oregon has the potential to positively affect water quality in the Washington portion of the river. BMPs recommended to reduce temperature problems include increasing riparian vegetation and decreasing channel width to depth ratios. Designated agencies then develop plans for how they will implement the TMDL. These plans may call for a variety of BMPs. For more information, visit: www.deq.state.or.us/wq/TMDLs/wallawalla.htm#wwb.

Umatilla National Forest

This TMDL does not address the Umatilla National Forest in Washington. However, ODEQ did address the Umatilla National Forest in their TMDL. The Umatilla National Forest participated and contributed to the development of TMDL and *Water Quality Management Plan* for the Walla Walla Subbasin in Oregon. In general, documentation of water quality conditions and management practices has been successful in demonstrating commitment to improving water quality. Any actions the Forest Service takes to maintain or enhance riparian areas and control erosion will help provide cleaner water downstream.

Region 6 of the U.S. Forest Service (Forest Service) and Ecology signed a memorandum of agreement for Meeting Responsibilities under Federal and State Water Quality Laws. This document recognizes the Forest Service as the designated management agency for meeting Clean Water Act requirements on National Forest Lands. Forest Service and Ecology staff meet annually to review progress on the MOA.

Forest Plan standards, guidelines and amendments, including the aquatic conservation strategy contained in Pacfish, are the foundation for water quality protection and management on the Umatilla National Forest. Project design, BMPs, monitoring activities, restoration programs, and collaboration are the mechanisms for achieving water quality protection. Long-term monitoring programs have been successful in identifying impaired water quality. Significant progress has been made addressing water quality problems over the last 10 years through a variety of means including changes in management practices, riparian protection, BMPs, and watershed/aquatic restoration.

The *Umatilla National Forest Land and Resource Management Plan* (USDA Forest Service, 1990) is currently being revised to account for resource and social changes as well as include new scientific information. The current plan was developed in 1990. For more information visit: www.fs.fed.us/r6/uma/blue_mtn_planrevision/index.shtml.

Walla Walla County Conservation District

Conservation districts have authority under Chapter 89.08 RCW to develop farm plans that protect water quality. Conservation districts also provide information, education, and technical assistance to residents on a voluntary basis. In 1988 Ecology signed a Memorandum of Agreement (MOA) with conservation districts. This MOA establishes a process for conservation districts to address and resolve agriculture-related water quality complaints received by Ecology.

The Walla Walla County Conservation District has been active in installing riparian buffers along watershed streams. The District also provides technical and financial assistance for:

- Irrigation efficiency projects.
- Fish passage barrier removal.
- Fish screen design and installation.
- Metering of pumps for surface and shallow groundwater withdrawals.
- Sediment reduction.
- Livestock-influenced water quality improvement projects.
- Stream restoration projects.

In addition, the District participates in educational programs. The District also applied for and received a grant to expand their riparian buffer program to urban areas in the watershed.

Walla Walla Watershed Planning Unit

The watershed planning process offers a tool to allow local guidance in identifying, prioritizing, and developing solutions to water resource management issues. The Walla Walla Watershed Planning Unit has been active since the year 2000. In May 2005, the final *Walla Walla Watershed Plan* was adopted. The Planning Unit has been awarded grants for various activities listed in their plan, and they anticipate additional grants will be received in the future for other activities in the plan.

The Planning Unit works with other local planning and advocacy groups, such as the Walla Walla Basin Watershed Council and Walla Walla Watershed Alliance, to address a variety of water resource issues. These groups have coordinated to varying degrees on the following planning processes:

- Bi-State Habitat Conservation Plan (HCP)
- Walla Walla Subbasin Plan
- Comprehensive Irrigation District Management Plan (CIDMP)

- Walla Walla Basin Water Management Initiative (WMI)
- The Snake River Salmon Recovery Plan

Washington State Department of Ecology (Ecology)

Ecology has been delegated authority under the federal Clean Water Act by the Environmental Protection Agency (EPA) to:

- Establish water quality standards.
- Administer the NPDES wastewater permitting program.
- Enforce water quality regulations under Chapter 90.48 RCW.

Ecology responds to complaints, conducts inspections, and issues NPDES and State Waste Discharge permits as part of its responsibilities under state and federal laws and regulations. Ecology recently completed a stormwater management manual for eastern Washington. This is designed to guide local authorities on how to meet new stormwater discharge regulations. Ecology issued the revised municipal general stormwater discharge permit on January 17, 2007. These permits may be required for the cities of Walla Walla and College Place. As these permits are implemented, they will help regulate stormwater-related water quality problems.

In cooperation with conservation districts and other local organizations, Ecology will pursue implementation of BMPs for agricultural and other land uses. Ecology provides technical and financial assistance to people interested in installing BMPs. Ecology has a competitive grant and loan process for local governments and nonprofit organizations. Grant money can be used to plan and install BMPs and loans can be used to purchase direct seed equipment or improve wastewater treatment facilities.

Ecology’s Environmental Assistance Program conducts effectiveness monitoring to determine if water quality is improving. Ecology is authorized under Chapter 90.48 RCW to initiate enforcement actions if voluntary compliance with state water quality standards is unsuccessful. However, it is the goal of all participants in the Walla Walla River TMDL process to achieve clean water through voluntary control actions.

Washington Department of Fish and Wildlife (WDFW)

WDFW is actively involved with habitat improvement, hatchery production, technical assistance, and assessments in the watershed. Habitat improvement activities include dam removal and passage projects, identifying areas in need of fish screens and installing them, developing a native plant nursery and assisting with Habitat Conservation Plans. WDFW’s hatchery production activities include releasing trout and steelhead, evaluating hatchery fish success, and performing habitat surveys. WDFW provides technical assistance on habitat improvement projects beginning with project identification and design through the permit process. WDFW also gives technical assistance to regional planning efforts. WDFW has an extensive assessment role in the watershed, including spawning surveys, monitoring species distribution, measuring streamflows, conducting instream flow studies, and monitoring stream temperature. WDFW staff also works to obtain funding for habitat improvement projects, and offers financial assistance to landowners for similar projects.

WDFW will need to make sure permits issued for habitat projects do not impact water quality. Also as WDFW acquires new land they should maintain the same BMPs necessary for healthy riparian corridors.

Washington State Department of Natural Resources (DNR)

DNR has primary administrative and enforcement responsibilities for the Forest Practices Act (Ch. 76.09 RCW), which includes implementation of the 1999 "Forests and Fish Report." The Forests and Fish Report (ESHB 2091) was adopted by the state Legislature to protect salmon listed under the federal Endangered Species Act, other aquatic species, and clean water, while keeping the timber industry economically viable. The resulting rules address forest roads, unstable slopes, riparian shading, and effectiveness monitoring. This report can be found online at: www.dnr.wa.gov/forestpractices/rules/forestsandfish.pdf.

Load allocations included in this TMDL for non-federal forest lands are in accordance with Section M-2 of the *Forests and Fish Report.* DNR is encouraged to condition forest practices to prohibit any further reduction of stream shade and not waive or modify any shade requirements for timber harvesting activities on state and private lands.

DNR is also responsible for oversight of activities on forest roads. New forest practices rules also apply for roads, including standards for new road construction and upgrading existing roads. Under the new rules, roads must provide for better control of road-related sediments, provide better streambank stability protection, and meet current best management practices (BMPs).

Washington State University Extension

WSU Cooperative Extension offers educational opportunities on a wide range of topics about water quality. Many of the educational materials offered by WSU Extension are located on the internet at www.wawater.wsu.edu. Meetings and satellite conferences with specific topics related to water quality are also held periodically. Anyone interested in participating in these events should contact the local WSU Extension office to be notified when they are offered. WSU Extension has an ongoing commitment to develop educational publications on emerging issues. Notices about these publications and funding opportunities are also posted on the above Web site.

WSU Extension staff members are willing to help inform watershed residents about this TMDL implementation strategy and BMPs that may be voluntarily applied to improve water quality.

Washington Water Trust (WWT)

WWT is a private, nonprofit organization whose mission is to restore instream flows to benefit water quality, fisheries, and recreation in Washington's rivers and streams. WWT cooperates with landowners, tribes, and local organizations to obtain existing water rights from people willing to sell, lease, or donate their water right. The group's focus is on small streams with endangered or threatened fish stocks. WWT believes that focusing their efforts on smaller streams will result in significant environmental benefits. For more information visit: www.thewatertrust.org.

Walla Walla Watershed Alliance

Created in 2001, the Walla Walla Watershed Alliance is a broad-based bi-state, nonprofit organization whose goal is to improve the watershed's environmental, economic, and cultural health for future generations. The Alliance promotes innovative restoration strategies and cooperation among various interests. For more information about the Alliance, visit www.wwwalliance.org.

What is the Schedule for Achieving Water Quality Standards?

The goal of this TMDL is to reduce nutrients in the Walla Walla River and its tributaries so that they meet dissolved oxygen and pH water quality standards. This TMDL shows that near background nutrient levels need to be maintained along watershed streams (a 20 to 99 percent decrease in concentrations). The dissolved oxygen and pH water standard are scheduled to be met in ten years from the completion of the Water Quality Implementation Plan, or 2018.

Interim targets and milestones are necessary to measure progress in meeting this ten-year goal. Table 20 shows the recommended milestones or timelines for achieving the targets identified in this TMDL. The schedule does not recommend focusing work in areas requiring the lowest reductions. Water quality will likely be achieved sooner where nutrient concentrations are not as large. Therefore, it may be wise to begin work in areas requiring the largest reductions. This will ensure sufficient time to achieve compliance. As a general guide, nutrient levels should be reduced by ten percent each year.

Table 20. Recommended schedule for reducing nutrients

Number of Years after Completion of the WQIP	Milestones (% decrease in nutrients)
3	30 %
6	60 %
10	99 %

Reasonable Assurances

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the waterbody. For the *Walla Walla Watershed Dissolved Oxygen and pH TMDL*, both point and nonpoint sources exist. TMDLs (and related Action Plans) must show "reasonable assurance" that these sources will be reduced to their allocated amount. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this water cleanup plan are met. Organizations and their commitments under laws, rules, and programs to reduce nutrient levels in the watershed are also expected to result in improved water quality.

Ecology believes that the following activities are already supporting this TMDL and add to the assurance that dissolved oxygen and pH in the Walla Walla watershed will meet conditions provided by Washington State water quality standards. This assumes that the activities described below are continued and maintained.

The goal of the *Walla Walla Watershed Water Quality Improvement Report* for dissolved oxygen and pH is for the waters of the basin to meet the state's water quality standards. There is considerable interest and local involvement toward resolving the water quality problems in the Walla Walla watershed. Numerous organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the dissolved oxygen and pH problem. The following rationale helps provide reasonable assurance that the Walla Walla watershed nonpoint source TMDL goals will be met in ten years after completion of the *Water Quality Implementation Plan* in 2008.

- Ecology will work with the City of Dayton to develop a compliance schedule in their NPDES permit to meet the requirements of this TMDL.

- In 1998 through 2001, the City of College Place restored approximately a third of a mile of Garrison Creek (HDR/EES, 2005). The City planted native vegetation in a buffer about 150 feet wide on both sides of the creek.

- In the Columbia County portion of the watershed, the Columbia Conservation District, FSA, and NRCS have 56 CREP contracts totaling 1007 acres along 50 stream miles.

- The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) received 400,000 dollars in funding from the Washington State Department of Ecology under the new Columbia River Management Initiative. CTUIR, in partnership with the U.S. Army Corps of Engineers, will use the money to help fund a feasibility study researching methods to enhance flows in the Walla Walla watershed with water from the Columbia River. CTUIR is also working on stream restoration activities. For example, 300 trees were planted along five miles of the South Fork Touchet River. In an effort led by the Walla Walla County Conservation District, CTUIR staff helped remove a fish passage barrier from the Walla Walla River at Gose Street (CTUIR Dept. of Natural Resources, 2006).

- As part of implementing the Snake River Salmon Recovery Plan, local governments in the Walla Walla watershed committed to restore and/or protect 30 acres of road right away per year for the next 15 years. In addition, the counties agreed to restore perennial grass to road ditches and cut slopes.

- Tri-State Steelheaders have planted countless trees and shrubs along streams to improve fish habitat. The group of volunteers also removed illegally dumped concrete and other debris. The group teaches conservation to hundreds of local students in elementary and high schools, and has also conducted the course in Spanish at a Walla Walla County farm-labor camp (Ecology, 2002).

- Upland best management practices (BMPs) are also being applied in the watershed. Dryland farmers are transitioning from traditional farming techniques, which involve intense soil tillage, to a more sustainable practice of direct seeding or minimum tillage practices. By limiting tillage trips through the field, the soil not only maintains its structure, but the relatively undisturbed crop residue from the previous crop shields the soil from wind and rain erosion. Other BMPs, such as grassed waterways, divided slope farming, and strip cropping, are being installed as further measures to keep the soil in place. These BMPs, coupled with direct seeding, become an effective system which results in a dramatic reduction in total runoff.

- The Washington Department of Fish and Wildlife (WDFW) has been working to improve fish habitat and monitor water quality. WDFW helped remove two dams and funded two Landowner

Incentive Program grants along McEvoy and Yellowhawk creeks to improve streamflow and riparian vegetation. Streamflow is measured during low flow every two weeks, and numerous temperature probes are also deployed in the summer. WDFW also provides technical assistance and permitting for stream restoration projects.

- The City of Walla Walla and the Walla Walla Basin Watershed Council are working on a shallow and deep aquifer recharge program. The program's goal is to supplement natural recharge of the shallow aquifer, and potentially increase the groundwater flow return to the Walla Walla River (Walla Walla Basin Watershed Council Web site, 2007).

- The Walla Walla Backyard Stream Team is a group of citizens volunteering time to promote stream and riparian restoration in urban areas. One of the Team's projects is called the Pledge Project, which gathers pledges from residents to perform actions that protect surface water and groundwater. The Pledge project aims to change the way people maintain their lawns, care for their septic system, reduce toxics, dispose of animal waste, reduce stormwater, and protect streamside vegetation. The Team's second major effort is to coordinate the restoration of 1,000 feet of riparian vegetation in Fort Walla Walla Park along Garrison Creek (Walla Walla Watershed Planning Website, 2006).

- In Walla Walla County, approximately 181 stream miles of riparian buffer have been installed through the Conservation Reserve Enhancement Program (CREP). Funding and assistance for this project is provided by the Walla Walla County Conservation District through Washington State, the Farm Service Agency (FSA), and the Natural Resources Conservation Service **(**NRCS) (NACD, 2004).

- During Ecology's 2006 funding cycle, the Walla Walla County Conservation District applied for and received a grant for their proposed Create Urban Riparian Buffers (CURB) program. This project will focus on Yellowhawk and Garrison creeks.

- The Walla Walla Water Management Initiative is an Ecology pilot project designed to identify innovative solutions to water management in the watershed.

- Working with the Walla Walla Watershed Planning Unit, Ecology is developing an instream flow rule that protects flows for fish and supplies the water needed for current demand and growth.

- The Walla Walla Watershed Planning Unit passes some of their grant funding to other entities to perform activities identified in the Watershed Plan. The Planning Unit is paying for a signage project to increase resident's awareness of watershed boundaries. Planning Unit funds are also paying for some riparian planting on Cottonwood, Yellowhawk, and Russell creeks and a part of the Gose Street Project led by the Walla Walla County Conservation District.

- Since 2003, the Washington Water Trust (WWT) has obtained an estimated eight cubic feet per second of water rights in the Walla Walla basin. Included in this estimate is the purchase of a water right on the Touchet River, one lease on Mill Creek, and two leases on Cold Creek (WWT Web site: www.thewatertrust.org).

These examples of implementation activities provide evidence of the funding commitments made by several agencies and organizations over the past 10 or more years to improve water quality and fish habitat. The Bonneville Power Administration, Salmon Recovery Funding Board, United States

Army Corps of Engineers, and the Confederated Tribes of the Umatilla Indian Reservation are just a few of the entities that dedicate funds to restore healthy habitat and good water quality for native salmonids. Financial assistance from these and other groups are likely to continue and are discussed further under the *Potential Funding Sources* section below.

Whenever applicable BMPs are not being used and Ecology has reason to believe that individual sites or facilities are causing pollution in violation of RCW 90.48.080, Ecology may pursue orders, directives, permits, or enforcement actions to gain compliance with Washington State's water quality standards. Ecology will enforce water quality regulations under Chapter 90.48 RCW in pursuit of the objectives of this TMDL. While Ecology has the authority to carry out these actions, it is the goal of all participants in the Walla Walla Watershed TMDL process (including Ecology) to achieve clean water through voluntary control actions.

Adaptive Management

TMDL reductions should be achieved in ten years from completion of the *Water Quality Implementation Plan* (WQIP) in 2008. However, if water quality standards are met and the load reductions are not met, the objectives of this TMDL shall be satisfied.

This report has identified interim targets described in terms of percentage load reductions. The *Water Quality Implementation Plan* will also identify targets in terms of implemented cleanup actions. Partners will work together to monitor progress towards these goals by evaluating successes, obstacles, and changing needs. Adjustments will be made to the cleanup strategy as needed. It is ultimately Ecology's responsibility to assure that cleanup is being actively pursued and water standards are achieved.

Adaptive management has been defined in state law as "*reliance on scientific methods to test the results of actions taken so that the management and related policy can be changed promptly and appropriately*" (RCW 79.09.020). So, adaptive management is a continuing attempt to adapt to uncertainty associated with management actions. The key stages of the adaptive management cycle are to monitor, evaluate, and implement.

The Water Quality Subcommittee and Ecology will use adaptive management when water monitoring data shows that the TMDL targets are not being met or implementation activities are not producing the desired result. A feedback loop consisting of the following steps will be implemented:

Step 1: The activities in the WQIP are put into practice.

Step 2: Programs and BMPs are evaluated for technical adequacy of design and installation. The effectiveness of the activities (or WQIP) is evaluated by assessing new water quality monitoring data and comparing it to the data used to set the TMDL targets.

Step 3: If the goals and objectives are achieved, the implementation efforts (or WQIP) are adequate as designed, installed, and maintained. Project success and accomplishments should be publicized and reported to continue project implementation and increase public support. If not, then BMPs (or the WQIP) could be modified or new actions identified. New or modified actions are then applied as in Step 1.

Where new (not previously identified) sources of nutrients are discovered, and the causes can be determined, additional implementation measures may be needed. If there is not an apparent cause for the nutrient levels (e.g., everyone is implementing required BMPs and all potential sources have been addressed, but targets are not being met), then more studies may be required.

Monitoring Progress

A monitoring program for evaluating progress is an important component of any implementation strategy. Monitoring is needed to keep track of what activities have or have not been done, as well as to measure the success or failure of management actions. Monitoring should also be done after water quality standards are achieved to ensure implementation measures are effective so that standards continue to be met.

A quality assurance project plan (QAPP) should be prepared for whatever monitoring is conducted. The QAPP should follow Ecology guidelines (Lombard and Kirchmer, 2004) paying particular attention to consistency in sampling and analytical methods.

Monitoring activities associated with this TMDL include interim monitoring, effectiveness monitoring, and implementation plan monitoring. These monitoring activities are described below:

Interim Monitoring

This dissolved oxygen and pH TMDL calls for a decrease in nutrients in surface and ground water. Interim monitoring of nutrients during the growing season (May through October) is recommended in surface and ground water. Monitoring may be required to identify sources of nutrients or determine nutrient levels at sites not sampled during the TMDL study.

Implementation Plan Monitoring

After the *Water Quality Implementation Plan* is completed, Ecology will track which activities are completed. Tracking implementation plan activities is important so actions that did not work can be identified. This is particularly important if an adaptive management is employed. The *Water Quality Implementation Plan* will give additional details about the process Ecology will use to track progress in applying identified actions. However, Ecology expects that those entities conducting restoration projects or installing BMPs will be responsible for monitoring and maintaining BMPs.

Effectiveness Monitoring

Effectiveness monitoring results are used to determine if the interim targets and/or water quality standards are being achieved. Ecology usually performs this monitoring five years after the *Water Quality Implementation Plan* is finished. The ability for Ecology to conduct this monitoring depends upon the availability of resources. However, volunteers and local groups can also conduct nutrient monitoring to measure progress of this TMDL.

If the streams are found to not meet the interim targets and/or water quality criteria, an adaptive management strategy will be adopted and future effectiveness monitoring will need to be scheduled.

Potential Funding Sources

A wide variety of potential funding sources exist for the water quality improvement projects in the Walla Walla basin. There is also the potential for collaborating with other planning processes to maximize efficiency. Implementation activities are varied and funding sources appropriate for some projects may not be suitable for others. Therefore, a more detailed analysis of available funding sources is needed as part of the Water Quality Implementation Plan.

Public sources of funding are administered by federal and state government programs. Private sources of funding normally come from private foundations. Foundations provide funding to nonprofit organizations with tax-exempt status. Forming partnerships with government agencies, nonprofit organizations, and private businesses can effectively maximize funding opportunities.

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and USDA Farm Service Agency (FSA) administer federal non-regulatory programs such as the:

- Conservation Reserve Program (CRP)
- Conservation Reserve Enhancement Program (CREP)
- Continuous Conservation Reserve Program (CCRP)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentives Program (WHIP)
- Grassland Reserve Program (GRP)
- Wetlands Reserve Program (WRP)
- Conservation Security Program (CSP)

The NRCS programs provide technical, educational, and financial assistance to eligible farmers and ranchers. The programs aid landowners in addressing natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The USDA FSA administers CREP and CRP, both of which the NRCS has technical responsibility over. These are both voluntary cost share programs designed to restore and enhance habitat and increase bank stability along waterways on private lands. These programs offer payments for annual rental, signing, cost share, practice, and maintenance. In exchange landowners must remove land from production and grazing, under 10-15 year contracts. For more information about these programs, please visit NRCS' Web site at: www.wa.nrcs.usda.gov/programs/index.html.

Potential funding sources available through Ecology's water quality financial assistance program include:

- Centennial Clean Water Fund grants.
- Section 319 grants under the federal Clean Water Act.
- State Revolving Fund (SRF) loans.
- Terry Husseman (Coastal Protection Funds).

