Water Quality Report

Malheur River Basin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)

September 2010

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Executive Summary

The Malheur River is located in southeast Oregon. It is a tributary of the Snake River, which forms the border between Oregon and Idaho. This report describes DEQ's requirements and strategy to reduce pollution in the Malheur River and its tributaries, as well as nearby small streams which drain directly into the Snake River in the nearby Middle Snake-Payette subbasin. The Malheur River Basin TMDL applies to all perennial and intermittent streams in the Malheur River Basin and the Middle Snake-Payette subbasin.

A number of streams in the Malheur River Basin and Middle Snake-Payette Subbasin are listed as "water quality limited" for dissolved oxygen, chlorophyll a, bacteria, toxics (the pesticides DDT and Dieldrin), and temperature. The Malheur River Basin/Middle Snake-Payette Subbasin TMDLs address the violation of standards for three water quality parameters: chlorophyll a (a product of excessive algae growth due to phosphorus loading), bacteria and temperature. The following table summarizes the completed TMDL count for the Malheur River Basin and Middle Snake-Payette Subbasin using DEQ and EPA counting methods:

Malheur River Basin, Middle Snake-Payette Subbasin TMDL count

Parameter	303(d) listings	DEQ TMDLs	EPA TMDLs
Chlorophyll a	3	3	3
DDT	1	Not addressed	Not addressed
Dieldrin	1	Not addressed	Not addressed
Dissolved Oxygen	1	delisted	delisted
E. coli	3	3	2 (1 duplicate listing)
Fecal Coliform	8	7 (1 delisted)	6 (1 duplicate listing, 1 delisted)
Temperature	21	21	21
Total	**38**	**34**	**32**

During development of the TMDL, two unlisted stream segments were identified that do not meet *E.coli* water quality criteria (Malheur River RM 129-170, Bully Creek RM 0-15.9), and two unlisted stream segments (Malheur River RM 67-123, North Fork Malheur RM 0-18) were identified for not meeting temperature criteria. These water quality impairments were addressed by the TMDL, but are not included in the table of TMDLs show above.

Dissolved Oxygen and Chlorophyll

Waterbodies in the Malheur River Basin were listed as water quality limited due to failure to meet applicable dissolved oxygen, and chlorophyll a water quality criteria. These factors indicate high levels algae growth. The dissolved oxygen 303(d) listing includes the mainstem Malheur River from its mouth to its headwaters in Logan Valley (RM 0-186.1). The chlorophyll a listings include the lower Malheur River (RM 0-67), lower Willow Creek (RM 0-27.4), and lower Bully Creek (RM 0-12.8). The dissolved oxygen listing occurs all year, while the chlorophyll a listings are for the Summer season only.

Detailed review of monitoring data and applicable water quality criteria performed during TMDL development indicate that despite high nutrient concentrations and eutrophic conditions, applicable dissolved oxygen criteria are actually being met throughout the year. The Malheur River had been listed for low dissolved oxygen because past data analysis did not account for the use of Warm-Water dissolved oxygen criteria in the lower Malheur River Basin. This standard allows for the lower dissolved oxygen concentrations found in warmer water. Based on the analysis of available dissolved oxygen data, it is recommended that the entire Malheur River from RM 0 to RM 186.1 be removed from the DEQ dissolved oxygen 303(d) list.

Review of chlorophyll a data performed during TMDL development also indicate that chlorophyll a criteria are being met the vast majority of the time during the critical Summer period in the Malheur River and tributaries. The historic data used for the chlorophyll a 303(d) listings were not corrected for the presence of dead algal matter and led to the conclusion that chlorophyll a criteria were being exceeded. Significant diurnal dissolved oxygen concentration and pH swings indicate that eutrophic conditions occur in the Lower Malheur River and tributaries as well as downstream in the Snake River. These conditions are likely caused by high phosphorus concentrations which encourage algae growth.

It was determined that phosphorus is a good surrogate parameter for chlorophyll and that efforts to reduce phosphorus will reduce chlorophyll a concentrations further and address the few instances where chlorophyll a concentrations exceed the seasonal water quality standard. Controlling phosphorus loading is also strongly related to control of sediment loading due to its affinity to bind to fine soil particles. The Malheur River was allocated a phosphorus load to the Snake River based on a total phosphorus concentration of 0.07 mg/l in the 2004 Snake River-Hells Canyon TMDL. Allocations within the Malheur River basin are based on this concentration limit.

Bacteria

Waterbodies in the Malheur River Basin are water quality limited due to fecal coliform bacteria concentrations which limit water contact recreation (such as wading, swimming and fishing) and other beneficial uses. Identified waterbodies of concern include the Upper Malheur River, Lower Malheur River, Lower Willow Creek, portions of Bully Creek, and the lower North Fork Malheur River. Portions of Shepherd Gulch and South Fork Jacobsen Gulch in the adjacent Middle Snake-Payette Subbasin are also included on the 303(d) list for fecal coliform bacteria. The 303(d) listings for bacteria occur in the summer period, with the exception of Willow Creek, which is listed all year. Analysis of the bacteria data conducted during development of the TMDL indicate that bacteria criteria are exceeded in Willow Creek, Bully Creek, the Malheur River, and the North Fork Malheur River year round, with reduced impacts during the non-irrigation season of late fall through early spring.

