CHAPTER 4

UMPQUA BASIN

ALGAE/AQUATIC WEEDS, DISSOLVED OXYGEN AND PH TMDL

Prepared by

DEQ

State of Oregon
Department of
Environmental
Quality

Table of Contents

TMDL COMPONENTS TABLES

Each table below summarizes the components that make up a Total Maximum Daily Load for Umpqua Basin streams on the 303(d) list for Dissolved Oxygen, pH or both:

Table 4.1 Calapooya Creek Dissolved Oxygen (DO) and pH TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Calapooya Creek, HUC (Hydrologic Unit Code) 1710030301, within the 4th field HUC 17100303 (Mainstem Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Increased algal biomass resulting from inorganic phosphorus loading and increases in stream temperature, channel modifications and near stream vegetation disturbance/removal. Organic solids which settle and cause a sediment oxygen demand.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016, 0021, 0007(2)** *CWA §303(d)(1)*	**Dissolved Oxygen:** For the summer period, the daily average target is 8.0 mg/L with an absolute minimum of 6.0 mg/L **pH:** The target is no measurable increase over natural conditions or 8.5, whichever is greater.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Wastewater treatment plants; runoff from forestry, agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	**Dissolved Oxygen:** Critical dissolved oxygen levels on Calapooya Creek have occurred during the late summer and fall periods, when stream flows are at a minimum. **pH:** Critical pH levels in Calapooya Creek have occurred during the late summer. The TMDL addresses period between May 16th and October 14th.
TMDL Loading Capacity **OAR 340-042-0040(4)(d)&(e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The loading capacity for both dissolved oxygen and pH was determined using continuous data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g)& (h)** *40 CFR 130.2(f), (g) & (h)*	The TMDL is divided into allocations to point sources (wasteload allocations), nonpoint sources (load allocations), and a margin of safety: Wasteload Allocations (Point Sources): 0 lbs of phosphorus per day between June 1 and October 31 (no existing, permitted WWTP discharge). Load Allocations (Nonpoint Sources): 0.7 lbs / day of inorganic phosphorus and 1.0 lbs/day of total phosphorus between June 1 and October 31, 67% year round decrease in volatile solids loading addressed through the implementation of Bacteria TMDL and heat load allocations from the Temperature TMDL.
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL: 1.7 lbs / day of inorganic phosphorus and 1.9 lbs / day of total phosphorus. Current volatile solids load is 200% more than the loading capacity. For excess heat load, see Temperature TMDL.
Margins of Safety *CWA §303(d)(1)* **OAR 340-042-0040(4)(i)**	Implicit through conservative assumptions in analysis.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Variable throughout the system and dependent on duration, magnitude and frequency. Additional sources may discharge phosphorus and/or volatile solids if loading analysis shows that they will not cause a measurable decrease DO or increase pH concentrations.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of pH and dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with the NPDES[1] permit process for wastewater treatment plants.

[1] NPDES stands for National Pollutant Discharge Elimination System, and is the name of the Clean Water Act permit program which applies to wastewater treatment plants and other facilities which discharge directly to state waters. It also applies to certain stormwater permits.

Table 4.2 Elk Creek Dissolved Oxygen TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Elk Creek, HUC (Hydrologic Unit Code) 1710030304, within the 4th field HUC 17100303 (Mainstem Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Organic solids which settle and cause a sediment oxygen demand.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016, 0021, 0007(2)** *CWA §303(d)(1)*	**Dissolved Oxygen:** For the summer period, the daily average target is 8.0 mg/L with an absolute minimum of 6.0 mg/L **pH:** The target is no measurable increase over natural conditions or 8.5, whichever is greater.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Wastewater treatment plants; runoff from forestry, agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	Critical dissolved oxygen levels on Calapooya Creek have occurred during the late summer and fall periods, when stream flows are at a minimum. The TMDL addresses period between May 16th and October 14th.
TMDL Loading Capacity **OAR 340-042-0040(4)(d)& (e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The loading capacity for dissolved oxygen was determined using continuous data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g) & (h)** *40 CFR 130.2(f), (g) &(h)*	The TMDL is divided into allocations to point sources (wasteload allocations), nonpoint sources (load allocations), and a margin of safety for *Waste Wasteload Allocations (Point Sources):*.Elimination of sewage overflows. *Load Allocations (Nonpoint Sources)*: 40% reduction of organic solids.
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL. Current volatile solids load is 67% more than the loading capacity.
Margins of Safety *CWA §303(d)(1)* **OAR 340-042-0040(4)(i)**	Implicit through conservative assumptions.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Variable throughout the system and dependent on duration, magnitude and frequency. Additional sources may discharge phosphorus and/or volatile solids if loading analysis shows that they will not cause a measurable decrease DO or increase pH concentrations.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with the NPDES permit process for wastewater treatment plants.

Table 4.3 Deer Creek Dissolved Oxygen TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Deer Creek, HUC (Hydrologic Unit Code) 1710030213, within the 4th field HUC 17100302 (South Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Biochemical oxygen demand (BOD)
Beneficial Uses **OAR 34-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016** *CWA §303(d)(1)*	**Dissolved Oxygen:** OAR 340-041-0016; For the spawning period (October 15 to May 15), the target is the applicable cold water criterion of 11.0 mg/l.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Runoff from forestry, agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	**Dissolved Oxygen:** Critical dissolved oxygen levels on Deer Creek have occurred during the spawning period. There is insufficient data to determine whether Deer Creek is meeting the DO standard during the non-spawning time period. The TMDL addresses period between October 15th and May 15th.
TMDL Loading Capacity **OAR 340-042-0040(4)(d) & (e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The loading capacity is the load equivalent to the instream concentration of 0.7 mg/L of BOD.
Allocations **OAR 340-042-0040(4)(g) & (h)** *40 CFR 130.2(f), (g) & (h)*	*Wasteload Allocation:* There are no WWTPs and other NPDES sources are allocated no increase to instream BOD concentrations. *Load Allocations (Nonpoint Sources)*: 50% reduction in BOD loading.
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL. Current BOD load is 100% more than the loading capacity.
Margins of Safety **OAR 340-042-0040(4)(i)** *CWA §303(d)(1)*	Dissolved oxygen: Explicit (.4 mg/l of DO);
Reserve Capacity **OAR 340-042-0040(4)(k)**	BOD load that causes no measurable reduction in DO concentrations.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Empirical analysis of TMDL loading capacities demonstrates attainment of dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards.

Table 4.4 Jackson and Black Canyon Creeks pH TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Jackson and Black Canyon Creeks, HUC (Hydrologic Unit Code) 1710030202, within the 4th field HUC 17100302 (South Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Increased algal biomass resulting from inorganic nitrogen and phosphorus loading and increases in stream temperature, channel modifications and near stream vegetation disturbance/removal.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0021, 0007(2)** *CWA §303(d)(1)*	The pH target is no measurable increase above 8.5 Standard Units (S.U.) or the naturally occurring pH which ever greater.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Nonpoint sources include excessive inputs of solar radiation because of streamside vegetation removal or reduction and anthropogenic channel degradation. No anthropogenic sources of nutrients were identified. Point sources: none.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	Critical pH levels in Jackson Creek have occurred during the late summer. The TMDL addresses period between June 16th and August 31st.
TMDL Loading Capacity **OAR 340-042-0040(4)(d)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The nutrient and heat loading capacity relating to pH was determined using continuous monitoring data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g)&(h)** *40 CFR 130.2(f), (g) and (h)*	Load Allocations (Nonpoint Sources): Natural background nutrient loads and heat loads are the targeted load allocation (see Temperature TMDL). Wasteload Allocations (Point Sources): none, no point sources.
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL. For excess heat load, see Temperature TMDL. There is no excess nitrogen or phosphorus load.
Margins of Safety **OAR 340-042-0040(4)(i)** *CWA §303(d)(1)*	Margins of safety are inherent to the nonpoint source load determination methodology.
Reserve Capacity **OAR 34-042-0040(4)(k)**	Nutrient load that causes no increase in pH.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of pH water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards.

Table 4.5 Steamboat Creek Dissolved Oxygen and pH TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Steamboat Creek, HUC (Hydrologic Unit Code) 1710030108, within the 4th field HUC 17100301 (North Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Increased algal biomass resulting from inorganic nitrogen and phosphorus loading and increases in stream temperature, channel modifications and near stream vegetation disturbance/removal.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016** *CWA §303(d)(1)*	**Dissolved Oxygen:** OAR 340-041-0016; For the summer period (non-spawning June 16 to August 31), the daily average target is 8.0 mg/L with an absolute minimum of 6.0 mg/L **pH:** OAR 340-041-0326(1) and -0007(2); The target is the applicable pH criterion of 8.5 Standard Units (S.U.) or the naturally occurring pH which ever greater.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Nonpoint sources include excessive inputs of solar radiation because of streamside vegetation removal or reduction and anthropogenic channel degradation. No anthropogenic sources of nutrients were identified. Point sources: none.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	**Dissolved Oxygen:** Critical dissolved oxygen levels on Steamboat Creek have occurred during the late summer, when stream flows are at a minimum. **pH:** Critical pH levels in Steamboat Creek have occurred during the late summer. The TMDL addresses period between June 16th and August 31st.
TMDL Loading Capacity **OAR 340-042-0040(4)(d) & (e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The loading capacity for both dissolved oxygen and pH was determined using continuous data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g) & (h)** *40 CFR 130.2(f), (g) &(h)*	Load Allocations (Nonpoint Sources): Natural background nutrient loads and heat loads are the targeted load allocation (see Temperature TMDL). Wasteload Allocations (Point Sources): none, no point sources. *Excess Load:* The difference between the current load and the TMDL.
Margins of Safety *CWA §303(d)(1)* **OAR 340-042-0040(4)(i)**	Margins of safety are inherent to the nonpoint source load determination methodology.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Nutrient load that causes no increase in pH or decrease in DO
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of pH and dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards.

Table 4.6 Cow Creek pH TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	Cow Creek, HUC (Hydrologic Unit Code) 1710030207, within the 4th field HUC 17100302 (South Umpqua Subbasin).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Inorganic phosphorus resulting in increased algal biomass.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016** *CWA §303(d)(1)*	**pH:** OAR 340-041-0326(1) and -0007(2); The target is the applicable pH criterion of 8.5 Standard Units (S.U.) or the naturally occurring pH which ever greater.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Wastewater treatment plants; runoff from agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	**pH:** Critical pH levels in Cow Creek have occurred during the late summer. Specific allocations from May 1st until October 30th will result in year round compliance with the pH criteria.
TMDL Loading Capacity **OAR 340-042-0040(4)(d) & (e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of a water body. The loading capacity for pH was determined using continuous data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g)& (h)** *40 CFR 130.2(f), (g) & (h)*	Load Allocations (Nonpoint Sources): Natural background nutrient loads and heat loads are the targeted load allocation (see Temperature TMDL). Wasteload Allocations (Point Sources): Glendale and Riddle WWTPs allocation vary by month. Other NPDES sources are allocated an inorganic phosphorus load that does not have a measurable increase in pH.
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL. Current, near the mouth, the inorganic and total phosphorus excess load is 1.2 and 0 lbs per day, respectively.
Margins of Safety **OAR 340-042-0040(4)(i)** *CWA §303(d)(1)*	Implicit through conservative assumptions.
Reserve Capacity **OAR 340-042-0040)(4)(k)**	Nutrient load that causes no measurable increase in pH.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of pH water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with the NPDES permit process for wastewater treatment plants.

Table 4.7 South Umpqua River Dissolved oxygen, pH, and Aquatic Weeds and Algae TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	South Umpqua River within the 4th field HUC 17100302 (South Umpqua Subbasin). Separate but integrated nutrient TMDLs are being developed for Cow, Deer, Jackson and Black Canyon Creeks.
Pollutant Identification **OAR 340-042-0040(4)(b)**	Increased inorganic phosphorus and total phosphorus from wastewater treatment plants and nonpoint sources, resulting excessive algae growth which causes pH increases and dissolved oxygen reductions.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning, rearing and aquatic life; OAR 340-41-0320, Table 320A
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0016, -0326, -0007(2), -0007(11), -0019** *CWA §303(d)(1)*	**Dissolved Oxygen:** For the non-spawning period (May 16 – October 14), DO shall not be less than 6.0 mg/l with a daily mean of 8.0 mg/L. **pH:** The target is no measurable increase in pH above the water quality standard of 8.5 Standard Units (S.U.). When natural conditions are greater than the numeric target, "no measurable increase" above natural conditions becomes the TMDL target. **Aquatic weeds or algae:** No numeric target is identified however large reductions are expected when compliance with the pH criteria is achieved.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Wastewater treatment plants; runoff from agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	Critical pH and DO levels in the South Umpqua River typically occur in late summer and early fall. The TMDL allocations apply between May 1st and October 31st and will result in the DO and pH criteria being achieved year round.
TMDL Loading Capacity **OAR 340-042-0040(4)(d) & (e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the **loading capacity** of a water body. The **inorganic and total phosphorus** loading capacity for both dissolved oxygen and pH criteria was determined using continuous data and the mathematical model QUAL2Kw.
Allocations **OAR 340-042-0040(4)(g),(h), (k)** *40 CFR 130.2(f), (g) &(h)*	The TMDL is divided into explicit phosphorus allocations to point sources by month (**wasteload allocations**) and nonpoint sources (**load allocations**).
Excess Load **OAR 340-042-0040(4)(e)**	Excess load is the difference between the current load and the TMDL. Current, near the mouth, the inorganic and total phosphorus excess load is 147 and 173 lbs per day, respectively.
Margins of Safety **OAR 340-042-0040(4)(i)** *CWA §303(d)(1)*	Conservative assumptions were used in the analysis to account for the MOS.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Allocations for **reserve capacity** are assigned a load that would insure compliance with the DO and pH standards and are dependent on location.
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Analytical modeling of TMDL loading capacities demonstrates attainment of pH and dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with the NPDES permit process for wastewater treatment plants.

OVERVIEW OF LISTED WATERBODIES

Eight streams in the Umpqua Basin have been identified on the 2002 303(d) water quality limited stream list as not achieving water quality standards for dissolved oxygen, pH, or aquatic weeds and algae, Map 4.1 and Tables 4.8 to 4.10. Low dissolved oxygen (DO) and high pH have a detrimental effect on aquatic species. In all cases nutrients directly or indirectly contribute to the dissolved oxygen, pH and algae problems. For that reason, the following three sections relate to all of the nutrient-related TMDLs. Following that, individual sections for each stream will set out the wasteload allocations (WLAs) for existing point sources and load allocations (LAs) for background and existing anthropogenic nonpoint sources. Technical documentation of the analysis used to develop the allocations can be found in the individual appendices for each stream.

Map 4.1 Rivers in the Umpqua Basin on the 2002 303(d) list for nutrient related parameters and addressed by this analysis.

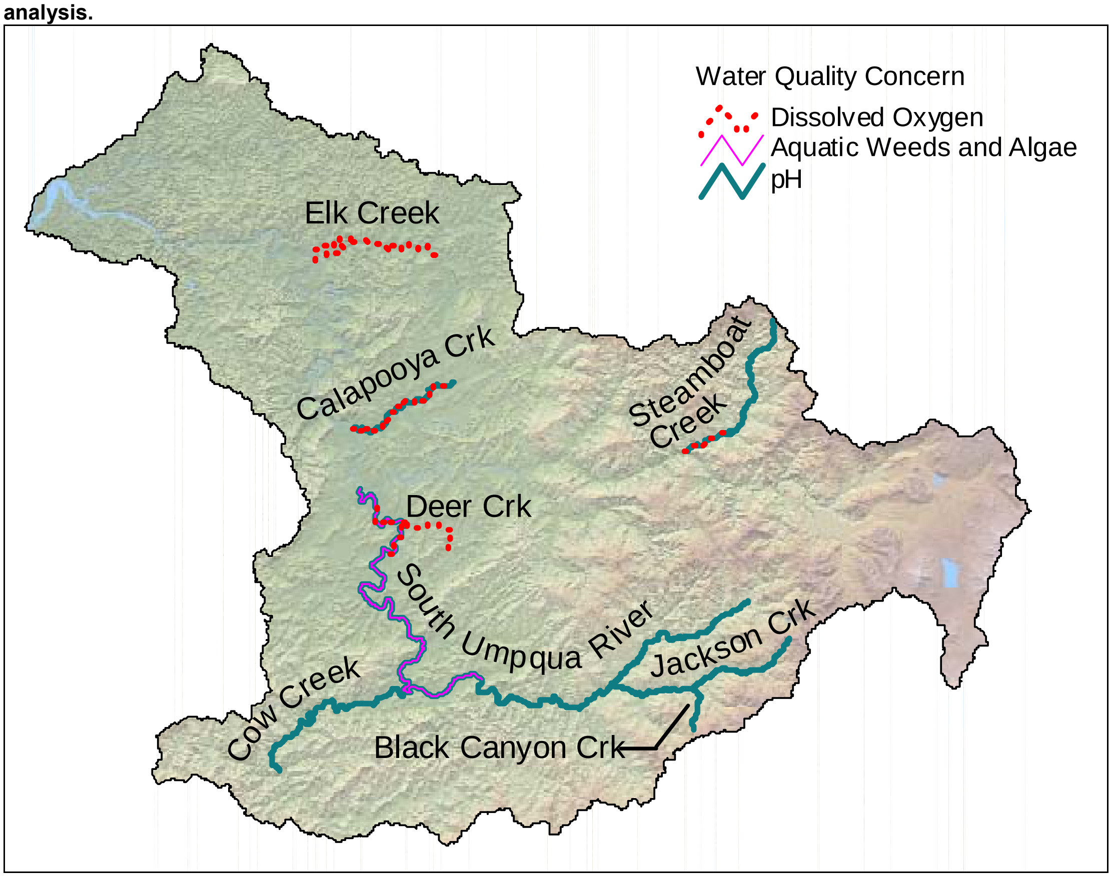


Table 4.8 2004 list of water quality impaired water bodies (303(d) list) needing a TMDL for the Umpqua Subbasin for impairments associated with nutrients.					
Watershed/ USGS 4th Field HUC/ Record ID	**Name/ LLID/ River Mile**	**Parameter**	**Season**	**Criteria**	**Status**
UMPQUA 17100303 21001	Calapooya Creek 1234686433656 0 to 24.8	Dissolved Oxygen	October 15 - May 15	Spawning: Not less than 11.0 mg/L or 95% of saturation	Not sufficient data to address at this time.
UMPQUA 17100303 12247	Calapooya Creek 1234686433656 0 to 36.1	Dissolved Oxygen	Year Around (Non-spawning: May 16 – October 14)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Addressed by this TMDL.
UMPQUA 17100303 5664	Calapooya Creek 1234686433656 0 to 18.7	pH	Summer (June 1 – September 30)	pH 6.5 to 8.5	Addressed by this TMDL.
UMPQUA 17100303 18320	Calapooya Creek 1234686433656 18.7 to 25.3	pH	Summer (June 1 – September 30)	pH 6.5 to 8.5	Addressed by this TMDL.
UMPQUA 17100303 12272	Elk Creek 1235674436327 0 to 45.6	Dissolved Oxygen	Year Around (Non-spawning: variable)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Addressed by this TMDL.
UMPQUA 17100303 5575	Elk Creek 1235674436327 0 to 25.9	pH	Summer (June 1 – September 30)	pH 6.5 to 8.5	Addressed by this TMDL.

Table 4.9 2004 list of water quality impaired water bodies (303(d) list) needing a TMDL for the North Umpqua Subbasin for impairments associated with nutrients.					
Watershed/ USGS 4th Field HUC/ Record ID	**Name/ LLID/ River Mile**	**Parameter**	**Season**	**Criteria**	**Status**
NORTH UMPQUA 17100301 5452	Diamond Lake / Diamond Lake 1221671431853 / 1221483431646 0 to 3.7	Aquatic Weeds Or Algae	Undefined	Null	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301 21091	Diamond Lake / Diamond Lake 1221671431853 / 1221483431646 0 to 3.7	Dissolved Oxygen	Summer	Cold water: Not less than 8.0 mg/l or 90% of saturation	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301 15699	Diamond Lake / Diamond Lake 1221671431853 / 1221483431646 0 to 3.7	pH	Fall/Winter/Spring	pH 6.0 to 8.5	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301 5562	Diamond Lake / Diamond Lake 1221671431853 / 1221483431646 0 to 3.7	pH	Summer	pH 6.5 to 8.5	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301 15700	Diamond Lake / Diamond Lake 1221671431853 / 1221483431646 0 to 3.7	pH	Summer	pH 6.0 to 8.5	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301 5861	Fish Creek 1224705432859 0 to 6.9	Dissolved Oxygen	Summer	Cold water: Not less than 8.0 mg/l or 90% of saturation	Data review indicates waterbody is meeting critieria (see discussion below)
NORTH UMPQUA 17100301 15751	Lake Creek 1221642431901 0 to 11.5	pH	Summer	pH 6.5 to 8.5	See Diamond Lake TMDL (this document)
NORTH UMPQUA 17100301	North Umpqua River 1234460432681 77 to 78	pH	Summer	pH 6.5 to 8.5	Not addressed by this TMDL (related to hydroproject)

5713					
NORTH UMPQUA 17100301 5438	Steamboat Creek 1227368433445 0 to 6.1	Dissolved Oxygen	Summer	Cold water: Not less than 8.0 mg/l or 90% of saturation	Addressed by this TMDL.
NORTH UMPQUA 17100301 5557	Steamboat Creek 1227368433445 0 to 6.1	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
NORTH UMPQUA 17100301 5558	Steamboat Creek 1227368433445 6.1 to 10.9	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
NORTH UMPQUA 17100301 5559	Steamboat Creek 1227368433445 10.9 to 23.4	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.

Table 4.10 2004 list of water quality impaired water bodies (303(d) list) needing a TMDL for the South Umpqua Subbasin for impairments associated with nutrients.

Watershed/ USGS 4th Field HUC/ Record ID	Name/ LLID/ River Mile	Parameter	Season	Criteria	Status
SOUTH UMPQUA 17100302 5564	Black Canyon Creek 1227031429632 0 to 5.2	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5566	Cow Creek 1233379429474 0 to 26.3	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5442	Deer Creek 1233443432145 0 to 9.6	Dissolved Oxygen	Year Around	Spawning: Not less than 11.0 mg/L or 95% of saturation	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5568	Jackson Creek 1228807429694 0 to 25	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5662	South Umpqua River 1234460432680 15.9 to 57.7	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5687	South Umpqua River 1234460432680 0 to 15.9	Aquatic Weeds Or Algae	Summer	Null	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5688	South Umpqua River 1234460432680 15.9 to 57.7	Aquatic Weeds Or Algae	Summer	Null	Addressed by this TMDL.
SOUTH UMPQUA 17100302 12234	South Umpqua River 1234460432680 0 to 68.8	Dissolved Oxygen	Year Around (Non-spawning)	Cold water: Not less than 8.0 mg/l or 90% of saturation	Addressed by this TMDL.
SOUTH UMPQUA 17100302 9370	South Umpqua River 1234460432680 0 to 5	pH	Fall/Winter/Spring	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5570	South Umpqua River 1234460432680 0 to 15.9	pH	June 1 - September 30	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5571	South Umpqua River 1234460432680 15.9 to 57.7	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.

SOUTH UMPQUA 17100302 5573	South Umpqua River 1234460432680 57.7 to 102.2	pH	Summer	pH 6.5 to 8.5	Addressed by this TMDL.
SOUTH UMPQUA 17100302 5552	South Umpqua River 1234460432680 0 to 15.9	Phosphorus	Summer	Null	Addressed by this TMDL.

Fish Creek Discussion

Fish Creek was identified as impaired for dissolved oxygen (DO) during the summer period as it impacts fish passage and rearing. The standard use to evaluate this use is not less than 8.0 mg/L of DO or not less than 90% saturation. The determination is reportedly based on data from August 1995. Additional data was provided to ODEQ during the 2001-2002 CWA §401 Certification process (§401) and summarized in the §401 Report for the relicensing of Pacificorp's North Umpqua hydroelectric project which impacts Fish Creek.

The FERC Application at Volume 21, page 3-54 included continuous DO data for river mile 6.7 (upstream of dam) for August 18-19, 1994. DO saturation was above 90% and diurnal concentrations ranged from 8.5 to 9.9 mg/L with an unknown number of total samples. A diel study (§401 Application page 7.2-8) from July 24-31, 1995 indicated a DO range of 8.5 to 10.4 mg/l at river mile 6.7 (upstream of dam) with 169 total samples. Same period measurements at river mile 0.0 showed a DO range of 8.5 to 10.5 mg/l with 154 total samples.

Based on this additional data, Fish Creek appears to be attaining the fish passage and rearing DO criteria and should be removed from the list of impaired waterbodies for this parameter. There is not sufficient information at this time to evaluate whether Fish Creek is attaining the spawning DO criteria.

BENEFICIAL USE IDENTIFICATION

The primary benefit to maintaining adequate dissolved oxygen (DO) concentrations and achieving the pH standard is to support a healthy and balanced distribution of aquatic life, and to protect salmonid fish spawning and rearing.

Oregon Administrative Rules specify the beneficial uses to be protected in the Umpqua Basin. OAR 340-041-0320 provides that water quality in the Umpqua Basin must be managed to protect the beneficial uses shown in Table 320(A). The uses which occur in the streams with nutrient problems are shown in Table 4.11, which highlights those that are related to dissolved oxygen and pH.

Table 4.11 Beneficial uses occurring in the Umpqua Basin

(From OAR 340-041-0320, Table 320A)
Beneficial uses related to Dissolved Oxygen and pH are marked in ***RED***

Beneficial Use	*Occurring*	*Beneficial Use*	*Occurring*
Public Domestic Water Supply	√	Salmonid Fish Spawning	√
Private Domestic Water Supply	√	Salmonid Fish Rearing	√
Industrial Water Supply	√	Resident Fish and Aquatic Life	√
Irrigation	√	Anadromous Fish Passage	√
Livestock Watering	√	Wildlife and Hunting	√
Boating	√	Fishing	√
Hydro Power	√	Water Contact Recreation	√
Aesthetic Quality	√	Commercial Navigation & Transportation	

The rule also designates fish uses to be protected in the Umpqua Basin as shown in Figures 320A and 320B of the rule. Figure 320A is a map of the waters of the Umpqua Basin with designations as to their use by salmonids, Figure 320B is a map showing when and where salmon and steelhead spawn in the basin.

The maps are available on DEQ's website: http://www.deq.state.or.us/wq/standards/FishUseMapsFinal. They show that all waters of the Umpqua Basin are designated as either "core cold water habitat" or "salmon and steelhead rearing and migration habitat." Both of these designations protect "cold water aquatic life" as defined in OAR 340-041-0002(9).

For dissolved oxygen and pH, spawning and rearing are the most sensitive beneficial uses. Therefore, those provisions of the dissolved oxygen standard protecting cold water aquatic life are the appropriate provisions for the listed Umpqua basin streams, except during spawning periods as shown on the map (Figure 320 B of the rule), when the more stringent provisions protecting spawning are applicable. In addition, the spawning criteria also protect trout which are not designated on the maps.

TARGET CRITERIA IDENTIFICATION

Dissolved Oxygen Water Quality Standard

Oregon Administrative Rule **340-041-0016** provides as follows, with the provisions applicable to Umpqua Basin highlighted in bold. (See Table 4.12)

(1) Dissolved oxygen (DO): No wastes may be discharged and no activities must be conducted that either alone or in combination with other wastes or activities will cause violation of the following standards: *The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply:*

(a) ***For water bodies identified as active spawning areas in the places and times indicated on the following Tables and Figures set out in OAR 340-041-0101 to OAR 340-041-0340:*** *Tables 101B, 121B, 180B, 201B and 260B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B,* ***320B****, and 340B, (as well as any active spawning area used by resident trout species),* ***the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures:***
(A) The dissolved oxygen may not be less than 11.0 mg/l. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/l or greater, then the DO criterion is 9.0 mg/l;
(B) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/l or 9.0 mg/l criteria, dissolved oxygen levels must not be less than 95 percent of saturation;
(C) The spatial median intergravel dissolved oxygen concentration must not fall below 8.0 mg/l.
(b) For water bodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and may not fall below 6.0 mg/l as an absolute minimum (Table 21);
(c) For water bodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/l as a 30-day mean minimum, 5.0 mg/l as a seven-day minimum mean, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(d) For water bodies identified by the Department as providing warm-water aquatic life, the dissolved oxygen may not be less than 5.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 5.5 mg/l as a 30-day mean minimum, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(e) For estuarine water, the dissolved oxygen concentrations may not be less than 6.5 mg/l (for coastal water bodies);
(f) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed.

Table 4.10 on the next page sets out the dissolved oxygen instream numerical criteria for the five Umpqua basin streams listed for dissolved oxygen. In a few cases, natural dissolved oxygen in a stream is lower than the numerical criteria. In those cases, OAR 340-041-0007(2) applies:

(2) Where a less stringent natural condition of a water of the State exceeds the numeric criteria set out in this Division, the natural condition supersedes the numeric criteria and becomes the standard for that water body. However, there are special restrictions, described in OAR 340-041-0004(9)(a)(C)(iii)[2], that may apply to discharges that affect dissolved oxygen.

OAR 340-041-0004(0(a)(D)(iii) provides:

(iii) Effective July 1, 1996, in water bodies designated water-quality limited for dissolved oxygen, when establishing WLAs under a TMDL for water bodies meeting the conditions defined in this rule, the Department may at its discretion provide an allowance for WLAs calculated to result in no measurable reduction of dissolved oxygen (DO). For this purpose, "no measurable reduction" is defined as no more than 0.10 mg/L for a single source and no more than 0.20 mg/L for all anthropogenic activities that influence the water quality limited segment. The allowance applies for surface water DO criteria and for Intergravel dissolved oxygen (IGDO) if a determination is made that the conditions are natural. The allowance for WLAs applies only to surface water 30-day and seven-day means;

[2] There is an error in this reference that will be corrected in the regular course of business. The correct reference is OAR 340-041-0004(9)(a)(D)(iii)

Table 4.12 Dissolved oxygen criteria used to evaluate Umpqua Basin streams for the 303(d) list.