Financial assistance for wastewater and stormwater projects is available through the following organizations:

- Department of Community, Trade and Economic Development
- Public Works Board
- United States Department of Agriculture Rural Development
- Washington State Department of Health

These organizations provide funding for the Public Works Trust Fund, Community Development Block Grants, and Drinking Water State Revolving Fund. Ecology provides loans to cities for upgrades or improvements to their wastewater treatment plants and stormwater projects. Ecology does give grants to communities for wastewater treatment plant upgrades when they can show an economic burden to rate payers.

The Walla Walla County and Columbia Conservation Districts provide cost-share programs to irrigators and ranchers. Implementing BMPs on private property usually requires that individual landowners make an investment in the practice. Conservation districts can apply for Washington State Conservation Commission and Ecology grants to provide funding for these cost-share programs.

The Confederated Tribes of the Umatilla Indian Reservation's involvement in the subbasin provides additional opportunities for funding. These include, but are not limited to, cost-matching from non-federal rate payer Bonneville Power Administration, EPA tribal gap, and Bureau of Indian Affairs money. These resources may be available to assist in on-the-ground research. CTUIR is ready to develop and implement habitat restoration projects that may ultimately result in temperature reductions.

Other funding sources available to some groups in the Walla Walla watershed are the Salmon Recovery Funding Board, the Bonneville Power Administration, and the Bonneville Power Foundation.

Landowners are using their own money to install BMPs, convert to minimum tillage practices, etc. Landowners can contribute 25 percent of project costs in a cost-share program to 100 of the cost to purchase direct seed equipment or replace septic systems. In either case, funding agencies should continue to help ease the economic burden landowners face when making changes to improve water quality.

Summary of Public Involvement Methods

Public involvement is vital in any TMDL. Nonpoint TMDLs are successful only when the watershed landowners and other residents are involved. They are the closest to and most knowledgeable of the watershed resources. The Walla Walla basin has a host of local, state, federal, and tribal agencies, and non-governmental organizations involved in water resource protection. Many private landowners in the area are intimately involved with these efforts.

Ecology's dissolved oxygen and pH technical report was reviewed by the Walla Walla Watershed Planning Unit's Water Quality Subcommittee (Water Quality Subcommittee) in November, 2006. CTUIR, Oregon Dept. of Environmental Quality, and the EPA had an opportunity to review the draft in the fall of 2006. The draft technical study report was edited based on the groups' comments and made available to the group for another review in March, 2007.

The TMDL advisory group merged into the Water Quality Subcommittee in June 2006. The Water Quality Subcommittee has provided invaluable assistance with the creation of the implementation strategy. This *Water Quality Improvement Report* has been reviewed at Water Quality Subcommittee meetings held in the spring of 2007. All Water Quality Subcommittee meetings are open to the public. Meeting announcements and past meeting notes are sent to a mailing list of approximately 70 people. Ecology also maintains a website on the TMDL at www.ecy.wa.gov/programs/wq/tmdl/wallawalla/index.html.

A 30-day public comment period for this report was held from April 18 through May 21, 2007. A news release was sent to all local media in the Walla Walla watershed. Advertisements about the comment period were placed in the following publications:

- Walla Walla Union-Bulletin
- Dayton Chronicle
- The Times

Ecology and the Columbia and Walla Walla County conservation districts developed a flyer to mail to watershed residents. The flyer provided information about the Walla Walla Temperature and pH and Dissolved Oxygen TMDLs and on the comment period. Approximately 1,000 flyers were mailed the week of May 7, 2007.

Four comments were received during the comment period. Responses to the comments are found in Appendix I.

Next Steps

After the public comment period on this *Water Quality Improvement Report* is complete and edits and responses to comments are done, the report is submitted to the Environmental Protection Agency (EPA) for approval.

Once the TMDL has been approved by EPA, the *Water Quality Implementation Plan* (WQIP) is developed within one year. Ecology will continue to work with the Water Quality Subcommittee and other residents to create the WQIP. The WQIP expands on information provided in this plan and includes a(n):

- Table of who will do what, where and when.
- Strategy of how to monitor progress
- Adaptive management strategy
- List of potential funding sources

Development of the WQIP will be delayed until all TMDLs in the watershed have been approved by EPA. One WQIP will be developed for all Walla Walla watershed TMDLs:

- Chlorinated Pesticides and PCBs TMDL (already approved by EPA)
- Fecal Coliform (already approved by EPA)
- Temperature (in publication)
- Dissolved Oxygen and pH (this document)

The Water Quality Subcommittee decided to write only one multi-parameter WQIP because many of the BMPs recommend for this TMDL will also help improve water quality problems identified in the other TMDLs. This approach will allow the most effective implementation strategy to address all the water quality impairments in the watershed.

Once the WQIP is in place, Ecology will strive to ensure that there continues to be good cooperation and coordination with other agencies and entities regarding implementation activities in the region.

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Glossary and Acronyms

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Best Management Practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

BOD: Biochemical oxygen demand

Clean Water Act: Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

CTUIR: Confederated Tribes of the Umatilla Indian Reservation

Designated Uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each waterbody or segment, regardless of whether or not the uses are currently attained.

Diel: 24-hour

Diurnal: Daily or daytime

DIN: Dissolved inorganic nitrogen

DO: Dissolved Oxygen

EA: Environmental Assessment

Ecology: Washington State Department of Ecology

EPA: U.S. Environmental Protection Agency

Existing Uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

Hyporheic: The area under and along the river channel where surface water and groundwater meet.

Load Allocation: The portion of a receiving waters' loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading Capacity: The greatest amount of a substance that a waterbody can receive and still meet water quality standards.

Margin of Safety (MOS): Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving waterbody.

Municipal Separate Storm Sewer Systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (i) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, storm water, or other wastes and (ii) designed or used for collecting or conveying stormwater; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

NAF: New appropriation flows

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

N/L: nitrogen per liter

Nonpoint Source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act.

ODEQ: Oregon Department of Environmental Quality.

P/L: phosphorus per liter

Point Source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

Primary Producer: An organism, usually a green plant or algae, capable of converting the sun's energy and simple nutrients into sugars.

QA: Quality assurance

Riparian: Relating to the banks along a natural course of water.

RM: River mile

RMSE: Root mean squared error

SRP: Soluble reactive phosphorus

STP: Sewage treatment plant

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: 1) individual wasteload allocations for point sources, 2) the load allocations for nonpoint sources, 3) the contribution of natural sources, and 4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

TSS: Total suspended solids

USGS: U.S. Geological Survey

WAC: Washington Administrative Code

Wasteload Allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

WDFW: Washington Department of Fish and Wildlife

WRIA: Washington Water Resource Inventory Area

WWTP: Wastewater Treatment Plant

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Appendices

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Appendix A. State Water Quality Standards and NPDES Permit Limits

Washington State Water Quality Standards

Table A-1. Class AA (extraordinary), Class A (excellent), and Class B (good) freshwater quality standards and characteristic uses.

	Class AA	**Class A**
General Characteristic	Shall markedly and uniformly exceed the requirements for all, or substantially all uses.	Shall meet or exceed the requirements for all, or substantially all uses.
Characteristic Uses	Shall include, but not be limited to, the following: domestic, industrial, and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning, and harvesting; wildlife habitat; primary contact recreation, sport fishing, boating, and aesthetic enjoyment; and commerce and navigation.	Same as AA.
Water Quality Criteria		
Fecal Coliform	Shall not exceed a geometric mean value of 50 organisms/100 mL, with not more than 10% of samples exceeding 100 organisms/100 mL.	Shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10% of samples exceeding 200 organisms/100 mL.
Dissolved Oxygen	Shall exceed 9.5 mg/L.	Shall exceed 8.0 mg/L.
Total Dissolved Gas	Shall not exceed 110% saturation.	Same as AA.
Temperature	Shall not exceed 16.0°C due to human activities. When conditions exceed 16.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C. Increases from non-point sources shall not exceed 2.8°C.	Shall not exceed 18.0°C due to human activities. When conditions exceed 18.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C. Increases from non-point sources shall not exceed 2.8°C.
pH	Shall be within the range of 6.5 to 8.5 with a human-caused variation with a range of less than 0.2 units.	Shall be within the range of 6.5 to 8.5 with a human-caused variation with a range of less than 0.5 units.
Turbidity	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background is more than 50 NTU.	Same as AA.
Toxic, Radioactive, or Deleterious Material	Shall be below concentrations which have the potential singularly or cumulatively to adversely affect characteristic uses, cause acute or chronic conditions to the most sensitive aquatic biota, or adversely affect public health.	Same as AA.
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.	Same as AA.

Table A-1 (continued)

	Class B
General Characteristic	Shall meet or exceed the uses for most uses.
Characteristic Uses	Shall include, but not be limited to, the following: water supply (industrial and agricultural); stock watering; fish and shellfish; salmonid and other fish migration, rearing, spawning, and harvesting; wildlife habitat; secondary contact recreation, sport fishing, boating, and aesthetic enjoyment; and commerce and navigation.
Water Quality Criteria	
Fecal Coliform	Shall both not exceed a geometric mean value of 200 organisms/100 mL, with not more than 10% of samples exceeding 400 organisms/100 mL.
Dissolved Oxygen	Shall exceed 6.5 mg/L.
Total Dissolved Gas	Shall not exceed 110% saturation.
Temperature	Shall not exceed 21.0°C due to human activities. When conditions exceed 21.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C. Increases from non-point sources shall not exceed 2.8°C.
pH	Shall be within the range of 6.5 to 8.5 with a human-caused variation with a range of less than 0.5 units
Turbidity	Shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background is more than 50 NTU.
Toxic, Radioactive, or Deleterious Material	Shall be below concentrations which have the potential singularly or cumulatively to adversely affect characteristic uses, cause acute or chronic conditions to the most sensitive aquatic biota, or adversely affect public health.
Aesthetic Values	Shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

Table A-2. Dissolved oxygen (DO) and intergravel dissolved oxygen (IG DO) criteria (applicable to all basins)

Class	Concentration and Period[1] (All Units are mg/L)				Use/Level of protection
	30-D	7-D	7-Mi	Min	
Salmonid Spawning		**11.0**[2,3]		**9.0**[3] **8.0**[4] **6.0**[5]	Principal use of salmonid spawning and incubation of embryos until emergence from the gravels. Low risk of impairment to cold-water aquatic life, other native fish and invertebrates. The IG DO criteria represent an acute threshold for survival based on field studies.
Cold Water	**8.0**[6]		**6.5**	**6.0**	Principally cold-water aquatic life. Salmon, trout, cold-water invertebrates, and other native cold-water species exist throughout all or most of the year. Juvenile anadromous salmonids may rear throughout the year. No measurable risk level for these communities
Cool Water	**6.5**		**5.0**	**4.0**	Mixed native cool-water aquatic life, such as sculpins, smelt, and lampreys. Waterbodies includes estuaries. Salmonids and other cold-water biota may be present during part or all of the year but do not form a dominant component of the community structure. No measurable risk to cool-water species, slight risk to cold-water species present.
Warm Water	**5.5**			**4.0**	Waterbodies whose aquatic life beneficial uses are characterized by introduced, or native, warm-water species.
No Risk	**No Risk from background**				No Risk No Change from Background: The only DO criterion that provides no additional risk is "no change from background". Waterbodies accorded this level of protection include marine waters and waters in wilderness areas.

[1] 30-D = 30-day mean minimum as defined in OAR 340-41-006.
7-D = 7-day mean minimum as defined in OAR 340-41-006.
7-Mi = 7-day minimum mean as defined in OAR 340-41-006.
Min = Absolute minimums for surface samples when applying the averaging period, spatial median of IG DO.
[2] When Intergravel DO levels are 8.0 mg/L or greater, DO levels may be as low as 9.0 mg/L, without triggering a violation.
[3] If conditions of barometric pressure, altitude and temperature preclude achievement of the footnoted criteria, then 95 percent saturation applies.
[4] Intergravel DO action level, spatial median minimum.
[5] Intergravel DO criterion, spatial median minimum.
[6] If conditions of barometric pressure, altitude and temperature preclude achievement of 8.0 mg/L, then 90 percent saturation applies.

Shaded values present the absolute minimum criteria, unless the Department believes adequate data exist to apply the multiple criteria and associated periods.

ODEQ, 2001

National Pollutant Discharge Elimination System Permit Limits

Table A-3. Pre-2005 National Pollutant Discharge Elimination System (NPDES) permit limits for wastewater treatment plants located in Washington State in the Walla Walla River basin.

Facility	Type of Treatment	Discharge Location	Season	Effluent Volume		NPDES Permit Limits						
				Maximum (mgd)		BOD (mg/L)	TSS (mg/L)	Fecal coli (cfu/ 100 mL)	pH (s.u.)	Temp. (degrees C)	Ammonia (mg/L)	Chlorine (mg/L)
				month average	daily	month/week			daily range	daily max.	month/day	
Walla Walla	Trickling filters w/ activated sludge & duo-media filtration	Mill Creek/ Irrigation	Dec.-May Jun.-Nov.	9.6	12.3	15 / 22* 16 / 24	30/45 10/15	200 / 400 2.2 / 23	6 - 9 7 - 9		8 / 12**	0.009/ 0.012
College Place	Activated sludge (sequencing batch reactor)	Garrison Cr/ wetland or spray fields	Apr.-Nov. Dec.-Mar.	1.65	2	15 / 23	15/23	23 / 240*** - / 23***	6 - 9	20	1 / 2 2 / 3	
Waitsburg	Oxidation ditch to infiltration lagoon	Hyporheic zone of Touchet R.	Dec.-May Jun.-Nov.		0.236	15 / 20	15 / 20	100 / 200	7 - 9		7 - 14 5.8 - 11.6	
Dayton	Trickling filter w/ nitrification & UV disinfection	Touchet R.		0.75	2.25	30 / 45	30 / 45	200 / 400	6.5 - 8.5			
Touchet	Infiltration lagoon	Hyporheic zone of Touchet R.										

* Biochemical oxygen demand (BOD) regulated for City of Walla Walla as carbonaceous biochemical oxygen demand (CBOD).
** Interim limit until December 2003 or if the ammonia TMDL for Mill Creek is modified before then. After 12/03, ammonia limits become 1.49 / 3.9 mg/L.
*** Total coliform, not fecal coliform - limits are 7-day median and daily maximum counts.

Appendix B. Water Quality Data from Other Ecology Projects

Ambient Monitoring Data Collected by Ecology's Environmental Assessment Program, Freshwater Monitoring Unit, at Three Sites in the Walla Walla Basin during the 2002-03 TMDL Surveys

Table B-1. Walla Walla River near Touchet 32A070

date	time	COND (umhos/c	FC (#/100ml)	FLOW (CFS)	NH3_N (mg/L)	NO2_NO3 (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	PH (pH)	PRESS (mm/Hg)	SUSSOL (mg/L)	TEMP (deg C)	TP_PInLin (mg/L)	TPN (mg/L)	TURB (NTU)
10/17/2001	11:05	249	110	58	0.011	0.394	0.0665	11.25	8.1	754.38	16	10.7	0.117*	0.607	10
11/7/2001	12:15	246	8	103	0.01	0.678	0.0743	13.1	8.3	762	3	6.8	0.103*	0.763	2.8
12/5/2001	10:40	134	32	470	0.01	0.789	0.0905	12.2	7.65	747.014	17	4.5	0.148*	0.892	9.6
1/16/2002	11:00	111	18	658	0.016	0.661	0.0851	12.83	8.03		25	2.9	0.129*	0.743	9.5
2/13/2002	14:15	74.5	15	735	0.01	0.889	0.0751	13.7	8.06	733.298	22	3.3	0.124*	0.989	12
3/13/2002	12:20	70	120	2560	0.029	0.465	0.0591	12.24	7.63	732.282	483	5.6	0.408*	0.738	160
4/10/2002	12:55	94	88	1280	0.02	0.454	0.0549	10.71	7.97	730.758	93	9.6	0.098*	0.595	14
5/15/2002	12:55	116	120	865	0.01	0.158	0.0338	10.53	8.39	735.076	28	14.4	0.065*	0.313	6.3
6/5/2002	12:40	110	120	623	0.021	0.193	0.05	9.41	8.21	730.504	30	19.7	0.093*	0.369	7.7
7/17/2002	12:10	338	88	38	0.034	0.547	0.0894	9.29	8.28	732.536	17	25	0.127*	0.797	7.2
8/14/2002	12:10	415	66	11	0.034	0.698	0.0847	10	8.44	729.234	6	25	0.109*	0.96	4.3
9/11/2002	12:45	273	23	24	0.01	0.309	0.0636	11.37	8.87	737.87	4	20.3	0.093*	0.528	3.6

date	time	COND (umhos/cm)	FC (#/100ml)	FLOW (CFS)	NH3_N (mg/L)	NO2_NO3 (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	PH (pH)	PRESS (mm/Hg)	SUSSOL (mg/L)	TEMP (deg C)	TP_PInLine (mg/L)	TPN (mg/L)	TURB (NTU)
10/16/2002	09:20	279	16 J	51	0.01 U	0.453	0.0358	10.5	7.9	752.856	6	8.6	0.077*	0.59	3.6
11/14/2002	08:40	223	10 J	155	0.01 U	0.567	0.0723	10.55	7.97		10	8.6	0.102*	0.771	3
12/18/2002	08:40	141	22	284	0.012	0.804	0.115	11.79	7.41	736.346	9 J	5.1	0.152*	0.895	4.6
1/8/2003	08:30	117	35 J	566	0.017	0.784	0.0884	12.22	7.77	743.966	20	4.4	0.126*	0.928	10
2/5/2003	08:40	96	35	2020	0.025	1	0.059	12.24	7.69	745.236	443	4.9	0.19*	1.14	75
3/5/2003	08:10	147	16 J	857	0.01 U	1.06	0.0844	11.59	7.79	736.854	82	6.6	0.15*	1.15	16
4/9/2003	08:45	106	50	1360	0.01 U	0.667	0.0588	10.2	7.65	740.41	107	11.7	0.114*	0.785	14
5/7/2003	08:20	118	52 J	877	0.01 U	0.235	0.03	10.35	7.9	738.124	29	10.6	0.065*	0.347	5.9
6/4/2003	08:00	224	100 J	203	0.055	0.496	0.0551	7.67	7.78	743.204	11	19.7	0.122*	0.719	4.8
7/9/2003	07:45	370	40 J	23	0.028	0.642	0.0717	8.06	8.27		9	21.1	0.109*	0.909	4.6
8/6/2003	08:40	403	110	30 J	0.033	0.654	0.0924	9.03	8.41	739.902	9	21.1	0.128*	0.901	3.7
9/10/2003	08:15	230	780 J	200	0.01	0.731	0.0928 J	7.71	7.9	742.188	10	15.8 J	0.138*	1.03	3.5

Table B-2. Touchet River @ Cummins Road 32B075

date	time	COND (umhos/cm)	FC (#/100ml)	FLOW (CFS)	NH3_N (mg/L)	NO2_NO3 (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	pH (pH)	PRESS (mm/Hg)	SUSSOL (mg/L)	TEMP (deg C)	TP_PInLine (mg/L)	TPN (mg/L)	TURB (NTU)
10/16/2002	08:50	105	56 J	107	0.01 U	0.055	0.0355	10.8	7.95	751.586	2	7.4	0.07*	0.148	1.7
11/14/2002	08:05	102	11 J	47.2	0.01 U	0.019	0.0463	11.06	8.15	744.474	2	7.9	0.072*	0.129	2.1
12/18/2002	08:00	87	39 J	76.7	0.01 U	0.272	0.0595	12.51	7.72	735.584	5 J	3.7	0.089*	0.342	2.9
1/8/2003	07:50	82	72 J	152	0.012	0.402	0.0544	12.82	7.66	742.95	15	3.2	0.089*	0.502	9
2/5/2003	07:50	78	44 J	728 J	0.038	0.889	0.0413	12.75	7.45	743.712	525	4.3	0.204*	1.08	95
3/5/2003	07:20	92	28 J	233	0.01 U	0.82	0.0634	12.2 J	7.9	736.092	34	5.8	0.118*	0.894	11
4/9/2003	07:45	78	16 J	447	0.01 U	0.626	0.0456	10.3	7.39	738.378	103	11.8	0.106*	0.753	15
5/7/2003	07:40	90	25 J	265	0.01 U	0.01 U	0.012	10.65	8.49	737.87	18	10.3	0.042*	0.12	4.5
6/4/2003	07:20	110	100 J	87.5	0.035	0.079	0.0405	8.28	7.9	742.188	13	18.7	0.096*	0.328	3.4
7/9/2003	07:00	140	420 J	8.13	0.017	0.184	0.0503	7.34	8.2	741.68	3	20.5	0.08*	0.325	1.6
8/6/2003	07:45	135	710 J	10.7	0.025	0.185	0.0793	6.59	7.78	739.394	5	21.3	0.125*	0.503	2.5
9/10/2003	07:30	123	780 J	37.9	0.01 U	0.024	0.0618 J	8.62	7.9	741.934	6	15.3 J	0.098*	0.278	1.9

Common data qualifiers:
- U - not detected at the reported level
- J - estimated value

Blue shading indicates that result exceeded water quality standards OR contrasted strongly with historical results.

Asterisk* indicates possible quality problem for the result. You may wish to discuss the result with the station contact person.