Fecal coliform bacteria sources may include wildlife, livestock waste, failing residential septic systems, waste water treatment plant malfunctions, rural residential runoff and urban runoff. There are no permitted point sources of bacteria in the basin, and the generally sparse residential development restricts potential septic and non-permitted point sources to localized areas. Confined Animal Feeding Operations (CAFOs) are considered to be point sources which are not allowed to discharge to waters of the state. CAFOs were given a zero allocation in this TMDL. The major developed areas of the basin such as Ontario and Vale do not discharge waste water to any Malheur River Basin surface waterbodies (Ontario discharges to the Snake River in winter) and there are no plans to do so in the future, therefore no reserve capacity was allocated. Fecal coliform bacteria loading in the Malheur River Basin appear to be dominated by non-point sources. Nonpoint source pollution comes from diffuse sources such as livestock, wildlife, and urban runoff. Stream flow based allocations have been developed for nonpoint sources and apply year-round. The highest reductions in bacteria loading are needed in the lower Malheur River and its tributaries, Bully Creek and Willow Creek.

Temperature

Temperature 303(d) listings occur on approximately 320 miles of streams including the mainstem Malheur and tributaries above Warm Springs Reservoir, the North Fork Malheur and tributaries above Beulah Reservoir, Cottonwood Creek and Pole Creek (tributaries of the Lower Malheur River), and Basin Creek tributary of Willow Creek. The temperature TMDL applies to all intermittent and perennial streams in the Malheur River Basin and Middle Snake-Payette subbasin.

The temperature TMDL identified the primary source of heating is from the removal of natural streamside vegetation which has increased the amount of solar radiation the stream receives. The loss of vegetation and stream warming is caused by a number of factors including agricultural activities, current and legacy grazing impacts, Western Juniper expansion, and hydrologic modifications (eg. water withdrawals and diversions). The TMDL requires designated management agencies to implement management strategies to restore or protect streamside vegetation, as well as encourage best management practices to minimize water withdrawals or diversions. The TMDL also requires the Bureau of Reclamation to eliminate excessive temperature increases downstream of their dams and to evaluate managed flows that may be required for the survival of downstream vegetation communities.

Toxics

Due to insufficient data, a TMDL was not developed to directly address the toxics listings for the Lower Malheur River. It was determined that the best management practices needed to manage sediment loading to reduce phosphorus concentrations, and the riparian vegetation improvements needed to address high stream temperatures, will reduce the loading of DDT and Dieldrin to streams.

TMDL Implementation

TMDL implementation in the Malheur River Basin and Middle Snake-Payette Subbasin will primarily be accomplished through activities on private agricultural land and on federal land. An Agricultural Water Quality Management Area Plan, which addresses agricultural activities on private lands, has been adopted for the basin by the Oregon Department of Agriculture. Malheur County, Harney County, the City of Ontario, and local irrigation districts are required to cooperate with restoration efforts outlined in the ODA Agricultural Water Quality Management Area Plan. Conditions contributing to water quality impairment on federal lands managed by the Burns and Vale Offices of the Bureau of Land Management, and the Malheur National Forest will be addressed through the development and implementation of Water Quality Restoration Plans. The U.S. Bureau of Reclamation and Oregon Department of Fish and Wildlife and Department of State Lands are also required to develop implementation plans for the public lands and programs that they manage.

MALHEUR RIVER BASIN TMDL

CHAPTER 1: INTRODUCTION

Final
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Quality

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1.1 TOTAL MAXIMUM DAILY LOAD

Waters of the State of Oregon are monitored by the Oregon Department of Environmental Quality (DEQ) and other agencies. This information is used to determine whether water quality standards are met, and consequently, whether beneficial uses of waters are fully supported. Section 303(d) of the federal Clean Water Act (CWA) requires that a list be developed of all water quality limited or threatened waters within each state. The CWA also requires the establishment of a pollutant total maximum daily load (TMDL) for each water body of concern. Some exceptions exist, such as cases where exceedance of standards is due to natural causes. This list of impaired water bodies is usually referred to as the 303(d) List. DEQ is responsible for assessing data, compiling the 303(d) list and developing TMDLs. Both the 303(d) list and TMDLs are submitted to EPA for approval.

A TMDL defines the maximum amount of pollutant that can be present in a water body without violating water quality standards. DEQ calculates the TMDLs from mathematical models and other analytical techniques designed to simulate and/or predict complex physical, chemical, and biological processes. TMDLs take into account the pollution from all sources, including discharges from industry and sewage treatment facilities; runoff from farms, forests and urban areas; and natural sources such as decaying organic matter or nutrients in soil. TMDLs may include a safety margin for uncertainty and growth that allows for future discharges to a river or stream without exceeding water quality standards. DEQ develops TMDLs on a watershed basis and attempts to address all 303(d) listed pollutants for that watershed. In addition, *allocations* can also be set aside in reserve for future uses. *Allocations* are quantified measures that assure water quality standard compliance. The *TMDL* is the integration of all these developed *Wasteload* and *Load Allocations.*

Along with the TMDL, DEQ prepares a Water Quality Management Plan (WQMP) that identifies the Designated Management Agencies (DMAs) who are required to submit TMDL Implementation Plans. Oregon's TMDL rule requires the development of a WQMP as part of TMDL development for 303(d) listed waterbodies. The WQMP identifies management strategies to achieve wasteload and load allocations in a TMDL. These management strategies will be implemented through water quality permits for those sources subject to permit requirements in ORS 468B.050, and through sector-specific or source-specific implementation plans for other sources. WQMPs identify the sector and source-specific implementation plans required and the persons, including DMAs, responsible for developing and revising those plans. DEQ has prepared a **TMDL Implementation Plan Guidance** (http://www.deq.state.or.us/WQ/TMDLs/implementation.htm) that generally outlines the contents of the implementation plan. The WQMP may include other required elements to be included in the plan.