Stream Name	Segment	Fish Use Designation	Listing Period	Winter-spring criteria (spawning)	Summer criteria	Fall criteria (spawning)
Calapooya	Mouth to Bachelor Creek	Rearing	Year round	January 1 - May 15: **11.0 mg/l**	May 16 - September 30: **8.0 mg/l**	October 15 - December 31: **11.0 mg/l**
Elk Creek	Mouth to Pass Creek	Rearing	Year round	January 1 - May 15: **11.0 mg/l**	May 16 - October 14: **8.0 mg/l**	October 15 - December 31: **11.0 mg/l**
Steamboat	All	Core Cold Water Habitat	Summer	Insufficient data	June 16 - September 1: **8.0 mg/l**	Insufficient data
Deer Creek	Mouth to South Deer Creek	Rearing	Year round	January 1 - May 15: **11.0 mg/l**	May 16 - October 14: **8.0 mg/l**	October 15 - December 31: **11.0 mg/l**
South Umpqua River	All listed segments	Rearing	Year round	January 1 - May 15: **11.0 mg/l**	May 16 - October 14: **8.0 mg/l**	October 15 - December 31: **11.0 mg/l**

pH Water Quality Standard

Oregon Administrative Rule **340-041-0326(1)** provides as follows, with the provisions applicable to Umpqua Basin highlighted in **bold**.

Water Quality Standards and Policies for [the Umpqua] Basin:
(1) pH (hydrogen ion concentration). pH values may not fall outside the following ranges:
(a) Marine waters: 7.0 – 8.5;
(b) Estuarine and ***fresh waters*** *(except Cascade lakes):* ***6.5 – 8.5****;*
(c) Cascade lakes above 3,000 feet altitude: pH values may not fall outside the range of 6.0 to 8.5.

In several of the pH limited streams, natural pH is higher than the standard. In that case, **OAR 340-041-0007(2)** applies:

(2) Where a less stringent natural condition of a water of the State exceeds the numeric criteria set out in this Division, the natural condition supersedes the numeric criteria and becomes the standard for that water body. *However, there are special restrictions, described in OAR 340-041-0004(9)(a)(C)(iii), that may apply to discharges that affect dissolved oxygen.*

The TMDLs target 'no measurable increase' above the standard (numeric or natural) in pH measurements. No measurable increase for pH is defined as no more than 0.3 pH for all anthropogenic sources. This definition is based on Oregon DEQ Data Quality Matrix (Revision 3.0, February 2004) which states that the precision of measurements for the highest level of data quality is less than or equal to 0.3 pH.

Aquatic Weeds and Algae Water Quality Standard

Oregon Administrative Rule **340-041-0007(11)** provides as follows,

(11) The development of fungi of other growths having a deleterious effect on stream bottoms, fish or other aquatic life or that are injurious to health, recreation, or industry may not be allowed.

In the portion of the Umpqua Basin which have been determined to be impaired for aquatic weeds and algae, the algae are also causing DO and pH impairments. Nutrient loading is linked to algal growth which is causing DO and pH impairments. The nutrient allocations suppress algal growth to meet the DO and pH criteria. It is likely that these allocations will be sufficient to address the aquatic weeds and algae narrative criteria.

Nuisance Phytoplankton Growth

Oregon Administrative Rule **340-041-0019(1)** in part provides as follows,

(a) The following values average Chlorophyll a values must be used to identify water bodies where phytoplankton may impair the recognized beneficial uses:
…
(B) Natural lakes that do not thermally stratify, reservoirs, rivers and estuaries: 0.015 mg/l;
…

EXISTING SOURCES

Algal Process Affecting Dissolved Oxygen and pH

Without external influences, DO and pH would reach an equilibrium concentration as a function of barometric pressure and water temperature. However, the growth and respiration of attached algae causes diel (daily cyclical) swings in DO and pH concentrations. As the algae grow, through photosynthesis, oxygen is released into the river, and as the algae respire, oxygen is consumed. At nighttime, when photosynthesis ceases, respiration will cause a reduction in DO. Similarly, inorganic carbon (i.e., carbon dioxide) is consumed and released through photosynthesis and respiration. Through the carbonate balance, as inorganic carbon is consumed, the concentration of the hydrogen ion decreases which increases the pH. Alkalinity, which dampens the diel swing in pH, is naturally low in the Umpqua Basin.

Elevated nutrient concentrations, specifically phosphorus and nitrogen, encourage algae growth. The preferred forms are dissolved inorganic phosphate and ammonia, nitrite, and nitrate, respectively. There are a number of natural processes that add nutrients to the river: leaching from the soil, degradation of plant material, and fish returning to spawn from the ocean. As the algae grow, they consume phosphorus and nitrogen. As algae respire and die, nutrients are released back into the river. Algae consume nitrogen and phosphorus at a fixed ratio. Therefore, if one nutrient is in short supply, it will limit the growth of algae regardless of the concentration of the other nutrient. The growth of attached algae can also be limited by available suitable substrate, light, and temperature.

Nutrient Sources

Point Sources

Wastewater Treatment Plants (WWTPs)

A portion of the streams with DO and pH limitations received treated effluent from wastewater treatment plants (WWTPs). WWTPs are the major source of phosphorus and nitrogen in Calapooya Creek, Cow Creek and the South Umpqua River. Most of the WWTPs are in compliance with their current NPDES permits however effluent that has received secondary treatment still contains significant nutrient concentrations.

Other Point Sources

There are 86 stormwater permits in the Umpqua Basin (see http://www.deq.state.or.us/wq/SISData/FacilityHomenew.asp). Because the water quality limitations are most severe during the period with the least rainfall, stormwater permitted facilities are not likely contributors of significant nutrient loading that support algal growth. If conditions of the permit are met, permitted stormwater facilities are not likely to contribute nutrient loading that will adversely impact DO or pH.

There are 47 industrial permits which discharge in the Umpqua Basin (see http://www.deq.state.or.us/wq/SISData/FacilityHomenew.asp). An initial examination of these permits does not indicate any significant sources of phosphorus. However, all permits in the subbasin will be reviewed during the regular permit cycle and, if necessary, modified to include nutrient limits.

Nonpoint Sources

Forestry Sources

Forests can contribute nutrients in several ways. First, sediment associated with timber harvesting and related road-building can carry nutrients, especially phosphorus, into streams. Second, Northwest forests are typically fertilized with urea nitrogen, and this may run off into streams under certain conditions. Riparian buffers help to intercept and retain both sediment and nutrients. There are a number of natural processes that add nutrients to the river: leaching from the soil, degradation of plant material, and fish returning to spawn from the ocean.

Agricultural Sources

Lands used for agriculture can contribute nutrients in a variety of ways. Soil erosion can carry nutrients with it, particularly phosphorus. Animal manure is another potential source of nutrients and particulate organic matter. Particulate organic matter can settle to the stream bed and increase a sediment oxygen demand (SOD) associated with the receiving water body. Finally, fertilizers can run off and contribute nutrients to the stream. Riparian buffers, where they exist, will help to intercept and retain both sediments and nutrients.

Urban Land Runoff

Urbanized land areas, with their high percentages of impervious surfaces and extensive drainage systems, have surface runoff even during relatively small rainfall events. Runoff from landscape irrigation can also carry high levels of nutrients from fertilizers. Inorganic phosphorus concentrations in Newton Creek, which predominately drains the Roseburg area, have been measured at approximately 10 times greater than estimated background conditions.

Unregulated (Unpermitted) Upland Sources

There may be upland sources other than runoff and other permitted discharges that are contributing nutrient loads. Possible sources include faulty septic and sewer systems, and illegal or illicit discharges. While these sources are not readily quantifiable, the nutrient loads are expected to be relatively small due to the control programs that were established previously. It is important that these programs continue to be implemented and are updated based on new data or other information.

Other Physical and Biological Processes Affecting Dissolved Oxygen

Sediment Oxygen Demand (SOD)**:** Sediments are important to riverine systems. However, too much sediment can increase levels of other pollutant parameters. When solids that contain organic matter settle to the bottom of a stream they may decompose anaerobically (with no oxygen present), or aerobically (in the presence of oxygen), depending on conditions. The oxygen consumed in aerobic decomposition of these sediments is called SOD and represents a loss of DO for a stream. The SOD can continue to reduce DO for a long period after the pollution discharge ceases (i.e., organic-containing sediment deposited as a result of rain-driven runoff may remain a problem long after the rain event has passed). In contrast, dissolved oxygen demand may be short lived and transported downstream.

Sources of organic sediments include runoff from farms, rangeland, forest, and urban lands and WWTPs. In the vicinity and downstream of WWTP outfalls, SOD concentrations ranged from 1 to 10 grams of oxygen / square meter / day (Chapra 1997).

***Ammonia*:** When nitrogen in the form of ammonia is introduced to natural waters, the ammonia may "consume" dissolved oxygen as nitrifying bacteria convert the ammonia into nitrite and nitrate. The process of ammonia being transformed into nitrite and nitrate is called nitrification. The consumption of oxygen during this process is called nitrogenous biochemical oxygen demand (NBOD). To what extent this process occurs, and how much oxygen is consumed, is related to several factors, including residence time, water temperature, ammonia concentration in the water, and the presence of nitrifying bacteria. It is because of this somewhat complex relationship that computer models are used to determine the amount of ammonia that can be attenuated by a waterbody and still meet the DO standards.

Wastewater treatment plant effluent, animal manure and fertilizers are the primary sources of ammonia.

***Carbonaceous Biochemical Oxygen Demand (CBOD)*:** Water column carbonaceous biochemical oxygen demand (CBOD) is the oxygen consumed by the decomposition of organic matter in the water column and is similar in complexity to ammonia. The sources of the organic matter can be varied, either resulting from natural sources such as direct deposition of leaf litter or from human-caused sources such as polluted runoff, WWTPs, or manure.

***Stream Temperature*:** Stream temperature has a significant impact on the dissolved oxygen in a stream in two ways. The first is that with increasing temperatures the amount of oxygen that can remain dissolved in water decreases. The second is that, in general, all of the oxygen-consuming dissolved oxygen processes listed above increase their oxygen consumption as temperature increases.

There are a variety of causes of increased stream temperatures. Please see the temperature TMDL (Chapter 3) for a complete discussion of this topic.

CALAPOOYA CREEK DISSOLVED OXYGEN AND PH TMDL

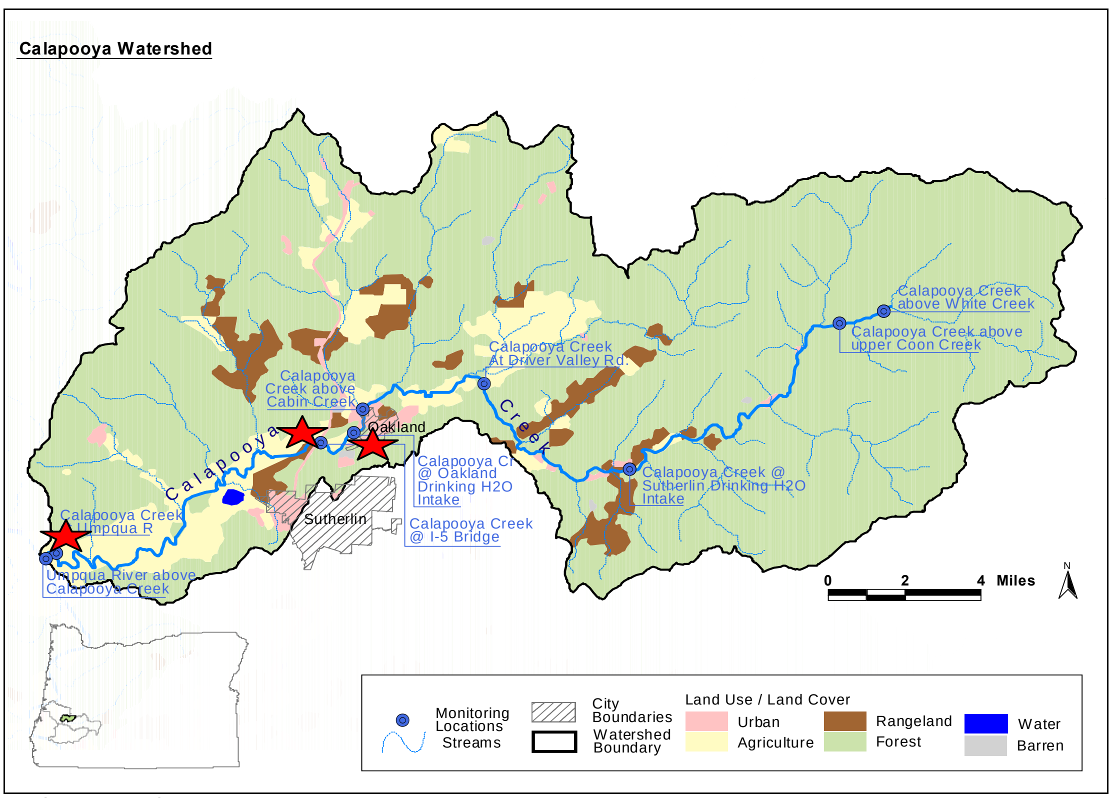
Overview

Calapooya Creek, (Map 4.2) from the mouth to river mile (RM) 18.7, has been placed on DEQ's 303(d) list for pH and dissolved oxygen. The listing for pH is for the summer period; the listing for dissolved oxygen is for the fall-winter-spring period, in particular, the salmonid spawning period of October 15 through May 15. Although not currently on the 303(d) list, violations of the DO standard have been observed during the non-spawning period. This analysis addresses pH and DO water quality limitations between May 15 and October 15.

Water quality based permit limits for the two WWTPs that discharge into Calapooya Creek where issued in 2000 and 2001 to address fall-winter-spring dissolved oxygen limitation noted on the 303(d) list. There is not sufficient data to assess current fall-winter-spring dissolved oxygen conditions and to compute the nonpoint source load allocation. Therefore, a TMDL to address the fall-winter-spring dissolved oxygen limitation will not be completed at this time.

To address the summer pH listing, DEQ conducted a study of Calapooya Creek during the summer of 2002. During that study, continuous data loggers were placed at various locations in the creek to gather data for a three-day period in July. "Grab" samples were also taken to confirm the continuous data reliability. The data from the study showed that in addition to exceeding the water quality standard for pH, the standard for dissolved oxygen was not consistently met during the summer.

Computer simulations (using the model QUAL2Kw, see Appendix 1 for more information) were developed using this data and data for hydrology, channel morphology and near stream vegetation developed for the temperature TMDL. Dissolved oxygen and pH were calibrated in a steady state hydraulic simulation with diurnal water quality kinetics and bottom algae simulations. The model was calibrated using the observed continuous dissolved oxygen and pH data.



Map 4.2 Calapooya Creek Watershed intensive survey monitoring sites. Locations marked with red stars are points where water quality standards were not met.

Simulated future conditions developed in the temperature TMDL were applied to riparian vegetation. The resulting decrease in solar loading and stream temperatures were demonstrated through modeling to improve dissolved oxygen and pH levels in Calapooya Creek. Additionally, the removal of the Sutherlin and Oakland wastewater treatment plant effluent during the summer months has reduced nutrient loading to significantly improve water quality. Lastly, the model simulation predicted that a 67% reduction in sediment oxygen demand in the reach near Oakland will cause water quality standards for dissolved oxygen and pH to be achieved.

Pollutant Identification

During the summer period, periphyton growth leads to low dissolved oxygen concentrations and high pH. Periphyton growth is encouraged by nitrogen, phosphorus and thermal loading. Additionally, thermal loading leading to increased stream temperature exacerbates impairments by decreasing the saturation concentration of dissolved oxygen and increasing the pH saturation concentration (see Temperature TMDL). The decay of organic matter causing an oxygen demand is less important during the summer period but still contributes to the dissolved oxygen impairment. Because of the low flow, sediment oxygen demand (SOD) impacts dissolved oxygen concentrations more than in stream dissolved biochemical oxygen demand (BOD). SOD is caused by the decay of volatile solids which have settled in slow moving reaches.

During the fall-winter-spring, BOD is the primary cause of the dissolved oxygen impairment.

Target Criteria Identification

Achieving the maximum pH target requires the strictest nutrient allocations, and therefore, it receives most of the analytical focus. For the water quality standards see “Target Criteria Identification” section of this chapter. The sensitive beneficial use was identified as cold water aquatic life (Overview Section). This TMDL does not apply to the time period when salmonid spawning occurs. The intensive monitoring effort and the water quality modeling provide adequate information to evaluate the 30-day mean and absolute minimum dissolved oxygen concentrations. The 30-day mean target is 8.0 mg/L and the absolute minimum target is 6.0 mg/L. Because the model only evaluates a 24 hour period, the model-mean is used as a surrogate for the 30-day mean and the model-minimum is used as a surrogate for the absolute minimum. This assumption is acceptable because the data that the model was based on were collected during a steady-state condition and the model evaluates a critical, low-flow condition. It is assumed that when meeting the 30-day mean and absolute minimum targets that the 7-day day minimum mean target will also be achieved. Additional loading reduction may be necessary if, after implementation, the 7-day minimum mean target is not achieved.

The daily maximum pH target is no measurable increase in pH above the numeric standard of 8.5 or the estimate of naturally occurring pH, whichever is greater. No measurable increase is defined as 0.3 standard units of pH (see Chapter Overview).

Water Quality Limitations and Seasonal Variation

Dissolved oxygen has been measured at Calapooya Creek near the mouth (river mile 0.4) routinely for many years, since this site is part of DEQ’s ambient monitoring network. Between January 1995 and January 2005, 5 out of 40 grab samples did not meet the spawning DO criteria of 11.0 mg/L or greater than 95% saturation as applied between October 15 and May 15 (Figure 4.1). One of 35 grab samples did not meet the non-spawning criteria of 8.0 mg/L or 90% saturation. During this same period there have been 3 exceedances of the pH standard of 8.5 S.U. and all occurred during the summer months (Figure 4.2).

In late July, 2002, DEQ conducted an intensive TMDL survey of Calapooya Creek, collecting continuous dissolved oxygen and pH readings at various sites in the watershed. Water quality standards violations were observed for dissolved oxygen and/or pH at the following locations on Calapooya Creek during the survey (Figures 4.3 and 4.4):

- Kilometer: 22.4 (RM 13.9, at the Oakland Drinking Water intake)
- Kilometer: 20.4 (RM 12.7, at Interstate 5)
- Kilometer: 0.7 (RM 0.4, near the mouth)

Figure 4.1 Dissolved oxygen grab data for Calapooya Creek at RM 0.7 collected between 1/1995 and 1/2005. Filled circles below the standard lines do not meet the applicable dissolved oxygen criteria.

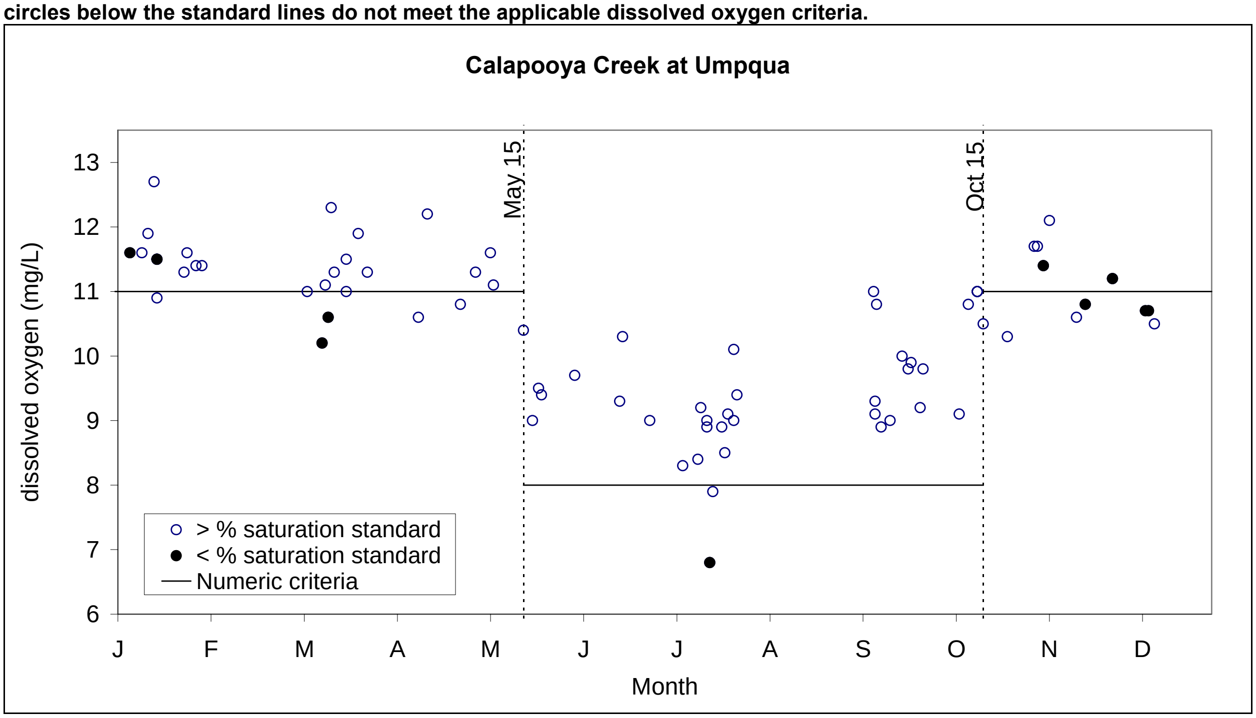


Figure 4.2 pH grab sample data for Calapooya Creek at RM 0.7 collected between 1/1995 and 1/2005.

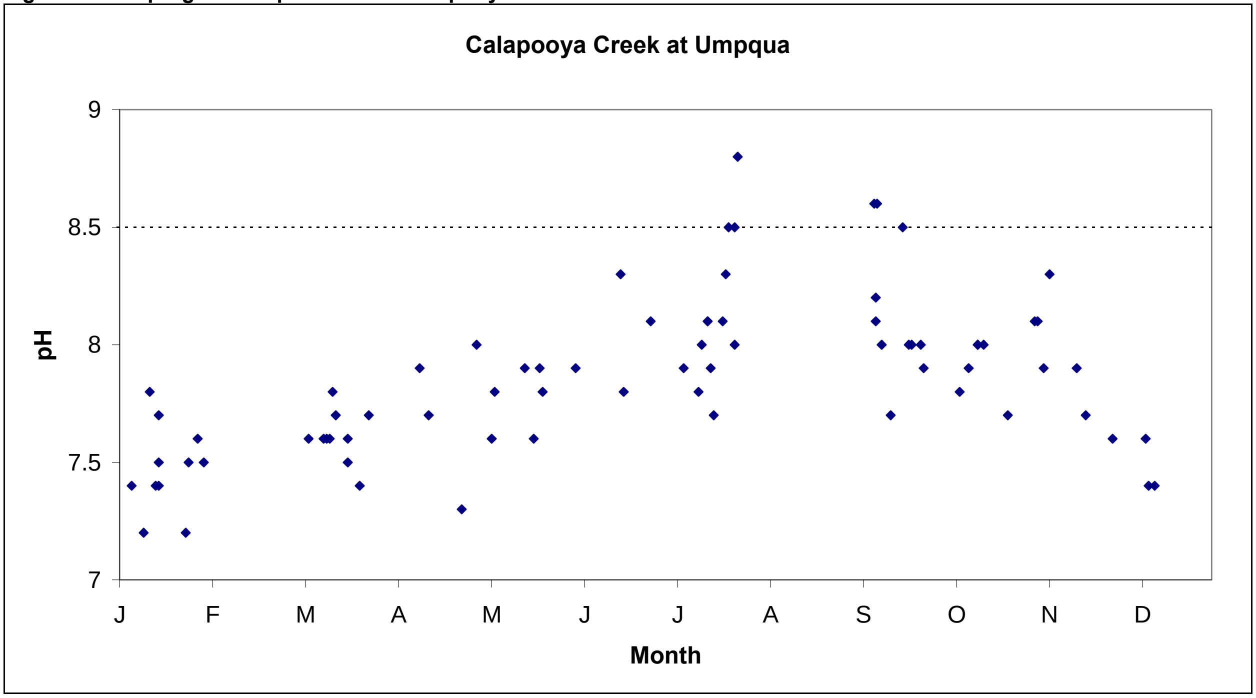


Figure 4.3 Continuous DO measurements during intensive TMDL survey. Critical dissolved oxygen and pH conditions occur during the summer low flow condition when slower velocities and elevated temperatures encourage excessive periphyton growth.

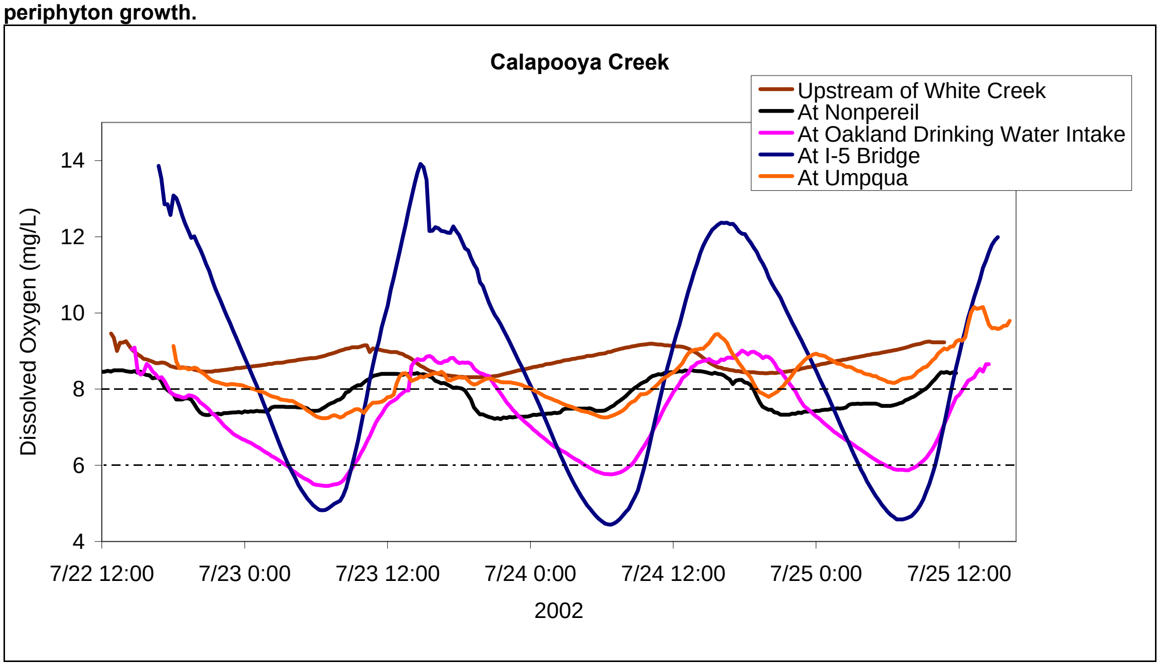
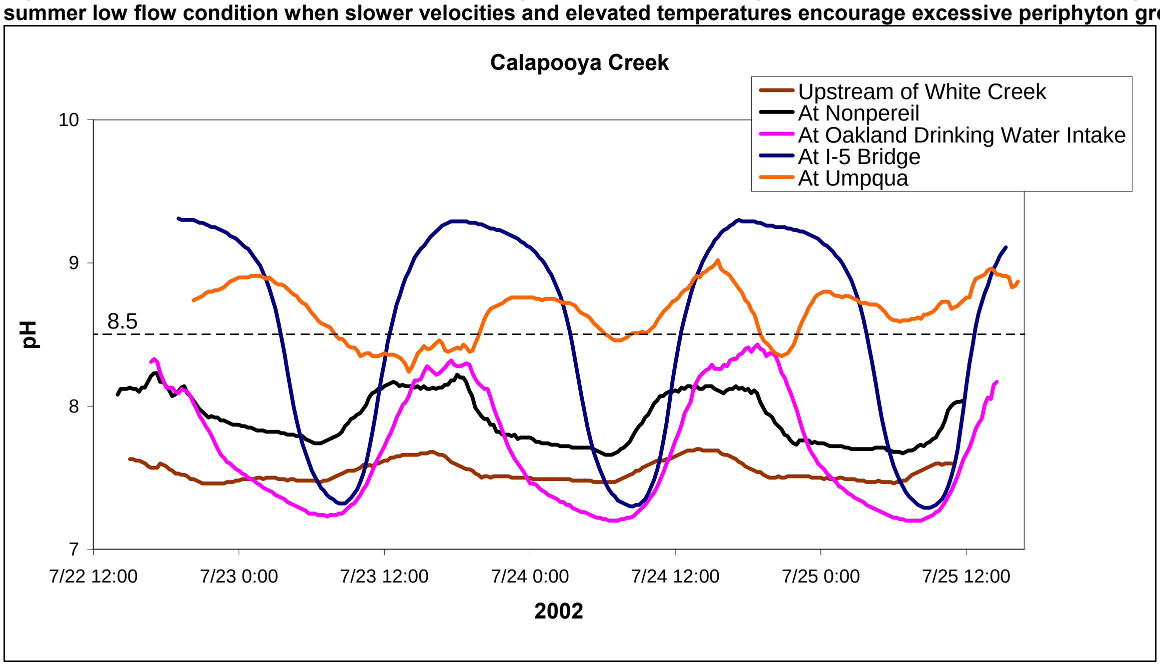


Figure 4.4 Continuous pH measurements during intensive TMDL survey. Critical pH conditions occur during the summer low flow condition when slower velocities and elevated temperatures encourage excessive periphyton growth



Existing Sources

Point Sources

Wastewater Treatment Plants

Two municipal wastewater treatment plants discharge into Calapooya Creek. The Sutherlin treatment plant's discharge is located at river mile 10, and the Oakland treatment plant's discharge is located at river mile 13.3. Neither facility may discharge effluent between June 1 and October 31 as specified in their NPDES permits. At the present time, the Sutherlin plant has an agreement to land-apply their effluent during the summer on a local golf course and is in the process of negotiating for an additional land application site. However, the City recently disclosed that the golf course has not been utilizing all the effluent delivered and have been discharging the excess effluent to Cook Creek, a tributary to Calapooya Creek. This discharge primarily occurs during May, June, July and October. Reportedly, if they occur, discharges during August and September would be rare.

The City of Oakland built a new treatment plant which came online in February of 2003. The plant currently does not discharge during the summer or early fall, but was discharging during the intensive TMDL sampling in July, 2002 and was a significant source of nutrients. When discharging, the WWTPs are a major source of nutrients and BOD. In Calapooya Creek, SOD rates do not appear to increase downstream of WWTPs, based on water quality modeling discussed below. Therefore, WWTPs do not appear to be a major source of settable volatile solids leading to SOD.

Other point sources

There are three industrial and one stormwater NPDES permits that allow discharge to Calapooya Creek. An initial examination of these permits does not indicate any significant sources of nutrients or settable volatile solids. However, all permits in the subbasin will be reviewed during the permit renewal process and, if necessary, modified to include phosphorus and volatile solid limits.