Table B-3. Mill Creek @ Swegle Road 32C070

date	time	COND (umho	FC (#/100ml)	NH3_N (mg/L)	NO2_NO (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	PH (pH)	PRESS (mm/Hg)	SUSSOL (mg/L)	TEMP (deg C)	TP_PInLin (mg/L)	TPN (mg/L)	TURB (NTU)
10/16/2002	08:10	380	2100 J	0.01 U	3.69	0.133	8.69	7.77	748.03	2	9.5	0.169*	3.8	0.8
11/14/2002	07:25	261	20 J	0.01 U	3.61	0.336	8.93	8.32	742.442	1 U	10	0.355*	3.79	0.5
12/18/2002	07:20	172	4 J	0.012	2.93	0.414	10.56	7.75	732.282	1 J	6.5	0.446*	2.75	0.9
1/8/2003	07:10	130	6 J	0.01 U	1.48	0.19	12.02	7.79	740.664	3	4.9	0.23*	1.59	2.6
2/5/2003	07:00	83	18 J	0.02	1	0.0765	12.04 J	7.31	741.426	35	4.9	0.128*	1.18	17
3/5/2003	06:45	148	19 J	0.01 U	1.34	0.188	13.12 J	7.96	733.806	3	6.6	0.236*	1.41	2.7
4/9/2003	07:00	81	52 J	0.01 U	0.558	0.0829	10.5	7.37	735.076	6	9.6	0.125*	0.685	4.7
5/7/2003	07:00	95	56 J	0.01 U	0.369	0.0482	11.16	7.49	737.616 J	11	7.4	0.081*	0.473	3.3
6/4/2003	06:25	215	28 J	0.02	1.95	0.149	7.67	7.58	739.14	4	16.3	0.206*	2.14	1.3
7/9/2003	06:30	374	270 J	0.015	1.38	0.0955	5.4	7.52	738.124	3	19.2	0.119*	1.46	1.6
8/6/2003	07:00	371	300 J	0.012	0.012	0.125	3.75	7.38	737.108	2	20.5	0.156*	0.19	0.6
9/10/2003	07:00	325	330 J	0.01 U	3.09	0.176 J	6.8	7.6	739.394	3	15.3 J	0.214*	3.41	0.8

Common data qualifiers:

- U - not detected at the reported level
- J - estimated value

Blue shading indicates that result exceeded water quality standards OR contrasted strongly with historical results.

Asterisk* indicates possible quality problem for the result. You may wish to discuss the result with the station contact person.

Groundwater Water Quality Data Collected by Ecology in 2002 as part of the Total Maximum Daily Load Study

Table B-4. Groundwater and stream water quality data from the Walla Walla River basin, 2002 (Marti, 2005).

Well I.D.			Temperature (°C)		Specific Conductivity µS/cm@25°C		Ammonia (mg/L)		Chloride (mg/L)		Dissolved Organic Carbon (mg/L)		Fecal Coliform (#/100mL)		Nitrite-Nitrate (mg/L)		Ortho-Phosphate (mg/L)		Phosphorus (mg/L)		Total Organic Carbon (mg/L)		Total Persulfate Nitroge (mg/L)	
Tag No.	Stream name	Date	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water	Stream	Ground water
AGJ703	Touchet	6-25-02					0.021		1.17				290 J		0.023		0.0607		0.087				0.195	
	River	7-9-02	20.5	16.5	116	**581**	0.016		1.51				230		0.026		0.0559		0.082				0.199	
	(Cummins	7-29-02					0.011		1.93				1800 J		0.03		0.0881		0.105				0.222	
	Road)	8-6-02	18.5	18	141	**555**																		
		8-7-02	20.6	18	137	**547**		0.01 U						1 U		**5.44**		0.026		0.104				**5.44**
		8-13-02					0.016		1.99				62		0.127		0.0576		0.082				0.338	
		9-2-02					0.011		3.76				160		0.08 J		0.0559		0.087				0.273	
		9-17-02					0.01 U		1.9				72		0.067		0.0498		0.075				0.262	
		9-19-02	-	-	131	**535**																		
		10-15-02							1.5				26											
		10-16-02	10	14.1	118	**574**																		
		10-17-02	8.5	14	103	**512**		0.01 U		**14.8**		2.2/2.1				**4.99/5.12**		0.022/0.024		0.057/0.061		2.2/2.1		**4.41/5.1**
AGJ710	Walla Walla	6-26-02							8.75				49											
	River	7-10-02	27.7	20.3	201	245			9.29				43											
	(McDonald	7-31-02					0.02		3.85				84		0.072		0.0994		0.111				0.216	
	Road)	8-7-02	21.8	20	164	253		0.014						1 U		0.01 U		0.035		0.139				0.073
		8-15-02							4.22				5											
		9-5-02					0.01 U		3.83				47 J		0.104 J		0.0693		0.095				0.19	
		9-18-02	18.2	17.7	138	295	0.01 U	0.016	3.65	8.02		1.6	340 J		0.145	0.01 U	0.0672	0.02	0.1	0.157		2.4	0.241	0.102
		10-17-02	8.8	13	176	270			8.2				23											
AGJ711	Walla Walla	6-26-02					0.049		9.34				80		0.308		0.08		0.109				0.504	
	River	7-10-02	28	18.6	226	205	0.022		9.55				120		0.118		0.0732		0.1				0.274	
	(Lowden	7-31-02					0.01 U		5.78		1.7		20		0.011		0.116		0.124		1.9		0.154	
	Road)	8-7-02	24.4	20.5	209	205		**0.147**						1 U		0.01 U		0.027		**0.26**				0.206
		8-15-02					0.016		6.72				16		0.028		0.103		0.138				0.155	
		9-5-02					0.01 U		4.8		1.6		49		0.01 UJ		0.0831		0.11		1.7		0.099	
		9-18-02					0.01 U		3.98		1.6		87		0.059		0.0731		0.098		1.6		0.16	
		10-17-02	9.6	15.2	217	223	0.01 U	**0.099**	9.01	8.15	1.8	1.6	6		0.284	0.016	0.0507	0.012	0.081	**0.144**	1.7	1.8	0.376	0.151
AGJ712	Walla Walla	6-26-02					0.032		16		2.7		890 J		0.361		0.105		0.166		2.9		0.66	
	River	7-10-02	26.3	16.5	356	**1272**	0.037		14		2.3		540		0.246		0.102		0.156		2.5		0.492	
	(Touchet-	7-31-02					0.031		18.1		3.5		1300		0.312		0.18		0.214		3.5		0.628	
	Gardena	8-7-02	21.3	16.2	367	**1297**		0.01 U						1 U		**1.6**		0.09		0.119				**1.69**
	Road)	8-15-02					0.01 U		16.5		2.6		120		0.286		0.129		0.146		2.9		0.551	
		9-5-02					0.01 U		13.2		2.4		69		0.213 J		0.113		0.149		2.6		0.396	
		9-18-02					0.01 U		7.83		2.5		160		0.074		0.11		0.142		2.6		0.244	
		10-17-02	8.6	14.2	347	**1320**	0.01 U	0.01 U	13.7	**84**	3.2	3	3 U		0.141	**1.6**	0.0602	0.082	0.097	0.142	3.4	3	0.312	**1.7**

Historical Ecology Ambient Water Quality Monitoring Data from Two Sites in the Walla Walla Watershed

1. **The range and median monthly statistics for daytime grab samples taken from the Walla Walla River near Touchet (Ecology Ambient Monitoring Station 32A070).**

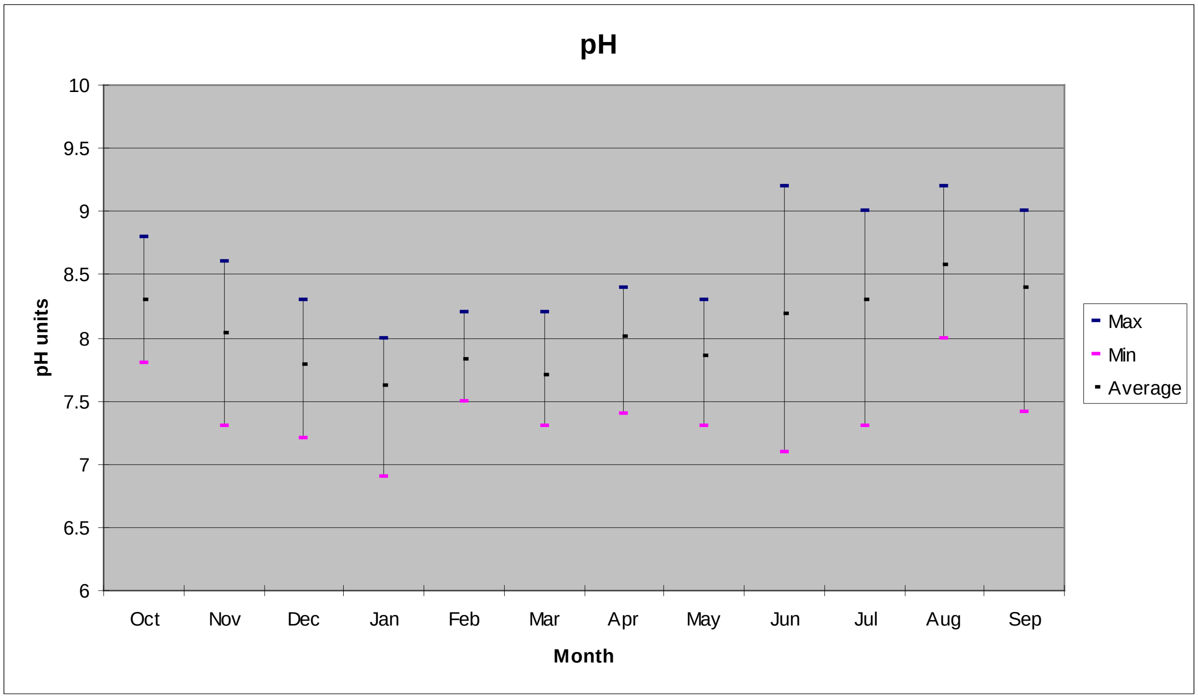

Figure B-1. Range and median pH value for monthly samples collected 1997 – 2000.

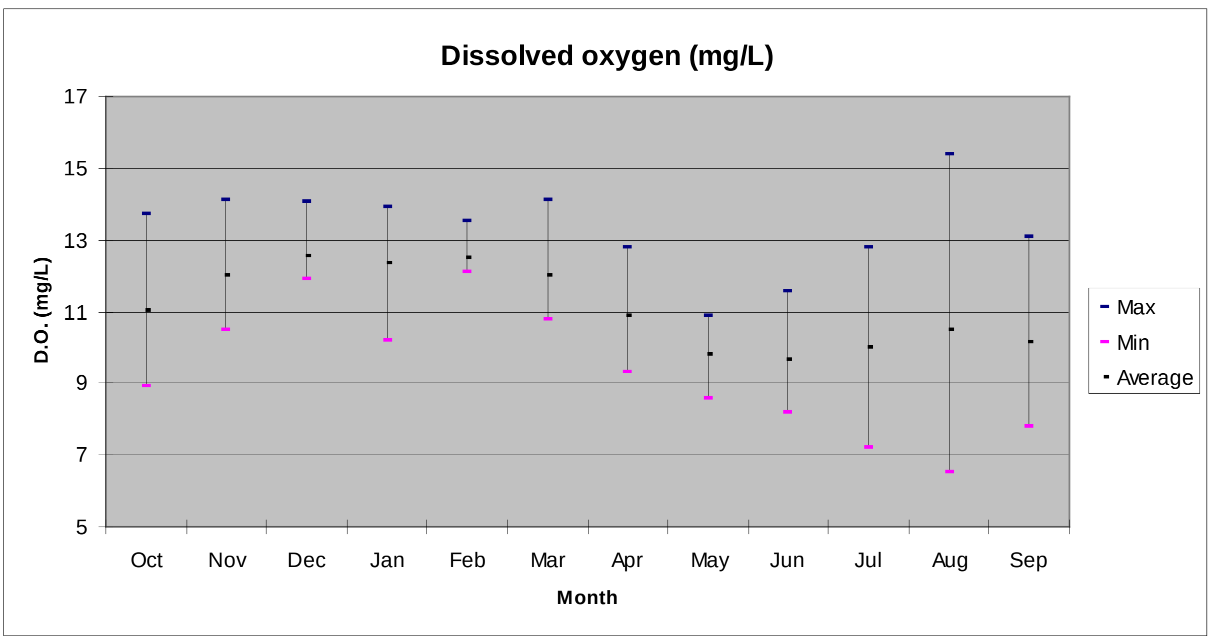

Figure B-2. Range and median dissolved oxygen (D.O) concentration for monthly samples collected 1997 – 2000.

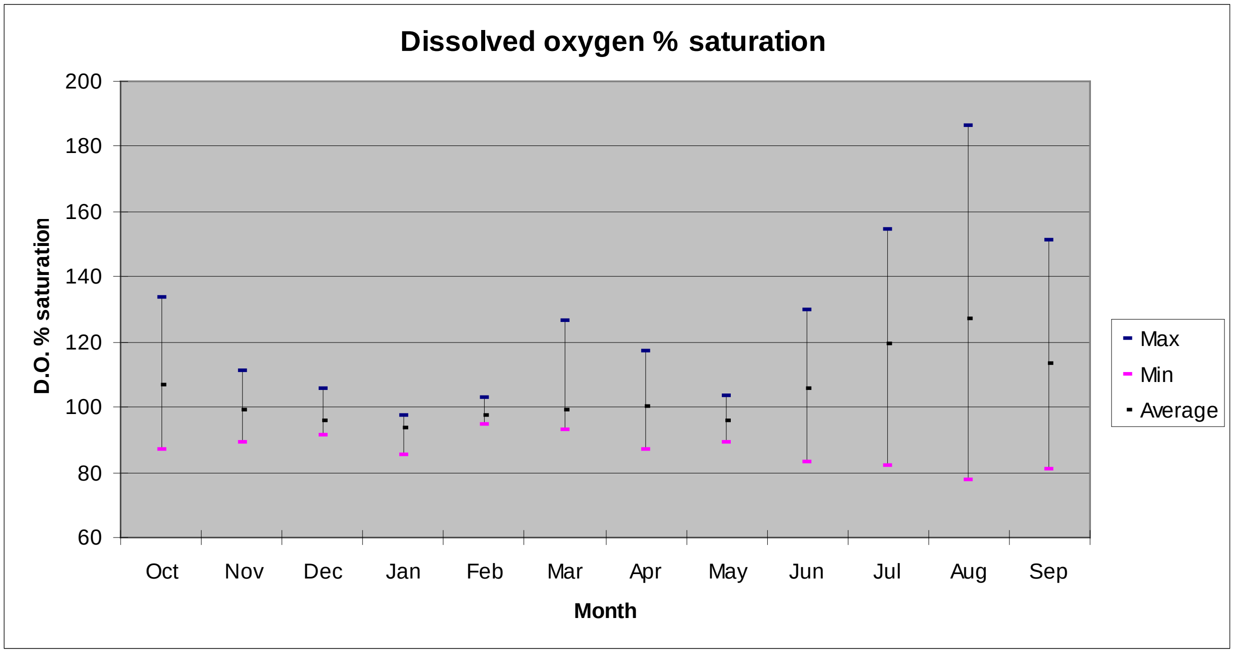

Figure B-3. Range and median percent saturation of dissolved oxygen for monthly samples collected 1997 – 2000.

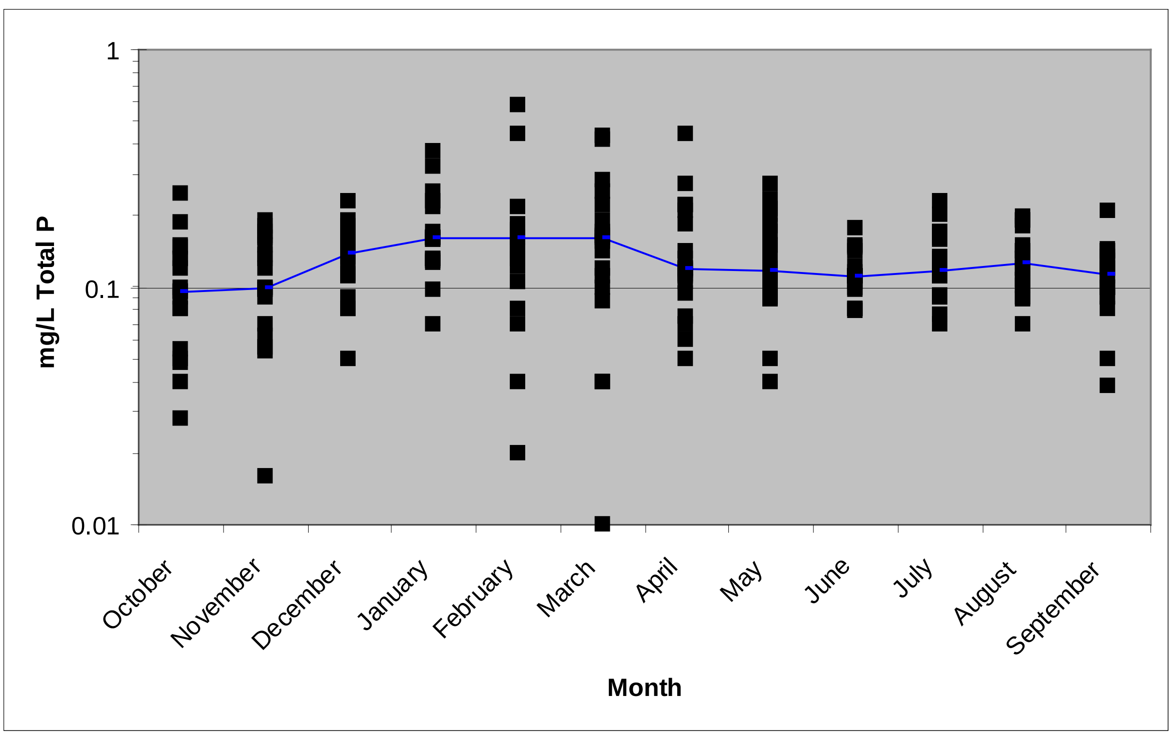

Figure B-4. Total phosphorus (Total P) concentrations and median concentration for monthly samples collected October 1979 – September 2001.

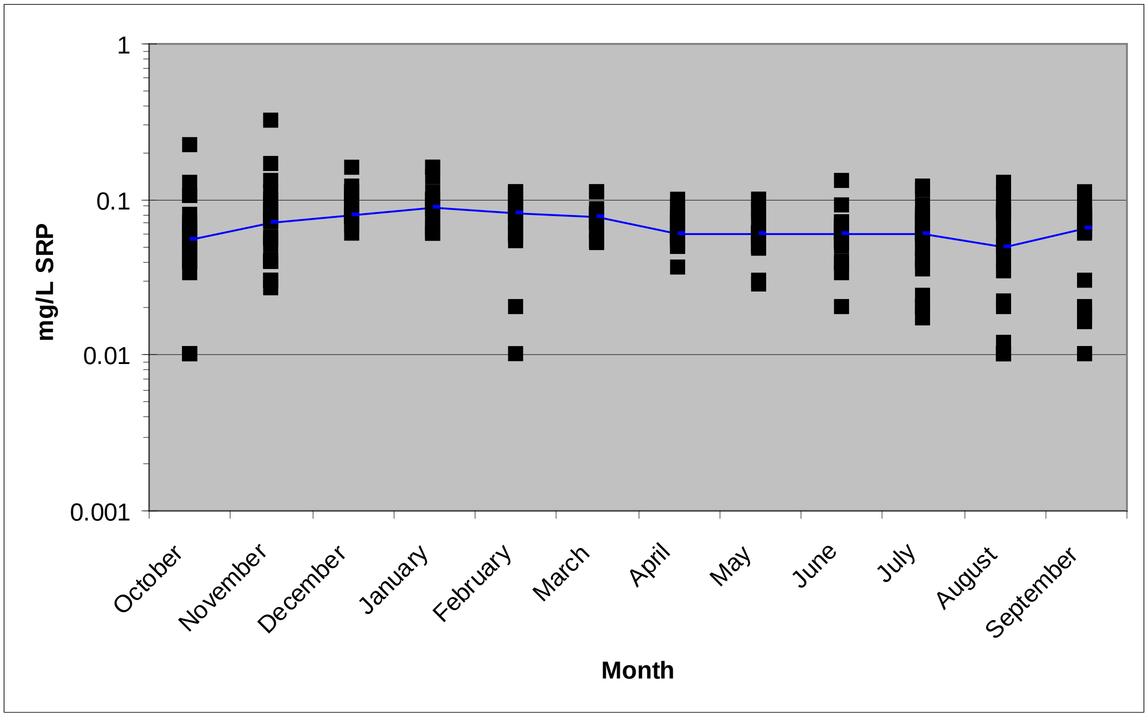

Figure B-5. Soluble reactive phosphorus (SRP) concentrations and median concentration (line) for monthly samples collected October 1979 – September 2001.

2. **The range and median monthly statistics for daytime grab samples taken from the Touchet River at Touchet (Ecology Ambient Monitoring Station 32B070), 1979 – 1997.**

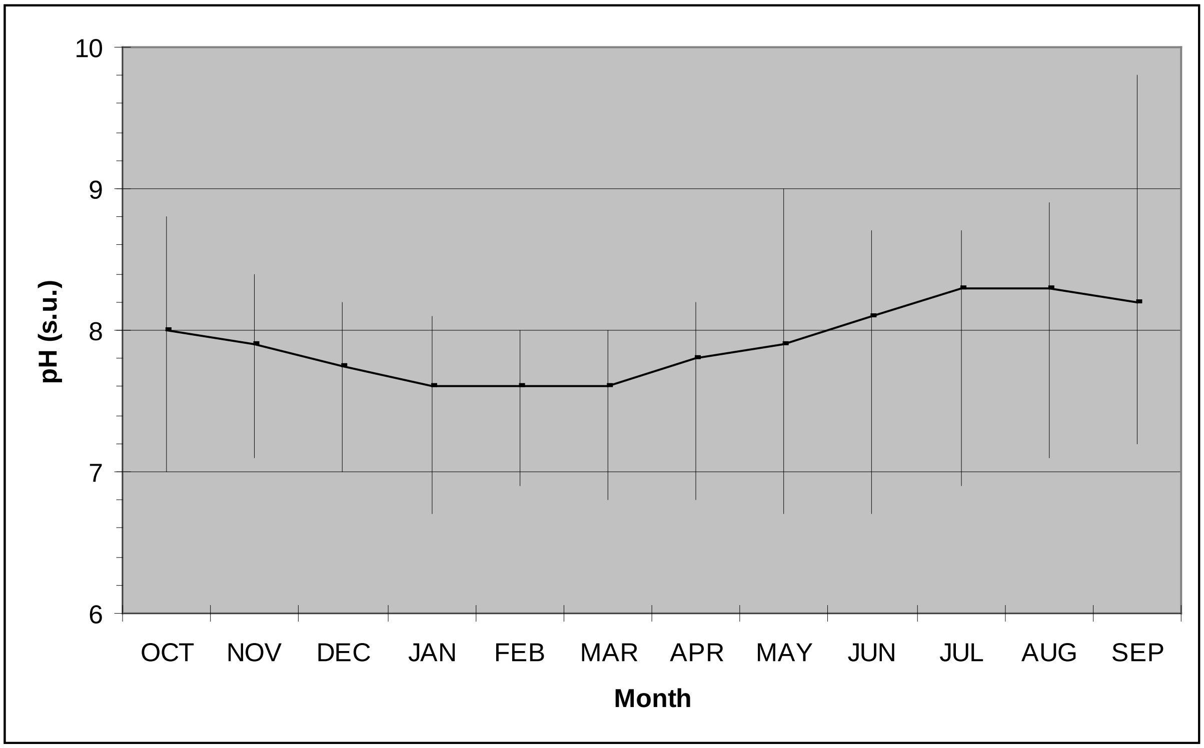

Figure B-6. Range and median pH value for monthly samples collected 1979 – 1997.