Water Quality Management Plans (WQMPs) are developed to implement TMDLs for both point and non-point water pollution sources. Discharge permits are issued to point sources for implementation of TMDLs. Load Allocations are the portion of the total allowable pollutant load that is allocated to non-point sources such as agriculture, forestry or urban areas. Waste Load allocations are the portion allocated to point sources such as industrial sources or waste water treatment plants. Some TMDLs are expressed as surrogates. An example of a surrogate would be percent effective shade targets designed to reduce daily solar energy loading and water temperature.

Rivers and streams in the Malheur River Basin have been placed on the 303(d) list of water quality limited water bodies due to a variety of non-point pollution-related problems including:

- bacteria,
- chlorophyll a,
- pesticide residues,
- low dissolved oxygen, and
- high temperatures.

The Malheur River Subbasin TMDLs will be implemented through the WQMP attached to this document. As implementation proceeds, the TMDLs will be re-visited as needed to address progress and new information regarding management effectiveness, limitations and water quality processes.

The essential elements of TMDLs stem from the Clean Water Act and are identified in a Memorandum of Agreement (MOA) between the US EPA and Oregon DEQ. This document is organized based on the list of elements in Oregon TMDLs according to rule (OAR 340-042). A checklist prepared by the US Environmental Protection Agency (EPA, 2002) provides further guidance for TMDL content. **Table 1-1** identifies the relationship between the two lists.

Table 1-1. Relationship between State and Federal identification of key TMDL elements.

Oregon Administrative Rule (340-042)	EPA Checklist
(a) Name and Location	Scope of TMDL
(b) Pollutant Identification	Applicable Water Quality Standards and Numeric Targets
(c) Water Quality Standards and Beneficial Uses	
(d) Loading Capacity	Loading Capacity
(e) Excess Load	
(f) Sources or Source Categories	
(g) Wasteload Allocations	Wasteload Allocations
(h) Load Allocations	Load Allocations
(i) Margin of Safety	Margin of Safety
(j) Seasonal Variation	Seasonal Variation
(k) Reserve Capacity	
(l)(j) Reasonable Assurance*	Reasonable Assurance (if wasteload allocations depend on load allocations)
OAR 340-042-0050 Public Participation*	Public Participation
For additional clarification relating narrative and numeric water quality standard criteria, DEQ typically prepares an additional section ‘Water Quality Standard Attainment Analysis.’	

*in Water Quality Management Plan

1.2 TMDL IMPLEMENTATION AND ADAPTIVE MANAGEMENT

The WQMP directs the following management agencies to prepare implementation plans leading toward TMDL attainment:

- Oregon Department of Agriculture (ODA),
- Oregon Department of Fish and Wildlife (ODF&W),
- Oregon Department of State Lands
- US Forest Service (USFS, Malheur National Forest),
- Bureau of Land Management (BLM, Vale and Burns Districts),
- Bureau of Reclamation (BOR, Pacific Northwest Region)

The following organizations are listed as DMAs which are directed to incorporate the goals of the TMDL into their operations and support the implementation of the Malheur River Basin Agricultural Water Quality Management Area Plan other appropriate implementation plans in the basin:

- Malheur County
- Harney County
- City of Ontario
- Old Owyhee Irrigation District
- Owyhee Irrigation District
- Vale Oregon Irrigation District
- Warmsprings Irrigation District

The form of response varies by organization. Some are governed by existing inter-agency agreements. DMAs are expected to respond in accordance with a timeline specified the Water Quality Management Plan attached to this document. TMDL Implementation Plans, specific to land use or water quality authorities, are the usual form of documentation addressing nonpoint source TMDLs. Normally existing programs are utilized.

The goal of the Clean Water Act and associated Oregon Administrative Rules (OAR) is to ensure that water quality standards are met or that all feasible steps are taken towards achieving the highest quality water attainable. DEQ recognizes that some improvement will require decades to fully manifest, particularly where nonpoint sources are the main concern. To achieve this goal, implementation should commence as soon as possible.

To clarify the Department's expectations, the following is acknowledged with regard to TMDLs and their implementation:

The TMDL process occurs in ongoing cycles based on implementation effectiveness, the availability of information, new 303(d) listings, and the state of understanding of watershed and management processes. DEQ recognizes that TMDL allocation attainment is not always feasible. This can be due to large margins of uncertainty or socioeconomic constraints. Limitations should be stated in Implementation Plans and evaluation of feasible measures is important in these instances. For example, where conditions such as riparian vegetation or stream channel geometry are TMDL objectives, DEQ encourages adaptive re-assessment of channel and vegetation potential. Technology and programs for controlling nonpoint source pollution are evolving. It is possible that multiple management approaches may be needed for success.