Nonpoint Sources

Forest Land

Approximately 64% of the Calapooya drainage is used for public or private forestry. During the intensive TMDL sampling in July, 2002, the upper sites in forest land did not show problems with dissolved oxygen or pH. Nutrients and BOD concentrations in Calapooya Creek from the forested portion of the watershed did not appear to be in excess of background concentrations.

Agricultural Land

Approximately 33% of the Calapooya Creek drainage is used for agriculture, primarily in the western (downstream) portion of the watershed. The 2002 intensive sampling indicates that agricultural lands are not a significant source of nutrients or BOD during the summer period (see Appendix 3). The Bacteria TMDL (this document) indicates that agricultural land is a major source of fecal bacteria. Although fecal bacteria do not directly impact DO concentrations, organic solids are usually associated with bacteria loading. A portion of the organic solids will settle and contribute to SOD.

Urban Land

In the Calapooya Creek drainage, the small cities of Oakland (2002 population estimated at 953) and Sutherlin (2002 population 6,962) border Calapooya Creek. About 1.0 mile of the Creek flows within Oakland city limits. About 3.63 miles of Calapooya Creek is within the Sutherlin city limits, as well as 1.9 miles of Cooper Creek and 0.72 miles of Cook Creek, both tributaries of the Calapooya. In Sutherlin, 71.1 % of the riparian area has no trees, and only 6.2% have a buffer zone of two or more tree widths. In Oakland, 16.1% of riparian areas are two or more tree widths, but 47.2% have no trees at all. This lack of riparian vegetation allows increased stream heating, reducing the capacity of the water for dissolved oxygen. The 2002 intensive sampling indicates that urban lands are not a significant source of nutrients or BOD during the summer period. The Bacteria TMDL (see Chapter 2) indicates that urban land is a source of fecal bacteria. Although fecal bacteria do not directly impact DO concentrations, organic solids are usually associated with bacteria loading. A portion of the organic solids will settle and contribute to SOD.

Loading Capacity

To achieve the DO and pH water quality standard during the summer period, the loading capacity was computed for inorganic phosphorus, total phosphorus and volatile solids for the critical condition (see Appendix 3). The critical flow condition was selected as the 14-day average low flow that is expected to occur every three years. Under natural loading conditions, pH would continue to exceed the 8.5 numeric target. Therefore, the natural occurring pH is the target of the TMDL. The total phosphorus loading capacity is 1.0 lbs / day and inorganic phosphorus is 0.7 lbs / day. The SOD from river KM 20.1 to 25.6 needs to be reduced from 1.5 to 0.5 grams of oxygen / m^2 / day. Assuming a linear relationship between SOD and volatile solids (see Chapra, 1997), volatile solids must be reduced by 67% from current loading.

Figure 4.5 Mean dissolved oxygen concentrations.

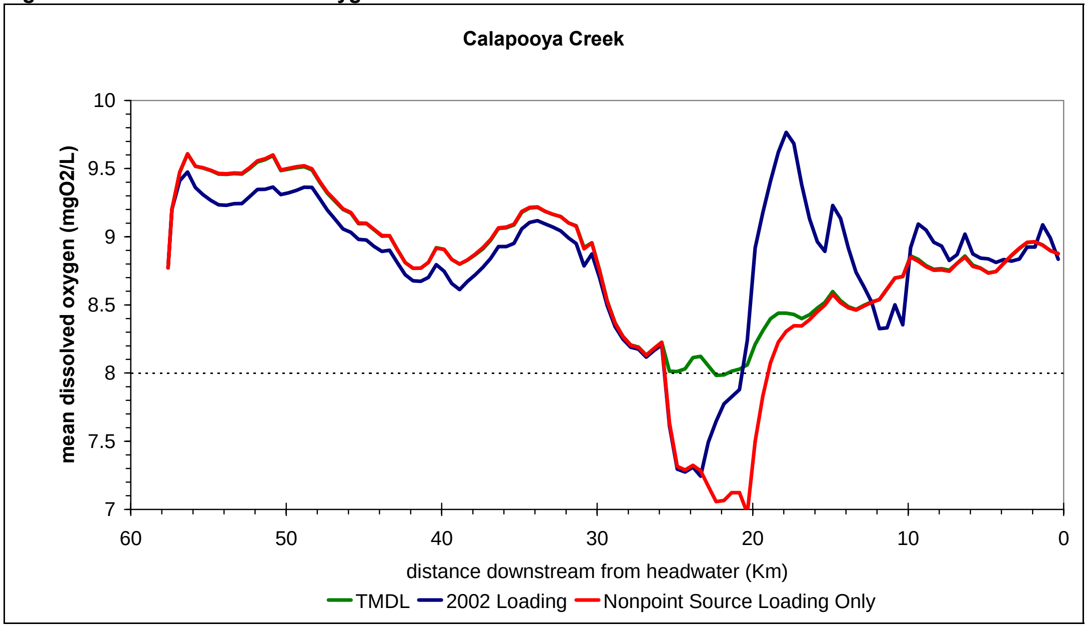


Figure 4.6 Minimum daily dissolved oxygen concentrations.

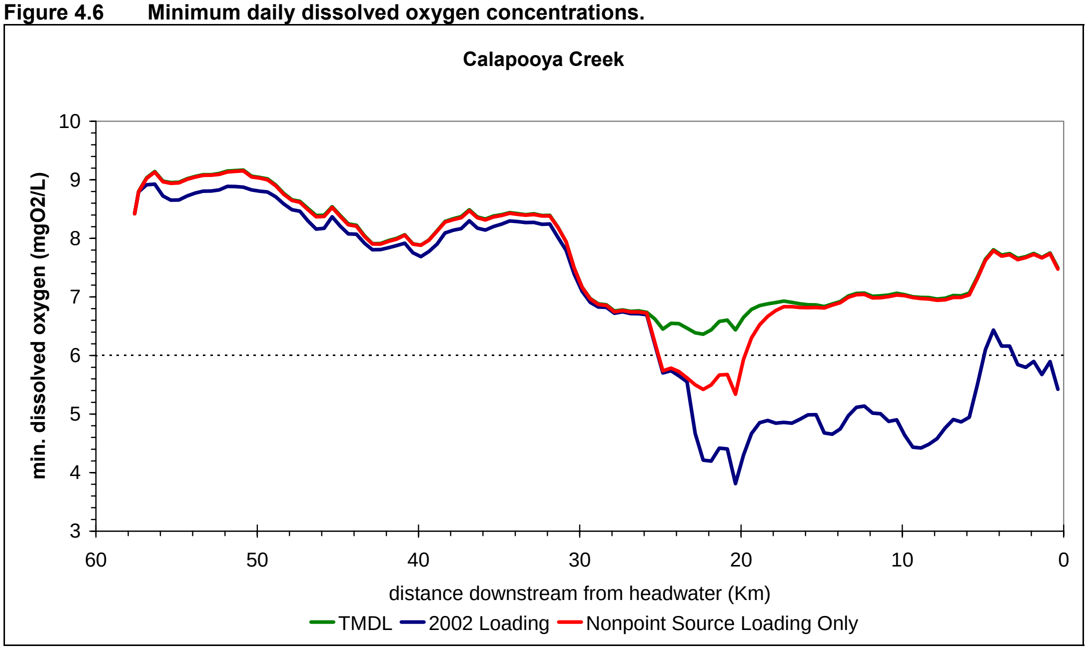
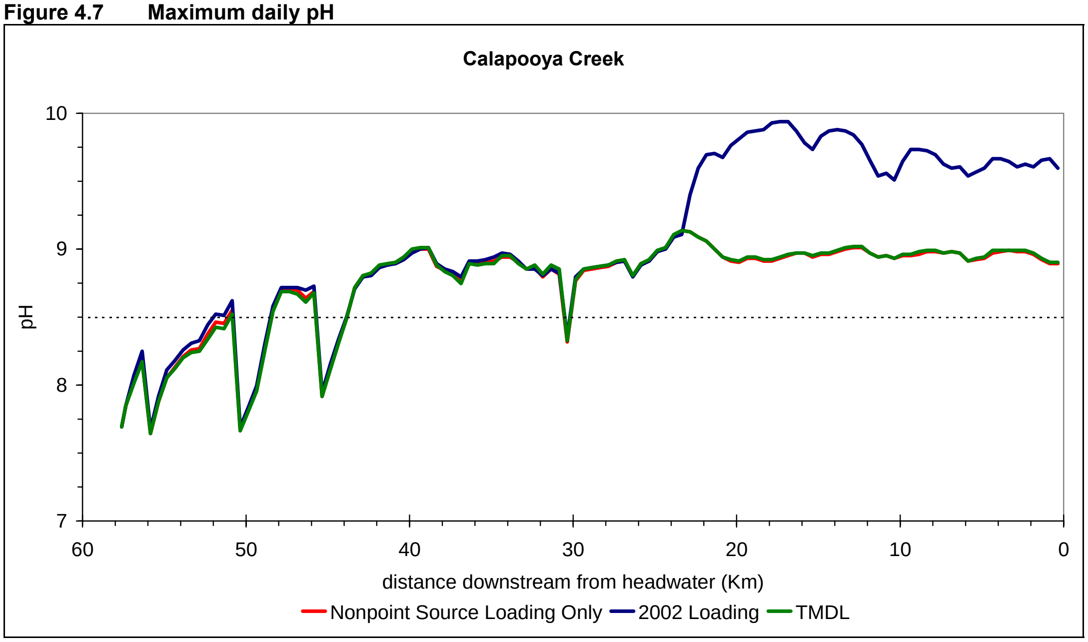


Figure 4.7 Maximum daily pH



Allocations

Load capacity and allocations were determined through the use of Qual2kw, an EPA supported mathematical water quality model (Appendix 3). Allocations are divided into wasteload allocation (WLAs) for point sources and load allocations (LA) for nonpoint sources, see Table 4.13. The model predicts that the allocations will results in attainment of the DO and pH standards.

Summer allocations are applicable from June 1 through October 31. The allocation period is based on meeting water quality criteria in Calapooya Creek. Summer allocations achieve the pH and non-spawning DO criteria.

During the summer period, nutrients to support periphyton growth are relatively low in Calapooya Creek upstream of the point sources. Therefore, the emphasis on achieving and maintaining the dissolved oxygen and pH standard is on the benefits from reducing the temperature effect on periphyton growth through instream temperature reduction and removing the wastewater treatment facilities' effluent from the creek during the summer months. The phosphorus allocations will achieve the pH target value and help to achieve the DO target concentration during the summer period (Figures 4.5 to 4.7, Table 4.13).

WLAs are assigned to existing point sources of pollution. Currently, neither WWTP is allowed to discharge during the summer period except under extreme rainfall events. Therefore the WWTP WLAs are zero. Point sources may, at their option, collect additional data, perform the necessary evaluations and request a portion of the reserve capacity. Similarly, additional analysis could determine monthly or flow based loading capacities. By rule, overflows of untreated sewage are prohibited in the summer months except during the 1-in-10 year 24 hour storm.

The summer period phosphorus allocations for non-WWTP point sources, the load allocations, and the reserve capacity is the phosphorus load which does not result in a measurable increase in pH above natural conditions. Discharge at background concentrations will achieve these allocations. Based on samples from the upper watershed, background concentration for dissolved othrophosphate is 20 ug P/L and for total phosphate is 20 ug P/L. A quantified LA could not be calculated because of the longitudinally variable assimilative capacity of the system and the spatially and temporally variable nature of nonpoint source pollution. Similarly, the reserve capacity and WLAs for general permits are difficult to quantify.

Table 4.13 Phosphorus TMDL and allocations for Calapooya Creek from June 1 through October 31.

Scenario	Inorganic Phosphorus (lbs / day)	Total Phosphorus (lbs /day)
2002 Loading	2.4	2.9
TMDL (allocations below)	0.7	1.0
Background Loading	*0.7*	*1.0*
WLA: Sutherlin WWTP	*0*	*0*
WLA: Oakland WWTP	*0*	*0*
WLA: General permit point sources	*No measurable increase in pH or decrease DO*	*No measurable increase in pH or decrease DO*
LA	*No measurable increase in pH or decrease DO*	*No measurable increase in pH or decrease DO*
Reserve Capacity	*No measurable increase in pH or decrease DO*	*No measurable increase in pH or decrease DO*

In addition to phosphorus allocations, the SOD from river KM 20.1 to 25.6 needs to be reduced from 1.5 to 0.5 grams of oxygen / m^2 / day in order to meet the summer period DO criteria (Figures 4.6 and 4.7). Assuming a linear relationship between SOD and volatile solids (see Chapra, 1997), volatile solids must be reduced by 67% from current loading. The Bacteria TMDL for Calapooya Creek (see Chapter 2) called for a 73% reduction in fecal bacteria loading during high flows. Although fecal bacteria do not directly impact DO concentrations, organic solids are usually associated with bacteria loading. It is anticipated meeting the Bacteria TMDL will provide at least a 67% reduction in volatile solids. If these measures do not improve the dissolved oxygen concentration to meet the water quality standard, further allocations will be necessary. The volatile solids allocations apply only to nonpoint sources because WWTPs were not identified during source assessment as a major contributor to SOD in Calapooya Creek. The volatile solids allocation applies year round because transport and deposition can occur during the fall-winter-spring and contribute to SOD during the summer.

Excess Load

The excess nutrient load in 2002 was 1.7 lbs of inorganic phosphorus per day and 1.9 lbs of total phosphorus per day. The current excess of SOD is 1.0 grams of oxygen / m^2 / day from river KM 20.1 to 25.6 and the excess volatile solids load is 200% more than the loading capacity.

Margin of Safety

The margin of safety can either be an explicit load or addressed implicitly through conservative assumptions in the analysis. The summer period TMDL addresses the margin of safety through conservative assumptions. Calculating loading capacity during the critical condition is a conservative assumption because it is when the least assimilative capacity is available. In addition, the model calibration for pH tended to over-predict the daily maximum pH. This would imply that the actual pH after implementation of the TMDL will be lower than is predicted. It is also anticipated that on going stream restoration such as large woody debris addition and channel complexity will result in creating seasonal sinks for nutrients in pools and in hyporeic zones creating additional assimilative capacity. The summer period TMDL is also conservative because it does not explicitly allocate loading above background loading.

Reserve Capacity

The assimilative capacity of the Calapooya Creek for additional phosphorus loading varies longitudinally. Additional or expanding sources may contribute phosphorus loading if analysis shows that they will not cause or contribute to DO or pH water quality limitations. During the summer period, effluent with phosphorus concentrations similar to background concentrations is presumed to not adversely impact DO or pH.

ELK CREEK DISSOLVED OXYGEN AND PH TMDL

Overview

Low dissolved oxygen (DO) concentrations result in water quality limitations in Elk Creek while pH levels generally achieve the standard (Table 4.14, Map 4.3 below). A water quality model, based on intensive sampling during September, 2002, was used to determine the total maximum daily load (TMDL) necessary to achieve water quality standards.

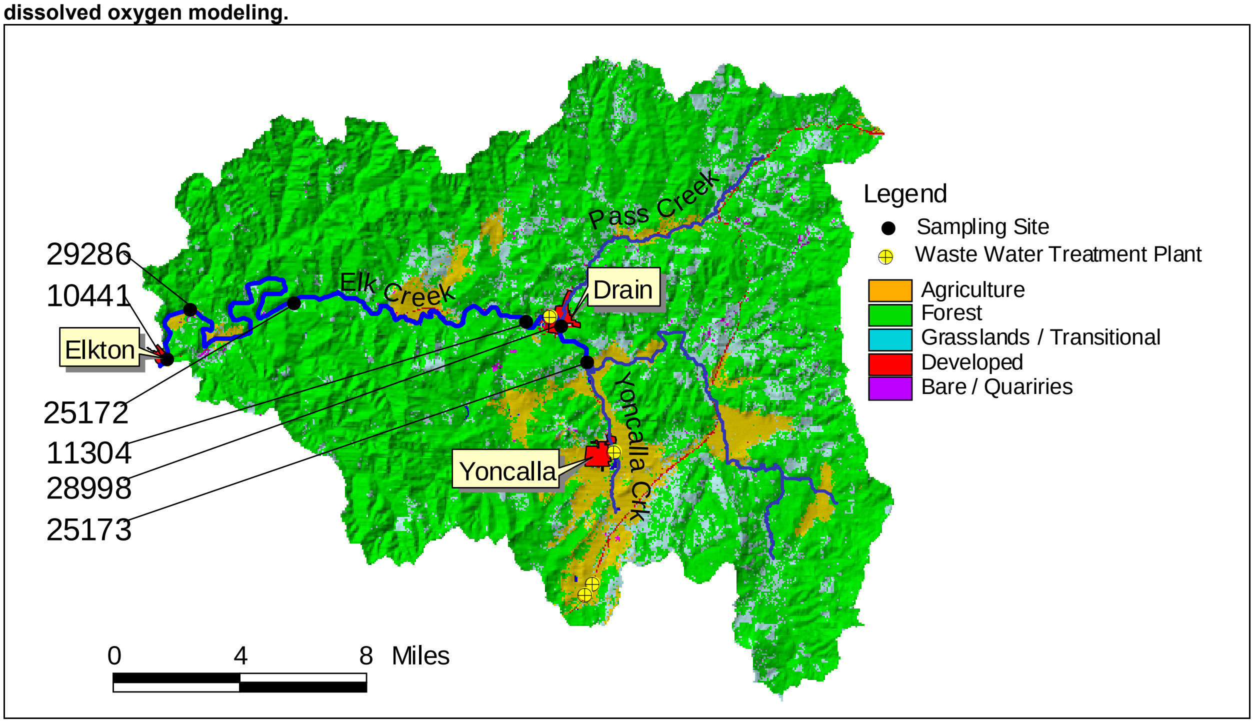
Table 4.14 Waterbodies addressed by this analysis

Stream	River mile	Parameter	Applicable Dates	Status
Elk Creek	0 – 25.9	Dissolved Oxygen	May 16 – Oct. 14 (non spawning)	303(d) List (1998)
Elk Creek	0 – 25.9	pH	Summer	303(d) List (1998)

Computer simulations (using the model QUAL2Kw, see Appendix 1 for more information) were developed using this data and data for hydrology, channel morphology and near stream vegetation developed for the temperature TMDL. Dissolved oxygen was calibrated in a steady state hydraulic simulation with diurnal water quality kinetics and bottom algae simulations. The model was calibrated using the observed continuous dissolved oxygen.

Sediment oxygen demand appears to be the dominant process causing reduced dissolved oxygen concentrations. Nonpoint and point sources contribute organic solids that settle in slow-moving reaches and exert an oxygen demand.

Map 4.3 Elk Creek Watershed with mainstem sampling sites and major features. Thick blue line represents the extent of dissolved oxygen modeling.



Pollutant Identification

DO measurements from Elk Creek at Hayhurst Road Bridge were relatively steady throughout the day during the 2002 sampling; the difference between the average and minimum DO was less than 0.5 mg/L. This contrasts with other measurements in Elk Creek and elsewhere in the Umpqua Basin where periphyton causes large swings in DO on a daily cycle. The depressed, average DO of 7.0 mg/L was at an average of 70% of saturation, based on stream temperature and elevation. It is likely that an oxygen demand other than periphyton is causing the water quality limitations. 5-day biochemical oxygen demand (BOD) measurements at the site were 1.0 mg/L during the September 2002 survey which is consistent with other sampling sites on Elk Creek with a range of 0.2 to 1.2. It is likely that the settling of volatile solids in this slow moving reach is leading to an increase in sediment oxygen demand (SOD) (see Overview Section).

Beneficial Use and Target Criteria Identification

The sensitive beneficial use was identified as cold water aquatic life (Overview Section). This TMDL does not apply to the time period when salmonid spawning occurs. The intensive monitoring effort and the water quality modeling provide adequate information to evaluate the 30-day mean and absolute minimum dissolved oxygen concentrations. The 30-day mean target is 8.0 mg/L and the absolute minimum target is 6.0 mg/L. Because the model only evaluates a 24 hour period, the model-mean is used as a surrogate for the 30-day mean and the model-minimum is used as a surrogate for the absolute minimum. This assumption is acceptable because the data that the model was based on were collected during a steady-state condition and the model evaluates a critical, low-flow condition. It is assumed that when meeting the 30-day mean and absolute minimum targets that the 7-day day minimum mean target will also be achieved. Additional loading reduction may be necessary if, after implementation, the 7-day minimum mean target is not achieved.

Water Quality Limitations and Seasonal Variation

Dissolved oxygen measurements in Elk Creek indicate a portion of it is water quality limited. An intensive water quality survey in September 2002 indicated that the DO impacted reach extends from approximately the confluence with Hardscrabble Creek (RM 20.8) to the confluence with Pass Creek (RM 24.4) (Figure 4.8). This reach corresponds to the area in and directly downstream of the city of Drain. The DO measurements from this reach were collected at Hayhurst Road Bridge at which point Elk Creek is a pool with a low velocity. DO measurements in other portions of Elk Creek were collected in faster moving reaches and achieved the mean.

Daily minimum DO measurements from two other sites downstream of Hayhurst Road Bridge were below 8.0 mg/L (Figure 4.8). Given the continuous measurements at this site and the ambient monitoring station located near the mouth (Figure 4.10), DEQ believes there is adequate information to evaluate DO water quality in terms of a daily average (which must be greater than 8.0 mg/L) and an absolute minimum (which must be greater than 6.0 mg/L). Continuous measurements from these two sites show that they are meeting water quality criteria (Table 4.15).

The pH levels generally achieve targets in Elk Creek with only occasional and modest exceedances. Therefore, technical analysis focused on setting loads to achieve the DO standard. The 303(d) list indicates that 4 out of 29 samples (14%) exceeded criterion during the summer period at one of four stations based on grab samples. During the synoptic survey, continuous measurements from 1 of 5 sites exceeded the 8.5 pH criteria with a maximum value of 8.8, see Figure 4.9. The diel swings in pH are likely caused by growth of periphyton similar to the other pH analysis in this chapter which shows natural pH in the basin can be as high as 9.0 (see Calapooya Creek pH TMDL). If a pH impairment exists due to anthropogenic sources, the nonpoint source load reductions required to meet the DO standard and temperature TMDL will likely lead to nutrient reductions that result in pH attainment. If future data indicate exceedances of the pH standard, allocations and targets will be carried over from the pH TMDL for Calapooya Creek which is a similar and neighboring watershed.

Figure 4.8 Continuous DO monitoring data. Stations listed in the downstream direction.

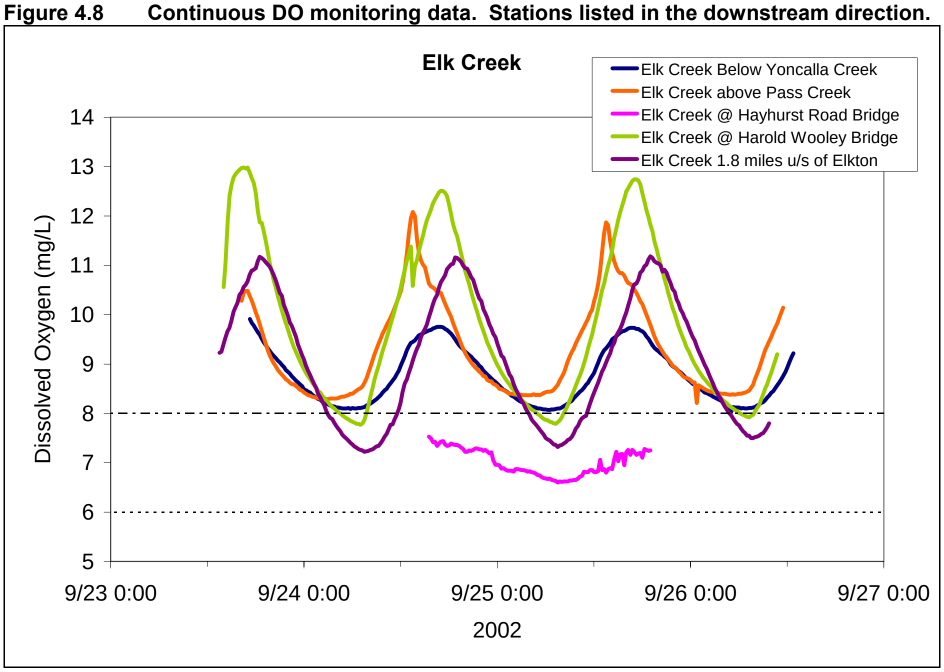


Table 4.15 Summary of continuous DO measurements for 9/24 and 9/25/2002.

ID #	Description	river KM	Average DO	Minimum DO
25173	Elk Creek d/s Yoncalla Creek	42.5	8.8	8.1
28998	Elk Creek above Pass Creek	39.45	9.4	8.3
11304	Elk Creek @ Hayhurst Road Bridge	36.85	7.0	6.6
25172	Elk Creek @ Harold Wooley Bridge	20.35	9.8	7.8
29286	Elk Creek 1.8 miles on rd.	3.9	9.0	7.2
		Applicable Criteria	8.0	6.0

Figure 4.9 Continuous pH monitoring data. Stations listed in the downstream direction.

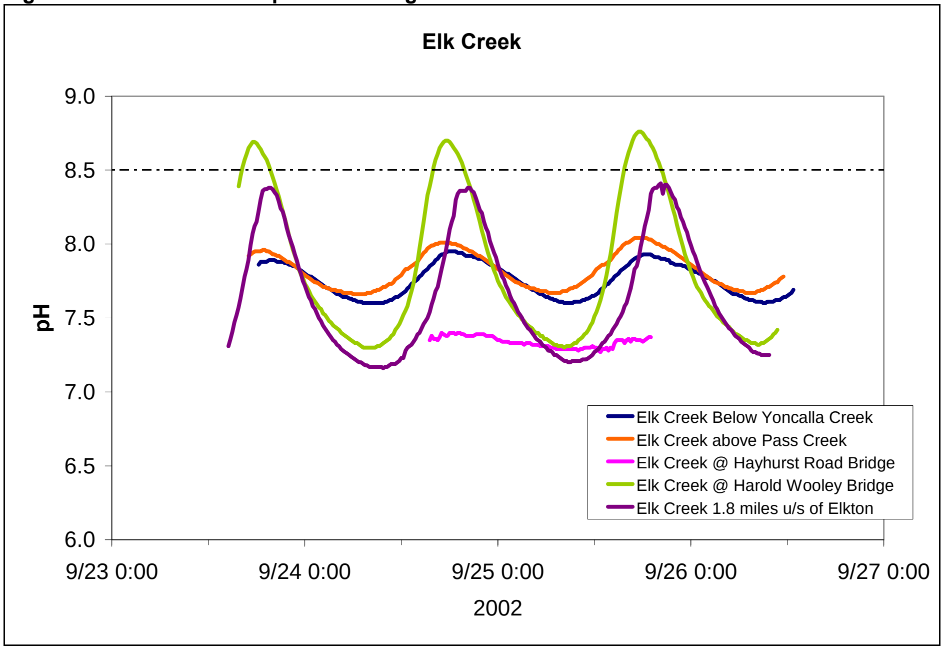
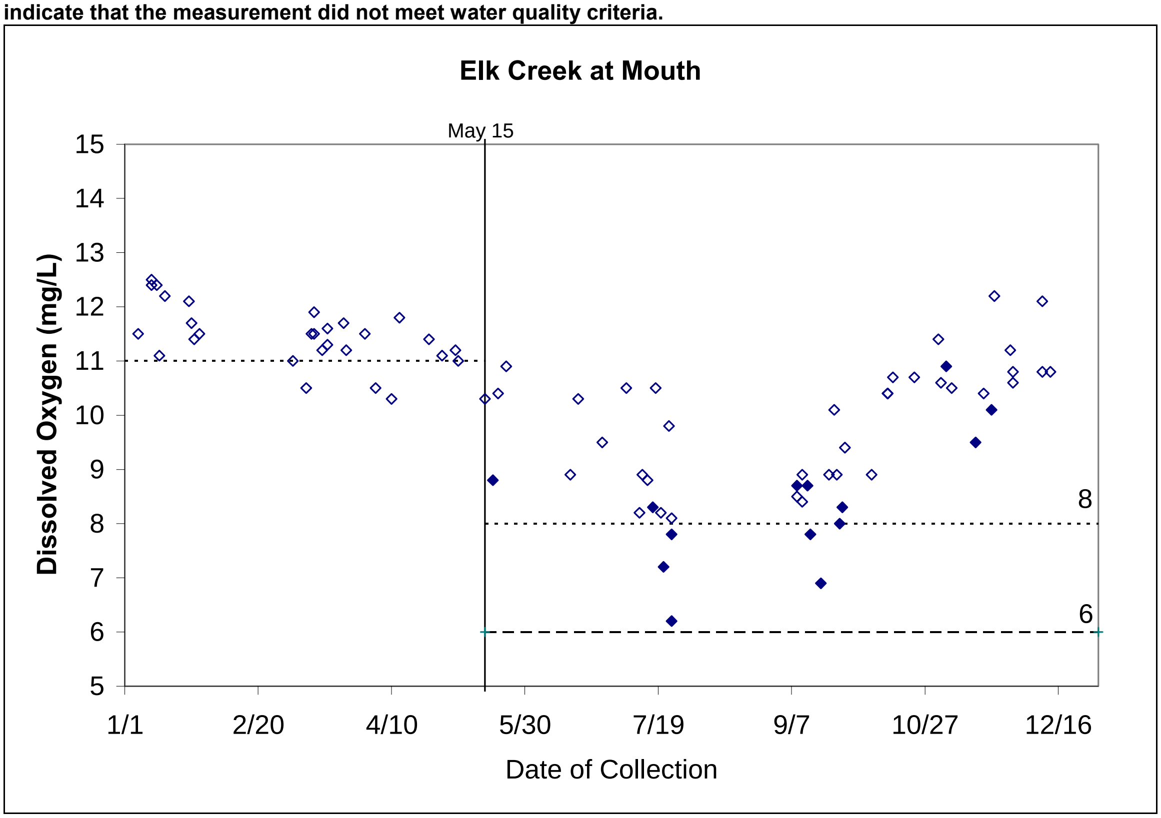


Figure 4.10 Ambient DO monitoring near the mouth of Elk Creek between 1/1995 and 3/2005. Filled diamonds indicate that the percent of saturation measurement is below the applicable criteria. Filled diamonds below the dashed line indicate that the measurement did not meet water quality criteria.



Existing Sources

A basin-wide generalized source assessment is included in the Dissolved Oxygen / pH / Algae Chapter Overview.