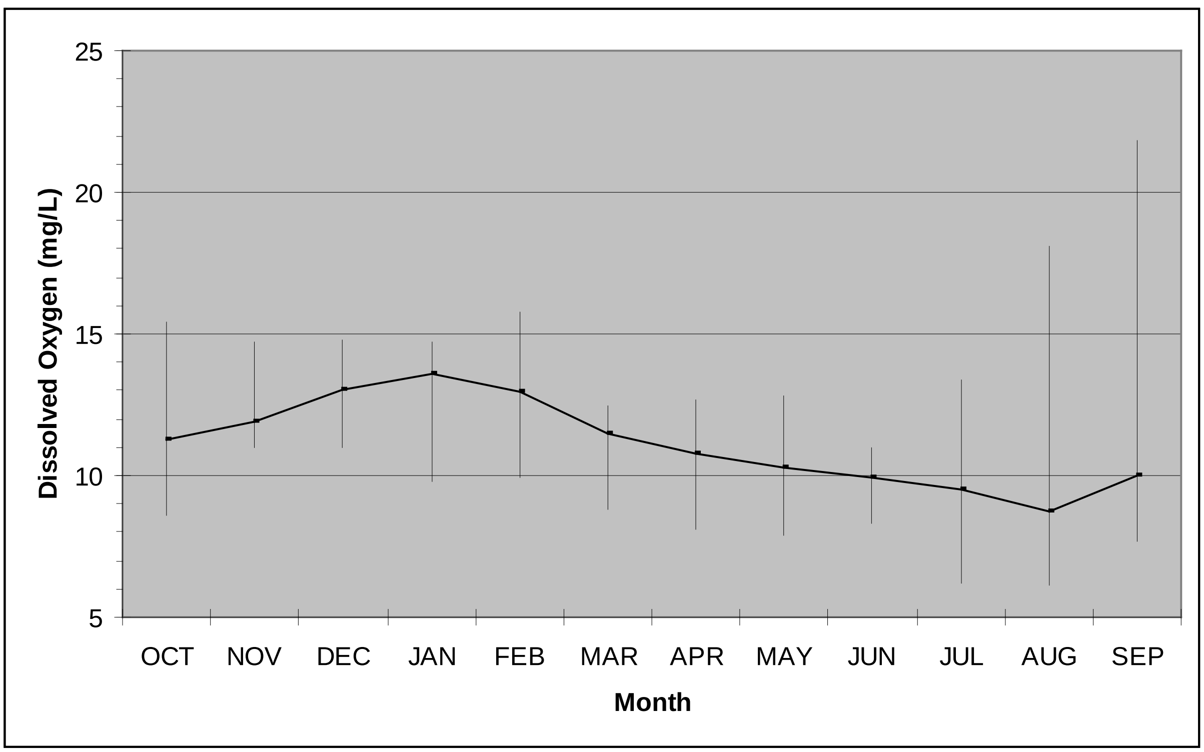

Figure B-7. Range and median dissolved oxygen (DO) concentration for monthly samples collected 1979 – 1997.

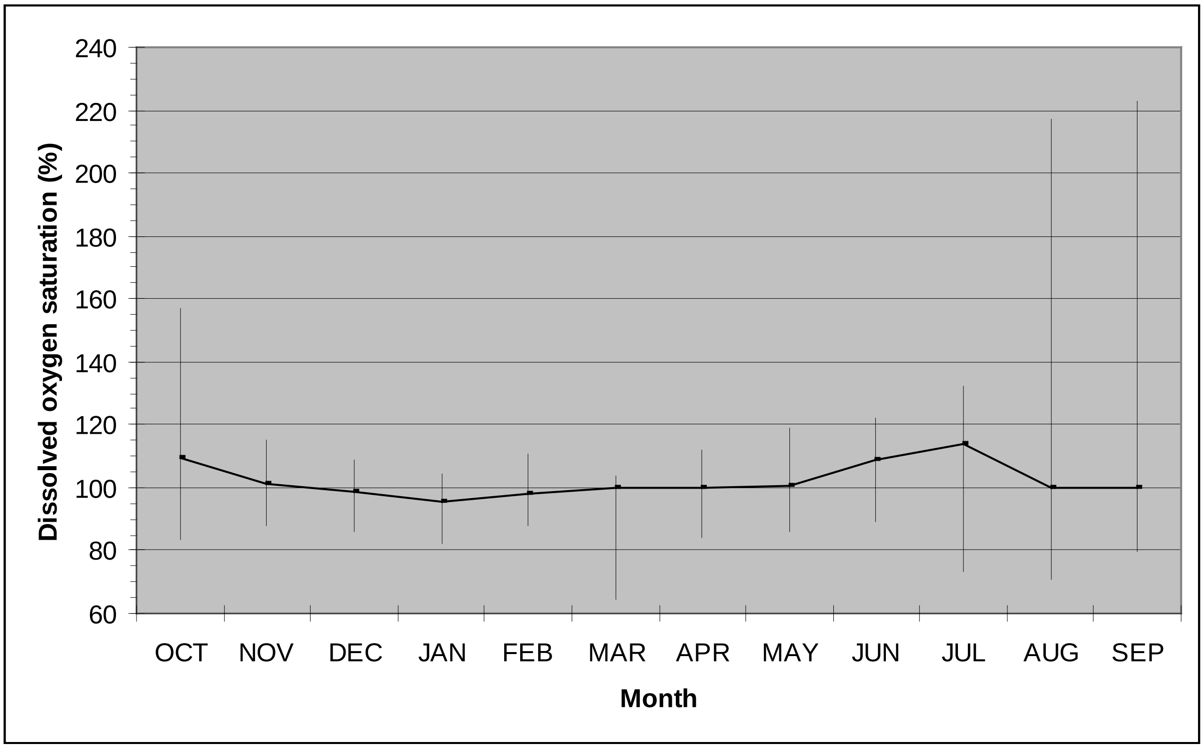

Figure B-8. Range and median percent saturation of dissolved oxygen for monthly samples collected 1979 – 1997.

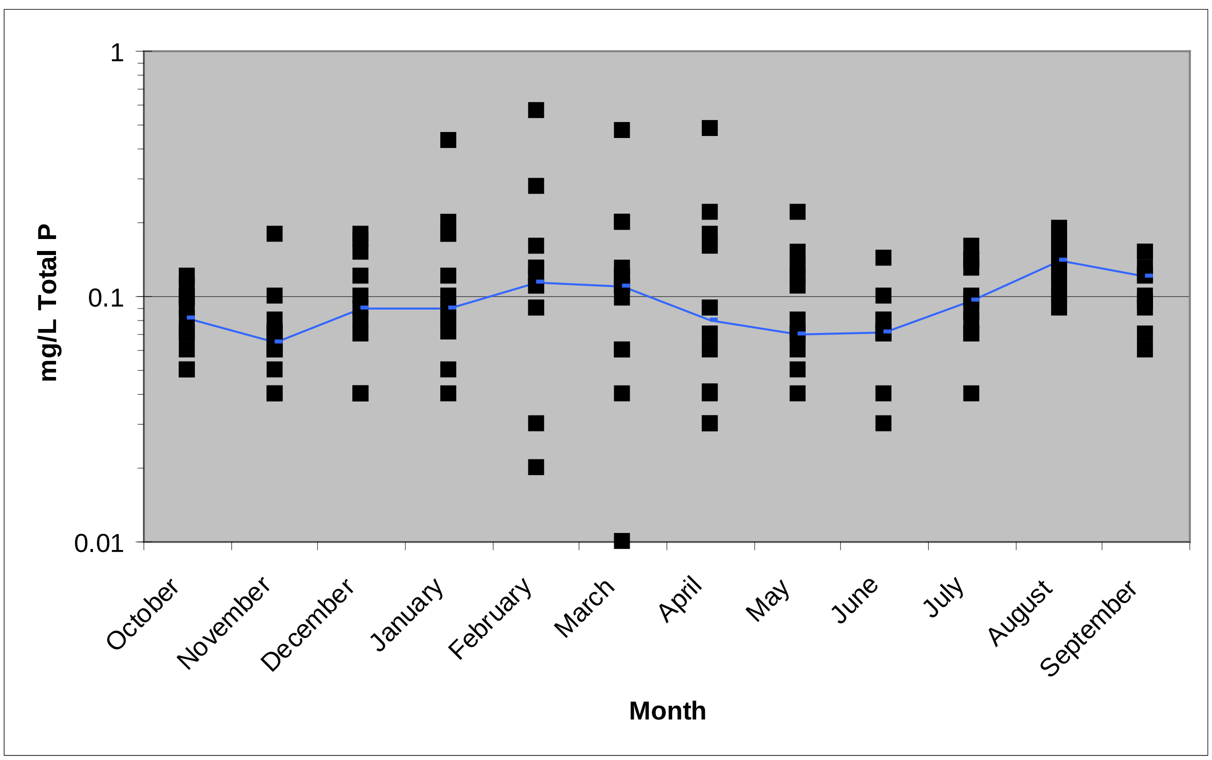

Figure B-9. Total phosphorus (Total P) concentrations and median concentration for monthly samples collected October 1979 – September 1997.

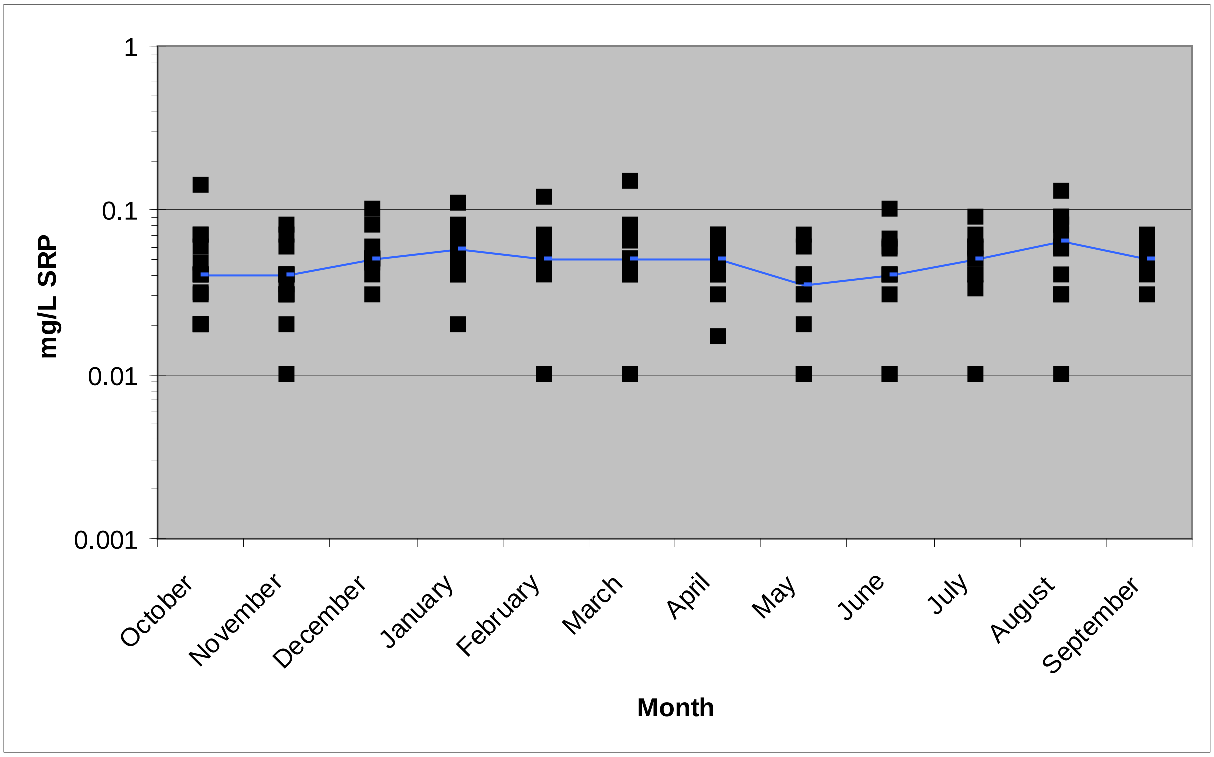

Figure B-10. Soluble reactive phosphorus (SRP) concentrations and median concentration for monthly samples collected October 1979 – September 1997.

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Appendix C. Walla Walla TMDL Data Quality Assurance Summaries

Following are quality assurance data for samples collected from the Walla Walla River basin from June 2002 to June 2003 by the Washington State Department of Ecology, Environmental Assessment Program, Water Quality Studies Unit.

The statistical summaries in Tables C-1 and C-2 compare the sample results to the measurement quality objectives set in the *Quality Assurance Project Plan: Walla Walla River Basin Fecal Coliform Bacteria and pH Total Maximum Daily Load Study* (Swanson and Joy, 2002).

Table C-1. Measurement quality objectives and results of laboratory duplicate samples. Data quality of the samples met the objectives.

Parameter	Median RSD (percent)	Average RSD (percent)	Average RPD (percent)	Precision Standard (RSD percent)	Number of duplicates taken	Total number of samples (less duplicates)	Percent of total samples duplicated
Alk	0.22	0.57	1.82	10	22	211	10
BOD5	0.00	0.00	1.15	25	6	24	25
Chl a	1.65	2.43	15.31	20	52	321	16
Cl	1.05	1.59	7.97	5	52	518	10
DOC	2.67	3.62	3.23	10	21	263	8
EC	2.41[1]	11.14[1]	2.22[1]	25[1]	55	228	24
Entero	0.00[1]	0.00[1]	0.00[1]	25[1]	1	3	33
FC	3.89[1]	15.03[1]	2.24[1]	25[1]	56	518	11
NH3	1.49	2.10	16.17	10	33	353	9
NO2/NO3	0.13	0.38	15.06	10	29	353	8
OP	0.51	0.70	10.91	10	34	347	10
TNVSS	0.00	1.54	16.88	10	36	141	26
TOC	2.72	3.65	3.54	10	24	270	9
TP	1.36	1.87	10.63	10	30	353	8
TPN	1.26	1.91	7.14	10	26	351	7
TSS	0.00	1.18	24.02	10	59	507	12
Periphyton	1.44	2.45	1.50	20	5	36	14

[1] Logtransformed data
RSD - Relative standard deviation
RPD - Relative percent difference

Table C-2. Measurement quality objectives and results of field replicate samples. Data quality of the samples met the objectives.

Parameter	Median RSD (percent)	Average RSD (percent)	Average RPD (percent)	Precision Standard (RSD percent)	Number of replicates taken	Total number of samples (less replicates)	Percent of total samples replicated
Alk	0.46	0.54	1.27	10	18	211	9
BOD5	0.00	3.57	1.56	25	8	24	33
Chl a	3.47	4.08	3.65	20	34	321	11
Cl	0.47	2.38	10.42	5	62	518	12
DOC	2.57	3.66	3.19	10	36	263	14
EC	3.45[1]	12.38[1]	1.78[1]	25[1]	42	228	18
Entero	0.16[1]	0.16[1]	0.00[1]	25[1]	1	3	33
FC	3.37[1]	10.68[1]	1.96[1]	25[1]	63	518	12
NH3	0.55	4.17	13.80	10	38	353	11
NO2/NO3	0.00	0.64	14.67	10	38	353	11
OP	0.47	0.78	13.69	10	36	347	10
TNVSS	0.00	6.37	11.02	10	15	141	11
TOC	2.89	5.09	3.95	10	37	270	14
TP	1.70	1.86	10.56	10	38	353	11
TPN	1.58	2.52	13.63	10	37	351	11
TSS	0.00	9.64	27.45	10	59	507	12
Periphyton	13.26	21.58	0.99	20	6	36	17

[1] Logtransformed data
RSD - Relative standard deviation
RPD - Relative percent difference

Appendix D. Walla Walla TMDL Monitoring Site Location Information

Table D-1. Identification numbers, locations, and general descriptions of sites monitored during the 2001 – 2002 Walla Walla pH and DO Total Maximum Daily Load study.

Station ID	River or Tributary Mile	Station Description
32COL-GARR	NA	College Place WWTP at outfall to Garrison Creek
32COL-WWTP	NA	College Place WWTP at sump before lagoons
32COP-00.5	0.5	Coppei Creek at Hwy 124
32COT-01.0	1.0	Cottonwood Creek at Braden Rd.
32DAY-WWTP	NA	Dayton WWTP just before outfall to Touchet River
32DRY-00.5	0.5	Dry Creek at Hwy 12
32GAR-00.5	0.5	Garrison Creek at Mission St.
32MIL-00.5	0.5	Mill Creek at Swegle Rd.
32MIL-02.8	2.8	Mill Creek at Wallula Ave.
32MIL-04.8	4.8	Mill Creek at Gose St.
32MIL-06.7	6.7	Mill Creek at 9th St.
32MIL-06.9	6.9	Mill Creek at 6th St.
32MIL-07.0	7.0	Mill Creek at 5th St.
32MIL-07.1	7.1	Mill Creek at 4th St.
32MIL-07.2	7.2	Mill Creek at 3th St.
32MIL-07.3	7.3	Mill Creek at 1st and Main
32MIL-07.4	7.4	Mill Creek at Colville St.
32MIL-08.5	8.5	Mill Creek at Roosevelt St.
32MIL-08.9	8.9	Mill Creek at Wilbur St.
32MIL-11.5	11.5	Mill Creek near Reservoir Rd.
32MIL-12.8	12.8	Mill Creek at Five Mile Rd.
32MIL-21.1	21.1	Mill Creek at Mill Ck. Rd. near Kooskooskie
32MIL-PIPE	NA	Pipe feeding into Mill Creek at 6th St.
32MUD-00.5	0.5	Mud Creek at Borgen Rd.
32NFT-00.0	0.0	North Fork Touchet R. at S. Fork confluence
32NFT-08.9	8.9	North Fork Touchet R. abv. Jim Creek
32PAT-00.1	0.1	Patit Creek at Front St.
32PIN-01.4	1.4	Pine Creek at Sand Pit Rd.
32RUS-00.1	0.1	Russell Creek at McDonald Rd./Plaza Way
32SFT-00.0	0.0	South Fork Touchet R. at N. Fork confluence
32TOU-00.5	0.5	Touchet R. at Hwy 12
32TOU-02.0	2.0	Touchet R. at Cummins Rd.
32TOU-07.0	7.0	Touchet R. at N. Touchet Rd.
32TOU-14.2	14.2	Touchet R. at N. Touchet Rd.
32TOU-17.8	17.8	Touchet R. at Luckenbill Rd.
32TOU-25.0	25.0	Touchet R. off of Lamar Rd.
32TOU-30.6	30.6	Touchet R. at Pettyjohn Rd.
32TOU-34.2	34.2	Touchet R. at Hwy 125
32TOU-36.6	36.6	Touchet R. at Hart Rd.
32TOU-40.5	40.5	Touchet R. at Hwy 24
32TOU-44.2	44.2	Touchet R. at Hwy 12 in Waitsburg
32TOU-46.2	46.2	Touchet R. at Lower Hogeye Rd.
32TOU-48.4	48.4	Touchet R. at Lewis and Clark State Park
32TOU-51.2	51.2	Touchet R. at Ward Rd.
32TOU-53.9	53.9	Touchet R. at Dayton City Park

Station ID	River or Tributary Mile	Station Description
32WAL-09.3	9.3	Walla Walla R. at Pierce's RV Park
32WAL-12.0	12.0	Walla Walla R. at Hwy 12
32WAL-15.6	15.6	Walla Walla R. at Cummins Bridge
32WAL-22.7	22.7	Walla Walla R. at Touchet-Gardena Rd.
32WAL-27.4	27.4	Walla Walla R. at Lowden Rd.
32WAL-29.3	29.3	Walla Walla R. at McDonald Rd.
32WAL-32.8	32.8	Walla Walla R. at Detour Rd.
32WAL-34.0	34.0	Walla Walla R. at Swegle Rd.
32WAL-35.2	35.2	Walla Walla R. at Last Chance Rd.
32WAL-38.7	38.7	Walla Walla R. at Hwy 125
32WAL-WWTP	NA	Walla Walla WWTP at outfall to Mill Creek
32WLW-00.8	0.8	West Little Walla Walla River
32YEL-00.2	0.2	Yellowhawk Creek at Old Milton Hwy
32YEL-03.5	3.5	Yellowhawk Creek at McDonald Rd.