Reduced stream heating often requires minimization of riparian disturbance. The purpose of the TMDL is not to eliminate human activity in riparian areas. It is DEQ's expectation, however, that designated agencies will work to achieve the allocations.

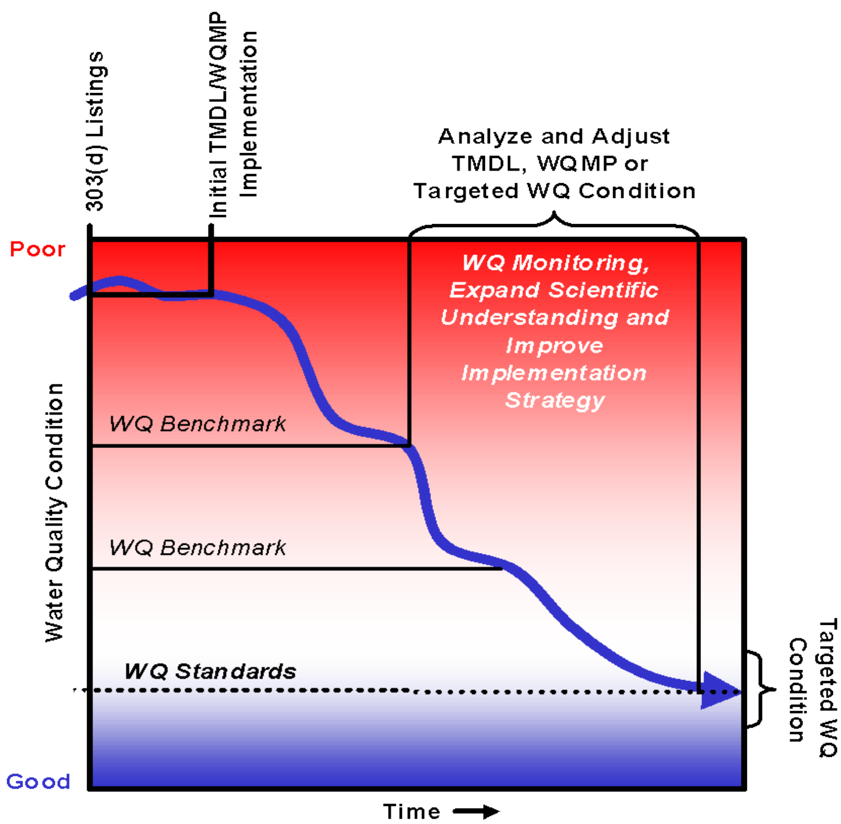
DEQ also recognizes that at various times and locations attainment of estimated natural conditions may be impeded by natural disturbance. The definition of *natural conditions* in rule includes: "…Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation, diseased vegetation are considered natural conditions" (OAR 340-041-0002(34)).

Full TMDL attainment at all locations may not be feasible due to physical, legal or regulatory constraints. To the extent possible, the Implementation Plans should identify potential constraints, but should also provide the ability to address those constraints as new opportunities arise. For instance, at this time an existing bridge may preclude attainment of channel potential and not be slated for reconfiguration due to feasibility issues. In the future, should the bridge undergo repair or modification, consideration should be given to designs that support TMDL implementation.

EPA and DEQ expect reasonable assurance of implementation. DEQ envisions that substantial initiative exists to achieve water quality goals in Oregon. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers to overcome impediments through education, technical support, and as a last resort where appropriate, enforcement.

DEQ anticipates that each management agency will monitor and document its progress in implementing the provisions of its Implementation Plan. This information will be provided to DEQ for TMDL review. Where implementation of TMDL planning or effectiveness of management techniques is found to be inadequate, DEQ expects management agencies to revise planning or benchmarks to address these deficiencies (**Figure 1-1**).

Figure 1-1. Adaptive Management Schematic Diagram.



1.3 REFERENCES

EPA Region 10, 2002, TMDL Review Guidelines, Seattle, WA.

MALHEUR RIVER BASIN TMDL

CHAPTER 2: SCOPE OF TMDL

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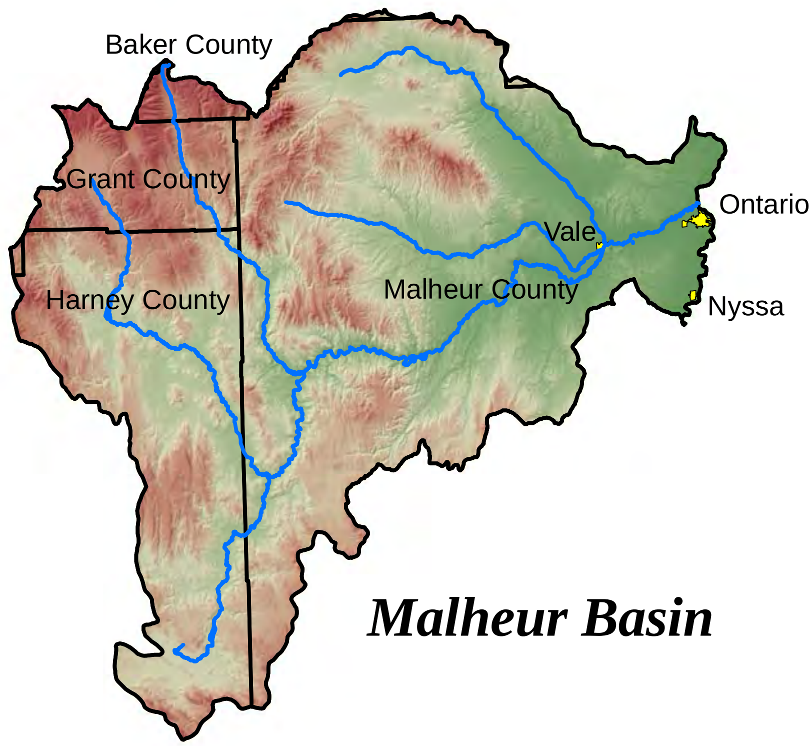