Sediment oxygen demand (SOD) appears to be the dominant process impacting DO downstream of the City of Drain, in a low-gradient, slow moving reach. SOD is the oxygen demand exerted by aerobic decomposition of sediments on the stream bottom. The settling of organic solids to the bottom of the stream causes SOD. Sources of settleable organic solids include wastewater treatment plant (WWTP) overflows, erosion, surface runoff and algae. While properly treated effluent from WWTPs contain little settable solids, raw sewage overflows contain appreciable amounts. Organic solids can be delivered to the stream during winter runoff events and still exert the largest impact during the low flow periods of summer. Similar to bacteria, rainfall-runoff events and WWTP upsets are likely sources of volatile solids. Another source of organic material is likely attached algae that have sloughed off upstream and settled in the low velocity pool. Based on water quality modeling, SOD from river KM 36.5 to 38.5 was estimated to be 2.5 grams of oxygen / m2 / day (Appendix 3).

Point Sources

<u>Wastewater Treatment Plants</u>

None of the four WWTPs in the Elk Creek watershed discharge effluent during the time period when poor water quality is observed (Table 4.16). However, as mentioned above, volatile solids can cause SOD long after loading. The City of Drain WWTP reported 12 sewage overflows into Elk Creek between September 2000 and September 2002. These overflows occurred during heavy rainfalls. DEQ is working with the City of Drain treatment plant to insure compliance with their water quality permit. The City of Drain WWTP discharges into Elk Creek approximately 0.5 miles upstream from Elk Creek at Hayhurst Road, the most impacted monitoring site.

Table 4.16 Wastewater treatment plants that discharge into the Elk Creek watershed. Yoncalla Creek is a tributary to Elk Creek at approximately river mile 26.7.

Facility	Receiving Stream	River mile	No discharge period
Drain WWTP	Elk Creek	23.5	May 1 – October 31
Yoncalla WWTP	Yoncalla Creek	4	May 1 – October 31
Rice Hill West WWTP	Yoncalla Creek	7.5	May 1 – October 31
Rice Hill East WWTP	Yoncalla Creek	7.8	May 1 – October 31

<u>Other Point Sources</u>

Other permitted sources, such as storm-water, could deliver significant volatile solids that could cause or contribute to water quality limitations.

Nonpoint Sources

Nonpoint sources of volatile solids are difficult to identify. Agriculture and urban runoff were identified as sources of bacteria in the bacteria TMDL. It is likely that the sources and transport mechanisms are similar. Nutrients may also contribute to the SOD by encouraging algae growth which can settle and exert an oxygen demand.

Loading Capacity

To achieve the DO water quality standard, the SOD from river KM 36.5 to 38.5 needs to be reduced from 2.5 to 1.5 grams of oxygen / m^2 / day (Figures 4.12 and 4.13). Assuming a linear relationship between SOD and volatile solids, volatile solids must be reduced by 40% from current loading (Chapra, 1997).

Figure 4.11 Current and TMDL mean daily dissolved oxygen concentration in Elk Creek.

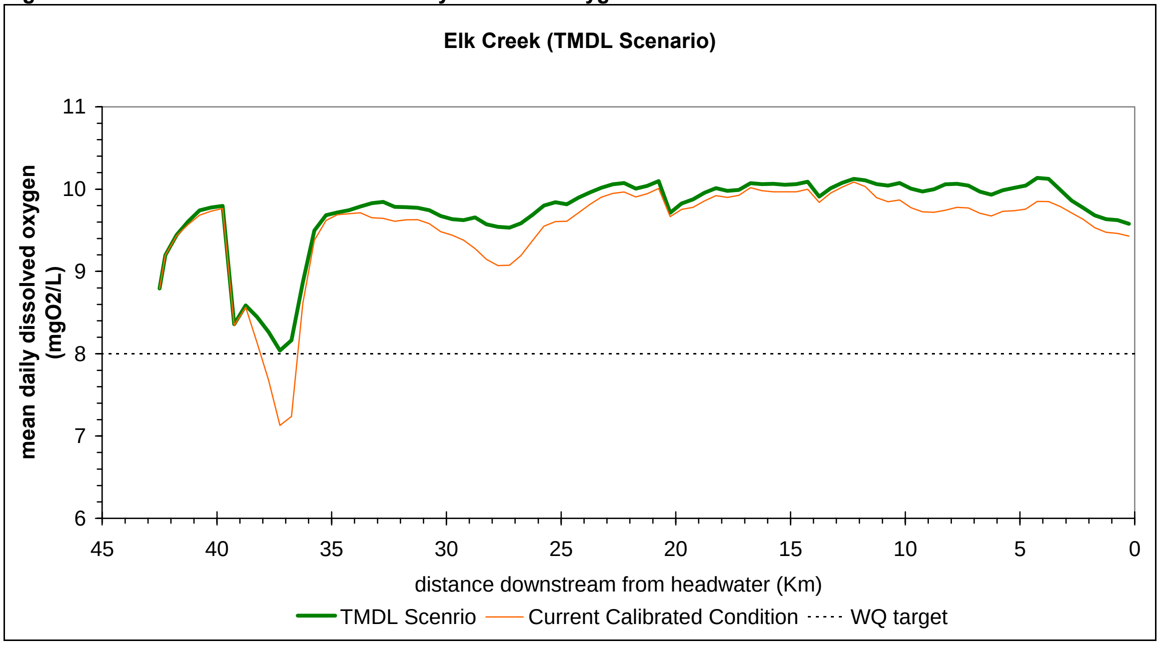
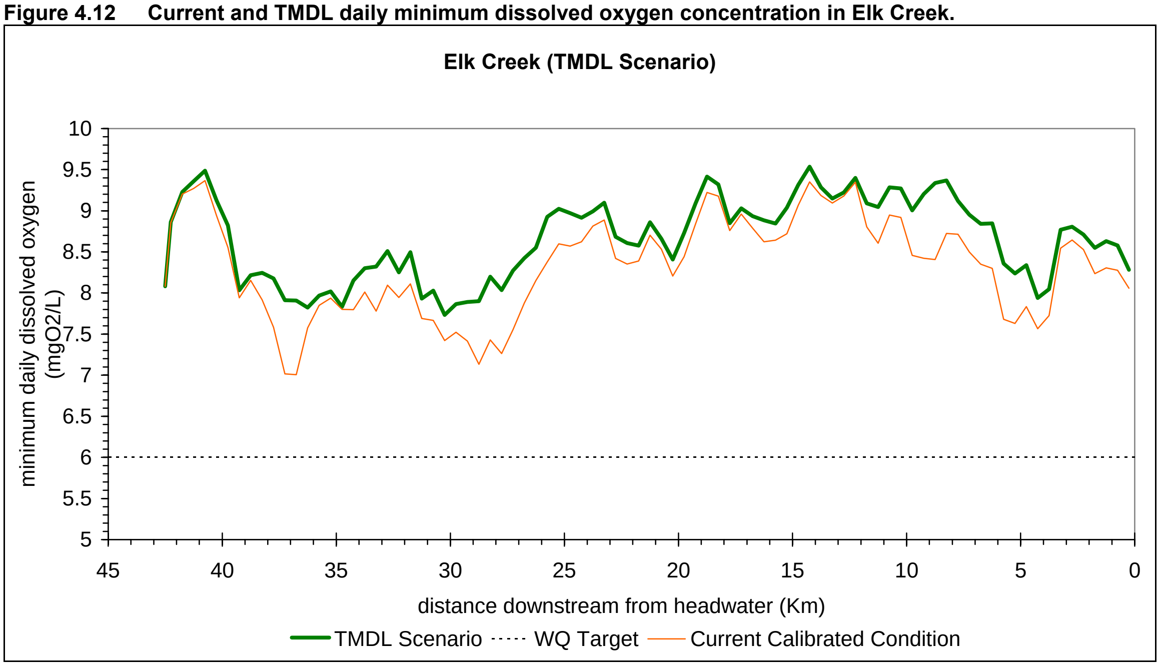


Figure 4.12 Current and TMDL daily minimum dissolved oxygen concentration in Elk Creek.



Allocations

It is anticipated that the WLA and LA allocations in the bacteria TMDL for Elk Creek (see Chapter 2) will provide at least a 40% reduction in volatile solids. The implementation of the Bacteria TMDL will lead to the elimination of plant upsets at the Drain WWTP except during extreme rainfall events and up to a 78% reduction in nonpoint source *E. coli* loading. By rule, overflows of untreated sewage are prohibited in the summer months except during the 1-in-10 year 24 hour storm. In the winter months, all municipalities are expected to convey and treat all sewage up to the 1-in-5 year 24 hour storm. Although fecal bacteria do not directly impact DO concentrations it is likely to be associated with organic material that could settle and cause increase SOD. If these measures do not improve the dissolved oxygen concentration to meet the water quality standard, additional allocations will be necessary. Sources may, at their option, collect the additional data, perform the necessary evaluations and request increased allocations during higher flow periods.

Excess Load

The current excess of SOD is 1.0 grams of oxygen / m^2 / day from river KM 36.5 to 38.5 and the excess volatile solids load is 67% more than the loading capacity.

Margins of Safety

The margin of safety is implicit in the analysis because allocations are based on meeting the Bacteria TMDL, which calls for greater reductions from sources (78 % during high flows) than are estimated as necessary to meet the dissolved oxygen TMDL (40% overall). It is likely that the sources and delivery mechanisms are similar between bacteria and volatile solids.

Reserve Capacity

There is no explicit reserve capacity allocated in this TMDL because it would be dependent on location in the watershed. New or expanding sources could be permitted to increase volatile solids if it can be shown that they will not cause or contribute to water quality limitations.

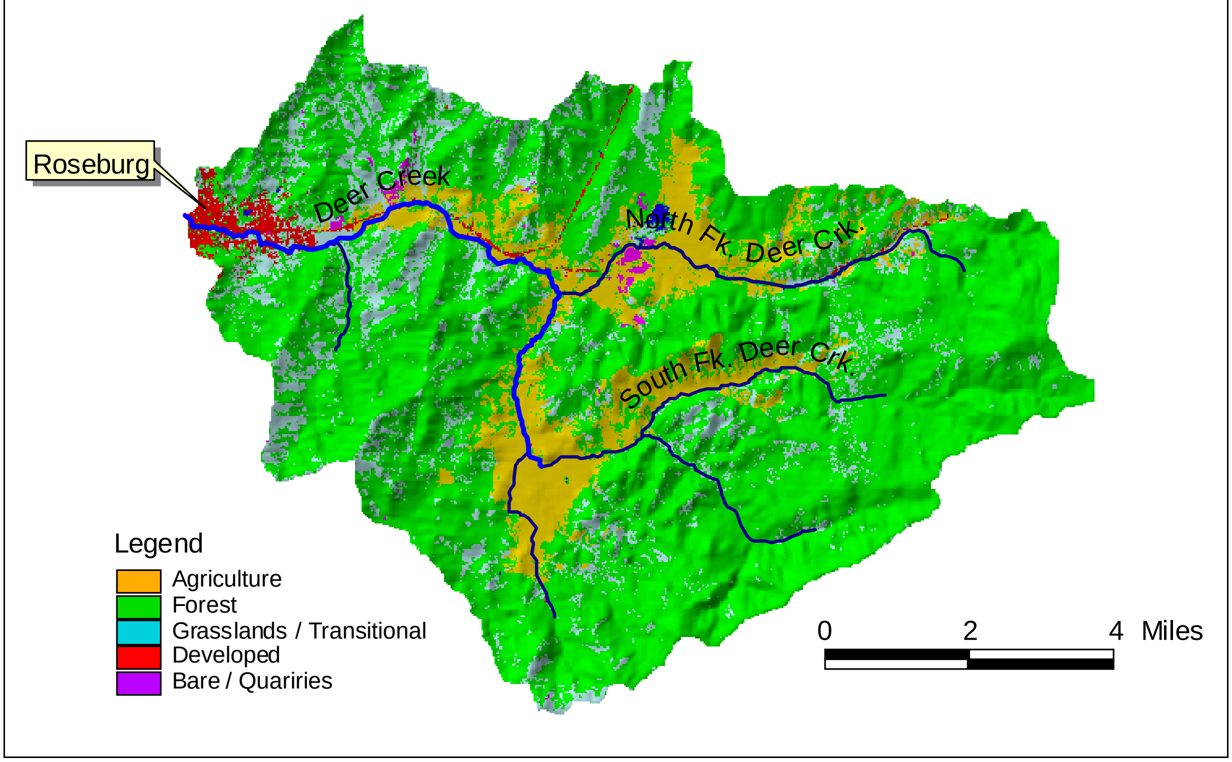
DEER CREEK DISSOLVED OXYGEN TMDL

Overview

Deer Creek, from the mouth to river mile 9.6, has identified as water quality limited on DEQ's 303(d) list for dissolved oxygen during the spawning period from October 15 through May 15 (Map 4.4). To address the DO listing, DEQ conducted a study of Deer Creek during the winter of 2001 and the spring of 2002. During that study, grab samples were collected at various locations in Deer Creek, including the North and South Forks. A regression model was developed to relate DO to biochemical oxygen demand (BOD). The model predicts that the DO standard will be achieved when the instream BOD in Deer Creek is 0.7 mg/L or less.

There are no point sources of BOD in the Deer Creek Watershed. To achieve the necessary load reductions, nonpoint source best management practices will need to be implemented that reduce BOD pollutant loading. Practices intended to achieve the Deer Creek bacteria and temperature TMDLs should also help to reduce the BOD load.

Map 4.4 Deer Creek Watershed with major features. Thick blue line represents the extent of dissolved oxygen limitation.



Pollutant Identification

Biochemical oxygen demand (BOD) is a key factor in maintaining adequate instream dissolved oxygen during the spawning period.

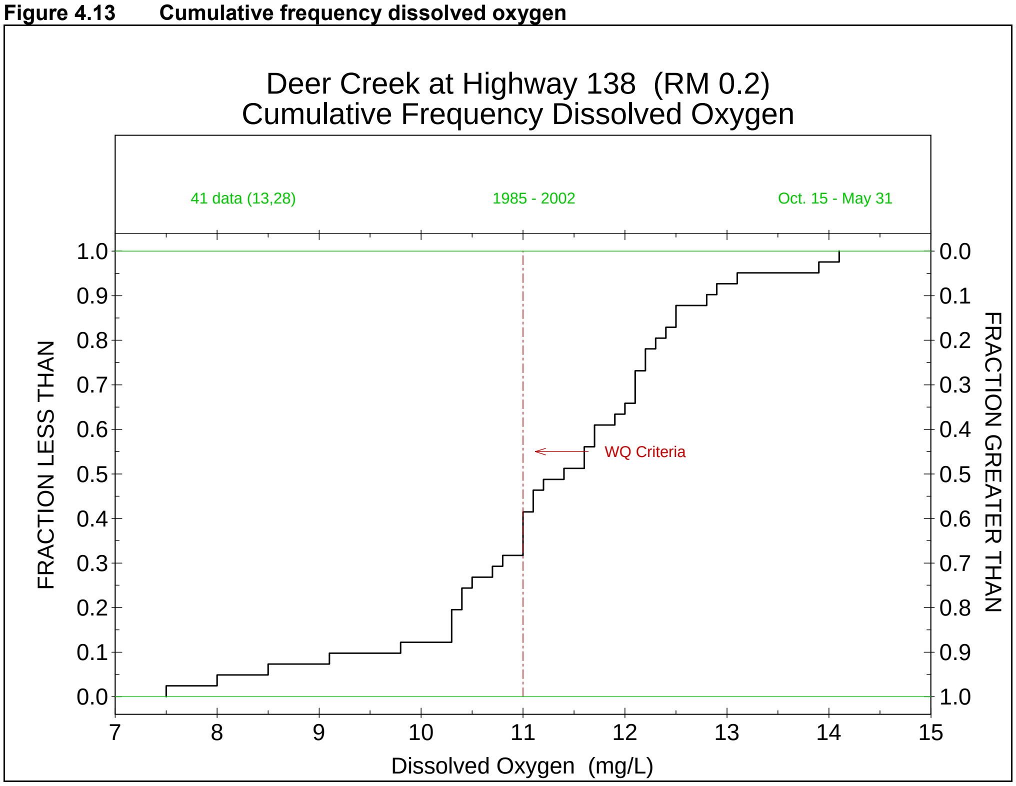
Beneficial Use and Target Criteria Identification

The most sensitive beneficial use is salmonid fish spawning which was determined to occur between October 15 and May 15. The water quality standard calls for 11.0 mg/L of DO or 95% saturation. This TMDL targets a greater DO as to incorporate a margin of safety in the target. The DO target criterion is 11.4 mg/L. In order to achieve the DO target it is estimated that instream BOD concentrations must be 0.7 mg/L or less.

Water Quality Limitation and Seasonal Variation

Dissolved oxygen was routinely measured near the mouth of Deer Creek until 1994. The water quality assessment of the 1998 303(d) list reported that Deer Creek was attaining uses for dissolved oxygen during the non-spawning time period with 6% (1 of 18) June - September values exceeding the cold water dissolved oxygen standard (8.0 mg/l) with a min of 7.5 mg/l between water years 1986 – 1995. The same report documented a water quality limitation during the spawning period where 17% (6 of 36) September - May values exceeded spawning dissolved oxygen standard (11.0 mg/l or 95% saturation) with a minimum of 7.5 mg/l. The following Figure 4.13 shows the cumulative frequency dissolved oxygen for the critical time period.

Figure 4.13 Cumulative frequency dissolved oxygen



The cumulative frequency distribution is an estimate of the underlying population of dissolved oxygen. The plot represents all data collected between 1985 and 2002, with the exception that the data were thinned to no more than one sample per month. Approximately 32% of the dissolved oxygen observations fell below the 11.0 mg/L criteria during the period of record.

Existing Sources

There were no point sources identified as a significant source of BOD and therefore, loading is attributed to nonpoint sources. The Deer Creek Watershed is approximately 65% forested, 28% agriculture, and 7% urban / residential. Forested landscape is not believed to be a significant source of BOD based on sampling in Jackson and Steamboat Creeks (see other TMDLs). The Deer Creek bacteria TMDL identifies agricultural and urban areas of bacteria loading. Although bacteria do not cause an oxygen depletion, it is likely associated with other organic loading which could cause BOD.

Loading Capacity

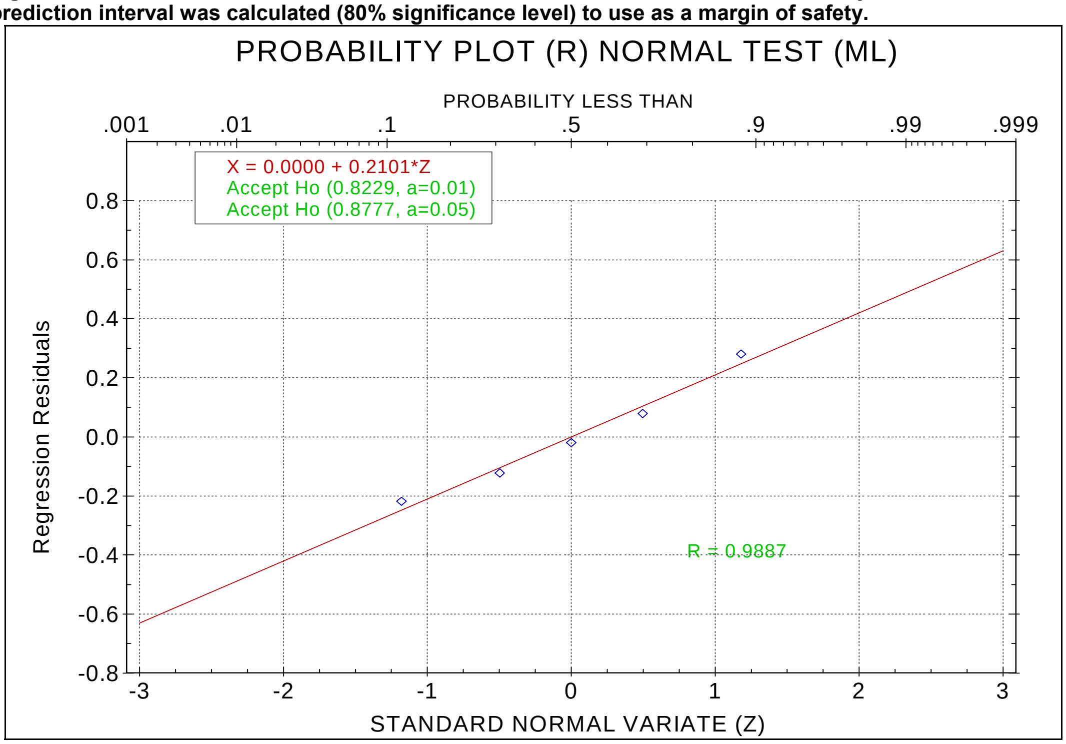
Data does not exist to support a robust process-based mathematical water quality model of Deer Creek. Therefore, a regression model of the association between DO and BOD was used to calculate the loading capacity.

An Ordinary Least Squares linear regression model was developed for Deer Creek in order to evaluate the association between dissolved oxygen and biochemical oxygen demand. The resulting regression model, using data collected during the winter/spring 2001 – 2002 intensive survey (R^2 = 0.7, standard error = 0.2 mg/L), allows for the estimation of the instream BOD concentration necessary to achieve the 11.0 mg/L DO criteria.

It is not necessary for the regression variables to follow normal distributions. In order to make inferences about regression parameters or compute confidence intervals about those parameters and regression estimates, however, it is necessary for the residual errors to be normally distributed. Heavily skewed, non-normal data are more likely to produce non-normal residuals (WQHydro Technical Appendix, April 1993).

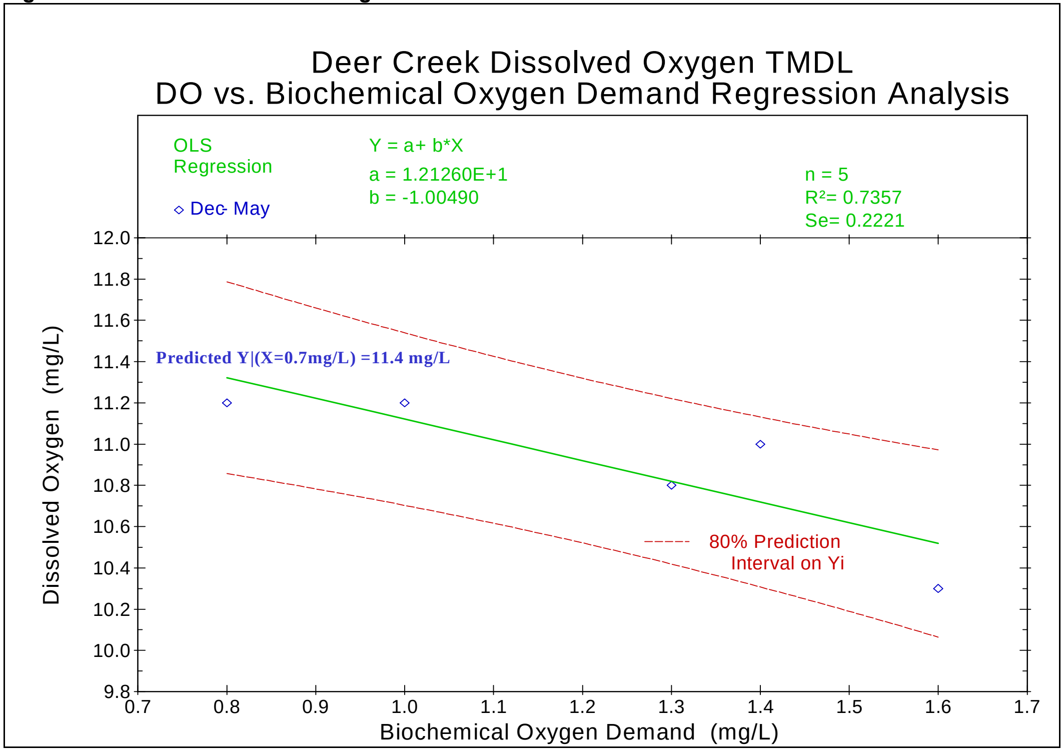
The following probability plot (Figure 4.14) includes a Maximum Likelihood (ML) test for normality that indicates that the residual errors in the regression analysis do fit a normal distribution.

Figure 4.14 Limited data was available to estimate the BOD concentration necessary to achieve the DO criteria, so a prediction interval was calculated (80% significance level) to use as a margin of safety.



The BOD concentration predicted to achieve the 11.0 mg/L DO criterion is 1.1 mg/L. The prediction interval around 11.0 mg/L DO = 10.6 to 11.4 mg/L. The upper value of the prediction interval was used to determine a margin of safety; a BOD of 0.7 mg/L is estimated to achieve a DO concentration of 11.4 mg/L DO.

Figure 4.15 Deer Creek TMDL Regression Plot



A TMDL calculated using a mathematical model is never absolutely correct. Rather, it is a useful approximation. Congress recognized that fact in the drafting of The Clean Water Act and required that a margin of safety be incorporated into the allocations to account for uncertainty in the analysis. The Clean Water Act also states that TMDLs are an iterative process. The TMDLs can be refined at a later date, if necessary, based on additional information gathered over time.

The BOD concentration predicted to achieve a DO concentration of 11.4 mg/L (upper value of the prediction interval) was extrapolated 0.1 mg/L beyond the observed BOD values, Figure 4.15. The further the X value falls outside the range upon which the empirical relationship was developed, the greater the risk of error in approximating Y. Fortunately, the BOD target doesn't extend far beyond the range of observations and the reason for the extrapolation is the BOD margin of safety.

Allocations

No point sources of BOD were identified, so allocations focus on nonpoint source load allocations. The regression analysis with a margin of safety estimates that the salmonid spawning criterion will be achieved when the instream BOD = 0.7 mg/L. The median Deer Creek BOD calculated at the DEQ routine monitoring site (Highway 138 bridge) = 1.4 mg/L. Therefore, the nonpoint source load allocation in the Deer Creek watershed is a **50%** reduction from the median BOD. BOD concentration and percent reduction are used as surrogate measures for loading.

Although the source assessment did not indicate that point sources were a significant source of BOD, the current general stormwater and industrial NPDES sources that discharge to Deer Creek will be reviewed during their renewal to ensure that they comply with the TMDL. Effluent BOD concentrations at the instream target (1.1 mg/L), analysis showing no measurable decrease to DO concentrations, or a 50% reduction from current loading are three possible waste load allocations.

Excess Load

Concentration of BOD was used as a surrogate measure for load. There is a 0.7 mg/L of BOD excess concentration in Deer Creek at the mouth.

Margin of Safety

This instream dissolved oxygen target (11.4 mg/L) includes an explicit 0.4 mg/L margin of safety to account for uncertainty in the analysis and resulting in less pollutant allocations.

Reserve Capacity

The reserve capacity varies longitudinally and is dependent on the frequency, duration, and magnitude of loading. The BOD reserve capacity is load that causes no measurable reduction in DO concentrations.

STEAMBOAT CREEK DISSOLVED OXYGEN AND PH TMDL

Overview

Dissolved oxygen (DO) and pH measurements from Steamboat Creek do not meet the numeric water quality criteria and Steamboat Creek was determined to be water quality limited for summer violations, see Table 4.17 (DEQ, 2002). PH values greater than the criteria likely occur under natural conditions; however, they are exacerbated by the removal of riparian shade. The removal of riparian shade causes warmer stream temperatures and increased solar radiation reaching the stream. Both of these factors lead to increases in attached algae (periphyton) growth. Algae photosynthesis and respiration cause daily swings in pH and DO levels. High pH levels in the afternoon exceed the water quality criteria. DO values do not appear to exceed the average and minimum numeric criteria, however temperature improvements will also improve DO concentrations. Nutrients also encourage the growth of algae; however, only natural sources of nutrients were identified. A mathematical water quality model was set up for Steamboat Creek to quantify the impact of riparian shade on pH and DO and to predict the naturally occurring pH. Allocations for heat load from the temperature TMDL and nutrient allocations will result in Steamboat Creek meeting the water quality standard for DO and pH between June 16 and August 31. The time period is based on the non-spawning period for the lower portion of Steamboat Creek. For details concerning stream temperature and heat load, refer to the Temperature TMDL, Chapter 5.

Table 4.17 Summary of pH water quality limitations for Steamboat Creek.

Parameter	Reach (RM)	Season
Dissolved Oxygen	0 to 6.1	Non Spawning (June 16 to Aug. 31)
pH	0 to 6.1	Summer
pH	6.1 to 10.9	Summer
pH	10.9 to 23.4	Summer

Summer = June 1 through September 30

The determination of pH water quality impairment according to the 1998 303(d) report is based on "Harza Data (Site near mouth): Diurnal study (8/9 - 11/94) measured pH values that exceeded pH standard (6.5 - 8.5) with exceedances ranging between 8.7 - 9.0." The DO impairment was based on "51% of values measured during diurnal study (8/9 - 11/94) measured below criteria".

Pollutant Identification

The pH values greater than 8.5 appear to be naturally occurring (Appendix 6). However, heat loading exacerbates the pH violations in Steamboat Creek (see Temperature TMDL). Although not occurring presently, nutrients in excess of background loading could also exacerbate the naturally high pH. Specifically, dissolved inorganic nitrogen (DIN) consisting of ammonia and nitrite/nitrate and inorganic phosphorus are the nutrients that promote algae growth and hence high pH. Both DIN and inorganic phosphorus are designated pollutants because in the upper portions of Steamboat Creek, nitrogen is the nutrient that is limiting growth, while in the lower reach, phosphorus is limiting growth.

Beneficial Use Identification

Oregon Administrative Rules specify the beneficial uses to be protected in the Umpqua Basin. OAR 340-041-0320 provides that water quality in the Umpqua Basin must be managed to protect the beneficial uses shown in Table 320(A) (see Chapter Overview). The most sensitive beneficial use which occurs in Steamboat Creek as related to dissolved oxygen and pH and the applicable season is salmonid fish rearing designated as cold water aquatic life.

Target Criteria Identification

For the DO and pH water quality standards see DO and pH Chapter Overview. Given the continuous monitoring data collected August 2000 and the water quality modeling (see Appendix 6), DEQ determined that adequate information exists to evaluate the water quality data based on a daily average criteria (8.0 mg/L) and a daily minimum criteria (6.0 mg/L). The pH standard states that pH shall remain between 6.5 and 8.5. The analysis below shows that natural conditions exceed a pH of 8.5 in portions of Steamboat Creek. Therefore, the natural conditions narrative criteria [OAR 340-041-007(2)] is applicable and the natural occurring pH becomes the standard in portions of the creek.