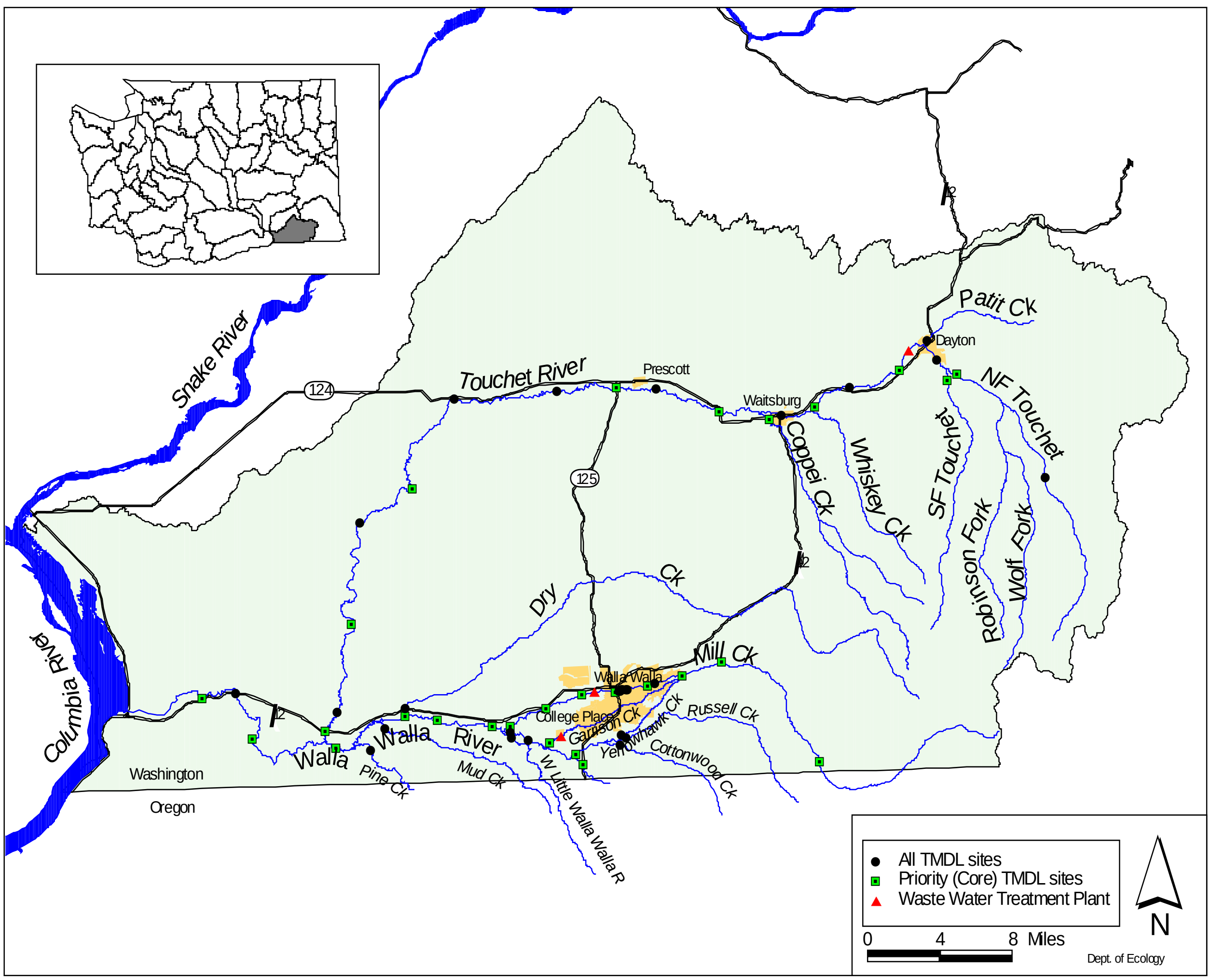

Figure D-1. Sampling sites in the Walla Walla basin for the 2002-03 DO and pH TMDL surveys.

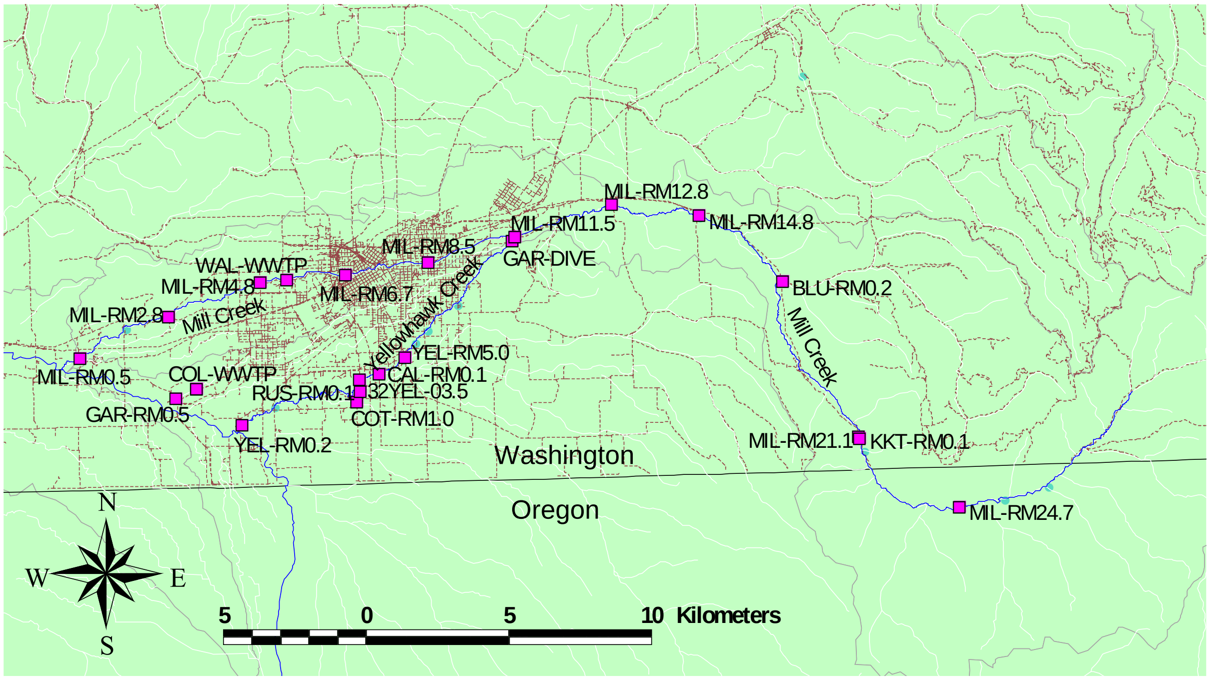

Figure D-2. Sampling stations in Mill, Yellowhawk, and Garrison Creeks during 2002 - 2004.

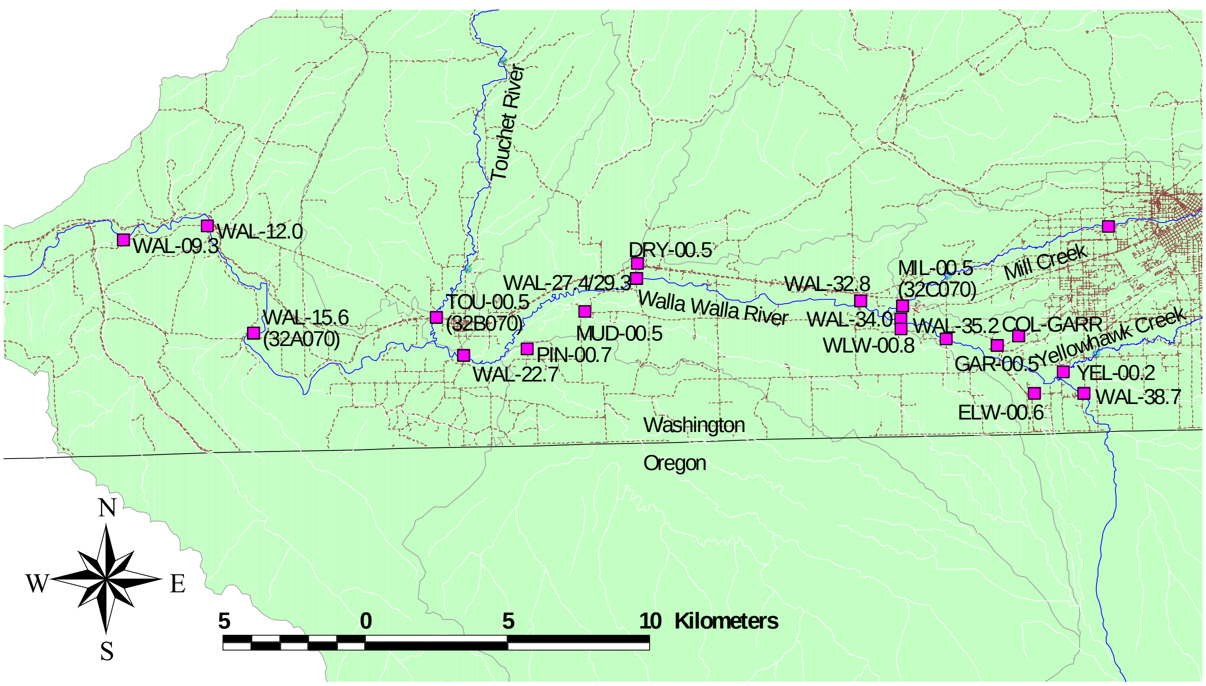

Figure D-3. Sampling stations in the Walla Walla River and tributaries during 2002 – 2004 and at Ecology's ambient monitoring stations.

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Appendix E. Channel and Discharge Data Used for Modeling and Analysis

Table E-1. Summary of hydraulic geometry relationships with flow (Q) in the Mill Creek watershed, June 2001 through August 2004.

Station name	Width (m) =a Q^b (Q in m^3/sec)		Velocity (m/sec) = c Q^d (Q in m^3/sec)		Depth (m) = e Q^f (Q in m^3/sec)	
	Width "a"	Width "b"	Velocity "d"	Depth "e"	Depth "f"	Depth "f"
Mill Creek at Swegle Rd.(32C070)	12.65	0.0179	0.4474	0.5579	0.1691	0.4731
Yellowhawk Cr. at mouth (32D050)	6.345	0.0092	0.5572	0.6730	0.2824	0.3147
Mill Cr at RM 0.4	8.01943	0.08943	1.0328	0.7421	0.1207	0.1685
Mill Cr at RM 0.5	5.1668	0.1512	0.8744	0.54	0.2213	0.3088
Mill Cr at RM 0.7	5.9713	0.2798				
Mill Cr at RM 1.7	7.8001	0.3045	0.5109	0.3839	0.2509	0.3116
Mill Cr at RM 2.7	6.3027	0.114	0.9391	0.6619	0.169	0.1941
Mill Cr at RM 2.8	6.2753	0.1683	1.1345	0.7046	0.1405	0.127
Mill Cr at RM 4.8	2.9376	0.137	1.199	0.3743	0.2839	0.4887
Mill Cr at RM 6.6	2.9918	0.0397	1.1733	0.4072	0.2849	0.5531
Mill Cr at RM 8.1	2.7184	-0.01776	1.5231	0.435	0.2415	0.5828
Mill Cr at RM 12.8	9.4567	0.2045	0.6616	0.5563	0.1572	0.2473
Mill Cr at RM 14.8	14.475	0.1728	0.3813	0.5509	0.1812	0.2763
Mill Cr at RM 19.1	12.596	0.1161	0.3326	0.6393	0.2387	0.2446
Mill Cr at RM 21.1	10.185	0.1546	0.4844	0.7111	0.2027	0.1342
Mill Cr at RM 21.3	9.2855	0.1019	0.3303	0.5998	0.326	0.2983
Mill Cr at RM 26.5	19.07	-0.1106	0.3811	0.9088	0.1376	0.2018
Mill Cr at RM 27.5	9.4984	0.1598	0.4161	0.4566	0.253	0.3835
Mill Cr at RM 28.4	9.0168	0.03802	0.4423	0.4882	0.2507	0.4738
				0.61		
Yellowhawk Cr at RM 0.2	6.6715	0.0508	0.6496	0.6376	0.2308	0.3116
Yellowhawk Cr at RM 1.0	6.4899	0.146	1.044	0.7023	0.1476	0.1516
Yellowhawk Cr at RM 1.1	6.3849	0.2764				
Yellowhawk Cr at RM 5.0	5.2947	0.07154	0.8144	0.3548	0.2319	0.5737
Yellowhawk Cr at RM 8.0	6.3759	0.2731	0.6927	0.1666	0.2264	0.5603
				0.58		
Garrison Cr at RM 0.3	3.0133	0.198	1.1167	0.338	0.2999	0.4686
Garrison Cr at RM 0.5	1.9432	0.1223	1.1853	0.3763	0.523	0.5147
Garrison Cr at RM 9.1	2.9939	0.007271	1.8139	0.9172	0.181	0.07224
Average of all Mill Cr stations	8.578	0.1178	0.7214	0.5716	0.2135	0.3216
Average of all Yellowhawk Cr stations	6.260	0.1378	0.7516	0.5069	0.2238	0.3824
Mill RM 0.4-0.7	7.5255	0.1891	0.9953	0.6625	0.1355	0.1939
Mill RM 2.7-2.8	6.3491	0.1438	0.945	0.6584	0.1667	0.1978
Mill RM 21.1-21.3	9.6865	0.07194	0.3967	0.4646	0.2603	0.4634
Yellowhawk RM 1.0-1.1	6.5338	0.1802	1.0512	0.7386	0.146	0.09622
Garrison RM 0.3-0.5	2.5701	0.1719	1.1808	0.3641	0.3364	0.4554

Table E-2. Summary of hydraulic geometry relationships with flow (Q) in the Touchet River watershed, June 2001 through June 2003.

Station	Station name	Velocity (m/sec) = c Q ^{d} (Q in m^3/sec)		Depth (m) = e Q ^{f} (Q in m^3/sec)	
		Velocity "c"	Velocity "d"	Depth "e"	Depth "f"
Touchet at RM 1.5 (WDFW) and RM 2.0 (Ecology)	Touchet R. near Cummins	0.55	0.64	0.19	0.27
Touchet at RM 7.0 to 3.9	Touchet R. above Hofer Diversion	0.20	0.61	0.28	0.26
Touchet at RM 7.0	Touchet R. above Hofer at N. Touchet Rd.	0.15	0.74	0.48	0.12
Touchet at RM 10.8	Touchet R. at Sims Rd.	0.15	0.74	0.66	0.15
Touchet at RM 12.8	Touchet R. north of Plucker	0.33	0.70	0.30	0.02
Touchet at RM 14.2	Touchet R. south of Luckenbill Rd.	0.20	0.79	0.37	0.18
32B090 (and RM 17.8)	Touchet R. at Luckenbill Rd.	0.21	0.67	0.35	0.31
Touchet at RM 25	Touchet R. at Lamar Rd (Tunnel)	0.30	0.83	0.33	0.06
Touchet at RM 34.2	Touchet R. at Hwy 125	0.37	0.26	0.22	0.52
Touchet RM 40.5	Touchet R. at Hwy 124 (near Bolles)	0.35	0.43	0.15	0.54
32B110 (and RM 46.2)	Touchet R. at County Line (Hogeye Rd.)	0.35	0.43	0.21	0.57
Touchet at RM 53.5 (WDFW)	Touchet R. above Dayton at Flagpole	0.35	0.43	0.20	0.33

Table E-3. Results of 21-Jul-04 dye study for time of travel in Mill and Yellowhawk Creeks

Location	Distance from mouth	Dye study travel times 21-Jul-04	Flows during 21-Jul-04 dye study	Reach-averaged velocity to that station during dye study	Power curve "a" coefficient for v = $aQ^{0.5716}$ (Mill) or $aQ^{0.5069}$ (Yellowhawk) (v in m/s, Q in m^3/s)
	(Km)	(days)	(m^3/sec)	(m/s)	
32MIL-21.3 (M4), USGS gage	33.9	0.000	1.1270		
32MIL-14.8 (M2) (temp) "Seven Mile"	22.4	0.305	0.8743	0.3847	0.4155
32MIL-12.8 (wq and temp) "Five Mile"	18.9	0.465	0.8382	0.2328	0.2576
Above Bennington Dam	16.4	0.571	0.7617	0.2109	0.2464
Above diversion dam, 32MIL-11.5 (wq)	14.9	0.878	0.7108	0.0667	0.0811
32YEL-05.0 (temp)	8.4	0.990	0.6003	0.4989	0.6462
32YEL-03.5 (wq)	6.4	1.066	0.5774	0.3676	0.4856
32YEL-00.2 (wq)	0.4	1.300	0.5069	0.2627	0.3707

Table E-4. Summary of root mean squared errors (RMSE) of QUAL2Kw calibration predictions of the 31-Aug-04 to 01-Sep-04 synoptic survey of Mill-Yellowhawk Creeks.

Variable	RMSE	RMSE/ Mean
Temperature (deg C)	0.65	4%
Conductivity (um/cm)	2.9	3%
Dissolved oxygen, all (mg/L)	0.46	5%
Dissolved oxygen, grabs (mg/L)	0.52	6%
Dissolved oxygen, Hydrolab (mg/L)	0.23	2%
Organic nitrogen (ugN/L)	21	60%
Ammonia nitrogen (ugN/L)	2.6	40%
Nitrate + nitrite N (ugN/L)	18	20%
Organic phosphorus (ugP/L)	5.1	120%
Soluble reactive P (ugP/L)	1.58	4%
Alkalinity (mgCaCO3/L)	0.97	2%
pH, all data	0.23	3%
pH, grabs	0.24	3%
pH, Hydrolab	0.23	3%
Periphyton (mgA/m2)	22	62%
Total nitrogen (ugN/L)	21	15%
Total phosphorus (ugP/L)	5.2	13%
Ultimate CBOD (mg/L)	0.63	28%
Total organic carbon (mgC/L)	0.24	29%

Table E-5. Summary of root mean squared errors (RMSE) and Nash-Sutcliffe coefficients for QUAL2Kw calibration predictions for the September 2002 survey of the Touchet River.

Variable	RMSE	RMSE/ Mean	Nash-Sutcliffe	Nash-Sutcliffe*
Temperature (deg C)	0.5	2%	0.98	
Conductivity (um/cm)	6.4	6%	0.88	
Dissolved oxygen, all (mg/L)	0.3	3%	0.95	
Total nitrogen (ugN/L)	68.9	26%	0.58	
Dissolved Inorganic N (ug/L)	17.8	14%	0.97	
Ammonia nitrogen (ugN/L)	6.7	75%	-1.5	
Nitrate + nitrite N (ugN/L)	17.1	15%	0.98	
Total phosphorus (ugP/L)	7.4	9%	-0.5*	0.97
Soluble reactive P (ugP/L)	7.2	12%	0.06*	0.93
Alkalinity (mgCaCO3/L)	8.6	14%	0.2	
pH, all data	0.2	3%	0.78	
Total organic carbon (mgC/L)	1.7	85%	-26	

* Effect on Nash-Sutcliffe coefficient by eliminating one ‘errant’ data point

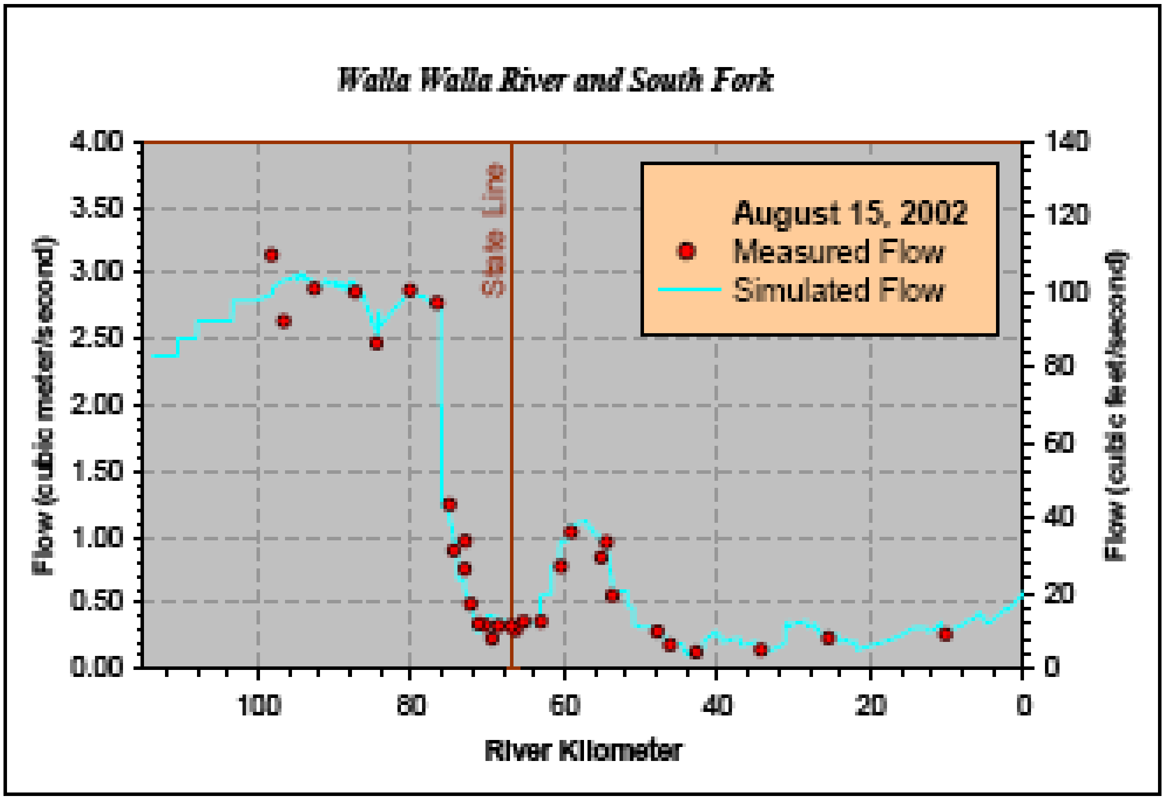

Figure E-1. The modeled and measured August 15, 2002 flow profile for the Walla Walla River and South Fork Walla Walla River from Skiphorton Creek to the Columbia River (Butcher and Bower, 2005).