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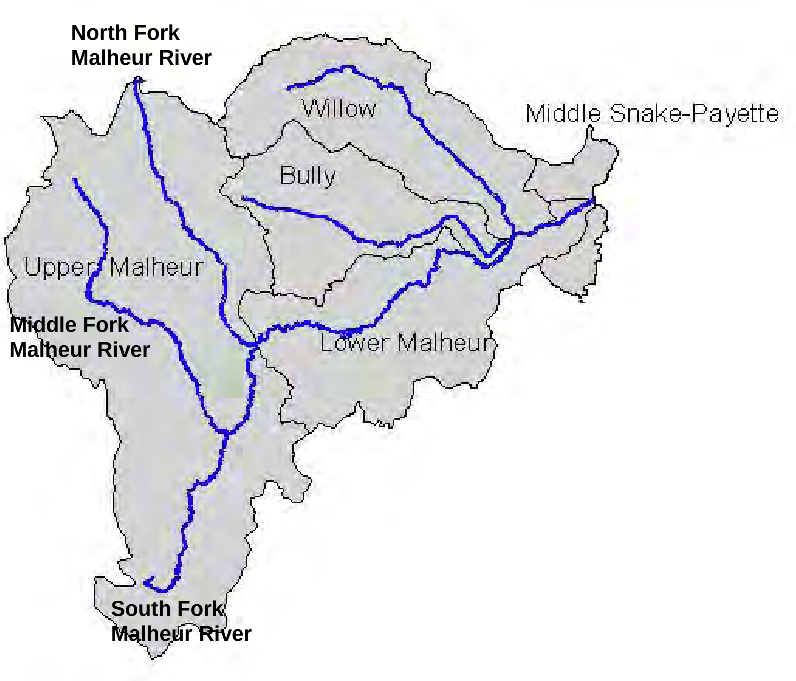
2.1 GEOGRAPHIC AREA

The TMDL process for the Malheur River Basin covers all intermittent and perennial streams within the Malheur River (170501) USGS 3rd Field Hydrologic Unit Code (HUC) watershed. The Malheur River Basin is divided into the Lower Malheur (17050117), Upper Malheur (17050116), Willow Creek (17050119), Bully Creek (17050118), and Middle Snake-Payette (17050115) Subbasins/4th Field HUCs (**Figure 2-1**).

Figure 2-1. Malheur River/Middle Snake-Payette Subbasins.



This document establishes TMDL allocations and other goals for streams within the Malheur Basin that are not currently on the Oregon 2004/2006 303(d) list This is consistent with State and Federal TMDL implementation law and policy. Streams which are not on the current 303(d) list are addressed when upstream improvements are needed to sufficiently decrease downstream water quality impairment or where impairment leading to water quality standard violations are found. For example, several previous studies have identified impaired riparian vegetation and channel form as significant problems throughout the Malheur Basin, including streams not currently present on the 303(d) list.

2.1.1 Indian Lands

The Malheur River Basin does not include Indian Reservation land. However, off-Reservation Tribal holdings are present in the Basin. The Burns Paiute Tribe owns the Logan Valley and Jones Ranch properties at the headwaters and along the main stem of the Malheur River. From DEQ's perspective, the load allocations for these areas are included for informational purposes, due to the sovereign status of the Tribe. The Burns Paiute Tribe manages the properties for restoration purposes and DEQ views that TMDL implementation is occurring. DEQ appreciates the input and coordination the Burns Paiute Tribe has provided during the development of the TMDL and looks forward to continuing that relationship during implementation. DEQ also recognizes that in the future Tribes and EPA may choose to formalize Tribal water quality efforts in relation to TMDLs.

2.2 DESIGNATED BENEFICIAL USES

The beneficial uses of surface water in the Malheur River Basin as listed in ORS 340-41-0201:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Fish and Aquatic Life
- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality

Fish and aquatic life is considered one of the most sensitive beneficial uses in the basin. The fish use designation for the lower 65 miles of the Malheur River, along with the lower portions of Willow and Bully Creeks is Cool Water Species (no salmonid use). The headwaters of the mainstem Malheur River, North Fork Malheur River, and Little Malheur River are designated either Bull Trout Spawning and Rearing or Core Cold-Water Habitat. According to Oregon Department of Fish and Wildlife surveys, Bull Trout are not present in the Little Malheur River or its tributaries. The remaining streams in the basin are designated Redband or Lahontan Cutthroat Trout habitat, however, Lahontan Cutthroat are not known to exist in the basin (**Figure 2-2**).