The DO target depends on the most sensitive beneficial use which was identified as cold water aquatic life (Overview Section). This TMDL does not apply to the time period when salmonid spawning occurs. The intensive monitoring effort and the water quality modeling provide adequate information to evaluate the 30-day mean and absolute minimum dissolved oxygen concentrations. The 30-day mean target is 8.0 mg/L and the absolute minimum target is 6.0 mg/L. Because the model only evaluates a 24 hour period, the model-mean is used as a surrogate for the 30-day mean and the model-minimum is used as a surrogate for the absolute minimum. This assumption is acceptable because the data that the model was based on was collected during a steady-state condition and the model evaluates a critical, low-flow condition. It is assumed that when meeting the 30-day mean and absolute minimum targets that the 7-day minimum mean target will also be achieved. Additional load reduction may be necessary if, after implementation, the 7-day minimum mean target is not achieved.

The daily maximum pH target is no measurable increase in pH above the numeric standard of 8.5 or the estimate of naturally occurring pH, whichever is greater. No measurable increase is defined as 0.3 standard units of pH (see Chapter Overview).

Water Quality Limitation and Seasonal Variation

Determination of water quality limitation and the computation of the TMDL are based primarily on a synoptic survey conducted in August 2000 (Map 4.5). During that study, continuous data loggers were placed at various locations in the creek to gather data for a three-day period (Table 4.18). “Grab” samples were also taken to confirm the continuous data reliability and to expand the spatial extent of monitoring. Three of the five monitoring locations had pH values greater than 8.5. Dissolved oxygen (DO) measurements were also collected during the 2000 synoptic survey. Based on the continuous monitoring and grab samples, Steamboat Creek is meeting the daily average and absolute minimum DO criteria, Figure 4.16

Most of the pH data from Steamboat Creek has been collected during the summer months when the maximum pH is likely to occur as a result of conditions conducive to periphyton growth. Such conditions include the increased steam temperature and solar radiation, and decreased stream velocity and depth. During cooler, higher flow conditions, pH concentrations will generally be lower than during summer low flow, which is the critical condition addressed in this TMDL. In addition, in the fall-winter-spring, flows are dominated by rain water which has a lower pH. This seasonal pattern of pH is documented in the Calapooya, Cow and Elk Creek and South Umpqua River pH TMDLs.

Map 4.5 August 2000 monitoring sites in the Steamboat Creek Watershed.

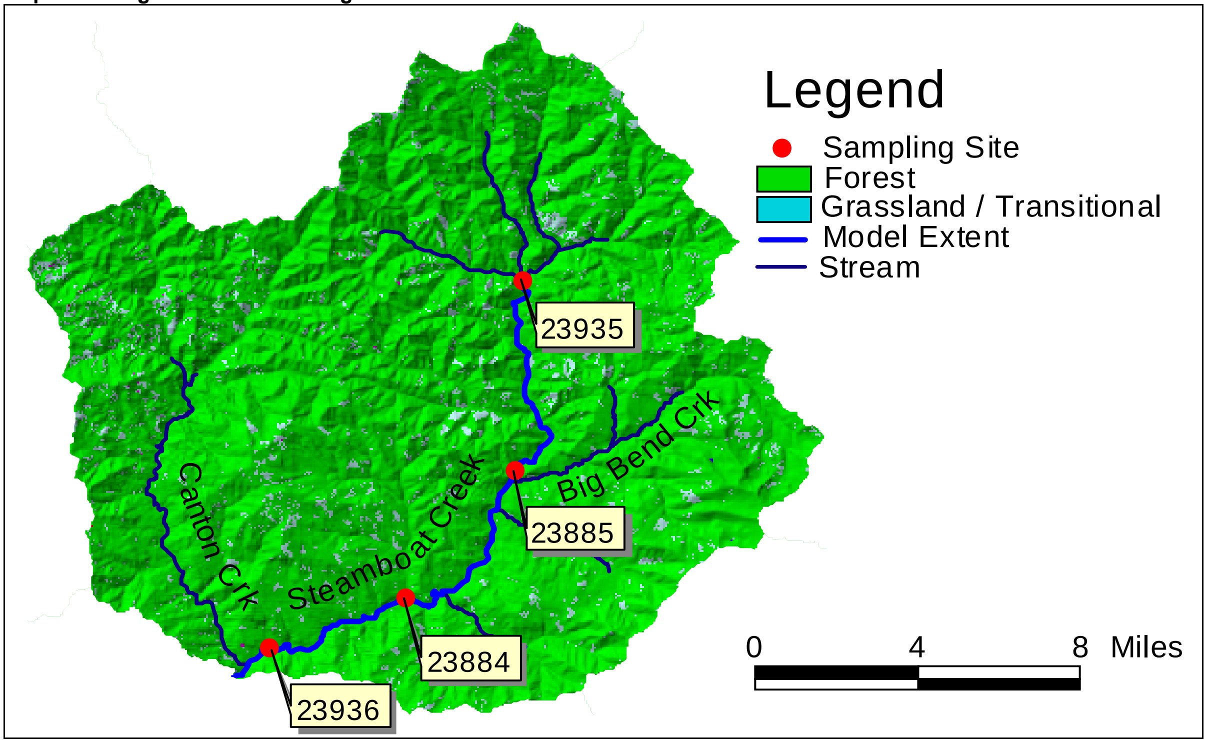
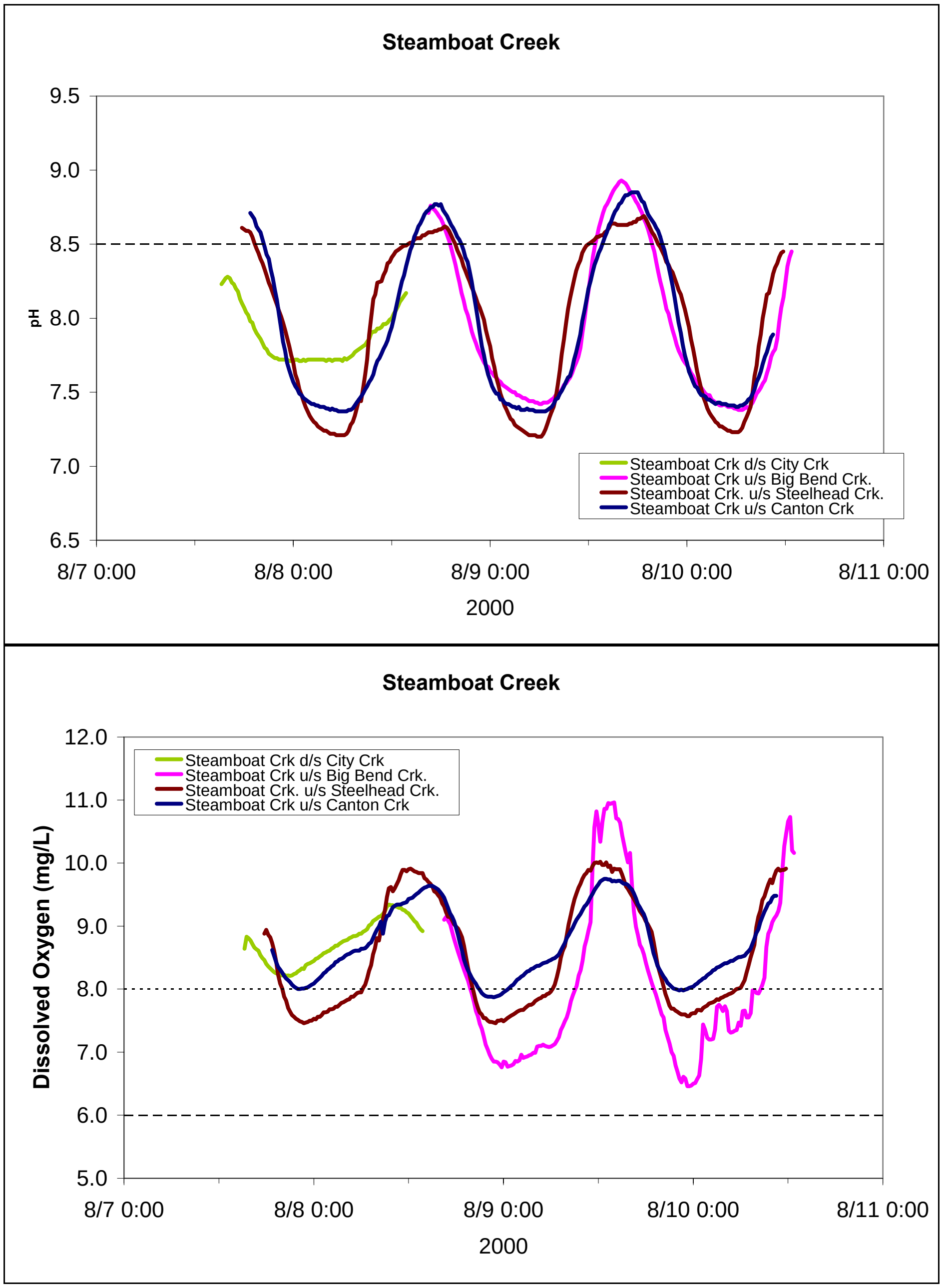


Table 4.18 Summary of DO and pH data for Steamboat Creek for August 7 – 10, 2000.

Lasar #	Station Name	River KM	River Mile	Sampling type	Daily Average DO (mg/L)	Minimum DO (mg/L)	Maximum pH
23935	Steamboat Creek below City Creek	28.7	17.8	continuous	8.7	8.2	8.3
23885	Steamboat Creek above Big Bend Creek	18.1	11.2	continuous	8.1	6.5	8.9
23884	Steamboat Creek above Steelhead Creek	9	5.6	continuous	8.6	7.5	8.7
23936	Steamboat Creek upstream of Canton Creek	2.2	1.4	continuous	8.8	7.9	8.9

Figure 4.16 Continuous pH and DO monitoring results from August 2000 synoptic survey. Sites are listed in the downstream direction.



Existing Sources

There are no point sources in the Steamboat Creek Watershed. Land use is approximately 100% forestry with private companies managing forest in the Canton Creek Watershed and the Umpqua National Forest managing the remainder. No anthropogenic sources of nutrients were identified during this study and the observed nitrogen and phosphorus loading is attributed to background loading. There has been no fertilization of the public forest land since at least the mid-1990s (Michael Jones, Umpqua National Forest, personal communication). All of the nutrient loading is attributed to natural nonpoint sources. The total load delivered to Steamboat Creek is 7.1 pounds / day of inorganic nitrogen and 2.1 pounds per day of inorganic phosphorus. The nonpoint sources of heat load due to the removal of riparian shade are presented the Temperature TMDL. This heat load increases pH by encouraging periphyton growth and changing the saturation value. There are no known anthropogenic sources of BOD.

Load Allocations

Because existing sources of nutrients are believed to be naturally occurring, loads are allocated at current levels. Reductions in heat load will reduce periphyton growth and lead to lower maximum pH values by a maximum 0.2 Standard Units (Figure 4.17). The TMDL scenario is equivalent to a predicted natural condition. Under natural conditions, the model predicts that pH will still exceed the numeric criteria, so the target becomes the natural occurring pH. Nutrient allocations are assigned to ensure future attainment of the water quality standard (Tables 4.19 and 4.20). Heat load allocations are necessary component to the pH TMDL and are described in the Temperature TMDL. These allocations will also insure future compliance with the dissolved oxygen criteria. The allocations apply between June 14 and August 31, the non-spawning period.

Figure 4.17 Current and TMDL scenario maximum daily pH. The TMDL scenario is equivalent to a predicted natural condition.

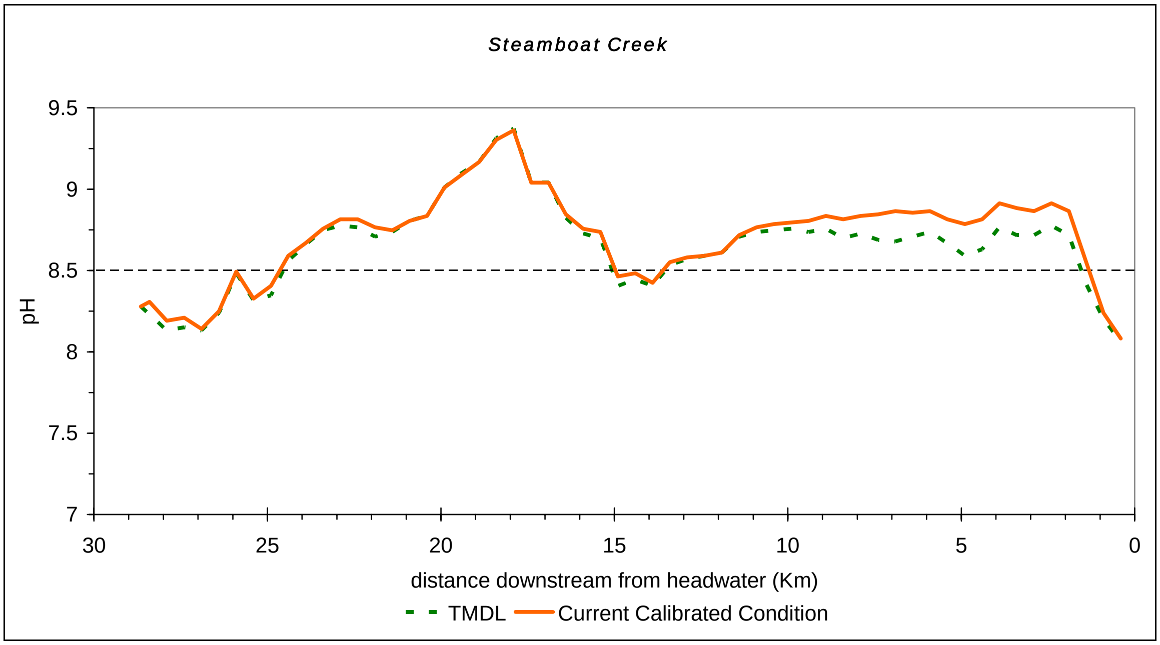


Table 4.19 Inorganic Phosphorus Allocations for the pH and DO TMDLs

	Current (lbs / day)	Allocated (lbs / day)
Background	2.1	2.1
Anthropogenic nonpoint source	0	No measurable increase
Point Source	0	0
Reserve Capacity	na	No measurable increase
TMDL		2.1

Table 4.20 Dissolved Inorganic Nitrogen Allocations for the pH and DO TMDLs

	Current (lbs / day)	Allocated (lbs / day)
Background	7.1	7.1
Anthropogenic nonpoint source	0	No measurable increase
Point Source	0	0
Reserve Capacity	na	No measurable increase
TMDL		7.1

Margins of Safety

The margin of safety is implicit in the technical analysis. The allocations are the naturally occurring heat and nutrient load and therefore will, by definition, achieve the naturally occurring pH. It is also anticipated that on going stream restoration such as large woody debris addition and channel complexity will result in creating seasonal sinks for nutrients in pools and in hyporeic zones creating additional assimilative capacity.

Reserve Capacity

The assimilative capacity of Steamboat Creek for additional phosphorus loading varies longitudinally. Additional sources may contribute phosphorus loading if analysis shows that they will not cause or contribute to pH water quality limitations.

COW CREEK PH TMDL

Overview

During the summer months, the pH measurements near the mouth of Cow Creek often exceed the pH criteria (Table 4.21 and Map 4.6). The high daily maximum pH values are attributed to periphyton (attached algal growth). The growth rate of periphyton is increased by the addition of phosphorus to Cow Creek by point and nonpoint sources. Cow Creek has been identified as water quality limited as reported through the Clean Water Act's 303(d) list. This analysis will address the summer pH water quality limitation. Phosphorus allocations are applicable between May 1 and October 31 to insure water quality standards attainment in Cow Creek and downstream in the South Umpqua River. The chlorine water quality limitation will be addressed through effluent limits specified in source NPDES permits. Continuous monitoring and grab data indicate a possible DO water quality limitation during the non-spawning period (May 16 to October 14). Cow Creek appears to be meeting water quality standard for DO during the spawning time period. The nutrient allocations in this TMDL used to address the pH limitation will result compliance with the DO non-spawning criteria.

Map 4.6 Cow Creek Watershed land use and point sources

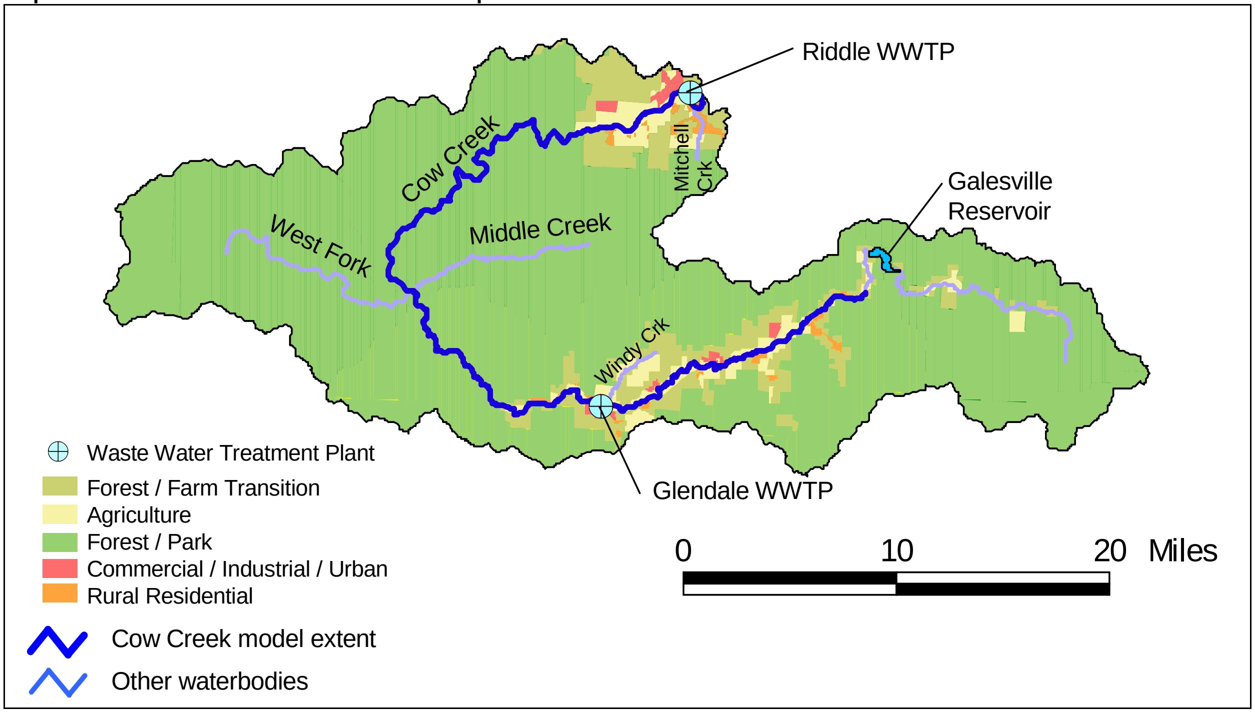


Table 4.21 Current applicable 303d list for Cow Creek				
Record ID	**River Mile**	**Parameter**	**Season**	**Status**
5566	0 to 26.3	pH	Summer	Addressed by this analysis

Target Criteria Identification

Achieving the maximum pH target requires the strictest nutrient allocations, and therefore, it receives most of the analytical focus. For the water quality standards see “Target Criteria Identification” section of this chapter. The sensitive beneficial use was identified as cold water aquatic life (Chapter Overview). This TMDL targets compliance with the pH and DO non-spawning criteria. The intensive monitoring effort and the water quality modeling provide adequate information to evaluate the 30-day mean and absolute minimum dissolved oxygen concentrations. The 30-day mean target is 8.0 mg/L and the absolute minimum target is 6.0 mg/L. Because the model only evaluates a 24 hour period, the model-mean is used as a surrogate for the 30-day mean and the model-minimum is used as a surrogate for the absolute minimum. This assumption is acceptable because the data that the model was based on was collected during a steady-state condition and the model evaluates a critical, low-flow condition. It is assumed that when meeting the 30-day mean and absolute minimum targets, the 7-day day minimum mean target will also be achieved. Additional loading reduction may be necessary if, after implementation, the 7-day minimum mean target is not achieved.

The daily maximum pH target is ‘no measurable increase’ in pH above the numeric standard of 8.5 or the estimate of naturally occurring pH, whichever is greater. No measurable increase is defined as 0.3 Standard Units of pH (see Overview Section).

Water Quality Limitation and Seasonal Variation

Cow Creek was determined to be water quality limited for pH based on DEQ Data (at river mile 0.3) where 62% (13 of 21) summer values exceeded pH maximum standard (6.5 - 8.5) with a maximum value of 9.4 between WY 1986 - 1995. Recent data collection efforts have included an intensive, synoptic survey by DEQ in August 2002 and ambient water quality monitoring at the mouth. DEQ’s water quality data is publicly available at http://www.deq.state.or.us/wq/lasar/Lasar2.asp. There is a diel (daily cyclical) pattern to pH and DO concentrations with maximums occurring in the late afternoon (Figures 4.18 and 4.19). During the August 2002 survey, three of the six water quality monitoring stations measured pH concentrations greater than the standard of 8.5 Standard Units. Although not previously identified as water quality limited for dissolved oxygen, three of the six water quality monitoring stations measured DO concentrations at or below the DO standard's 6.0 mg/L absolute minimum, and at one station, the daily average DO was less than the 8.0 mg/L average criteria (Table 4.22). Stream flows were approximately half of the 3-year low flow condition (14Q3) and are likely to have exacerbated water quality conditions.

Figure 4.18 PH continuous monitoring data for Cow Creek with river mile indicated in parenthesis.

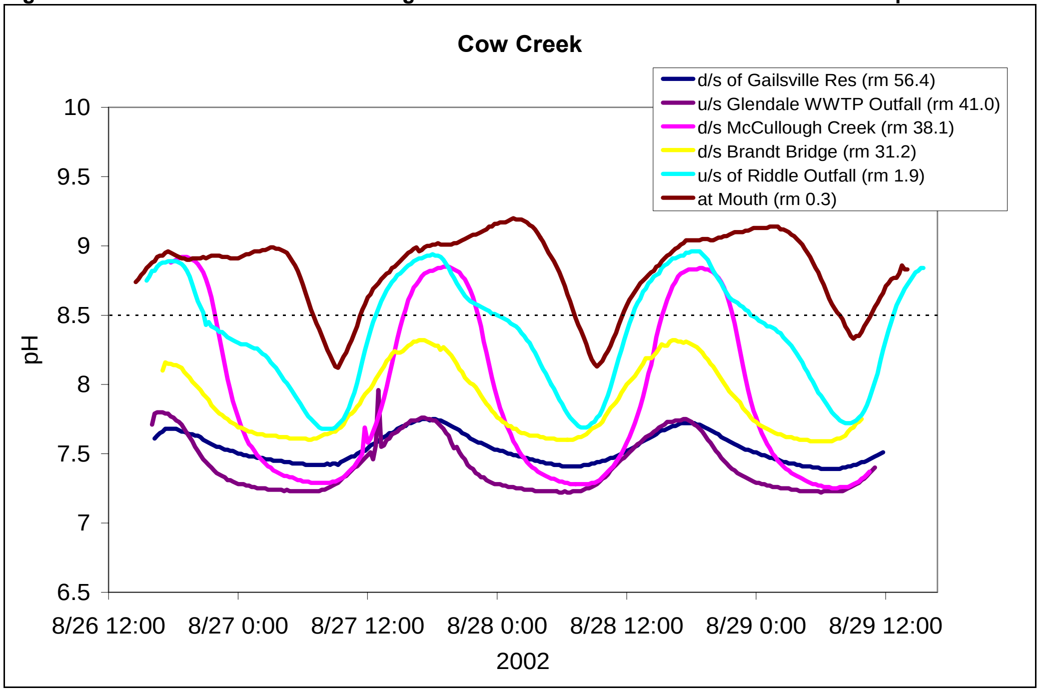


Figure 4.19 Dissolved oxygen continuous monitoring data for Cow Creek with river mile indicated in parenthesis.

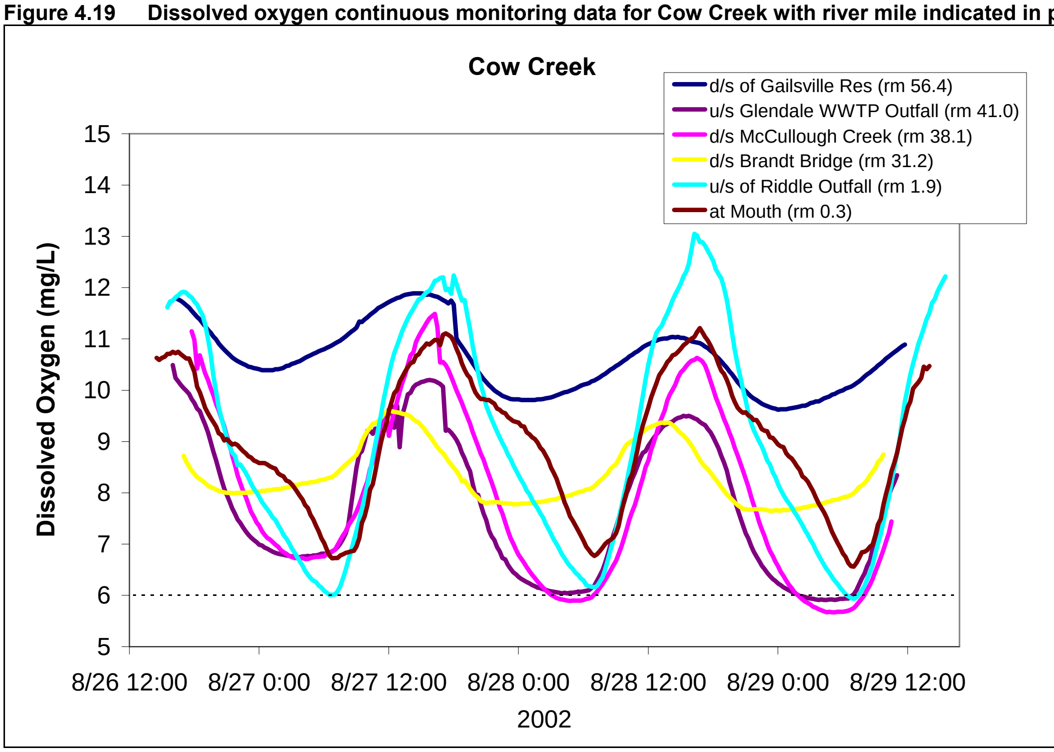


Table 4.22 Daily average dissolved oxygen concentrations computed from two full days of continuous monitoring data on 8/27 and 8/28/2002.

Cow Creek Monitoring Station	Daily Average DO (mg/L)
d/s of Galesville Reservoir	10.7
U/S Glendale STP Outfall	7.8
d/s McCullough Creek	8.1

At Brandt Bridge	8.4
U/S Riddle Outfall	9.1
At Mouth	9.1

Exceedances of the pH standard in the most impacted reach (downstream of Riddle, at the mouth) typically occur between May 1 and October 31 (Figures 4.20). This same pattern is not observed in the DO sample grab data (Figure 4.21). This site is typically monitored in the afternoon, so the DO and pH results will likely be greater than the daily average. The period between May 1 and October 31 provides increased solar radiation, warmer stream temperatures, and lower flows, which are all act to support the large algae mats. The worst water quality typically occurs during July, August, and September. The wasteload allocations have a seasonal component to reflect these changing conditions. Cow Creek does not appear to be water quality limited for dissolved oxygen during the spawning period of October 15 to May 15 with 1 of 41 samples (<10%) not meeting the criteria (Figure 4.21).

Figure 4.20 pH grab sample data from 1/1995 through 1/2005. Average sample time is 2:50 PM.

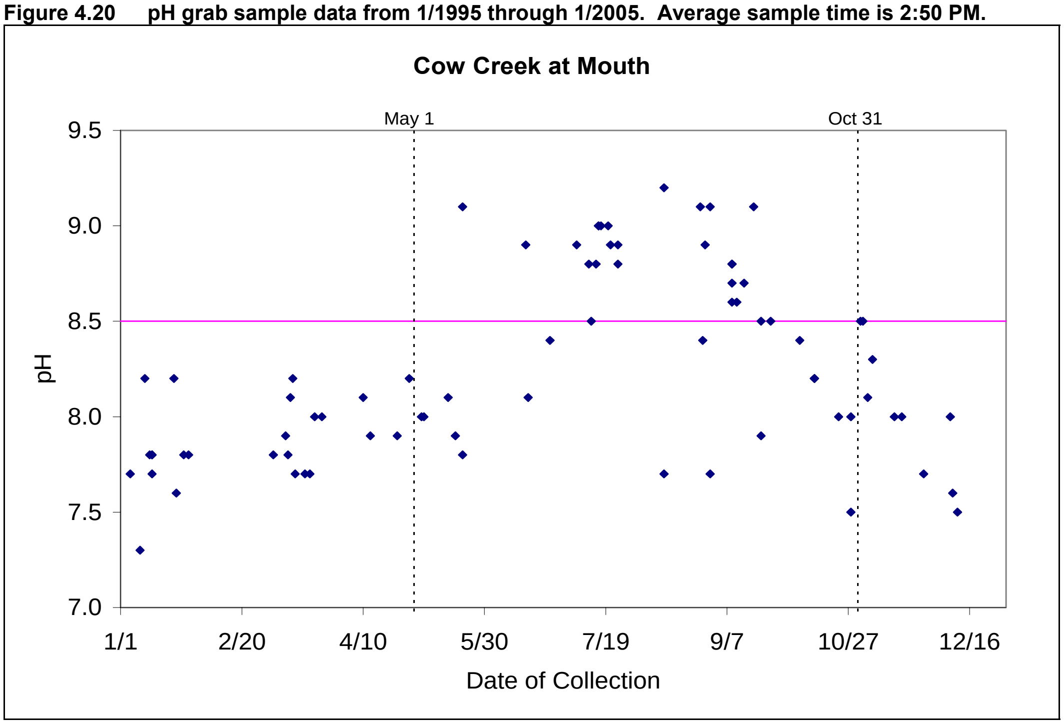
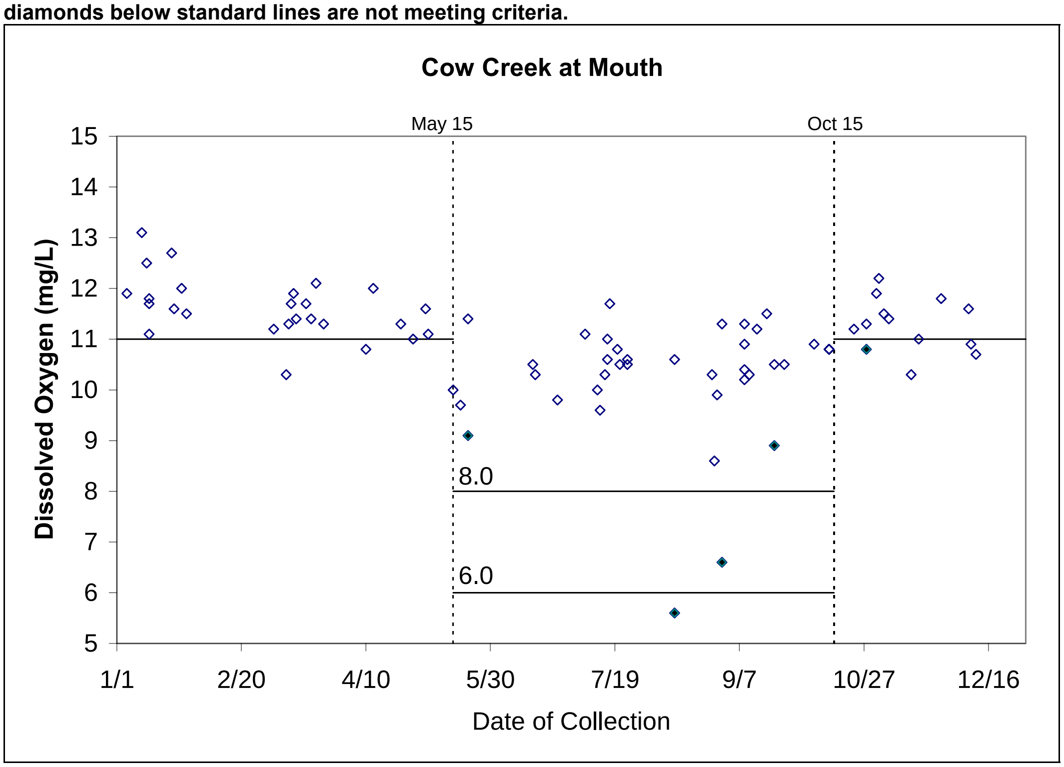


Figure 4.21 Dissolved oxygen grab sample data from 1/1995 through 1/2005. Concentration of 21.4 mg/L collected on 1/9/1995 not shown. Average sample time is 2:50 PM. Spawning in this reach is occurs from October 15 to May 15. Filled diamonds below standard lines are not meeting criteria.