Appendix F. Beales Ratio Equation

Beales ratio estimator from *Principles of Surface Water Quality Modeling and Control* by Thomann and Mueller (1987) provides a mass loading rate estimate of a pollutant. The formula for the unbiased stratified ratio estimator is used when continuous flow data are available for sites with less frequent pollutant sample data. The average load is then:

$$\overline{W}_p = \overline{Q}_p \cdot \frac{\overline{W}_c}{\overline{Q}_c} \cdot \left[\frac{1 + \left(\frac{1}{n}\right) \cdot \left(S_{QW} / \left(\overline{Q}_c \overline{W}_c\right)\right)}{1 + \left(\frac{1}{n}\right) \cdot \left(S_Q^2 / \overline{Q}_c^2\right)} \right]$$

where,

$\overline{W}_p$ is the estimated average load for the period
p is the period
$\overline{Q}_p$ is the mean flow for the period
$\overline{W}_c$ is the mean daily loading for the days on which pollutant samples were collected
$\overline{Q}_c$ is the mean daily flow for days when samples were collected
n is the number of days when pollutant samples were collected

Also,

$$S_{QW} = [1 / (n-1)]^* \left[\left(\sum_{i=1}^{n} Q_{ci} * W_{ci} \right) - n * \overline{W_c} \overline{Q_c} \right]$$

and

$$S^2_Q = [1/ (n-1)]^* \left[\left(\sum_{i=1}^{n} Q_{ci}^2 \right) - n * \overline{Q_c^2} \right]$$

where,

Q_{ci} are the individually measured flows
W_{ci} is the daily loading for the day the pollutant samples were collected

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Appendix G. WRIA 32 Watershed Planning: New Appropriation Flows (NAF)

Tables 6-1 through 6-4 summarize the recommended new appropriation flows (NAFs) for the four management points (HDR/EES, 2005). These recommended NAFs were approved by the Instream Flow Subcommittee on May 2005.

The values shown in the NAF column of Tables 6-1 through 6-4 (HDR, 2006) "… *reflect the minimum flow for allowing new consumptive out-of-stream uses and withdrawals. This value reflects the intent to optimize weighted useable area as balanced with the Planning Unit's intent to enhance instream base flows with environmentally beneficial storage projects. The minimum instream flow levels listed in the tables do not affect existing water rights."*

The net environmental enhancement storage projects (NEESP) values in the tables (HDR, 2006) "*…reflect an allowance for flows to be dedicated to projects that enhance instream base flows directly or indirectly."*

Table 6-1
Monthly NAF Recommendations and Flow Statistics
MP 1 - Mill Creek at Kooskooskie
(N 46o 00' 29"; W 118o 07' 03")
(Flow in cfs)

Month	NAF	NEESP Reserve	10%	50%	90%	FERC(1)	FERC(2)
October	*48		48	34	26	32	35
November	100	125	116	66	34	35	39
December	110	125	199	96	39	37	40
January	110	125	245	120	52	44	44
February	125	125	253	140	74	53	53
March	150	125	239	150	90	63	63
April	150	125	272	164	102	86	74
May	125	125	205	132	75	64	56
June	100	125	120	65	41	39	34
July	*53		53	36	27	32	33
August	*41		41	30	24	31	33
September	*41		41	30	24	31	34

*Reflects 10% exceedance flow
The NAF value is based on achieving 87% - 91% weighted usable area (WUA) for bull trout adult and 86% - 92% WUA for steelhead juveniles for November through February, and May and June. These minimum instream flow values do not affect existing water rights, including but not limited to City of Walla Walla as yet undeveloped Washington Permit No. 13121 or any seasonal water right obtained by the City of Walla Walla exercised in lieu of this right.

Table 6-2
Monthly NAF Recommendations and Flow Statistics
MP-6a North Fork Touchet
(N 46° 17' 50"; W 117° 57' 04")
(Flow in cfs)

Month	NAF	NEESP Reserve	10%	50%	90%
October	*63		63	49	40
November	95	110	137	70	49
December	95	110	252	116	68
January	95	110	211	116	59
February	95	110	302	170	95
March	125	110	252	169	120
April	125	110	314	215	138
May	125	110	275	179	99
June	95	110	137	95	59
July	*65		65	54	41
August	*53		53	41	37
September	*51		51	43	37

*Reflects 10% exceedance flow
The NAF value is based on achieving 91% weighted usable area (WUA) for bull trout adult and 100% WUA for steelhead juveniles for November through February, and June. These minimum instream flow values do not affect existing water rights.

Table 6-3
Monthly NAF Recommendations and Flow Statistics
MP-11 Touchet River at Bolles Bridge
(N 46° 16' 28"; W 118° 13' 15")
(Flow in cfs)

Month	NAF	NEESP Reserve	10%	50%	90%
October	*82		82	60	48
November	150	175	227	111	68
December	150	175	520	210	76
January	150	175	754	368	105
February	150	175	744	423	171
March	200	175	626	422	204
April	200	175	673	419	202
May	200	175	403	275	120
June	125	175	230	130	57
July	*74		74	47	28
August	*48		48	37	20
September	*56		56	46	32

*Reflects 10% exceedance flow
The NAF value is based on achieving 88% weighted usable area (WUA) for bull trout adult and 91% WUA for steelhead juveniles for November through February, and June. These minimum instream flow values do not affect existing water rights.

Table 6-4 NAF Flow Recommendations for MP 5a Walla Walla River below West Little Walla Walla (propose measure at Detour Road Bridge – N 46° 02' 34"; W 118° 29' 29") (Flow in cfs)		
Month	**NAF/Closure**	**NEESP Reserve**
October	Stream Closure	
November	Stream Closure	
December	250*	300
January	250*	300
February	250*	300
March	350*	300
April	350*	300
May	250*	300
June	Stream Closure	
July	Stream Closure	
August	Stream Closure	
September	Stream Closure	

*These values are for a five year period only as the available data to support the technical basis for establishing flows at this MP may be better informed when additional data is collected over time. The Planning Unit and its Flow/Quantity committee spent considerable time trying to develop flows for this MP.

The value above which new water rights could be allocated, i.e. the NAF flow are based upon a number of factors including the Ecology/WDFW IFIM study (2002), data and analysis on fish migration presented to the Planning Unit by CTUIR staff, extrapolated hydrograph data, and considerations of channel maintenance.

These minimum instream flow values do not affect existing water rights.

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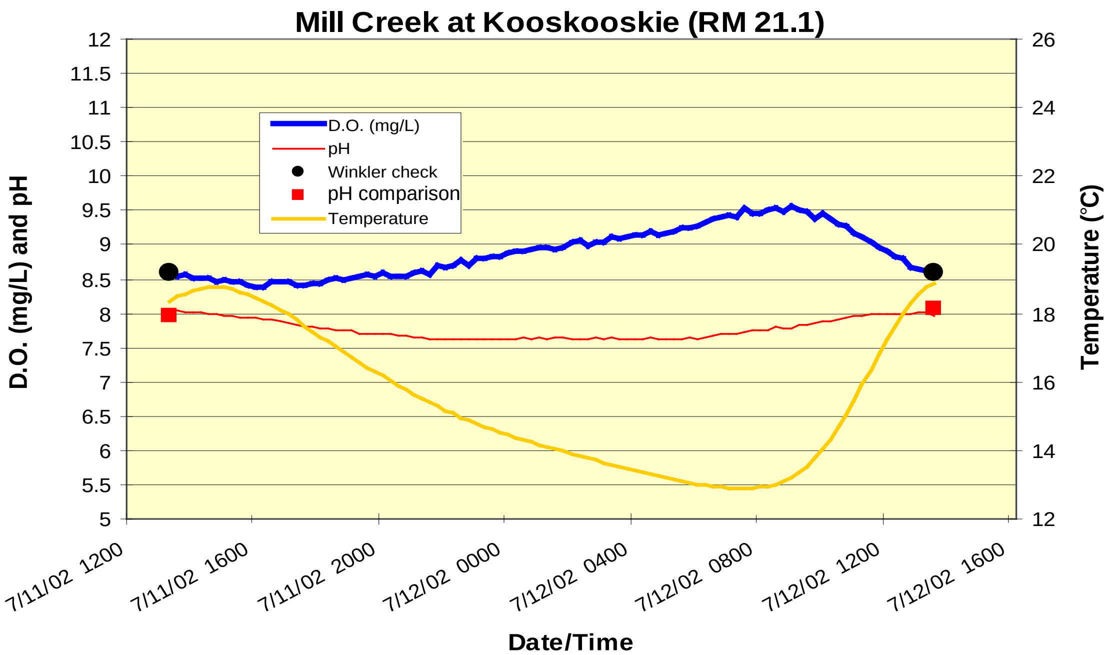
Appendix H. Continuous Measurements (every 15 minutes) of Dissolved Oxygen, pH, and Temperature



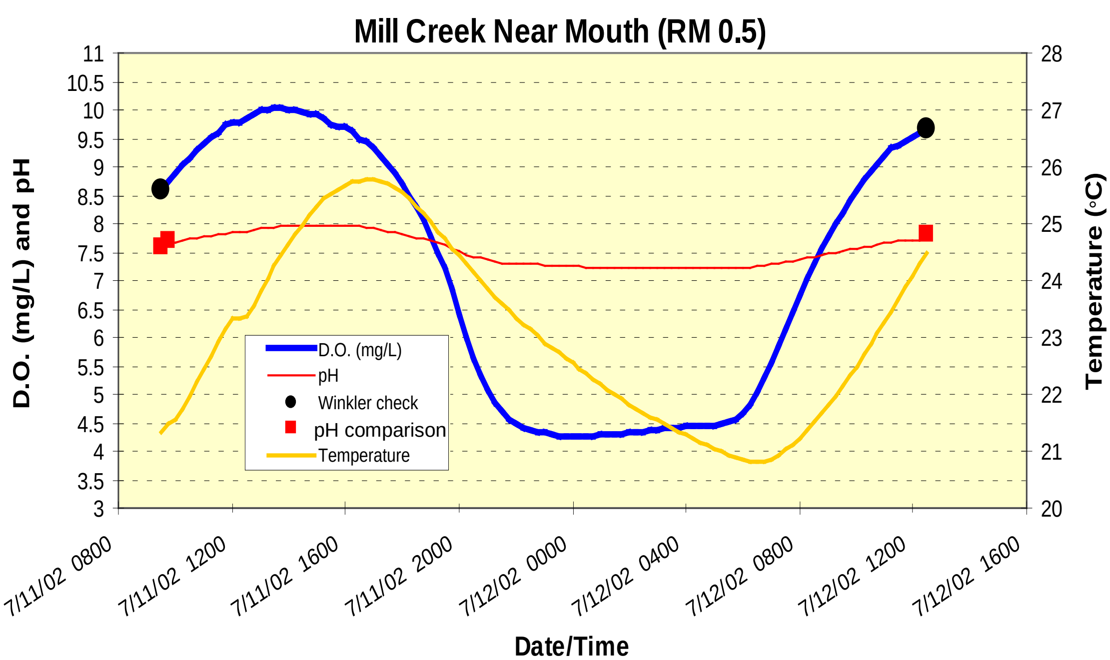
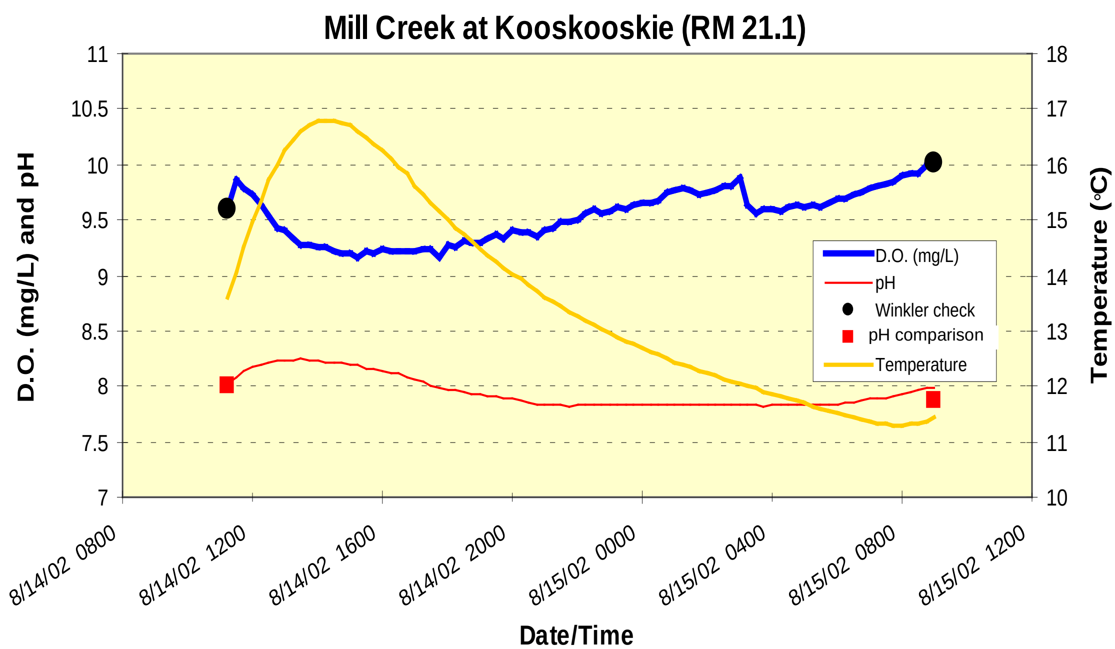


Figure H-1. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Mill Creek, July 11-12, 2002



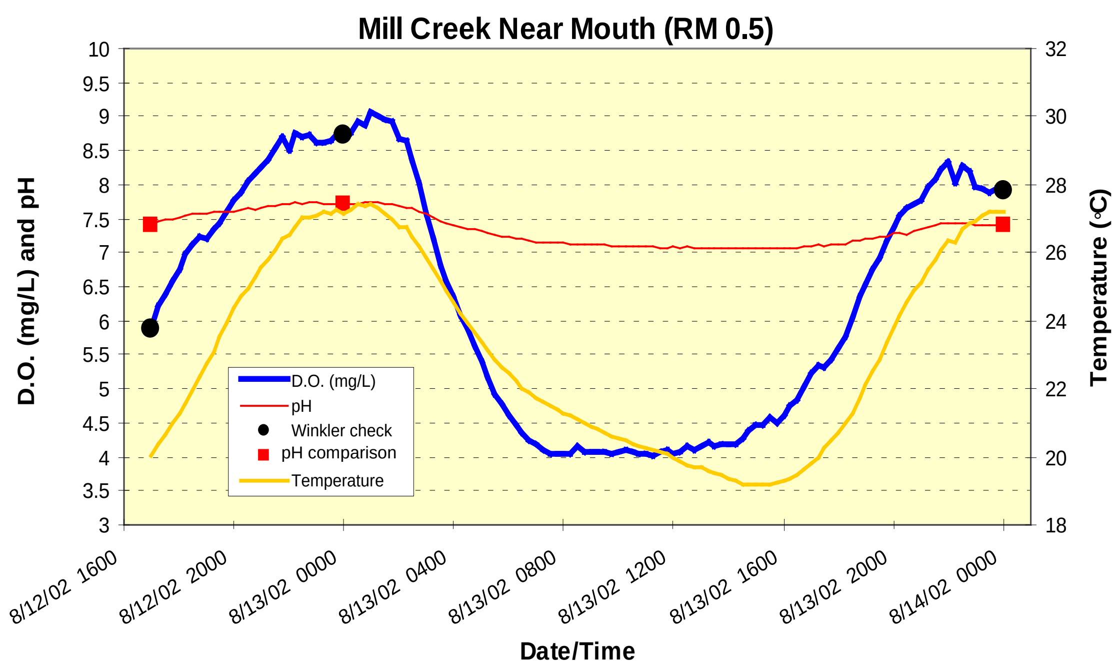


Figure H-2. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Mill Creek, August 12-15, 2002

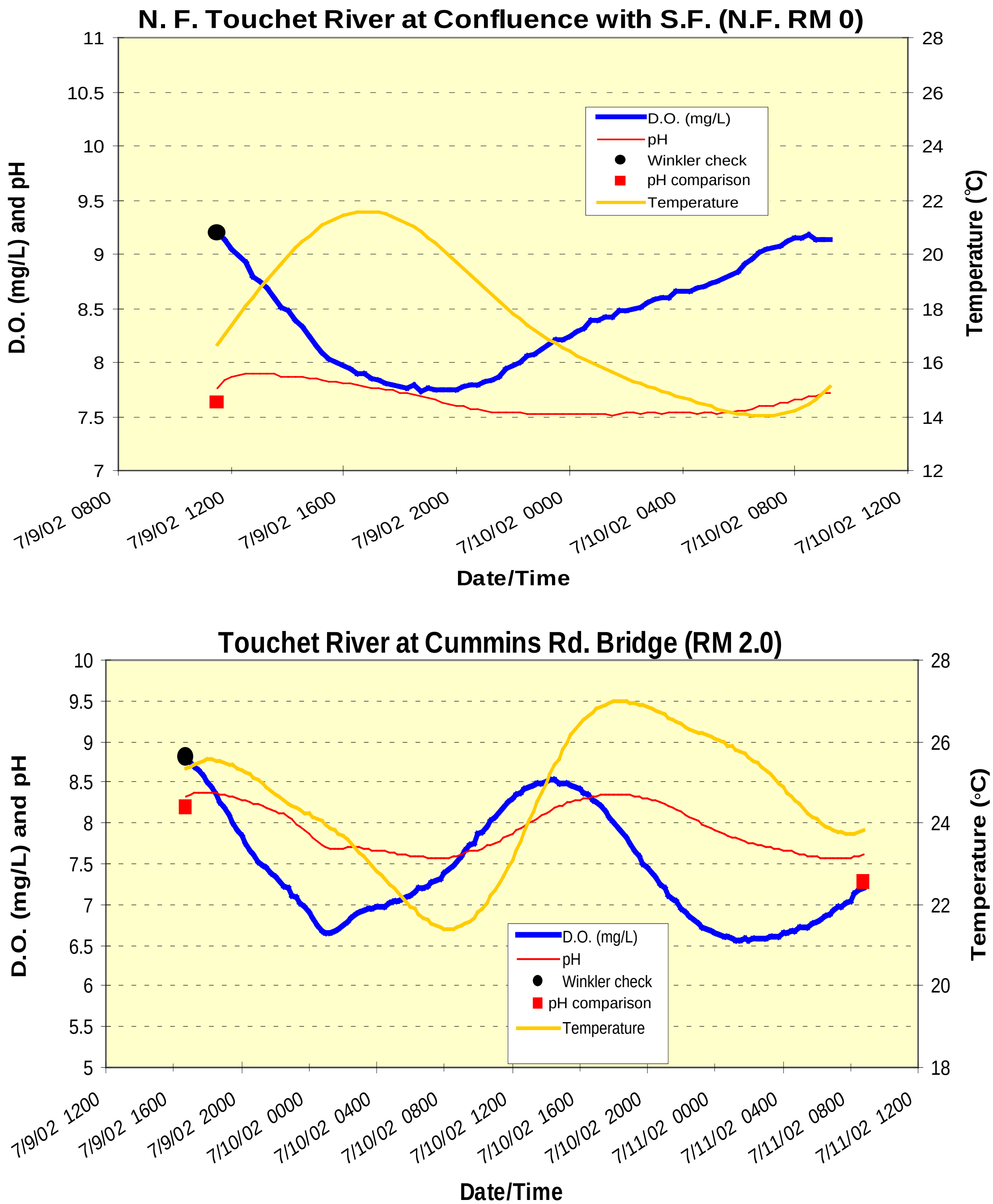
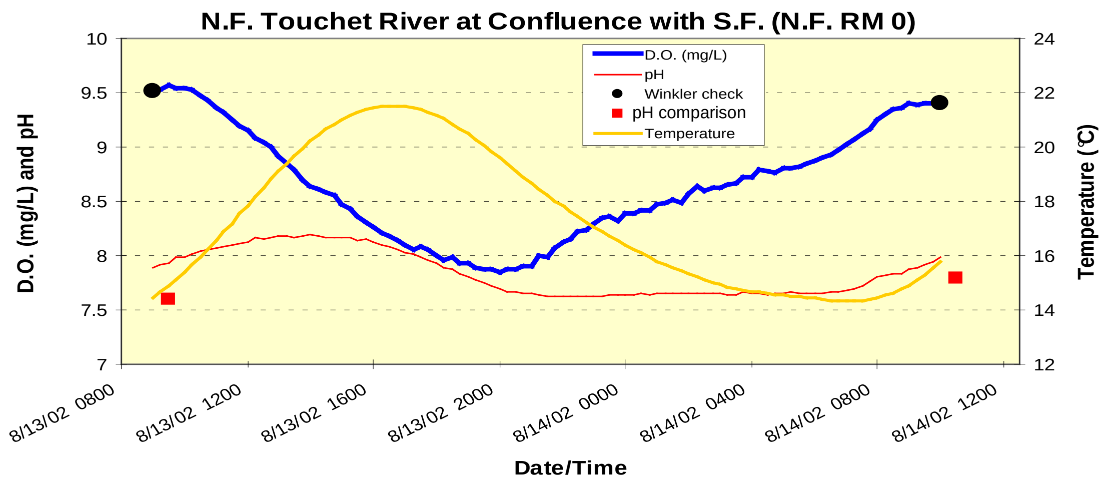
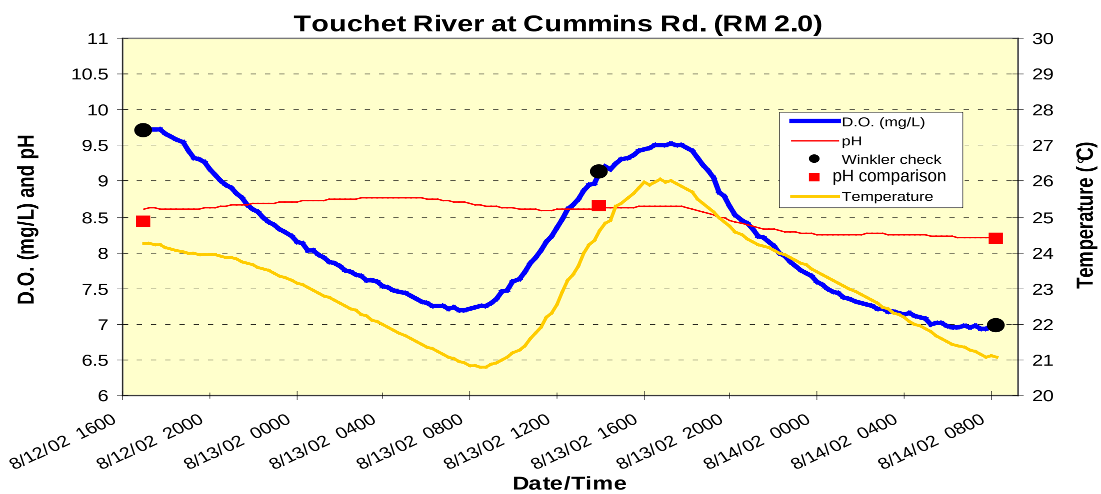