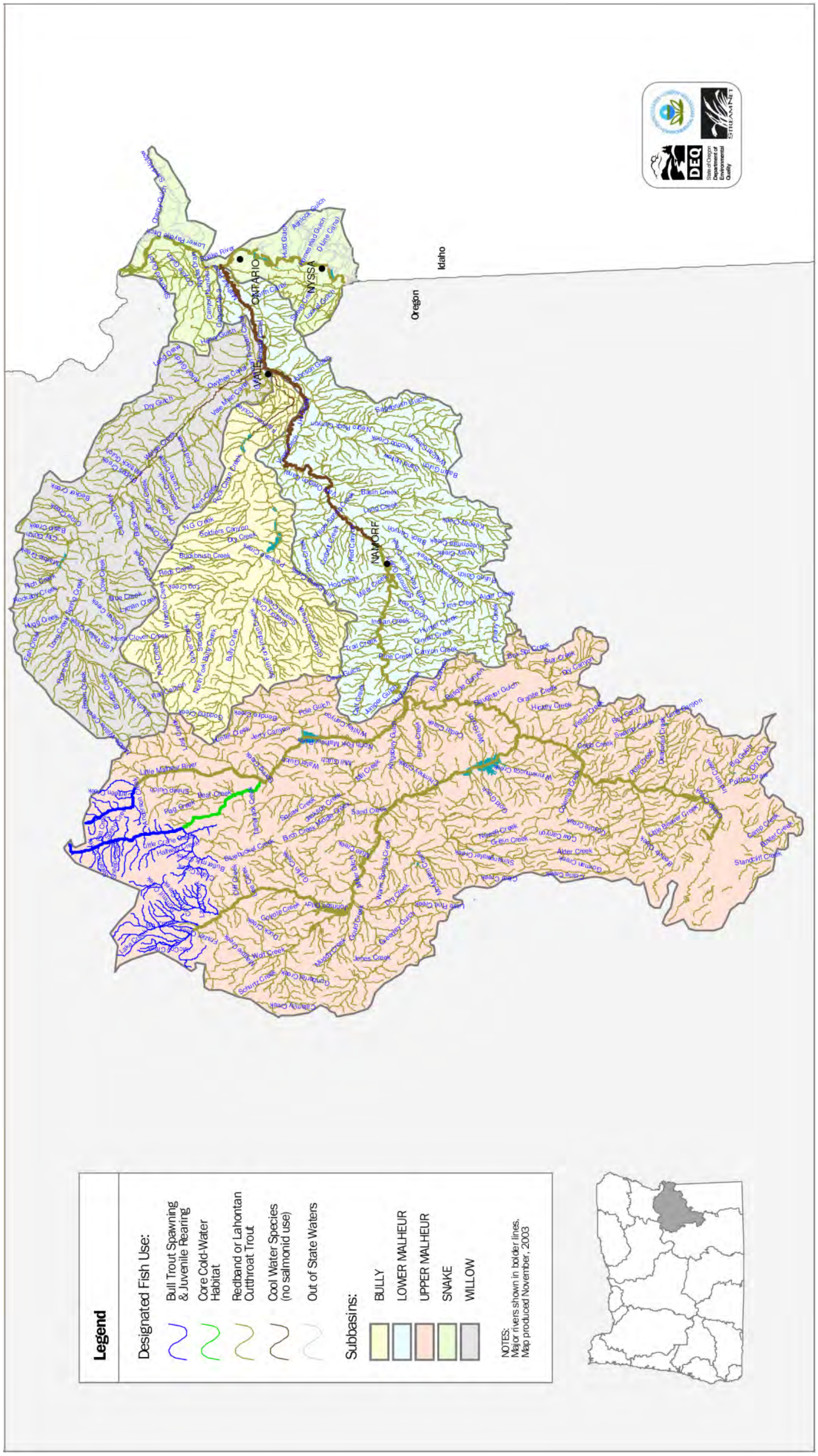


Figure 2-2. Fish Use Designations, Malheur River Basin ORS 340-41-0201.

2.3 WATER QUALITY CONCERNS/303D LISTINGS

Section 303d of the federal Clean Water act requires each state to develop a list of water bodies that do not meet water quality standards, and submit this list to the U.S. Environmental Protection Agency. The list is updated every two years. Streams in the Malheur River Basin are listed as water quality limited for bacteria, chlorophyll-a, toxics (the pesticides DDT and dieldrin), dissolved oxygen, and temperature. As shown in **Figure 2-3** the 303(d) listings for bacteria, chlorophyll, and toxics (DDT and dieldrin) are found in the Lower Malheur and its major tributaries, Bully Creek and Willow Creek. Temperature listings occur on the mainstem Malheur and tributaries above Warm Springs Reservoir, the North Fork Malheur and tributaries above Beulah Reservoir, Cottonwood Creek and Pole Creek (tributaries of the Lower Malheur River) and Basin Creek tributary of Willow Creek (**Figure 2-4**). The Malheur River is listed for low dissolved oxygen throughout its length (**Figure 2-4**). **Table 2-1** contains detailed descriptions of 303d listings in the Malheur River Basin from the 2004/2006 integrated report.