Existing Sources

A generalized source assessment is included in the DO and pH Chapter Overview. Below is more specific information relating to the Cow Creek Watershed.

Point Sources

There are two WWTPs that discharge effluent to Cow Creek: Riddle at river mile 2 and Glendale at river mile 41 (Map 4.6). The facilities had approximately the same effluent flow for August 2002 of 0.1 million gallons per day (MGD). During August 2002, the WWTPs contributed approximately 73% of the inorganic phosphorus and 58% of the total phosphorus to Cow Creek but only 1% of the flow (Table 4.23 and Figures 4.22 and 4.23). Other point sources, including stormwater permits, are discussed in the South Umpqua River Dissolved Oxygen and pH TMDL and apply to the Cow Creek pH TMDL.

Nonpoint Source

Nonpoint sources are either background or anthropogenic. In the South Umpqua basin, background phosphorus concentrations are estimated to be 5 ugP/L of dissolved othrophosphate and 14 ugP/L of total phosphate (see South Umpqua section). The study headwater (downstream of Galesville Reservoir) and major tributaries (West Fork Cow Creek and Middle Creek) had low phosphorus concentrations similar to estimated background concentrations and there loading is assumed to be from background sources. The notable amount total phosphorus loading from Galesville Reservoir (Table 4.23) is due to the large flow contribution and not elevated phosphorus concentrations.

Phosphorus loading greater than background and point source contributions are attributed to anthropogenic nonpoint sources. Diel swings in pH and DO are prominent upstream of the Riddle WWTP. The water quality model does not predict that loading from the Glendale WWTP (39 river miles upstream) would cause this magnitude of biological activity. 1.3 lbs / day of diffuse (i.e. non-tributary) inorganic phosphorus between river mile 3.1 and 6.2 is needed to reproduce the observed DO and pH concentrations. Additionally, there appears to be a significant nonpoint source of nitrite/nitrate below the reservoir and upstream of Glendale (see Appendix 3). Nitrite/nitrate loading would not directly influence algal growth given the phosphorus limitation but could be associated with subtle phosphorus loading not detected in the sampling due to algal uptake.

Both of the reaches of anthropogenic nonpoint source nutrient loading are areas of agricultural lands and residential development. Possible sources could include nutrient rich shallow groundwater due to on-site treatment system and fertilizers, misapplication of fertilizers either in the residential or agricultural setting, or irrigation return flows. Implementation of the TMDL should include further investigation of these reaches.

Table 4.23 Existing phosphorus sources to Cow Creek

	Location	Discharge	Discharge	Inorganic P	Total P	Inorganic P	Total P
Sources	River mile	m3/s	MGD	ugP/L	ugP/L	lbs/day	lbs/day
Point Sources:							
Glendale WWTP	41.0	0.0036	0.083	3651	4090	2.5	2.8
Riddle WWTP	2.0	0.0035	0.080	2750	3100	1.8	2.1
Nonpoint Sources:							
Cow Creek downstream of Galesville Reservoir	58.4	0.63		0	10	0.0	1.2
Windy Creek	41.5	0.00		4	4	0.0	0.0
Middle Creek	26.8	0.04		4	4	0.0	0.0
West Fork Cow	26.4	0.15		6	20	0.2	0.6
Mitchell Creek	0.9	0.01		4	4	0.0	0.0
Diffuse Background Sources	various					0.1	0.3
Diffuse Anthropogenic Sources	3.1 - 6.2					1.3	1.5

Figure 4.22 Sources of Inorganic Phosphorus Loading to Cow Creek. (See technical Appendix 5 for methodology)

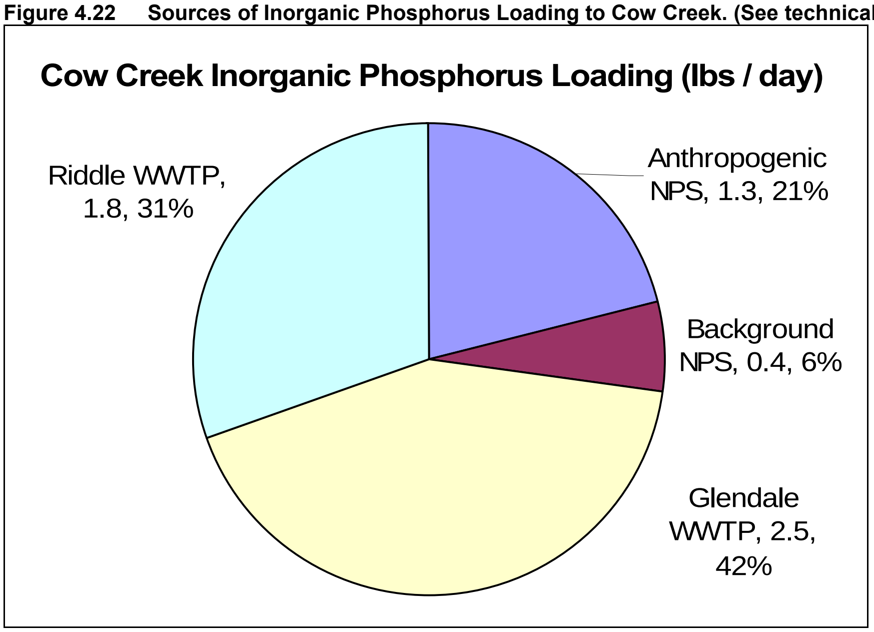
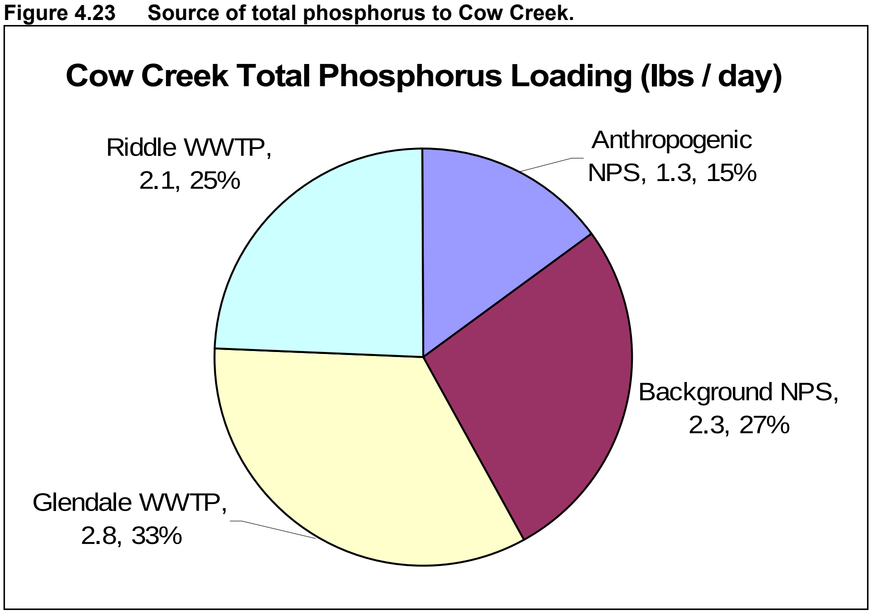


Figure 4.23 Source of total phosphorus to Cow Creek.



Loading Capacity

The phosphorus loading capacity of Cow Creek varies along its length. It is dependent on stream temperature, channel and hydraulic properties, and dilution. Additionally, it is dependent on the configuration of the sources. If all the sources were close geographically, the overall loading capacity would be less because of less time for assimilation between sources. Loading capacity was also based on the decreased solar radiation predicted by the implementation of the Temperature TMDL. Because of changes in flow and stream temperatures within the allocation period, four difference loading capacities where determined: May, June, July through September, and October.

With the current configuration of sources, the overall loading capacity is 4.7 pounds of inorganic phosphorus per day and 8.5 pounds of total phosphorus per day for July through September. This loading capacity was computed for the critical period when water quality limitations are expected to be the worst. The critical flow was 50 cfs at the USGS gage near Riddle which is the 3-year low flow when considering 14-day moving average of the daily flows (14Q3). Critical flow conditions vary throughout the system because of inputs and withdrawals, so in other portions of Cow Creek, the critical flow is the flow that is expected when the flow is 50 cfs at the Riddle gage. This critical flow condition is greater than the flows during the intensive 2002 water quality survey which were extreme drought conditions.

Allocations

Loading capacity and allocations were determined through the use of QUAL2Kw, an EPA supported mathematical water quality model (Appendix 3). Allocations are divided into wasteload allocation (WLAs) for point sources and load allocations (LA) for nonpoint sources. The model predicts that the allocations will result in attainment of the DO and pH standards (Figures 4.24 to 4.26). Data does not show water quality limitations between November 1 and April 30, therefore no phosphorus reductions from current loading are necessary during these months. The allocation time period is based on meeting water quality criteria in the South Umpqua River (May 1 to October 31). Explicit wasteload and load allocations for the critical period are presented in Table 4.24. Flow proportional WLAs are presented in the South Umpqua River nutrient TMDL which follows. Other point sources (including Stormwater permits) are narratively addressed in the South Umpqua Dissolved Oxygen and pH TMDL.

The computed WLA for Glendale WWTP is greater than the estimated current loading. Reduction in phosphorus loading is necessary for anthropogenic nonpoint sources in the vicinity of Riddle (only identified anthropogenic nonpoint sources of phosphorus) and Riddle WWTP. These allocations were computed by iteratively by applying the same percent reduction to inorganic phosphorus and keeping the ratio between inorganic phosphorus and total phosphorus at current levels. These allocations rely on the implementation of the allocations in the Temperature TMDL although the expected increase in assimilative capacity is minor. By rule, overflows of untreated sewage are prohibited in the summer months except during the 1-in-10 year 24 hour storm.

Figure 4.24 Comparison of three loading scenarios under critical flow conditions to the pH water quality target of 8.8: (1) current loading, (2) background loading, and (3) the TMDL. The pH TMDL target is 8.8 (no measurable increase, or 0.3, above the numeric criteria of 8.5).

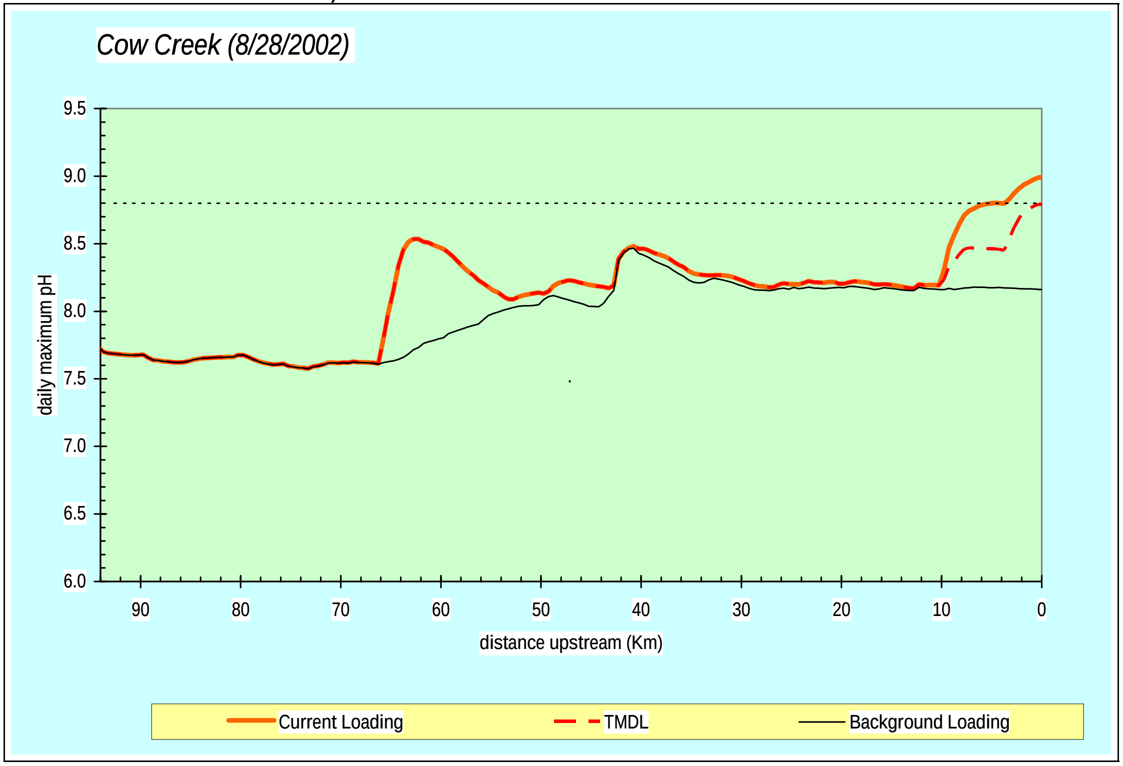


Figure 4.25 Comparison of three loading scenarios under critical flow conditions to the daily average dissolved oxygen water quality target of 8.0: (1) current loading, (2) background loading, and (3) the TMDL

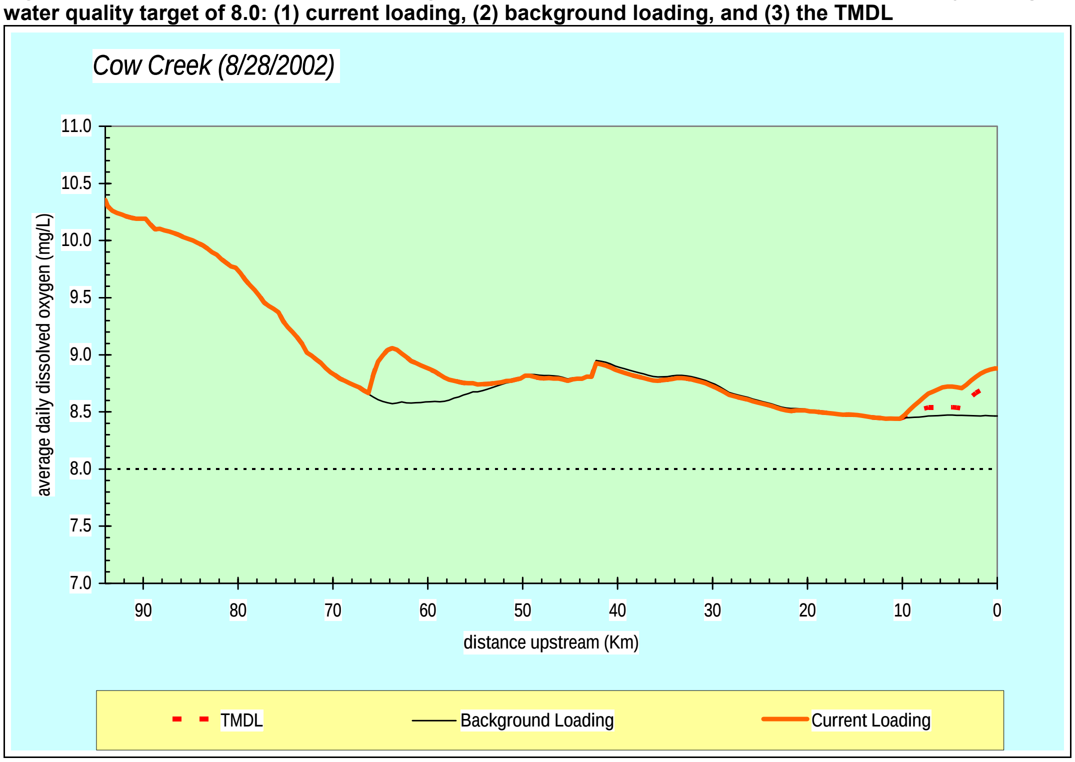


Figure 4.26 Comparison of three loading scenarios under critical flow conditions to the minimum dissolved oxygen water quality target of 6.0: (1) current loading, (2) background loading, and (3) the TMDL

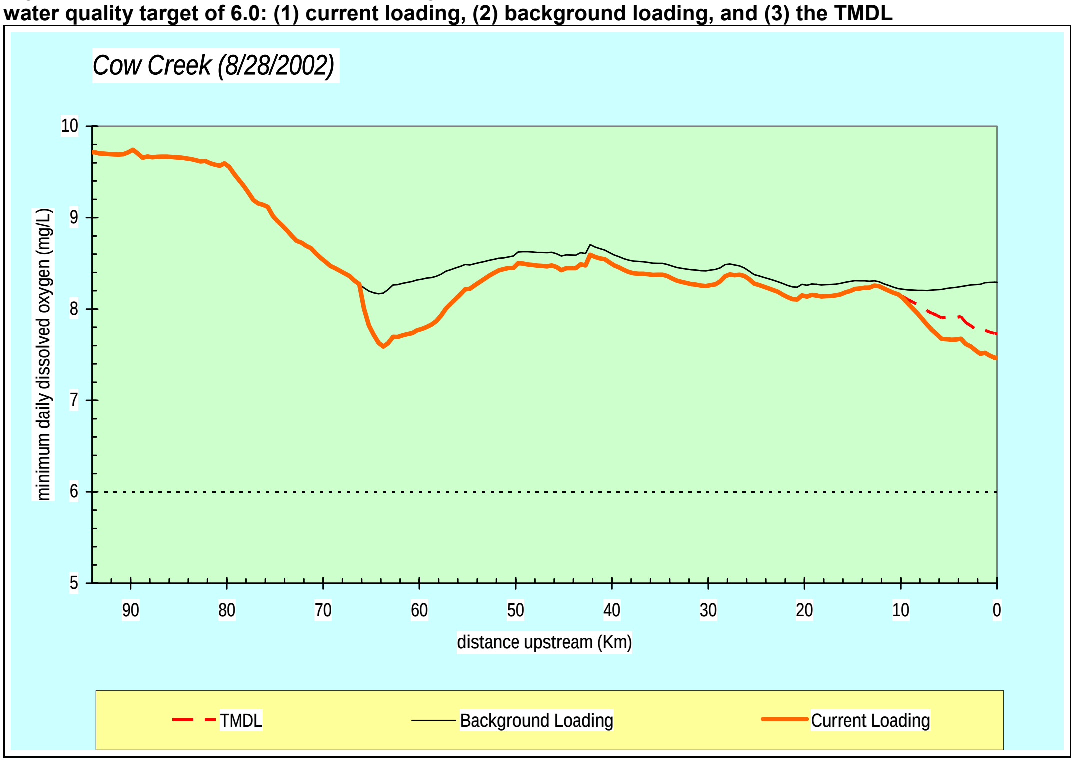


Table 4.24 Wasteload and load allocations for phosphorus during critical flow conditions (see Tables 4.29 and 4.30 for flow proportional allocations).

	Location	Discharge	Discharge	Inorganic P	Total P	Inorganic P	Total P
	River mile	m3/s	MGD	ugP/L	ugP/L	lbs/day	lbs/day
Point Sources:							
Glendale WWTP	41.0	0.0036	0.083	3651	4090	2.5	2.8
Riddle WWTP	2.0	0.0035	0.080	1400	1578	0.94	1.1
Nonpoint Sources:							
Background	various					0.3	3.6
Anthropogenic	various					0.5	0.6

Excess Load

The excess load is the difference between the actual pollutant load in a waterbody and the loading capacity of that water body. The inorganic phosphorus excess load is approximately 1.2 pounds per day when comparing the August 2002 monitoring event to the critical condition-based TMDL. There was no excess total phosphorus load measured during the August 2002 monitoring event when compared with the loading capacity.

Margins of Safety

The margin of safety (MOS) for the Cow Creek pH TMDL is implicit in the analysis through the use of conservative assumptions. A 14-day average, 3-year low-flow condition was used to determine the loading capacity. Using a critical condition to set allocation is a conservative assumption because it applies throughout the time period when there is additional assimilative capacity.

Reserve Capacity

The assimilative capacity of the Cow Creek for additional phosphorus loading varies longitudinally. New or expanding sources may be permitted to contribute phosphorus loading if analysis shows that they will not cause or contribute to pH water quality limitations.

SOUTH UMPQUA RIVER DISSOLVED OXYGEN, PH, PHOSPHORUS AND ALGAE TMDL

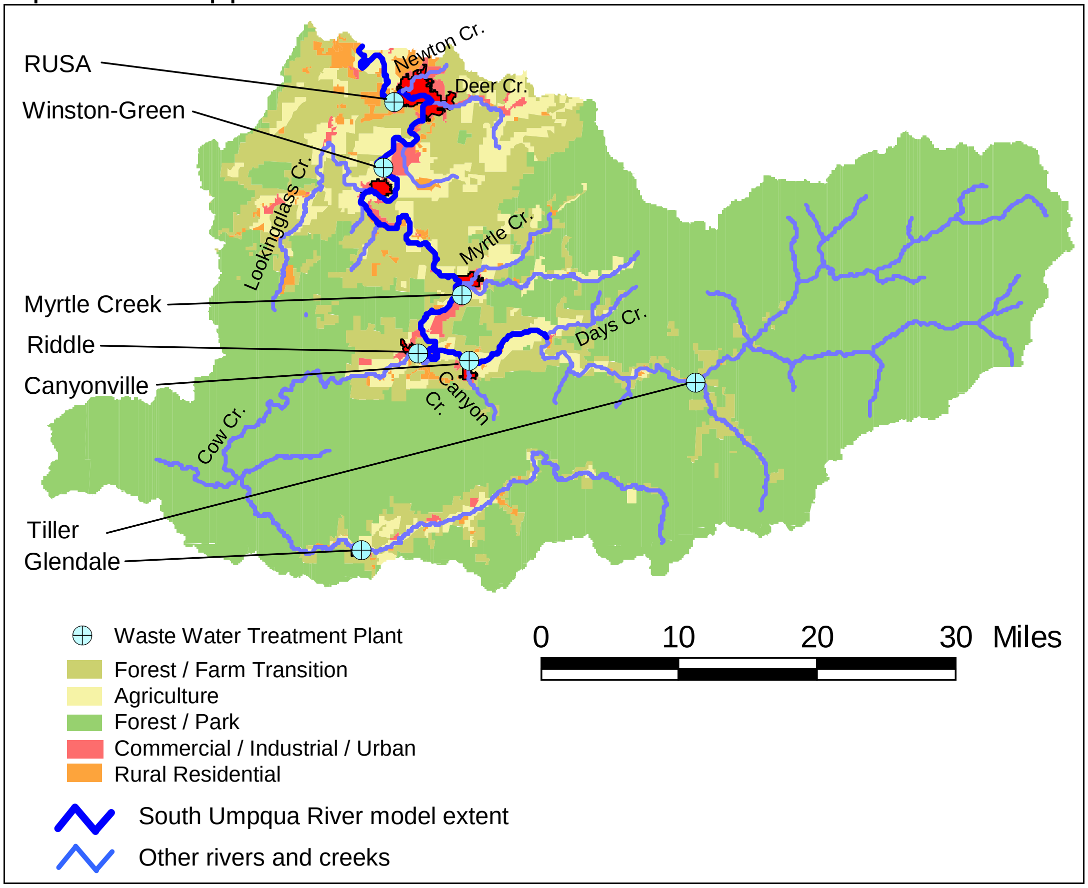
Overview

During the summer months, the dissolved oxygen (DO) and pH measurements from South Umpqua River often do not meet water quality standards (Map 4.7). Impaired water quality is not limited to the lower reaches where the bulk of the population resides. PH measurements taken at locations in the upper watershed which drain only forested land have exceeded the numeric standard. More extreme values of pH and DO occur in the lower reaches and are attributed to anthropogenic activities. Phosphorus allocations which apply between May 1 and October 31 will result in achieving water quality standard.

The South Umpqua River provides excellent growing conditions for attached algae. The South Umpqua River is generally wide and shallow with an average approximate width of 50 meters and a depth of less than 1 meter. There are warm, naturally-occurring temperatures with daily maximums reaching up to 29 degrees Celsius and little shading (see Chapter 5, Temperature TMDL). Lastly, there is bedrock and cobble substrate that provide suitable habitat for large mats of attached algae. Even with no anthropogenic nutrient loading, portions of the South Umpqua River would not meet the numeric water quality criteria for pH.

The phosphorus limits in this TMDL apply to all sources in the South Umpqua Subbasin that contribute to the South Umpqua River. The sources in the Cow and Jackson Creek watersheds are allocated phosphorus in separate TMDLs presented elsewhere in this document.

Map 4.7 South Umpqua River Watershed



Pollutant Identification

While many chemical and physical processes can affect dissolved oxygen and pH levels, this analysis determines that water quality standards can be achieved by targeting pollutant loading. The pollutant is phosphorus in the forms of inorganic phosphorus and total phosphorus, which encourage the growth of periphyton. The technical analysis shows that the South Umpqua River is phosphorus limited under background conditions. Improvements in stream temperature (see Temperature TMDL) will not lead to significant improvements in DO and pH.

Beneficial Use Identification

The primary benefit to maintaining adequate DO and pH is to support a healthy and balanced distribution of aquatic life. The pH standard protects all forms aquatic life and does not depend on the presence of salmonid fish. The applicable sections of the dissolved oxygen rule (OAR 340-041-0016) are determined by the presence of cool or cold-water aquatic life and the stages of any salmonids present (i.e. spawning and rearing). Based on available fish survey information, habitat assessment and professional judgment, Oregon Department of Fish and Wildlife has determined that salmonid rearing and migration occur along the entire length of the South Umpqua River and its tributaries. Therefore, the cold-water aquatic life portion of the DO standard, 340-041-0016(2), is applicable. The assimilative capacity of the South Umpqua River for phosphorus loading is determined by the pH. In other words, greater reductions to phosphorus loading are necessary to meet the pH target than the DO target. Therefore, the designation of “cold-water” does not impact the allocations.

Aesthetics and irrigation are also impacted by the large mats of periphyton. There have been reports of irrigation pumps being clogged by organic material. It is expected that these beneficial uses will also be protected by this TMDL.

Target Criteria Identification

Achieving the maximum pH target requires the strictest nutrient allocations, and therefore, it receives most of the analytical focus. For the water quality standards see “Target Criteria Identification” section of this chapter. This TMDL does not apply to the time period when salmonid spawning occurs. The intensive monitoring effort and the water quality modeling provide adequate information to evaluate the 30-day mean and absolute minimum dissolved oxygen concentrations. The 30-day mean target is 8.0 mg/L and the absolute minimum target is 6.0 mg/L. Because the model only evaluates 24 hour period, the model-mean is used as a surrogate for the 30-day mean and the model-minimum is used as a surrogate for the absolute minimum. The assumption is acceptable because the data that the model was based was collected during a steady-state condition and the model evaluates a critical, low-flow condition. It is assumed that when meeting the 30-day mean and absolute minimum targets that the 7-day day minimum mean target will also be achieved. Additional loading reduction may be necessary if after implementation, the 7-day minimum mean target is not achieved.

The pH standard states that pH shall remain between 6.5 and 8.5. Through water quality modeling, it is estimated that naturally occurring pH maximums ranged from 8.2 to 9.0, exceeding the water quality standard of 8.5 in portions of the river. The TMDL will target ‘no measurable increase’ in pH above natural conditions or the above the numeric standard. No measurable increase for pH is defined as no more than 0.3 pH. This definition is based on Oregon DEQ Data Quality Matrix (Revision 3.0, February 2004) which states that the precision of measurements for the highest level of data quality is less than or equal to 0.3 pH.

The aquatic weeds and algae standard is a narrative standard which does not define a numeric target. To address the DO and pH impairments large reductions in the growth of algae are necessary. It is likely that these reductions will be sufficient to address the aquatic weeds and algae narrative criteria. The nuisance phytoplankton growth criterion calls for concentrations of Chlorophyll a to be less than 0.015 mg/L.

The State of Oregon does not have a state-wide water quality standard that specifically addresses phosphorus concentrations. This TMDL computes the phosphorus loading capacity in order to meet the DO and pH water quality standards.

Water Quality Limitation and Seasonal Variation

This analysis will address the parameters summarized in Tables 4.25. Data collection efforts have included a study by the USGS in the early 1990s (Anderson et. al., 1994), DEQ's ambient river monitoring network, which collects samples every other month, and DEQ synoptic surveys conducted in 1996, 2002, and 2004. DEQ's water quality data is publicly available at http://www.deq.state.or.us/wq/lasar/Lasar2.asp.

Table 4.25 Current applicable 303(d) list for the South Umpqua River.