Figure H-3. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Touchet River, July 9-11, 2002





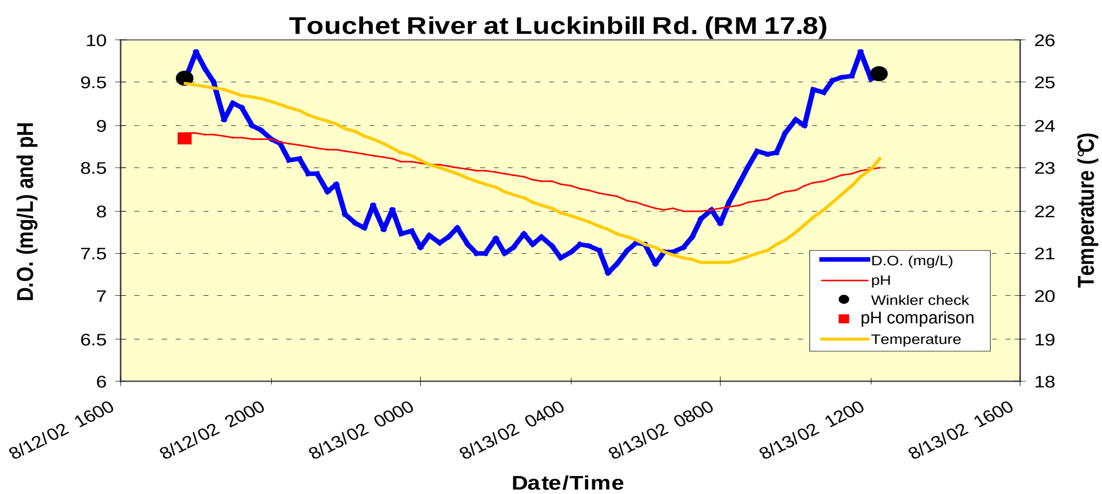
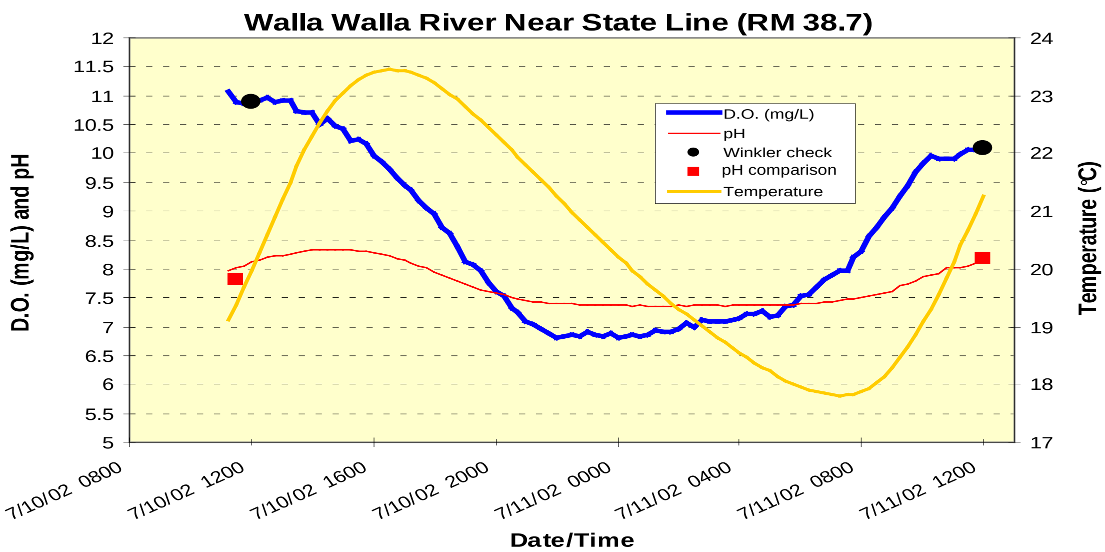


Figure H-4. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Touchet River, August 12-14, 2002



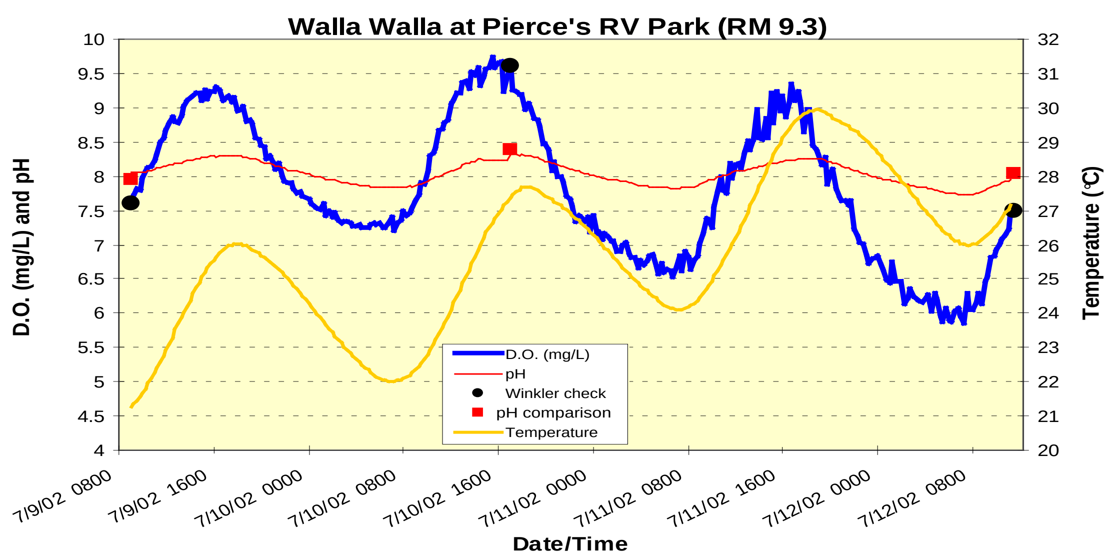


Figure H-5. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in the Walla Walla River, August 9-12, 2002

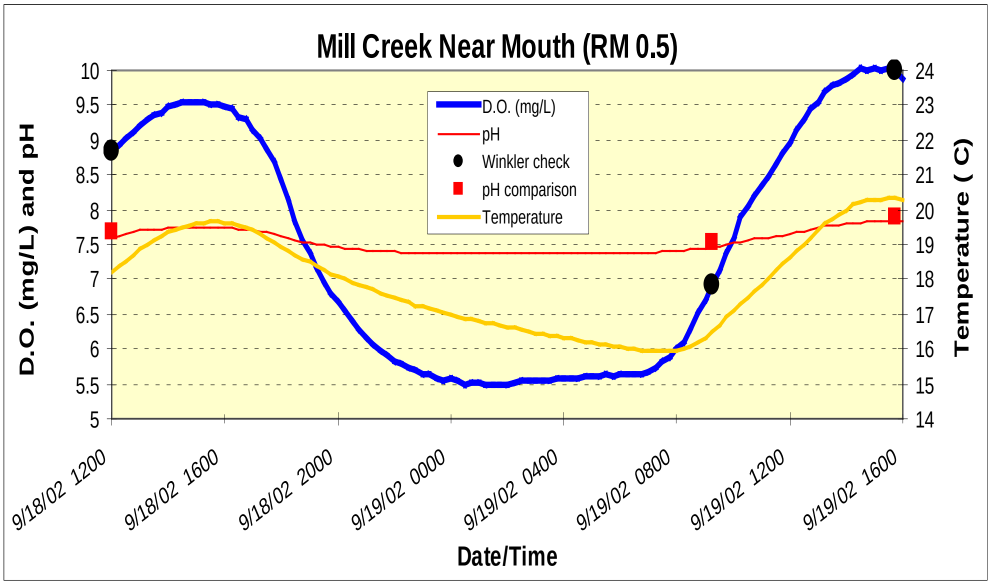
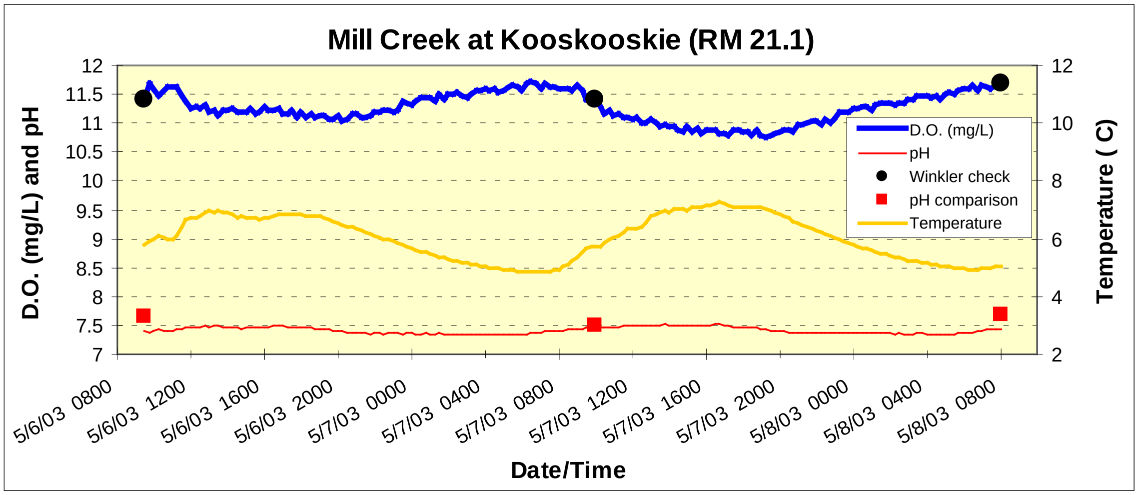
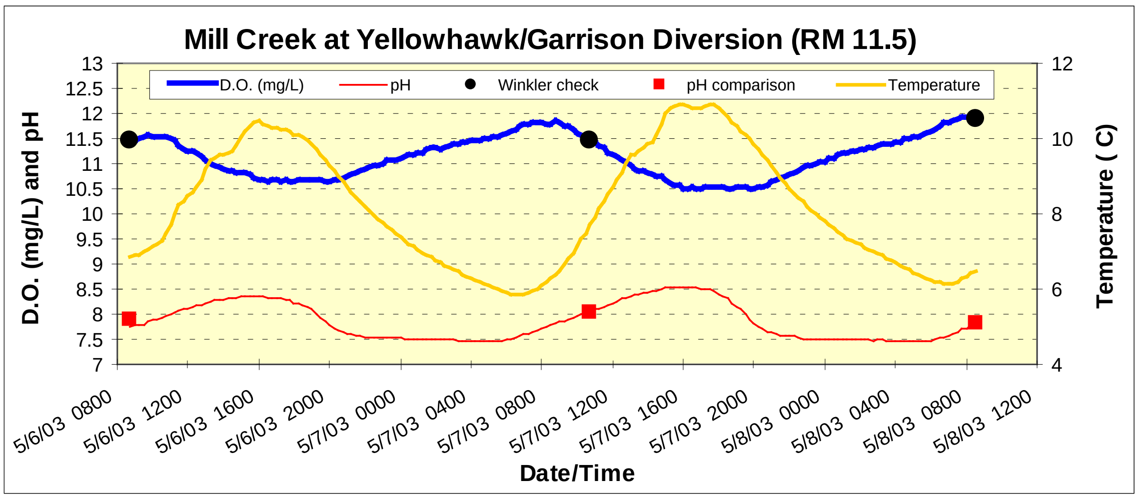


Figure H-6. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Mill Creek, August 12-15, 2002





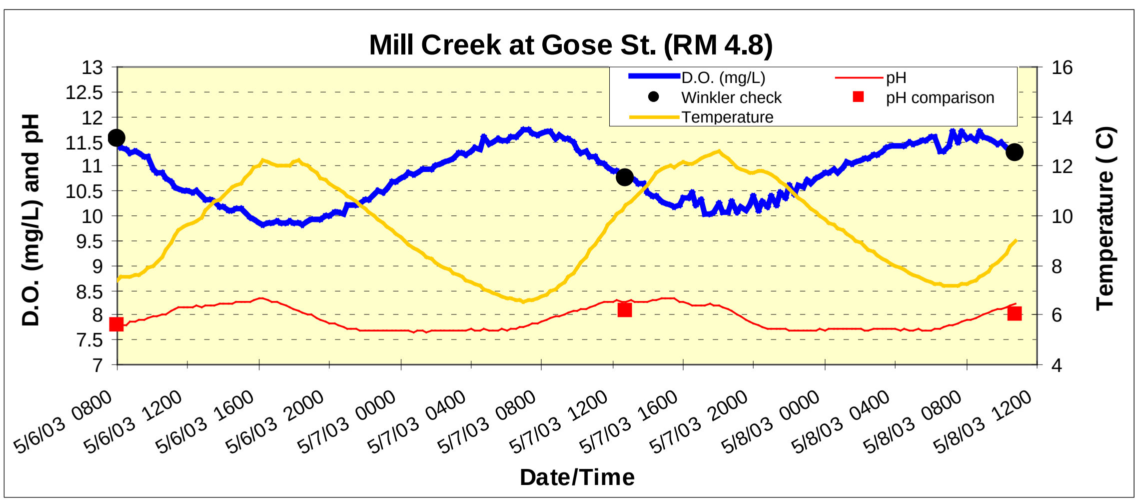
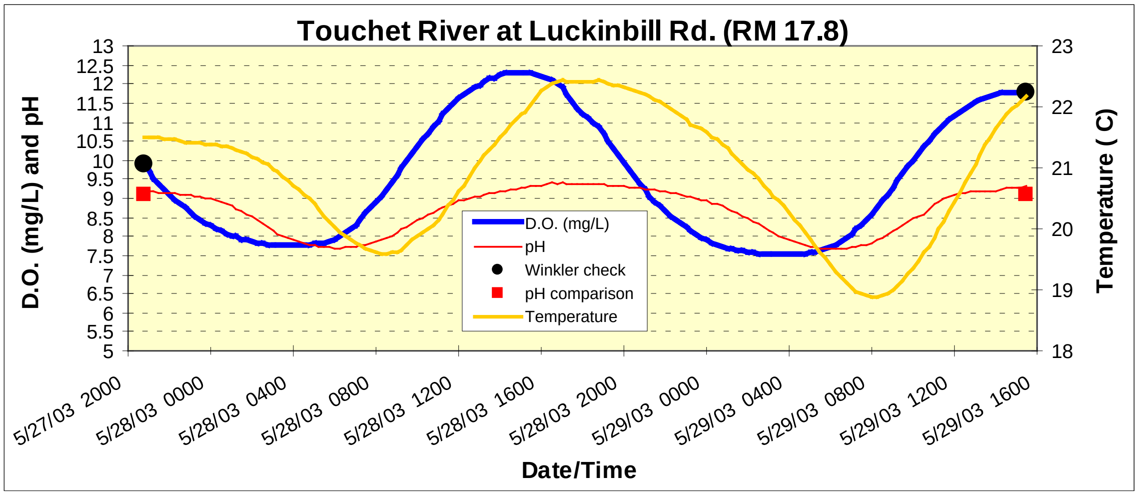


Figure H-7. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Mill Creek, May 6-8, 2003.



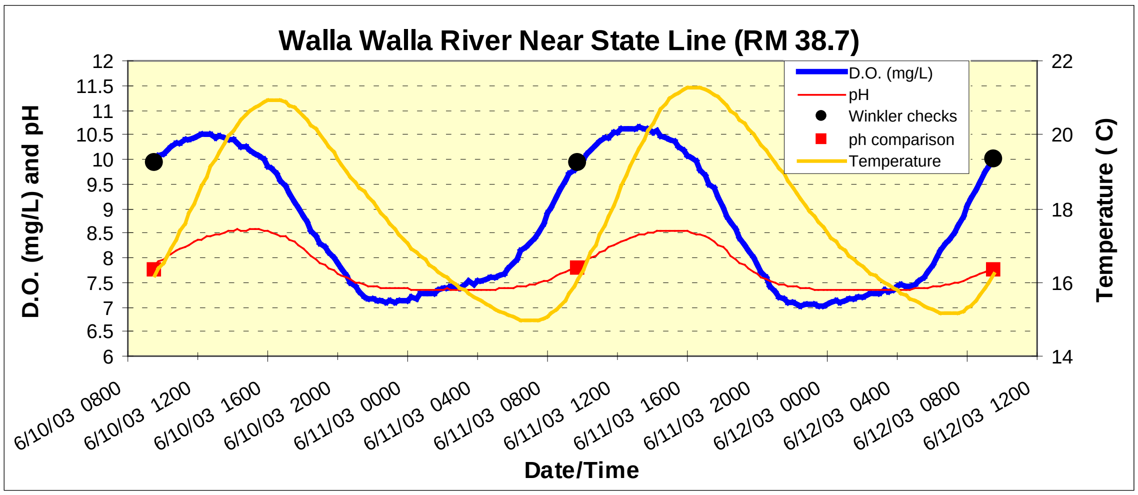


Figure H-8. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in the Walla Walla and Touchet Rivers, May and June, 2003.

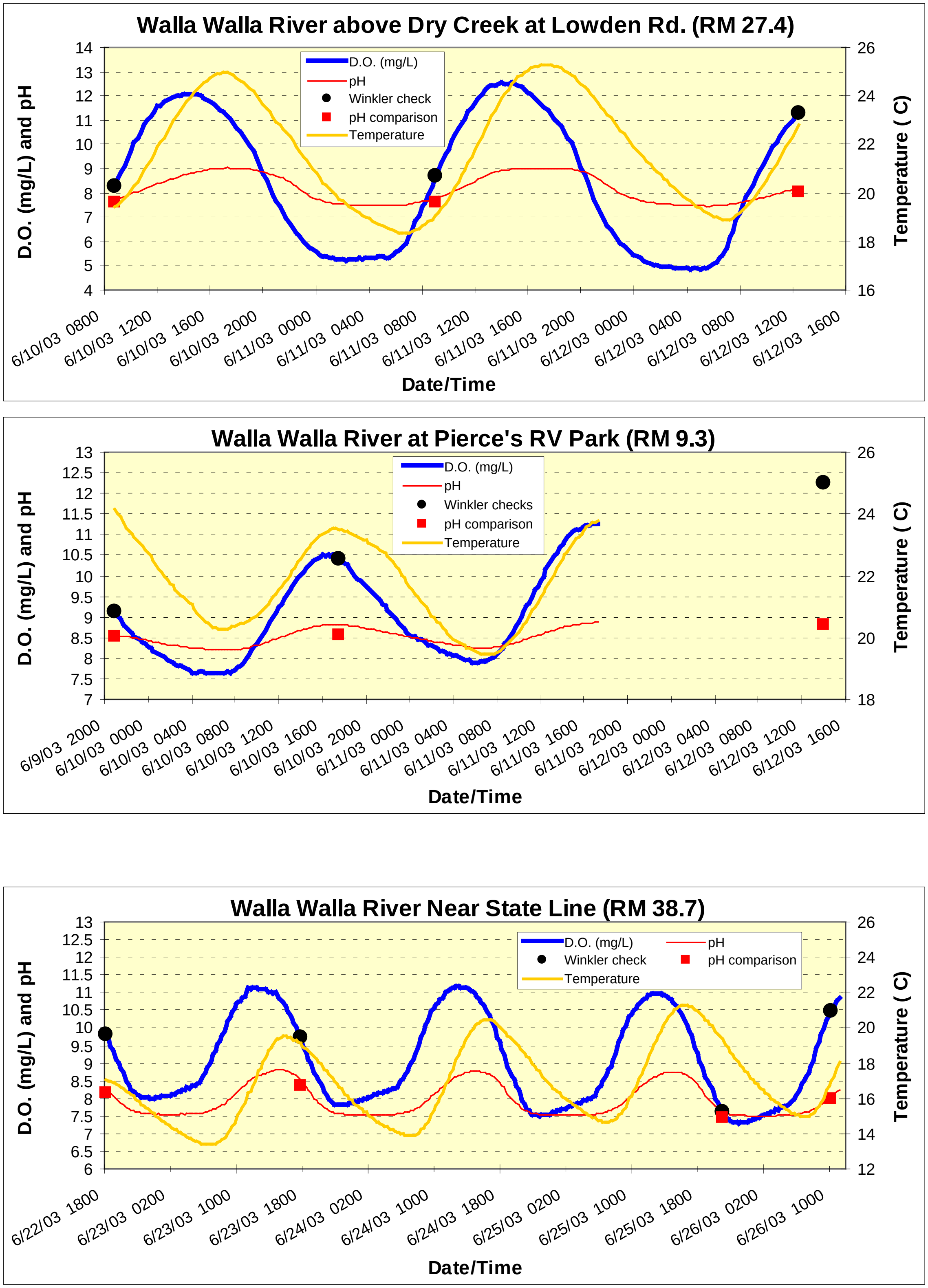
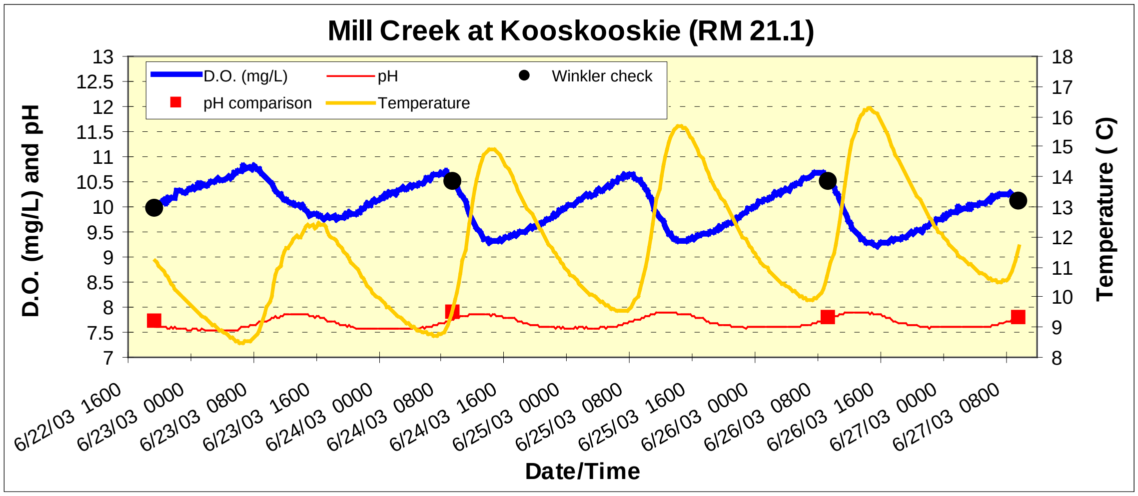


Figure H-9. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in the Walla Walla River, June 2003.