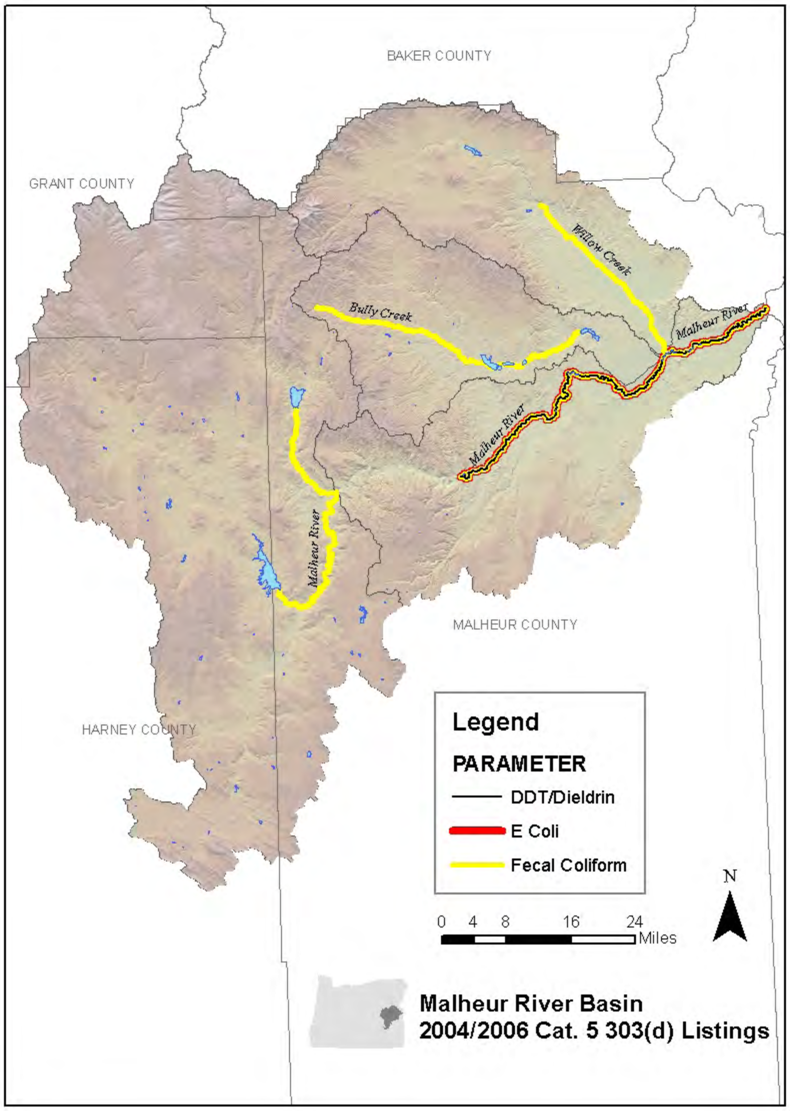


Figure 2-3. Malheur River Basin DDT/Dieldrin, E. coli, and Fecal Coliform 303(d) Listings.