Record ID	River Mile	Parameter	Season	Status
5662	15.9 to 57.7	Chlorophyll a	Summer	Addressed by this analysis
5687	0 to 15.9	Aquatic Weeds Or Algae	Summer	Addressed by this analysis
5688	15.9 to 57.7	Aquatic Weeds Or Algae	Summer	Addressed by this analysis
12234	0 to 68.8	Dissolved Oxygen	Year Around (Non-Spawning)	Addressed by this analysis
5552	0 to 15.9	Phosphorus	Summer	Addressed by this analysis
5570	0 to 15.9	pH	Summer/Fall	Addressed by this analysis
5571	15.9 to 57.7	pH	Summer	Addressed by this analysis
5573	57.7 to 102.2	pH	Summer	Addressed by this analysis
9370	0 to 5	pH	Winter/Spring/Fall	Exceedances are rare (<10%) between November 1 and April 30, so no allocations are necessary. Separate allocations are designated for May, June, and October.

Water quality conditions were consistent throughout each of the water quality surveys during the summer. PH values peak in the late afternoon in the South Umpqua River with much of the river exceeding 8.5 (Figures 4.27 and 4.28). DO concentrations reach their minimum in the morning with portions of river, failing to meet the absolute minimum criteria of 6.0 mg/L (Figure 4.27 and 4.29). There are large mats of filamentous periphyton prevalent downstream of Myrtle Creek during the summer months (Tanner and Anderson, 1996). Chlorophyll a samples exceed the nuisance phytoplankton growth criteria of 0.015 mg/L.

In the 1998 303(d) list, the South Umpqua River was designated as water quality limited for phosphorus based on data from river mile 5.1 where 45% (14 of 31) of the summer values exceeded nationally recommended criteria (0.10) with a maximum value of 0.520 between water years 1986 to 1995. Those criteria are guidance values and have no regulatory impact. This TMDL calls for instream phosphorus concentrations to be less than 0.10 mgP /L and will protect for cold water aquatic life.

Figure 4.27 DO and pH data from USGS station #1432260 over the period of interest.

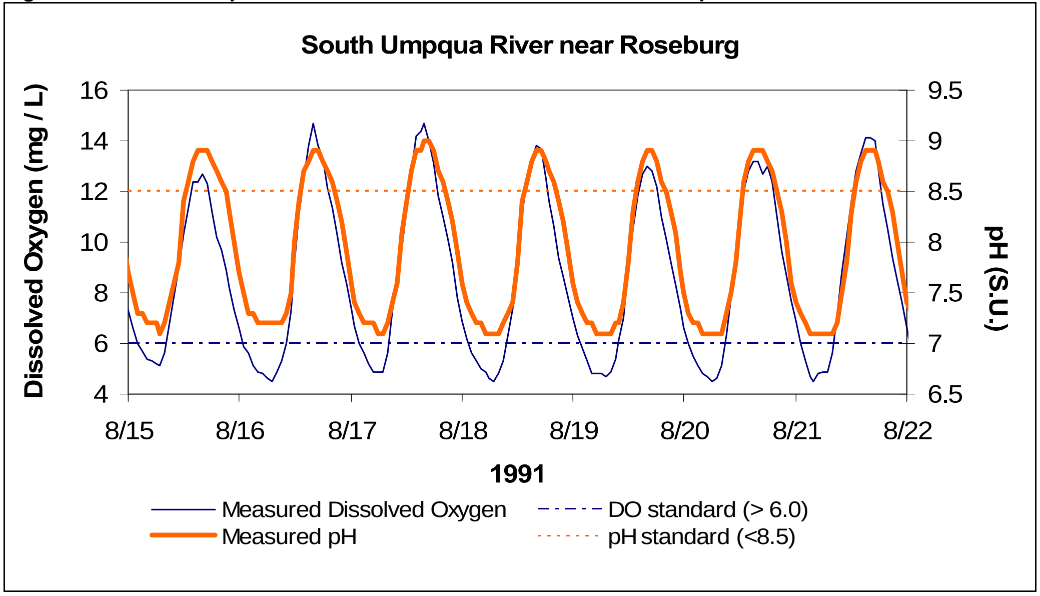


Figure 4.28 Late afternoon (between 2:30 and 5:00 PM) pH measurements along the South Umpqua River.

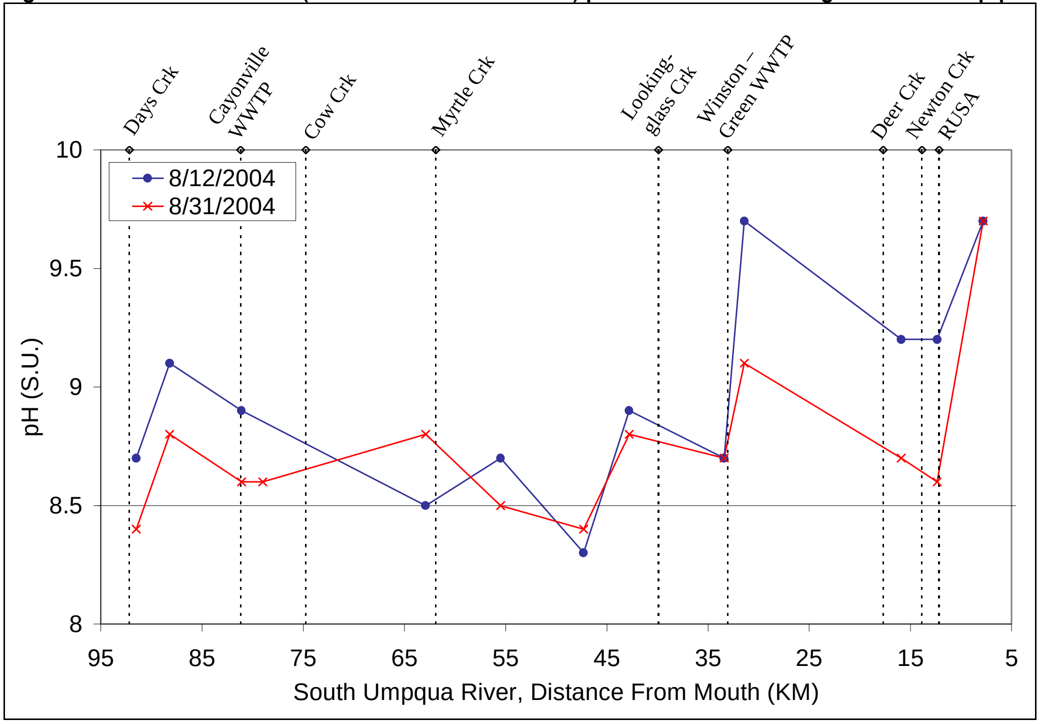
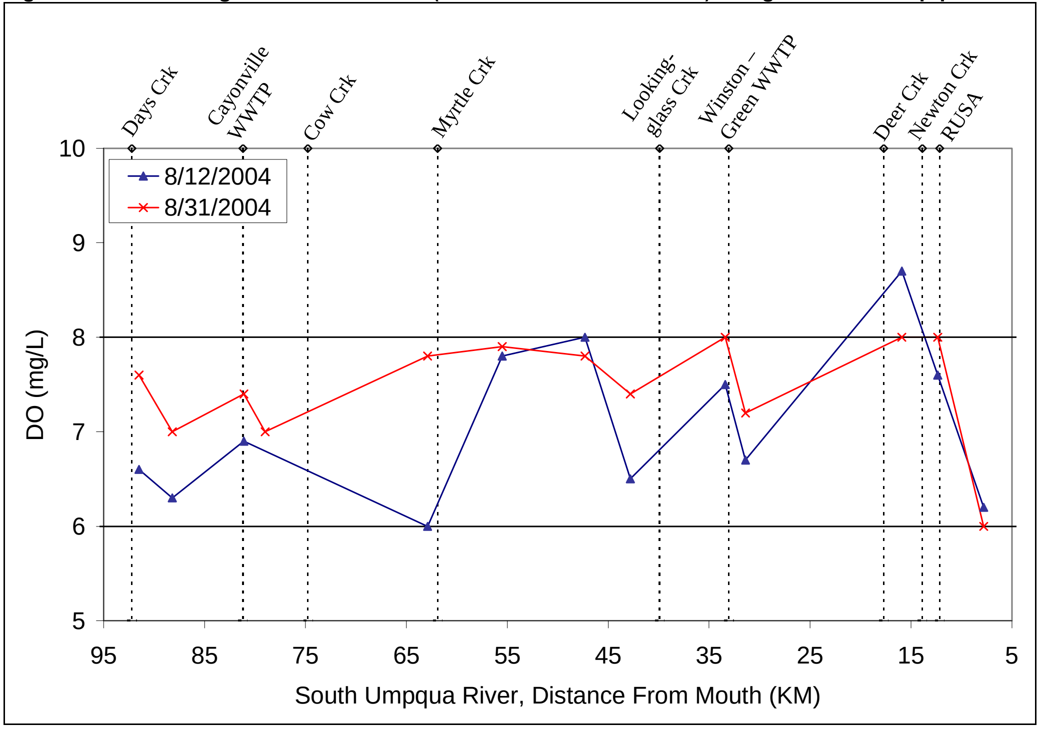


Figure 4.29 Morning DO measurements (between 6:00 and 9:00 AM) along the South Umpqua River.



Exceedances of the DO and pH standards in the most impacted reach (downstream of Roseburg) typically occur between May 1 and October 31 (Figures 4.30 and 4.31). This period provides increased solar radiation, warmer stream temperatures, and lower flows which are all necessary to support the large algae mats. The worst water quality typically occurs during July, August, and September. The wasteload allocations have a seasonal component to reflect these changing conditions. The draft 2004 303(d) list analysis determined that the South Umpqua River was "attaining uses" considering dissolved oxygen during the spawning period (October 15 to May 15).

Figure 4.30 Seasonality of pH measurements at river mile 5.1. Measurements are from grab samples typically sampled in the afternoon. The dashed lines below indicate period of allocations.

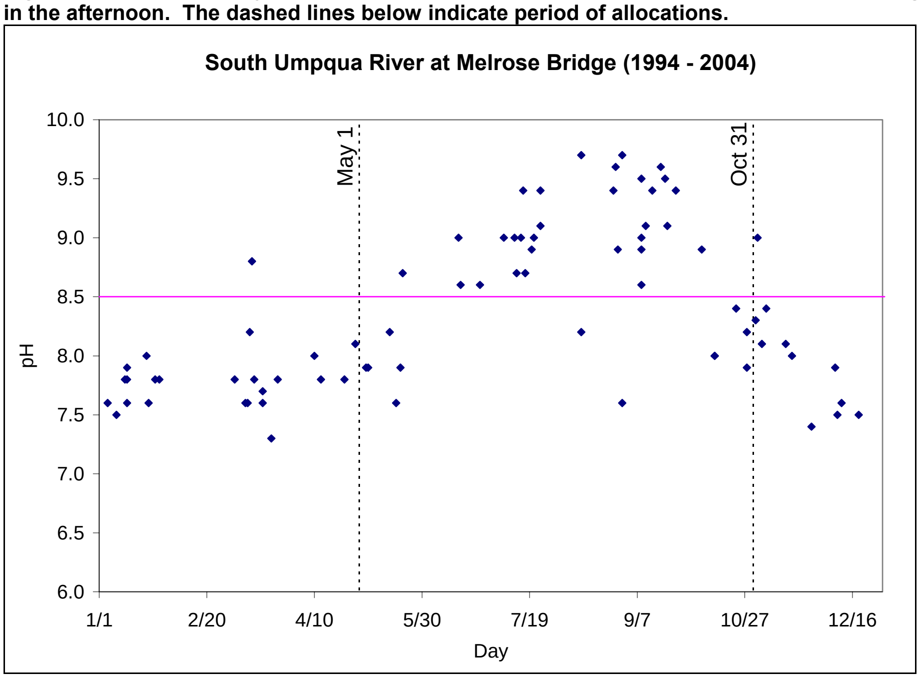
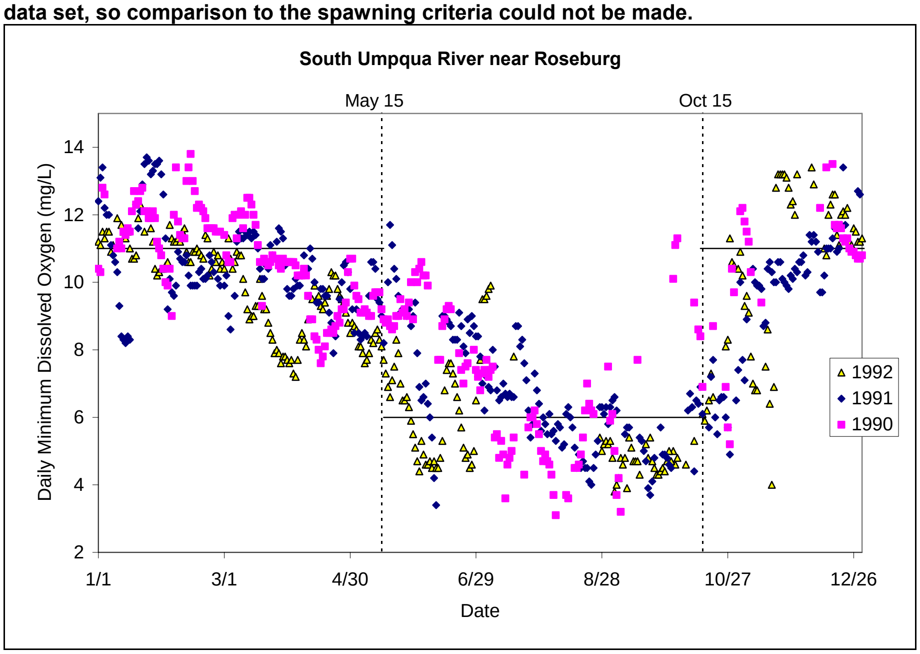


Figure 4.31 Minimum daily DO measurements from USGS continuous monitoring (station# 14312260, Anderson et. al, 1994) for the South Umpqua River. The data below was filtered to remove concentrations that were believed not to be representative of actual water quality conditions as identified by rapid decreases in DO caused by the bio-fouling of instrumentation. The DO standard is dependent on salmonid spawning time period. No DO saturation was included in this data set, so comparison to the spawning criteria could not be made.



Existing Sources

A generalized source assessment is included in the DO and pH Overview Section. Below is more specific information relating to the South Umpqua River. Sources in Jackson and Cow Creek watersheds are discussed specifically in separate sections. Anthropogenic nutrient loading from point and nonpoint sources, exacerbate water quality conditions in the South Umpqua River. Currently, wastewater treatment plants provide approximately 85% of the total phosphorus and ammonia loading while only 5% of the flow, Figures 4.32-4.34.

Table 4.26 Current phosphorus loading to the South Umpqua River. South Umpqua nonpoint source (NPS) loading includes headwater, tributary, and diffuse loading from background and anthropogenic sources. Cow Creek loading, as measured at its mouth, includes point and nonpoint source loading. Cow Creek's load to the South Umpqua River is less than the load Cow Creek receives because algae are a nutrient sink. Glendale and Riddle WWTPs are included for informational purposes. Further discussion is included in the Cow Creek TMDL.

	Location	Discharge	Discharge	Inorganic P	Total P	Inorganic P	Total P
Name	River mile	m3/s	MGD	ugP/L	ugP/L	lbs/day	lbs/day
Tiller Ranger Station WWTP	75.5	0.0013	0.029	48	190	0.012	0.046
Canyonville WWTP	50.5	0.0087	0.20	3170	4760	5.2	7.9
Myrtle Creek WWTP	38.5	0.026	0.60	3070	3685	15	18
Winston-Green WWTP	20.6	0.047	1.1	3040	3100	27	28
RUSA	7.6	0.135	3.1	4050	4450	104	115
South Umpqua NPS	various	various	na	various	various	2.4	17
Cow Creek (at mouth)	46.5	1.3	na	10	20	2.4	4.9
Glendale WWTP	*Cow Creek*	*0.0036*	*0.083*	*3651*	*4090*	*2.5*	*2.8*
Riddle WWTP	*Cow Creek*	*0.0035*	*0.080*	*2750*	*3100*	*1.8*	*2.1*

Point Sources

Wastewater Treatment Plants

There are five WWTPs that discharge effluent to the South Umpqua River: Roseburg Urban Sanitary Authority (RUSA), Winston-Green, Myrtle Creek, Canyonville, and Tiller Ranger Station, see Map 4.7. Of these RUSA is the largest and contributes approximately 73% of the entire inorganic phosphorus loading to the South Umpqua River, Figure 4.32. Myrtle Creek WWTP has a permit to discharge treated effluent during the summer but has been reusing its effluent for irrigation. The WWTPs contribute approximately 96% of the inorganic phosphorus loading during low-flow conditions. The load contribution from the point sources is generally a function of the population served (effluent volume) and the secondary treatment efficiency that the facilities were designed to achieve.

Figure 4.32 Sources of inorganic phosphorus to the South Umpqua River during August 2004. Both point and nonpoint source loading comprise the "Headwater" and "Cow Creek" loading.

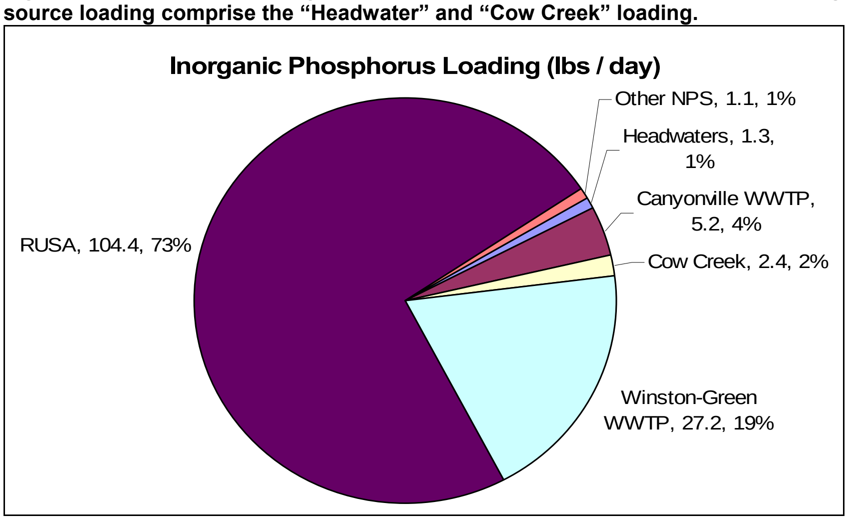


Figure 4.33 Sources of total phosphorus to the South Umpqua River during August 2004. Both point and nonpoint source loading comprise the "Headwater" and "Cow Creek" loading.

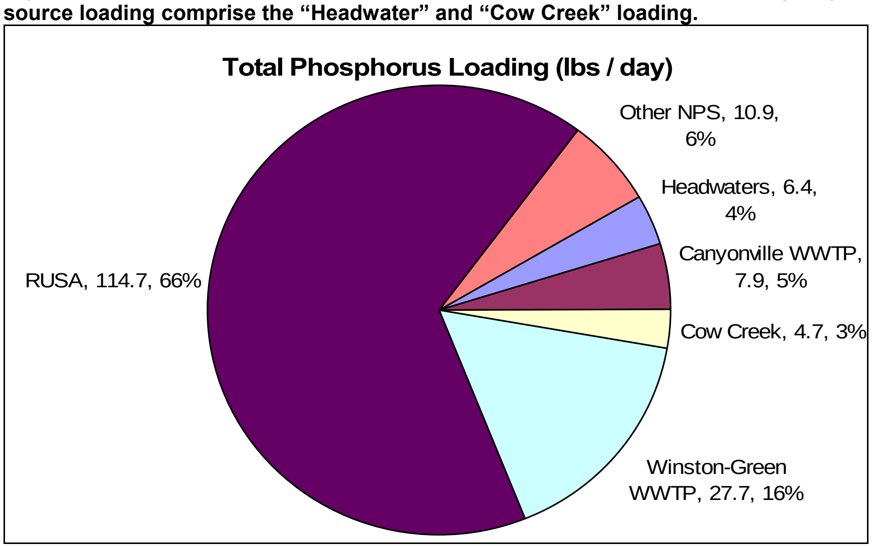
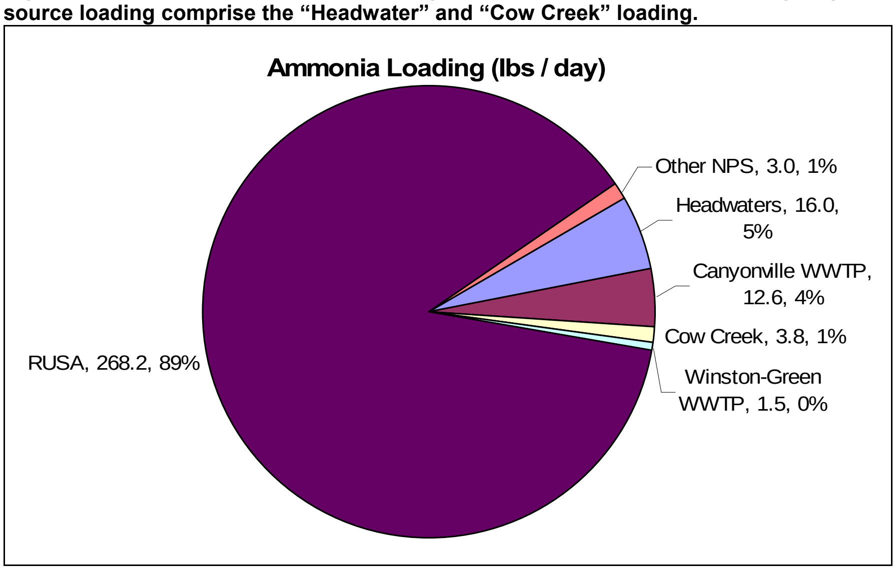


Figure 4.34 Sources of ammonia loading to the South Umpqua River during August 2004. Both point and nonpoint source loading comprise the "Headwater" and "Cow Creek" loading.



Other Point Sources

The Roseburg Landfill, operated by Douglas County Public Works Department, discharges leachate into an treatment wetland which overflows into an unnamed stream which flows into the South Umpqua River at river KM 22.6. Flow levels and total phosphorus concentrations indicate that it is not a significant source of phosphorus and is not likely causing or contributing to water quality limitations in the South Umpqua River.

There are 49 stormwater permits in the South Umpqua Subbasin. Because the water quality limitations are most severe during the period with the least rainfall, stormwater permitted facilities are not likely contributors of significant nutrient loading. If conditions of the permit are met, permitted stormwater facilities are not likely to contribute nutrient loading that will adversely impact DO or pH.

There are 24 industrial permits which discharge in the South Umpqua Subbasin. An initial examination of these permits does not indicate any significant sources of phosphorus. However, all permits in the subbasin will be reviewed during the permit renewal process and modified to include phosphorus monitoring and/or limits, as necessary.

Nonpoint Sources

Nonpoint sources are either background or anthropogenic. Predominately nonpoint sources are delivered to the South Umpqua River through tributaries during the dry summer months (Table 4.27). Newton, Deer, and Myrtle Creeks had the greatest phosphorus concentrations and much higher than the estimated background concentration. The creeks drain urban and agricultural areas and possible sources include urban runoff, agricultural runoff, livestock, failing septic systems, illegal discharges and streambank erosion.

Table 4.27 Phosphorus concentrations of major tributaries and South Umpqua River upstream of major point sources. Results are the average of two synoptic surveys from August 2004. Background concentration was determined through averaging concentration from sites believed to have no anthropogenic loading (see technical Appendix 7). There are two WWTPs located on Cow Creek.

Station #	Name	River Mile	Dissolved Orthophosphate as P (ug/L)	Total Phosphate as P (ug/L)
31693	South Umpqua R. d/s Days Creek (upstream of major point sources)	56.9	6	15
10997	Cow Creek at Mouth	46.5	10	20
11316	Myrtle Creek at Mouth	38.5	17	40
12248	Lookingglass Creek @ Hwy 42	24.8	6	20
11310	Deer Creek at Hwy 138	11.0	18	45
31694	Newton Creek at Mouth	8.6	57	95
	Estimated background concentration		5	14

DEQ and USGS measured phosphorus concentrations in the South Umpqua River that could not be attributed to point sources or tributaries. It is believed that these sources of phosphorus are anthropogenic nonpoint sources. However, patterns were not consistent patterns between the surveys. On August 13, 2004, measurements indicated phosphorus and nitrogen loading between river mile 39.1 (just upstream of Myrtle Creek) and river mile 34.5, (upstream of Clark Branch). On August 31, 2004, measurement indicated nutrient loading downstream of this location and upstream of Highway 99 bridge (RM 29.4). Tanner and Anderson of the USGS (1996) also indicated an unidentified nutrient source between the Mary Moore Bridge (RM 34.5) and Brockway (RM 26.6). In addition they indicated nutrient loading in the Roseburg area up to 12 miles upstream of Roseburg's WWTP.

Loading Capacity

The loading capacity is the amount of a pollutant that a waterbody can receive and still meet water quality standards. The phosphorus loading capacity of the South Umpqua River varies along its length. It is dependent on channel and hydraulic properties and dilution. Additionally, it is dependent on the configuration of the sources. If all the sources were close geographically, the overall loading capacity would be less. Because of increases in flow within the allocation period increase the loading capacity, flow proportional loading allocations were determined. With the current configuration of sources, the over-all loading capacity is 10 pounds of inorganic phosphorus per day and 17 pounds of total phosphorus per day during critical conditions (see Appendix 3).

Excess Load

The excess load is the difference between the actual pollutant load in a waterbody and the loading capacity of that water body. The inorganic phosphorus excess load is 147 pounds per day and the total phosphorus excess load is 173 pounds per day.

Allocations

Load capacity and allocations were determined through the use of Qual2kw, an EPA supported mathematical water quality model (Appendix 3). Inorganic phosphorus and total phosphorus allocations are divided into wasteload allocation (WLAs) for point sources and load allocations (LA) for nonpoint sources under critical flow and temperature conditions (Table 4.28). Flow proportional phosphorus WLAs apply to the non-critical periods between May 1 and October 31. Data does not show water quality limitations between November 1 and April 30 (DEQ 2004 303(d) list and Figure 4.30). Therefore, no phosphorus reductions beyond current loading are necessary during those months.

The model predicts that the allocations will results in attainment of the DO and pH standards during critical flow and temperature conditions (Table 4.28). The critical condition is defined as the low flow that is expected to occur every three years when averaged over a 14-day period (14Q3). The 14Q3 at the South Umpqua at Brockway gage was computed as 84 cfs (2.38 cms). Critical temperature conditions typically occur in July and August. The allocation to each source differs because of upstream river conditions, morphology, flow, and effluent chemistry.

Flow proportional waste load allocations were calculated for 7 flow regimes using the ratio between critical load and critical flow to determine protective loading at greater flows (Tables 4.29 to 4.31). The critical condition, as discussed above, defines the first flow regime with South Umpqua at Brockway = 86 cfs, South Umpqua at Tiller = 56 cfs, and Cow Creek at Riddle = 50 cfs. Critical WLA are presented in Table 4.28. For each flow regime, the lowest flow was used to calculate the appropriate loading. This allocation strategy could be used to further refine the flow regimes. Flows regimes are defined as the median flow for a month calculated from the observed mean daily values reported on the USGS website for that specific month / year. The flow proportional WLAs are likely conservative estimates because increased river velocity, depth and reaeration rates and decreased temperatures associated with increased flow should lead to additional assimilative capacity not accounted for by this method. Additional monitoring and analysis during the wastewater permit process could refine the loading capacity during the non-critical months (i.e. May, June and October) which may result in a different loading rate if the analysis shows that pH concentrations in the South Umpqua River would meet the water quality standard downstream of this location. By rule, overflows of untreated sewage are prohibited in the summer months except during the 1-in-10 year 24 hour storm.

Table 4.28 Phosphorus allocations for sources of the South Umpqua River to address DO, pH, algae and phosphorus water quality limitations. South Umpqua nonpoint source (NPS) loading includes headwater, tributary, and diffuse loading from background and anthropogenic sources. Cow Creek loading, as modeled at its mouth, includes point and nonpoint source loading. Cow Creeks load to the South Umpqua River is less than the load Cow Creek receives because algae along the length of Cow Creek take up nutrients. Glendale and Riddle WWTPs are included for informational purposes. Further discussion is included in the Cow Creek TMDL.

	Location	Dis-charge	Dis-charge	Dry Weather Design	Inorganic P	Total P	Inorganic P	Total P
Name	Km	m3/s	MGD	MGD	ugP/L	ugP/L	lbs/day	lbs/day
Tiller Ranger Station (WLA)	121.5	0.0013	0.029	0.029	48	190	0.012	0.046
Canyonville WWTP (WLA)	81.2	0.0087	0.20	0.5	500	751	0.83	1.2
Myrtle Creek WWTP (WLA)	61.9	0.026	0.60	1.8	300	360	1.5	1.8
Winston-Green WWTP (WLA)	33.1	0.047	1.1	1.6	200	209	1.8	1.9
Roseburg Landfill (WLA)	22.6	0.0013	0.030	na	400	400	0.10	0.10
RUSA (WLA)	12.2	0.135	3.1	7.9	120	132	3.1	3.4
South Umpqua NPS (LA)	various	various	na	na	various	various	2.1	6.3
Cow Creek (at mouth)	74.8	1.3	na	na	3	11	0.73	2.7
Glendale WWTP (WLA)	*Cow Creek*	*0.0036*	*0.083*	*0.25*	*3651*	*4090*	*2.5*	*2.8*
Riddle WWTP (WLA)	*Cow Creek*	*0.0035*	*0.080*	*0.25*	*1400*	*1578*	*0.94*	*1.1*

Table 4.29 Flow proportional inorganic phosphorus WLAs for May 1 to October 31. Values in bold **indicate that the allocation was based on design load as it was less than the calculated flow-based load.**

	Inorganic Phosphorus (pounds / day)						
WWTP	Flow #1	Flow #2	Flow #3	Flow #4	Flow #5	Flow #6	Flow #7
Canyonville (Gage A)	0.83	1.5	3.0	5.9	10	**13**	**13**
Myrtle Creek (Gage B)	1.5	2.7	5.4	11	18	36	**46**
Winston-Green (Gage B)	1.8	3.2	6.4	13	21	**41**	**41**
RUSA (Gage B)	3.1	5.5	11	22	37	74	111
Glendale (Gage C)	2.5	4.5	**7.6**	**7.6**	**7.6**	**7.6**	**7.6**
Riddle (Gage C)	0.94	1.7	3.3	**5.7**	**5.7**	**5.7**	**5.7**

Table 4.30 Flow proportional total phosphorus WLAs for May 1 to October 31. Values in bold **indicate that the allocation was based on design load as it was less than the calculated flow-based load.**

	Total Phosphorus (pounds / day)						
WWTP	Flow #1	Flow #2	Flow #3	Flow #4	Flow #5	Flow #6	Flow #7
Canyonville (Gage A)	1.2	2.2	4.4	8.9	15	**20**	**20**
Myrtle Creek (Gage B)	1.8	3.2	6.5	13	22	43	**55**
Winston-Green (Gage B)	1.8	3.3	6.5	13	22	41	**41**
RUSA (Gage B)	3.4	6.1	12	24	40	81	121
Glendale (Gage C)	2.8	5.1	**8.5**	**8.5**	**8.5**	**8.5**	**8.5**
Riddle (Gage C)	1.1	1.9	3.8	**6.4**	**6.4**	**6.4**	**6.4**

Table 4.31 Definition of flow regimes from Tables 4.31 and 4.32.