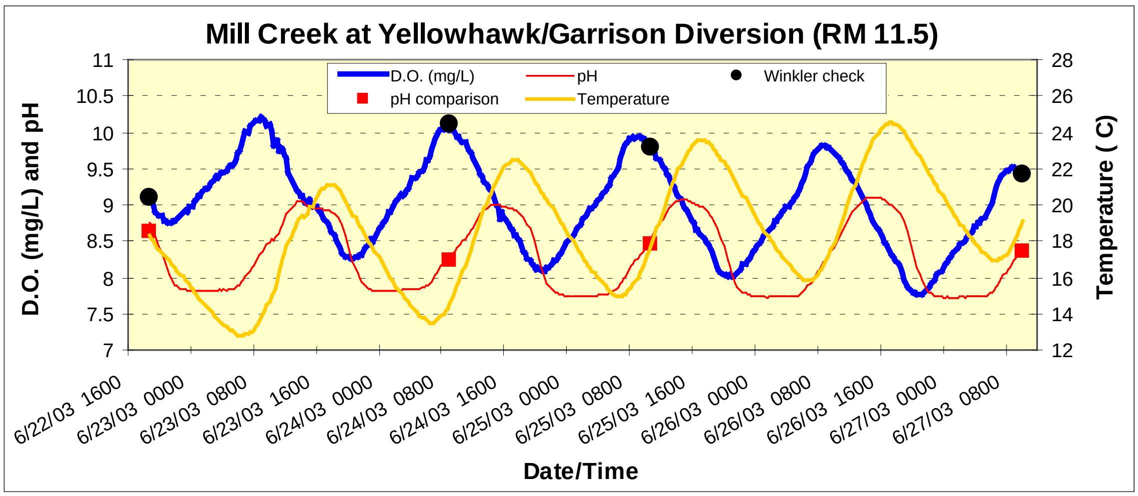


Figure H-10. Continuous measurements (every 15 minutes) of dissolved oxygen (D.O.), pH, and temperature in Mill Creek, June 22-27, 2003.

Appendix I. Record of Public Participation

Summary of comments and responses

Comment:

WALLA WALLA COUNTY
WATERSHED PLANNING
310 W. Poplar -Suite 201 -Walla Walla, WA 99362-2865
Telephone (509) 524-2645 • FAX (509) 524-2630

MAY 15 2007

May 11, 2007

Ms. Karin Baldwin, Water Quality Program
Washington State Department of Ecology, Eastern Regional Office
4601 N Monroe Street
Spokane, WA 99205-1295

Dear Ms. Baldwin:

The Walla Walla Watershed Planning Unit (PU), after being informed by members of the Water Quality Subcommittee concerning the draft Water Quality Improvement Report for pH and Dissolved Oxygen (DO), submits the following comments for the public comment period ending May 21, 2007 on behalf of the PU

The feasibility of the 10 year schedule for achieving water quality standards on page 142, Table 20 of the report is questioned. The PU while acknowledging certain precedents in regards to pH and DO scheduling at the Federal and State level considers a 50 year timeline similar to that used in the Temperature report to be more technically feasible than the proposed 10 year timeline due to their interrelated nature.

If you have any questions concerning this comment please contact Matt Rajnus, Walla Walla County Watershed Planning Project Coordinator, at (509) 524-2647 or via email at mrajnus@co.walla-walla.wa.us.

Sincerely,

Hal Thomas
WRIA 32 Planning Unit Co-Chair
Walla Walla County

Eric Myers
WRIA 32 Planning Unit Co-Chair
Columbia County

cc: Walla Walla Water Quality Subcommittee (electronic)

Response:

Thank you for commenting. While it is true that cooler water contains more dissolved oxygen, data shows the low dissolved oxygen and high pH levels in the Walla Walla watershed are a result of abundant aquatic vegetation taking oxygen out of the water at night, and increasing pH levels during the day. So, to decrease the amount of aquatic vegetation it is necessary to reduce nutrients. Ten years should be enough time to see increased dissolved oxygen and reduced pH levels by substantially cutting down on nutrient loads from point and diffuse sources.

Minimizing aquatic vegetation growth by decreasing the amount of nutrients will take much less time to achieve than growing a tree to produce the greatest amount of shade possible. The temperature TMDL has a 50 year timeline because it will take that many years for a tree to become full-grown and produce the maximum amount of shade. However, many planting projects are showing significant improvements within the first 10 years in creating shade, taking up subsurface nutrients, and reducing light used by aquatic vegetation for growth. We expect that trees planted today will show great benefit in 10 to 20 years (although it takes 50 years for the trees to grow to full size). So, the shade that will be produced in 10 years will help to meet the water quality standards for dissolved oxygen and pH if nutrient loads are also reduced.

The 10 year timeframe of the pH and dissolved oxygen TMDL will help wastewater treatment plants meet water quality standards. Area wastewater treatment plants by rule have 10 years to comply with water quality standards. Wastewater treatment plants discharging to surface waters that do not meet water quality standards are severely limited because their permits are based on all nutrient loads discharged by watershed residents. Identification and elimination of diffuse (nonpoint) sources of nutrients may improve dissolved oxygen and pH enough to allow wastewater treatment plants more flexibility to meet water quality standards. This flexibility can ultimately reduce expenses of city rate payers.

Comment:

From: Bob Hutchens 20 May 2007
Member Walla Walla Watershed Planning Unit
Member Columbia/Blue Mountain Counties Farm Bureau
142 Fullerton Road
Dayton, WA 99328

Ms. Karin Baldwin, Water Quality Program
Washington State Department of Ecology, Eastern Regional Office
4601 N. Monroe Street
Spokane, WA 99205-1295

Dear Karin,

I am submitting the following comments as input to the ph-Dissolved Oxygen and Temperature TMDL proposals by the Washington State Department of Ecology. Also, I am submitting the following comments as an individual and for the Columbia/Blue Mountain Counties Farm Bureau, which by motion, endorsed this letter.

I know that DOE is doing what it is called to do by the Environmental Protection Agency by setting TMDL goals and describing ways of reaching those goals. The methods, which the proposal describes for reaching ph-Dissolved Oxygen and Temperature goals, are where I believe that there is a problem. The Detailed Implementation Plan described in the proposal includes, for upland agricultural management, Best Management Practices as a means of reaching goals. Herein lies the problem. Best Management Practices were developed under a completely different set of circumstances than the present demand by DOE/EPA to reach acceptable TMDL goals for our water resources. Best Management Practices had at least 3 criteria to be considered for adoption. They were: 1. Economically feasible; 2. Socially acceptable; and 3. They had to be effective. Currently farmers are using BMP's to the extent they are comfortable and to the extent that they satisfy the National Resource Conservation Service conservation demands. I feel that the NRCS demands for conservation is nowhere near as stringent as the demands of DOE/EPA. So I see farmers and EPA on a collision course. It will eventually need to be clearly defined for the agricultural industry, which set of regulations will prevail, EPA or USDA. EPA needs to consult with USDA NRCS and really study what the TMDL could do to conservation compliance demands. Then they need to consider the criteria for BMP's, and, if they are a reasonable route to use to reach TMDL goals.

I suspect that your response to this concern will be that the BMP approach should be attempted first, see how effective they are, then reassess the issue. But I say the BMP approach has, by definition, already been put in place and will not do much more to move dryland farming practices in the direction DOE/EPA wants them to go.

So what do I suggest? Probably the most logical approach, because there is already an effort underway, is to see that the USDA Conservation Security Program be implemented nation-wide, not just on a watershed-by-watershed basis. The basin by basin approach creates some serious injustices and imbalances in the agricultural community. EPA should consider supporting this approach if they hope to reach their TMDL goals, short of direct regulation. Regulation will cause prescription farming, and conservation farming is far too complex to be well served by such an approach.

Most importantly to me, is that DOE/EPA is aware, that in my opinion the current proposal does not include the necessary elements for TMDL proposal success, and that the agricultural community is not particularly aware of the potential expectations that may be placed on them by EPA in the near future, regardless of the NRCS demands.

Thank you for accepting my input.

Sincerely,

Bob Hutchens
Member, WIRA 32 Planning Unit and
Member, WIRA 32 Water Quality Committee
Member Columbia/Blue Mountain Counties Farm Bureau

Response:

Thank you for submitting a comment. You are correct; according to the Natural Conservation Resources Service (NRCS) conservation compliance requirements from the Food Security Act were not established to meet TMDLs or any other water quality regulation. The conservation practices are designed to fit the producer's needs while still meeting multiple resource concerns. The inability of NRCS' requirements to achieve water quality standards was discussed at a recent national TMDL meeting.

In the Walla Walla watershed, there are several farmers in the watershed who may be applying a specific best management practice (BMP), but could apply additional BMPs to protect water quality. So at this local level we have an opportunity to be a model for the nation. The Water Quality Subcommittee can work with the Department of Ecology (Ecology), local NRCS and conservation districts to promote upland BMPs, such as direct seeding, that will protect water quality. When the Water Quality Subcommittee begins writing the Water Quality Implementation Plan, strategies to inform and educate farmers and more specific upland BMPs that will improve water quality can be included. Ecology is interested in promoting BMPs that will help make the TMDL successful and we will work with the NRCS, other agencies and local growers to achieve the TMDL targets. Participation and involvement in NRCS' Local Work Groups is one of the ways Ecology and watershed residents can work with NRCS.

Comment:

CITY OF
DAYTON

May 16, 2007

MAY 21 2007

Washington State Department of Ecology
4601 North Monroe Street
Spokane, WA 99205-1295

Attn: Ms Karin Baldwin

RE: Comments on Proposed TMDLs for Walla Walla River Basin

Dear Karin:

We appreciated your attendance and that of Richard Koch and Pat McGuire of the Washington State Department of Ecology at the City of Dayton's Council meeting of May 14, 2007. Your presentation and the ensuing discussion of the proposed total maximum daily loads (TMDLs) for dissolved oxygen, pH, and temperature in the Walla Walla River Basin and its potential impact to the City were informative and helpful to the Council in gaining a better understanding of the proposed rules. From your presentation, we foresee the proposed TMDLs and associated wasteload allocation (WLA) for nitrogen on the Dayton's wastewater treatment plant (WWTP) effluent will present the City with significant challenges. The City is submitting the following comments on the proposed TMDLs in the Walla Walla River Basin for consideration by the Department

1. While the City understands that its WWTP effluent discharge is a point source for nutrients in the River and will likely be required to reduce this loading, we believe that additional monitoring (referred to as interim monitoring in the TMDL study) is needed to determine and better assess upstream nutrient sources. One of the conclusions of the modeling of the Touchet River is that nutrient loads from non-point sources in the headwaters must be reduced. TMDL monitoring and modeling thus far has been limited to downstream of the confluences of the North and South Fork of the River. Additional monitoring upstream of the confluence of the North and South Forks and of Patit Creek may identify areas with significant nutrient loading to the River or Creek.

2. The City will not be able to comply with the proposed 0.28 lb/day of DIN (dissolved inorganic nitrogen) in the WWTP effluent discharge to the creek due to technological and cost constraints. As such, the proposed rules will force the City to redirect its WWTP effluent, between May and October, to either land application or water reuse. The City is not sure whether the benefits of removing its WWTP effluent discharge to the River during the driest part of the year will be significant or evident as WWTP diversion will reduce stream flow and will not likely result in water quality criteria to be attained in the River near Dayton which was predicted by the Department's modeling.

We appreciate the opportunity to comment on the proposed TMDLs for the Walla Walla River Basin.

Sincerely,

Craig George
Mayor Pro-Tem
City of Dayton

Response:

Thank you for commenting on the TMDLs. The Department of Ecology (Ecology) agrees there is a need for additional monitoring for nutrient sources through and upstream of the City of Dayton on the North, South and Wolf Forks of the Touchet River. Ecology has requested that our Environmental Assessment Program conduct an intensive study to identify nutrient sources in the area. The study has been conditionally approved for funding during the next fiscal year (July 2007 through June 2008). As more information becomes available, Ecology staff will contact the city. If resources allow, Ecology may be able to take samples above the confluence of the North and South forks of the Touchet River. There may be other organizations that can monitor these areas as well.

Removing the treatment plant's nutrient load from May through October is necessary to improve water quality in the Touchet River. When Ecology modeled low flow conditions we found that in order for increasing stream flow to improve water quality, nutrients had to be reduced and shade had to be added. From May through October, the City's wastewater treatment plant discharges an average maximum of about half of a cubic foot per second (0.5 cfs), or about 1% of the flow. Monitoring data shows that the effluent doubles the amount of phosphorus and triples the amount of nitrogen in the river during low flow. The nutrient load greatly contributes to pH and dissolved oxygen problems downstream.

If the city chooses to go to Water Reuse, the city may have to complete a water rights impairment analysis and mitigate for the water removed from the stream. Ecology will continue to work with the City on finding economical approaches to alleviate the negative impact of the effluent on the Touchet River.

Comment:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
OREGON OPERATIONS OFFICE
811 S.W. 6th Avenue
Portland, Oregon 97204

Reply To
Attn Of: OOO

May 21, 2007

Ms. Karin Baldwin
Washington Dept of Ecology
4601 N Monroe Street,
Spokane, WA 99205

Dear Ms. Baldwin:

Following are the Environmental Protection Agency's (EPA) comments on the draft Walla Walla River pH and Dissolved Oxygen and Temperature Total Maximum Daily Load (TMDL) Submittal Reports which were both released for public comment on April 17, 2007.

These draft documents present TMDLs for the Walla Walla Subbasin and the analysis utilized in developing the TMDLs. In general, EPA finds the information presented in the TMDLs to be presented in a clear and complete format and inclusive of all the statutory and regulatory components required of TMDLs. The following comments provide some suggestions on minor changes which would clarify the TMDL.

EPA wishes to acknowledge the excellent work presented in the TMDL. In developing these TMDLs, Ecology did an excellent job of presenting a complicated array of information and compiling it so that quantitative loading capacity could be established.

Following are comments on specific elements of the TMDLs:

Temperature TMDL

p. 57 – Load Allocations; Figure 24, Predicted daily maximum water temperatures in the Touchet River for critical conditions during July-August 7Q2 and 7Q10:

This figure does not depict the effects of holding the Dayton WWTP to a 18 degree Celsius effluent limit. It only shows scenarios where this and another change are made so that it is difficult to determine the impact this facility is having on stream temperature by itself. It appears as though the effluent effect is significant, though this may be a combined effect with excessive stream width in the same area of the river. It would be more informative to have a separate line in the graph for the scenario in which the treatment plant effluent is reduced to 18 degrees Celsius.

p. 61 - Load Allocations

Load allocations of system potential shade are given for Walla Walla River tributaries below the National Forest Boundary and downstream of the Mill Creek Diversion. Reaches upstream of the diversion are in compliance with the current water quality standards and not given allocations for this reason. However the text mentions that temperatures in reaches of Mill Creek upstream of the diversion exceed the numeric criteria for bull trout that are part of the new water quality standards that have not yet been approved by EPA. These reaches are given no allocation and will be considered impaired waters not covered by a TMDL if Washington's revised water quality standards are approved by EPA. This could be addressed by assigning system potential vegetation allocations to these reached in this TMDL. In addition, giving system potential vegetation allocations in the upper reaches of Mill Creek would help attain the dissolved oxygen and pH criteria in those reaches.

No mention is made in the text of why stream reaches above the Forest Boundary are not given load allocations but it would be helpful to explain that here. If data collected in these reaches in the future indicated impairment, these reaches would require a TMDL. This could be avoided if this TMDL assigned these reaches system potential shade load allocations.

Figure 28 states that the load allocations apply to all perennial streams. In the Walla Walla Subbasin there are streams that go dry because of water diversions. This used to be the case with the Walla Walla River mainstem due to withdrawals in Oregon. It would be good to clarify that the term "perennial" here refers only to streams that are intermittent under natural flow conditions.

p.68 - 69 – Conclusions and Recommendations

Several bullet points on page 69 seem to imply that channel width load allocations have been assigned to reaches of the Touchet River, but the Load Allocation section of the document does not specify these types of allocations. Please clarify.

Bullet 4 on page 68 states that reductions of the widest reaches of the Touchet River will result in little reduction of stream temperature, because the channel is still difficult to shade. Reductions in stream width can provide benefits other than shade that reduce stream temperature, such as reconnection to the hyporheic zone.

p. 82 – Mainstem; Results and Discussion; Figure 34, Existing and Simulated temperature profiles for an afternoon in August

It is difficult to understand this figure. It was a color figure originally, and in black and white it is not possible to tell which lines represent which model scenarios.

Dissolved Oxygen and pH TMDL

p.119 – 120 – Load Allocations; Walla Walla River and Minor Tributaries
Dry Creek is listed on the 303(d) list as impaired for dissolved oxygen. There do not appear to be allocations to address the impairment in this waterbody. The TMDL states that it will be addressing impairment in Dry Creek. Please clarify what allocations have been set for this waterbody.

p. 120 – Wasteload Allocations
The last sentence of the first paragraph uses the wording "as soon as it can be achieved" in referring to diversion of the Walla Walla and College Place WWTP discharges from the stream during the May through October critical season. If these facilities are currently discharging to the impaired waters in the critical season they will need to receive allocations in the TMDL. If they are not, this should be stated clearly here.

It would be helpful to state the season in which the Dayton WWTP wasteload allocations apply here.

CONCLUSION

We commend you for the efforts you have made to date and look forward to the submittal of the final TMDLs in the near future. If you have any questions regarding comments on the draft TMDLs, please contact me at (503)326-3280.

Sincerely,

Helen Rueda
TMDL Project Manager

Cc:
Dave Croxton, EPA
Laurie Mann, EPA

Response:

Thank you for your comments. Please see the responses to your comments below:

Temperature TMDL:

Pg. 57 - Figure 24: This figure was used to calculate the system potential condition, so discharge from the Dayton wastewater treatment plant is not included. The legend item saying Dayton 18 ^{o}C, means that water being delivered to the beginning of the model segment in Dayton is coming in at 18 ^{o}C. Therefore, the figure represents the South and North forks of the Touchet River delivering water at 18 ^{o}C. The Dayton wastewater treatment plant is dealt with in the point source section. A clarifying statement has been added to the text after the figure's reference.

Pg. 61 – Load Allocations: The City of Walla Walla's diversion dam in Mill Creek is located in Oregon. Upstream of the diversion dam, Mill Creek in Washington State is within the Umatilla National Forest. (All of the area above the diversion dam is protected as a municipal watershed.) The Department of Ecology (Ecology) is completing TMDLs on federal lands separate from private and state owned lands. We intend to complete a TMDL for the Umatilla National Forest in the future. Therefore, any water quality impairments located on the Umatilla National Forest will be addressed by another TMDL. However, because the Umatilla National Forest is interested in addressing water quality impairments watershed by watershed, Forest Service staff are participating on the Water Quality Subcommittee for this TMDL and are working to improve water quality.

Figure 28 on page 61 does apply to perennial streams that go dry part of the year due to withdrawals. The definition of perennial will be relocated earlier in the paragraph that references Figure 28 to clarify which streams have load allocations.

Pg. 68-69 – Conclusions and Recommendations: Channel width load allocations were not assigned. However, narrower channel widths were modeled for those stream segments that could potentially narrow as riparian vegetation and processes are restored. As sediment is trapped by riparian vegetation, streambanks are built, allowing vegetation to become established closer to the stream, thereby narrowing the stream channel. The surface area of the stream is also reduced, allowing for less solar radiation to hit the stream. So, channel width reductions result in higher "effective shade" load allocations, which is the reason for modeling narrower stream widths. Under the Load Allocation section on page 61, the last paragraph was revised to state that channel width reductions were considered in the effective shade allocations.

You are correct, narrower stream channels do provide benefits other than shade. A discussion of these other benefits such as reconnection to the hyporheic zone and increased channel complexity is found under the 'Overview of stream heating processes' section. However, at this time, our models can not estimate the temperature effects of reconnection with the hyporheic zone with enough accuracy to report it as a number in TMDLs.

Pg. 82 – Figure 34: Ecology will have the figure printed in color for the final report.

Dissolved Oxygen and pH TMDL:

Pg. 119-120 - Load Allocations: Walla Walla River and Minor Tributaries: The last paragraph on page 119 states that "Diffuse and groundwater nutrient sources to Dry Creek, Mud Creek…need to be reduced as much as possible to state line concentrations." We will rearrange this section so that these load allocations are more easily found.

Pg. 120 – Wasteload Allocations: We will clarify the wasteload allocations for the College Place and Walla Walla wastewater treatment plants and delete "as soon as it can be achieved." We will also state the season in which the Dayton wastewater treatment plant wasteload allocations apply.