Flow Regime	Gage A (cfs) South Umpqua at Tiller USGS 14308000	Gage B (cfs) South Umpqua River near Brockway USGS 14312000	Gage C (cfs) Cow Creek near Riddle USGS 14310000
Flow #1	< 100	< 150	< 89
Flow #2	100 - 199	150 - 299	89 - 178
Flow #3	200 - 399	300 - 599	179 - 356
Flow #4	400 - 666	600 - 999	357 - 594
Flow #5	667 - 1332	1000 - 1999	595 - 1189
Flow #6	1333 - 1999	2000 - 2999	1190 - 1785
Flow #7	>= 2000	>= 3000	>= 1786

The United States Department of Agriculture operates a WWTP at the Tiller Ranger Station which discharges effluent into the South Umpqua River at river KM 121.5. The South Umpqua River water quality model did not extend to this reach because of lack of data. Assuming the dry weather design flow of 0.029 MGD and an inorganic P concentration of 48 ugP/L (DEQ grab 10/2/1997), Tiller Ranger Station WWTP would raise the inorganic P concentration in the South Umpqua from 3 ugP/L (average of 4 samples collected by USGS) to 3.05 under 14Q3 flows (1.21 cms). This change in concentration would not be measurable and would not be expected to adversely impact downstream pH. Therefore, the WLA for Tiller Ranger Station WWTP is 0.012 lbs of inorganic phosphorus per day. Additional monitoring and analysis for the wastewater permit process could result in a greater WLA if the analysis shows that pH concentrations in the South Umpqua River would meet the water quality standard downstream of this location.

The Roseburg Landfill, operated by Douglas County Public Works Department, discharges leachate into a treatment wetland which overflows into an unnamed stream and from there flows into the South

Umpqua River at river KM 22.6. Effluent flow is measured exiting the treatment wetland however it is not known how much reaches the South Umpqua River via the unnamed stream. Review of DMRs from 1/2004 to 8/2006 indicates that under current operations discharge could be up to 30,000 gallons / day with total phosphorus concentration up to 400 ugP/L between May 1 and October 31. Assuming that the total phosphorus is entirely inorganic phosphorus (a conservative assumption), these values give a reasonable worst-case loading of 0.10 lbs of inorganic P per day. Assuming this entire load reaches the South Umpqua River (another conservative assumption) the model predicts, under TMDL conditions, a maximum pH increase of 0.037 S.U. with no cause or contribution to pH impairments. Therefore, the WLA for the Roseburg Landfill is the current reasonable-worst-case-scenario loading of 0.10 lbs of total phosphorus to the South Umpqua River. Additional monitoring and analysis for the wastewater permit process could result in a greater WLA if the analysis shows that pH concentrations in the South Umpqua River would meet the water quality standard downstream of this location. Furthermore, a flow-proportional WLA could be computed with the same methodology as present above for the WWTPs.

There are numerous stormwater permits in the South Umpqua Subbasin. Because the water quality limitations are most severe during the period with the least rainfall, stormwater permitted facilities are not likely contributors of significant nutrient loading. If conditions of the permit are met, permitted stormwater facilities are not likely to contribute nutrient loading that will adversely impact DO or pH. If discharges occur during the summer low-flow period, phosphorus concentrations should not exceed background concentrations or should not cause or contribute to DO or pH water quality limitations. Likewise, for other point sources other than WWTPs, phosphorus concentrations should not exceed background concentrations or should not cause or contribute to DO or pH water quality limitations.

The water quality model predicts that the phosphorus allocations will result in meeting the water quality criteria for DO, pH, Chlorophyll a, and aquatic weeds and algae. The model predicts that the average DO concentration at river kilometer 47 will be 0.1 mg/L less than the 8.0 mg/L target, see Figures 4.35– 4.37. The water quality standard does not consider this a measurable decrease in DO and therefore, the prediction is in compliance with the standard. The model predicts that the maximum Chlorophyll a concentration will be less than the 0.015 mg/L target.

Figure 4.35 Daily minimum DO concentrations based on modeling scenarios under critical flow condition. Numeric criterion = 6.0 mg/L.

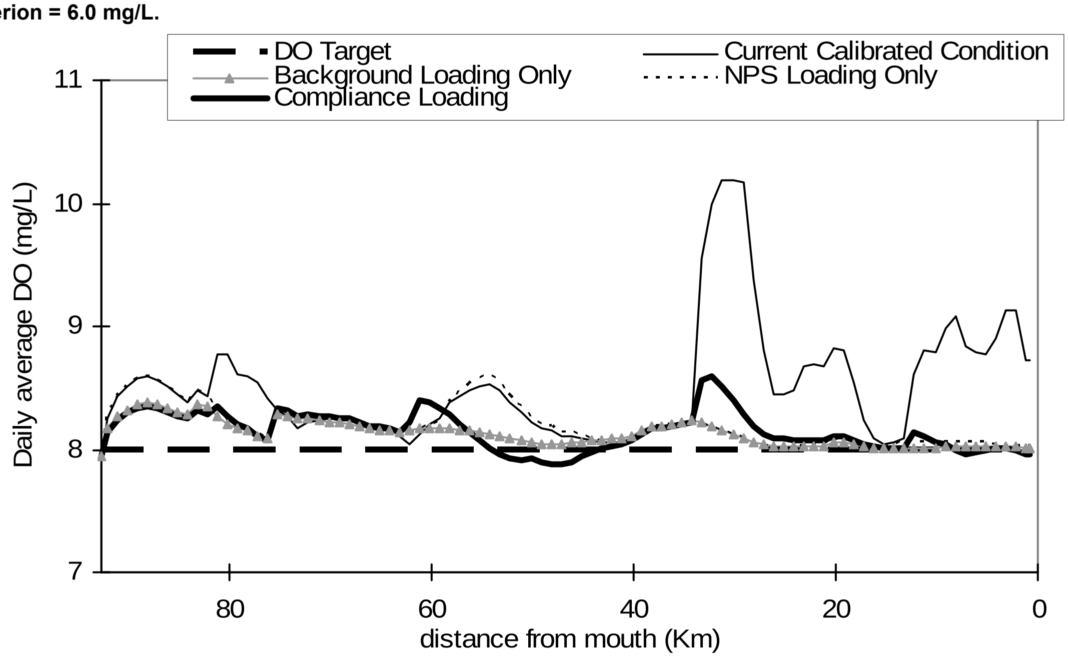


Figure 4.36 Daily mean DO concentrations based on modeling scenarios under critical flow condition. Numeric criterion = 8.0 mg/L

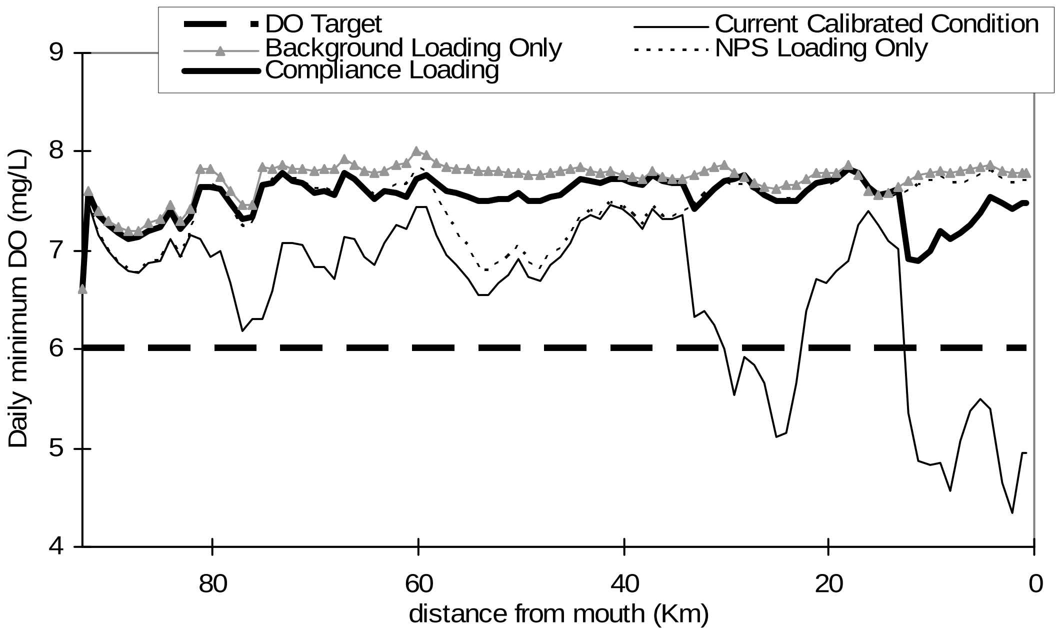
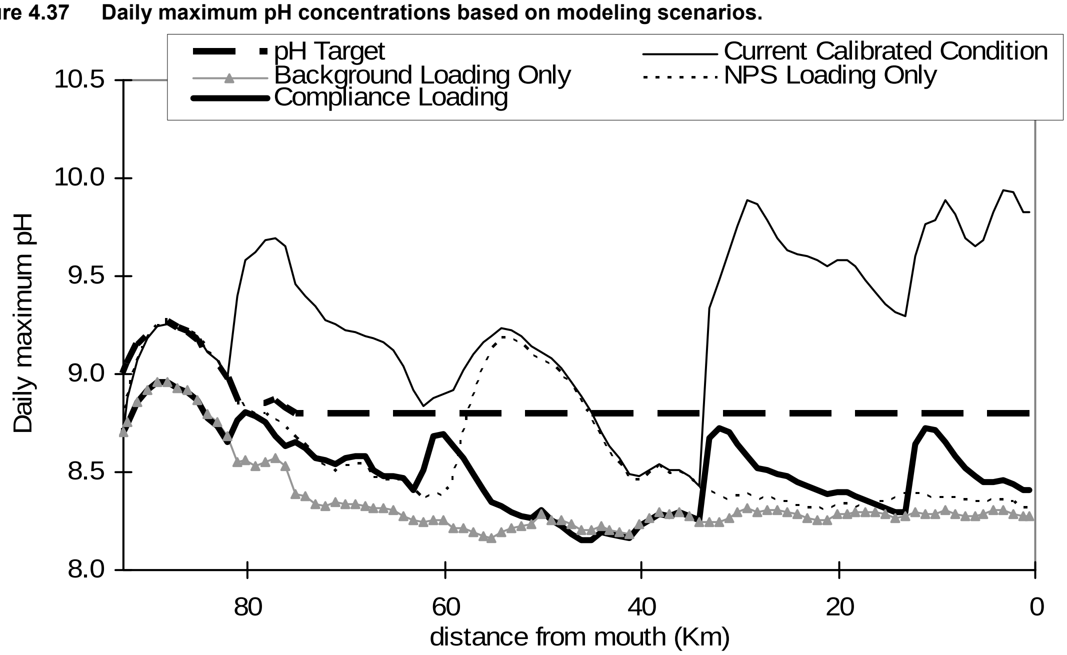


Figure 4.37 Daily maximum pH concentrations based on modeling scenarios.



Margins of Safety

The margin of safety (MOS) for the South Umpqua River DO and pH TMDL is implicit in the analysis through the use of conservative assumptions. The 14-day average, 3 year low-flow condition was used to determine the allocations. This is a conservative assumption because it allows for additional assimilative during most of the time period. The flow proportional WLAs are likely conservative estimates because increased river velocity, depth and reaeration rates and decreased temperatures associated with increased flow should lead to additional assimilative capacity not accounted for by this allocation method. Additionally, loads for each flow regime were calculated using the lowest flow for each flow regime.

Reserve Capacity

The assimilative capacity of the South Umpqua River for additional phosphorus loading varies longitudinally. Additional sources may contribute phosphorus loading if analysis shows that they are not likely to cause or contribute to pH water quality limitations.

JACKSON AND BLACK CANYON CREEK PH TMDL

Overview

PH values in Jackson and Black Canyon Creeks greater than numeric criteria likely occur under natural conditions but are exacerbated by the removal of riparian shade. The removal of riparian shade causes warmer stream temperatures and increased solar radiation reaching the stream. Both of these factors lead to increases in attached algae (periphyton) growth. Algae photosynthesis and respiration cause daily pH swings. High pH in the afternoon exceeds the water quality standard. Nutrients also encourage the growth of algae; however only natural sources of nutrients were identified. A mathematical water quality model was set up for Jackson Creek to quantify the impact of riparian shade on pH and to predict the naturally occurring pH. Allocations for heat load from the temperature TMDL and nutrient allocations will result in Jackson Creek meeting the water quality standard. For details concerning stream temperature and heat load, refer to the Chapter 5,Temperature TMDL.

Black Canyon Creek is a small tributary to Jackson Creek with summer flows of less than 1 cubic foot per second (cfs). Given the low flow, it is not practicable to set up a water quality model. Water quality and land use conditions in Black Canyon Creek watershed are similar to the remainder of the Jackson Creek watershed. Therefore, the allocation strategy determined for Jackson Creek will also apply to Black Canyon Creek and the assumption is made that it will result in compliance with the water quality standard.

Water Quality Limited Stream Segments

Jackson and Black Canyon Creeks in the South Umpqua Subbasin are listed on the 2002 303(d) list for violations of the water quality standards for pH during the summer (Tables 4.32 and 4.33). The determination of water quality limitation is updated based on additional data.

Table 4.32 Summary of pH water quality limitations for Jackson Creek.

Parameter	Reach (river mile)	Season	2002 Status	Current Status	Notes
pH	0 to 7.7	Summer	Water Quality Limited	Water Quality Limited	Confirmed by 2002 synoptic survey.
pH	7.7 to 25	Summer	Water Quality Limited	Attaining Criteria	Updated based on 2002 synoptic survey.

Summer = June 1 through September 30

Table 4.33 Summary of pH water quality limitations for Black Canyon Creek.

Parameter	Reach (river mile)	Season	2002 Status	Current Status	Notes
pH	0 to 5.2	Summer	Water Quality Limited	Water Quality Limited	Confirmed by 2002 synoptic survey.

Summer = June 1 through September 30

Pollutant Identification

Heat loading is the primary pollutant which results in the pH violations in Jackson and Black Canyon Creek (see Temperature TMDL). Nutrients in excess of background loading could exacerbate the naturally high pH. Specifically, dissolved inorganic nitrogen (DIN) consisting of ammonia and nitrite/nitrate and dissolved orthophosphate (DOP) are the nutrients that promote algae growth and hence high pH. Both DIN and DOP are designated pollutants because in the upper portions of Jackson Creek, nitrogen is nutrient that is limiting growth, while in the lower reach, phosphorus is limiting growth.

Target Criteria Identification

The primary benefit to maintaining adequate pH is to support a healthy and balanced distribution of aquatic life. The pH standard protects all forms aquatic life and does not depend on the presence of salmonid fish. Oregon Department of Fish and Wildlife has determined that salmonid rearing and migration occur in Jackson Creek and its tributaries.

The pH standard states that pH shall remain between 6.5 and 8.5. The analysis below shows that natural conditions exceed a pH of 8.5 in portions of Jackson Creek. Therefore, the natural conditions narrative criteria [OAR 340-041-007(2)] is applicable and the natural occurring pH becomes the standard in portions of the creek (see Overview section).

Water Quality Impairment and Seasonal Variation

Determination of water quality limitation and the computation of the TMDL are primarily based on a synoptic survey conducted in August 2002 (Map 4.8). During that study, continuous data loggers were placed at various locations in the creek to gather data for a three-day period (Table 4.34). "Grab" samples were also taken to confirm the continuous data reliability and to expand the spatial extent of monitoring. Data from 1994 was used to make the assessment for the 1998 303(d) list that Jackson Creek and Black Canyon Creek are water quality limited for pH.

Dissolved oxygen (DO) measurements were also collected during the 2002 synoptic survey. Based on the continuous monitoring and grab samples, Jackson Creek is meeting the DO criteria, see Figure 4.38.

Map 4.8 August 2002 monitoring sites in the Jackson Creek Watershed. Reaches marked in red indicate water quality limitation for pH in the summer period.

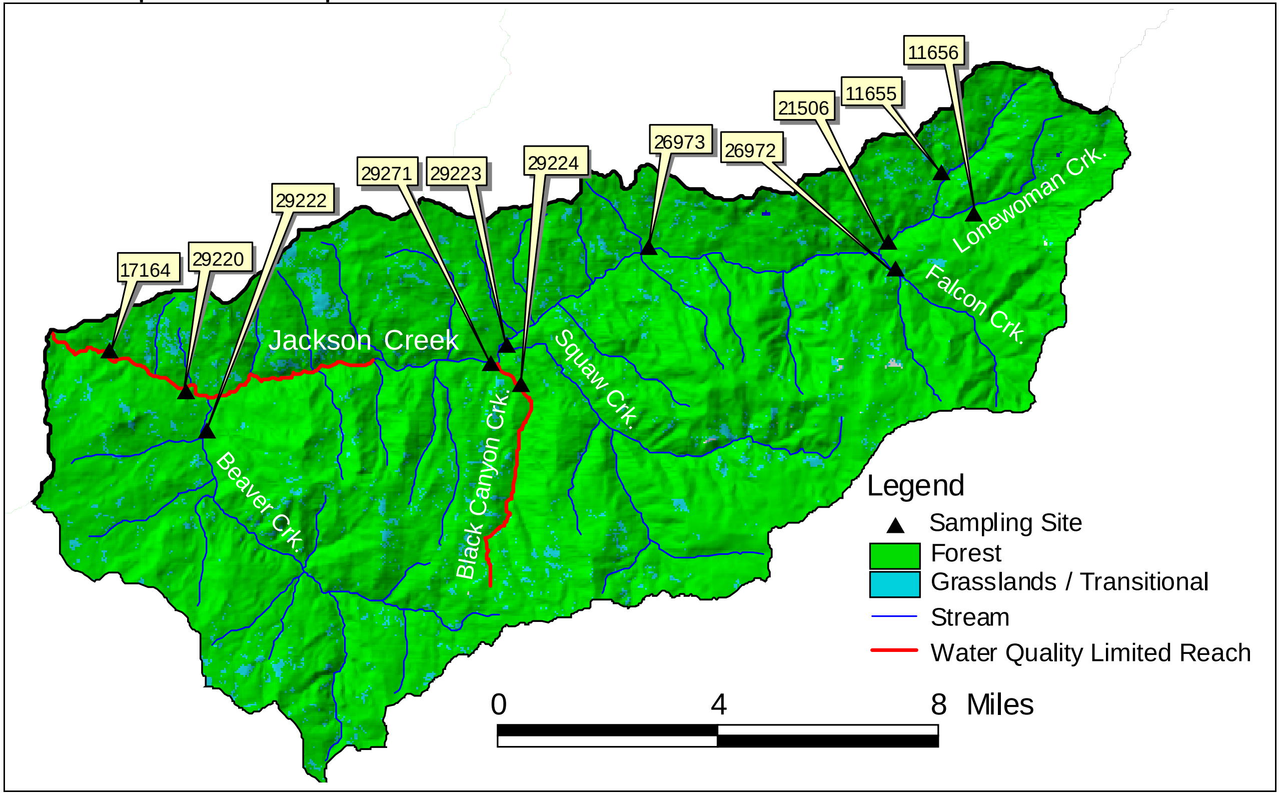
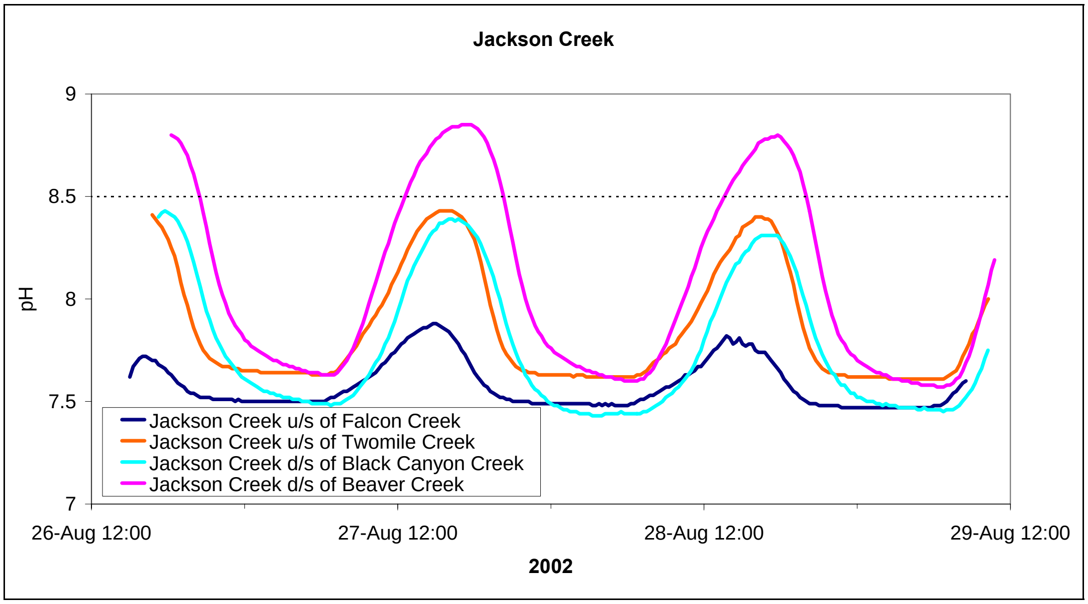


Table 4.34 Summary of DO and pH data for Jackson Creek Watershed.

Lasar #	Station Name	River mile	Sampling type (#)	Average DO (mg/L)	Minimum DO (percent saturation)	Maximum pH
11655	Jackson Creek 200 Ft u/s Of USFS Road #400	21.4	Grab (2)	9.5	9.4 (98%)	8.0
11656	Lonewoman Creek u/s from USFS Road #410	0.1	Grab (2)	9.6	9.5 (98%)	7.8
21506	Jackson Creek u/s of Falcon Creek	20.8	Continuous	9.5	8.9 (96%)	7.9
26972	Falcon Creek at Mouth	0.1	Grab (2)	9.2	9.1 (96%)	7.8
26973	Jackson Creek u/s of Two mile Creek	15.3	Continuous	9.6*	9.4 (100%)*	8.4
29223	Squaw Creek u/s mouth	0.1	Grab (1)	9.5	9.5 (97%)	7.6
29227	Black Canyon Creek at mouth	0.1	Grab (2)	10.2	9.9 (106 %)	8.8
29271	Jackson Creek d/s of Black Canyon Creek	10.8	Continuous	9.1	7.8 (83%)	8.4
29222	Beaver Creek just u/s mouth	0.1	Grab (2)	9.1	8.7 (94%)	8.2
29220	Jackson Creek d/s of Beaver Creek	4.2	Continuous	9.1	8.1 (90%)	8.9
17164	Jackson Creek at Road Mile 1.3	1.5	Grab (5)	9.7	8.4 (96%)	8.7

*DO probe failed, instead based on 4 grab samples. u/s=upstream, d/s=downstream

Figure 4.38 Continuous pH monitoring results from August 2002 synoptic survey. Sites are listed in the downstream direction.



Most of the pH data from the Jackson and Black Canyon Creeks has been collected during the summer months when the maximum pH occurs as a result of conditions conducive to periphyton growth. Such conditions include the increased steam temperature and solar radiation, and decreased stream velocity and depth. During cooler, higher flow conditions, pH concentrations will generally be lower than during summer low flow, which is the critical condition addressed in this TMDL. In addition, in the fall-winter-spring, flows are dominated by rain water which has a lower pH. This seasonal pattern of pH is documented in the Calapooya Creek pH TMDL.

Existing Sources

There are no point sources in the Jackson Creek Watershed. Land use is approximately 100% forestry with USFS managing land in the upper and middle portion of the watershed and a mix of private / public land nearer the mouth. No anthropogenic sources of nutrients were identified during this study and the observed nitrogen and phosphorus concentrations are attributed to background loading. There has been no fertilization of the public forest land since at least the mid-1990s (Michael Jones, U.S. Forest Service, personal communication). The observed concentrations of nutrients did not increase in the lower portions of Jackson Creek where there is private land present (see Technical Appendix 4).

All of the loading is attributed to natural nonpoint sources. The total load delivered to Jackson Creek is 2.1 pounds / day of total phosphorus and 1.4 pounds / day of ammonia as nitrogen.

Load Allocations

Because existing sources of nutrients are believed to be naturally occurring, loads are allocated at current levels. Reductions in heat load will reduce periphyton growth and lead to lower maximum pH values by an average of 0.1 and a maximum of 0.5. (Figure 4.39). The TMDL scenario is equivalent to a predicted natural condition. Under natural conditions, the model predicts that pH will still exceed the numeric criteria in portions of the stream, so the target becomes the natural occurring pH. Nutrient allocations are assigned to ensure future attainment of the water quality standard (Tables 4.35 and 4.36). Heat load allocations are necessary component to the pH TMDL and are described in the Temperature TMDL. These allocations will also insure future compliance with the dissolved oxygen criteria. The allocations apply between June 1 and September 30, the season in which pH values are typically the greatest.

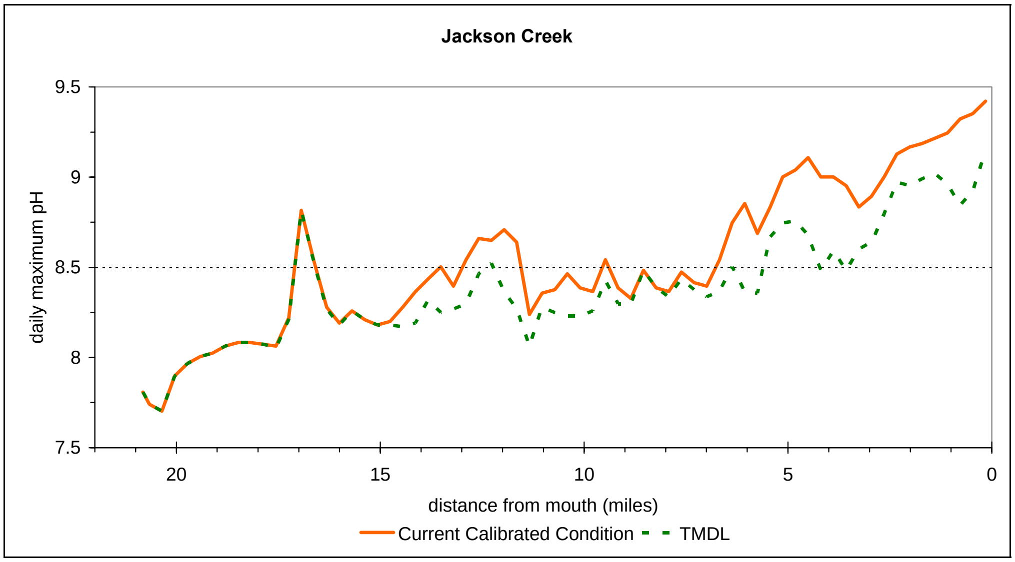
Table 4.35 Inorganic Phosphorus TMDL

	Jackson Creek		Black Canyon Creek	
	Current (lbs / day)	Allocated (lbs / day)	Current (lbs / day)	Allocated (lbs / day)
Background LA	1.4	1.4	0.02	0.02
Existing Anthropogenic Nonpoint source LA	0	0	0	0
Existing Point Source WLA	0	0	0	0
Reserve Capacity	na	No measurable increase in pH	na	No measurable increase in pH
TMDL		1.4		0.02

Table 4.36 Dissolved Inorganic Nitrogen TMDL

	Jackson Creek		Black Canyon Creek	
	Current (lbs / day)	Allocated (lbs / day)	Current (lbs / day)	Allocated (lbs / day)
Background	2.2	2.2	0.03	0.03
Existing Anthropogenic Nonpoint source	0	0	0	0
Existing Point Source	0	0	0	0
Reserve Capacity	na	No measurable increase in pH	na	No measurable increase in pH
TMDL		2.2		0.03

Figure 4.39 Current and TMDL scenario pH. The TMDL scenario is equivalent to a predicted natural condition.



Margin of Safety

The margin of safety is implicit in the technical analysis. The allocations are the naturally occurring heat and nutrient load and therefore will, by definition, achieve the naturally occurring pH. Additional, assimilative capacity may become available through channel restoration efforts including the additional of large woody debris and increasing channel complexity which could create seasonal nutrient sinks. Lastly, Jackson Creek load capacity was determined during a critical period of low flow and high stream temperatures.

Reserve Capacity

The assimilative capacity of the Jackson and Black Canyon Creeks for additional phosphorus and nitrogen loading varies longitudinally. Additional sources may contribute phosphorus or nitrogen loading if analysis shows that they are not likely to cause or contribute to pH water quality limitations (i.e. 0.3 increase to the daily maximum, naturally occurring pH).

REFERENCES:

Anderson C.W., D.Q. Tanner, and D.B. Lee. 1994. Water Quality Data for the South Umpqua River Basin, Oregon, 1990-92. Oregon U.S. Geological Survey Open-File report 94-40, pp.71.

Laenen, A. and W.H Woo. 1984. Stream Velocities and Reareation Coefficients for the South Umpqua River between Tiller and Roseburg, Oregon, 1991. USGS Water-Resources Investigation Report 92-4191.

Mrazik, S. 2004. Water Quality Report: Ambient Monitoring Stations in the Oregon Coast Coho Evolutionarily Significant Unit. State of Oregon. Department of Environmental Quality. Portland, Oregon. February.

Pelletier, G. and S. Chapra, 2005a, Qual2kw user manual (Version 5.1), Deparment of Ecology, Olympia, Washington.

Pelletier, G. and S. Chapra, 2005b, Qual2kw Theory and Documentation (Version 5.1), Deparment of Ecology, Olympia, Washington.

Tanner, D.Q., and C.W. Anderson. 1996. Assessment of Water Quality, Nutrients, Algal Productivity, and Management Alternatives for low-Flow Conditions, South Umpqua River Basin, Oregon, 1990-92. Oregon U.S. Geological Survey – Water Resources Investigation Report 96-4082.