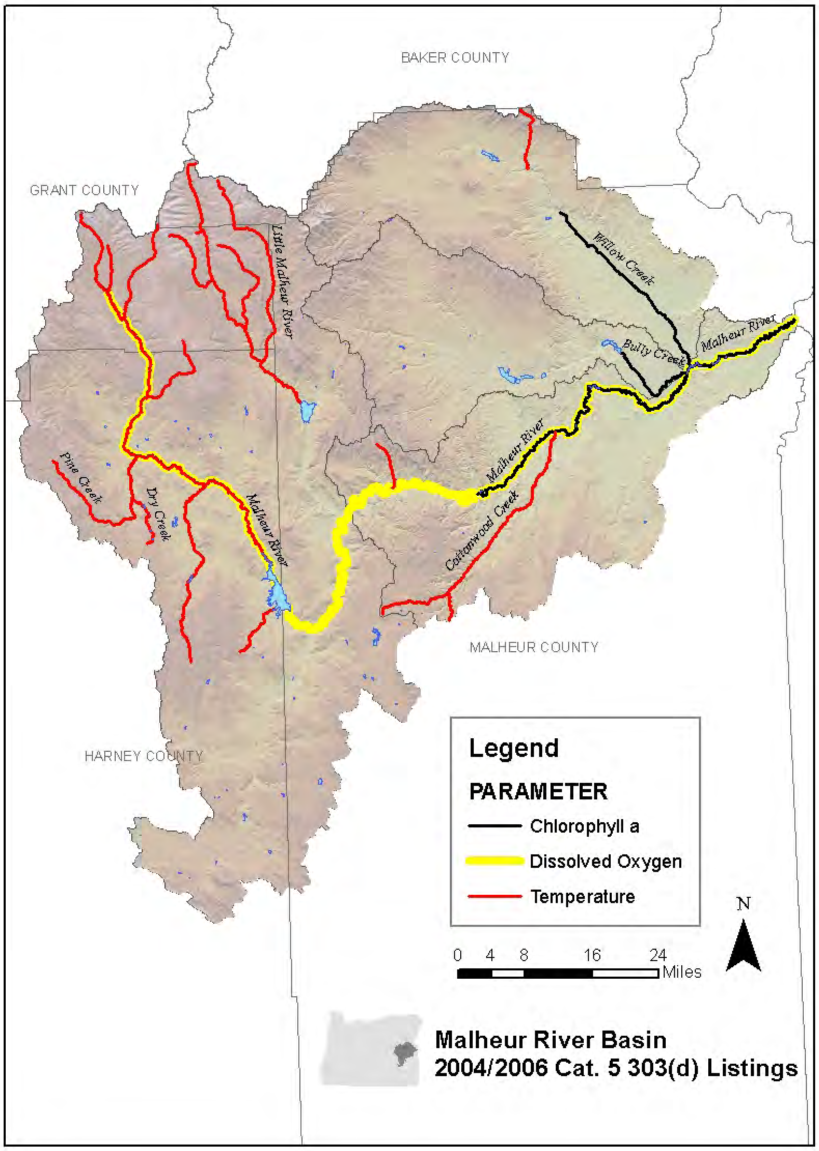


Figure 2-4. Malheur River Basin Chlorophyll a, Dissolved Oxygen, and Temperature Listings.

Table 2-1. 303(d) Listings for Malheur River and Middle Snake-Payette Basins.

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2265	Malheur River	0 to 67	Chlorophyll a	Summer	303(d)	2004
2440	Malheur River	0 to 67	DDT	Year Around	303(d)	1998
2375	Malheur River	0 to 67	Dieldrin	Year Around	303(d)	1998
11764	Malheur River	0 to 186.1	Dissolved Oxygen	Year Around (Non-spawning)	303(d)	2004
13552	Malheur River	0 to 67	E Coli	Summer	303(d)	2004
2431	Malheur River	0 to 67	Fecal Coliform	Summer	303(d)	1998
2250	Malheur River	93.4 to 119.9	Fecal Coliform	Summer	303(d)	1998
2190	Malheur River	126.8 to 162.3	Temperature	Summer	303(d)	1998
2191	Malheur River	162.3 to 185.9	Temperature	Summer	303(d)	1998

Lower Malheur Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2465	Alder Creek	0 to 4.1	Temperature	Summer	303(d)	1998
2464	Cottonwood Creek	0 to 35.3	Temperature	Summer	303(d)	1998
2231	Pole Creek	0 to 6.3	Temperature	Summer	303(d)	1998
9098	Willow Creek	0 to 0.2	E Coli	Fall/Winter/Spring	303(d)	2004
9097	Willow Creek	0 to 0.2	E Coli	Summer	303(d)	2004

Willow Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
12566	Basin Creek	0 to 8.8	Temperature	Year Around (Non-spawning)	303(d)	2004
2267	Willow Creek	0 to 27.4	Chlorophyll a	Summer	303(d)	1998
2434	Willow Creek	0 to 27.4	Fecal Coliform	Fall/Winter/Spring	303(d)	1998
2254	Willow Creek	0 to 27.4	Fecal Coliform	Summer	303(d)	1998

Table 2-1, continued.

Bully Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2438	Bully Creek	0 to 12.8	Chlorophyll a	Summer	303(d)	2004
2253	Bully Creek	15.9 to 57.1	Fecal Coliform	June 1 - September 30	303(d)	1998

Upper Malheur Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2193	Bear Creek	0 to 14.7	Temperature	Summer	303(d)	1998
2194	Big Creek	0 to 6.1	Temperature	Summer	303(d)	1998
12604	Bluebucket Creek	0 to 12.1	Temperature	Year Around (Non-spawning)	303(d)	2004
2201	Crane Creek	0 to 1.1	Temperature	Summer	303(d)	1998
2444	Dry Creek	0 to 8.3	Temperature	Summer	303(d)	1998
2204	Elk Creek	0 to 1	Temperature	Summer	303(d)	1998
2206	Lake Creek	0 to 11.9	Temperature	Summer	303(d)	1998
2202	Little Crane Creek	0 to 9.3	Temperature	Summer	303(d)	1998
2208	Little Malheur River	0 to 28.5	Temperature	Summer	303(d)	1998
2251	North Fork Malheur River	0 to 18	Fecal Coliform	Spring/Summer	303(d)	1998
2210	North Fork Malheur River	20.8 to 43.1	Temperature	Summer	303(d)	1998
2211	North Fork Malheur River	43.1 to 59.3	Temperature	Summer	303(d)	1998
2217	Pine Creek	0 to 24.7	Temperature	Summer	303(d)	1998
2220	Stinkingwater Creek	0 to 27.8	Temperature	Summer	303(d)	1998
2222	Summit Creek	0 to 14.2	Temperature	Summer	303(d)	1998
12589	Warm Springs Creek	0 to 9	Temperature	Year Around (Non-spawning)	303(d)	2004

Middle Snake-Payette Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2256	Shepherd Gulch	0 to 3.6	Fecal Coliform	Spring/Summer	303(d)	1998
2255	South Fork Jacobsen Gulch	0 to 3	Fecal Coliform	Spring/Summer	303(d)	1998

2.4 WATER QUALITY DATA SOURCES

DEQ currently maintains four ambient water quality stations in the Malheur Basin. They are located near the mouth of the Malheur in Ontario, at the lower portions of Willow Creek and Bully Creek near Vale (Malheur RM 20), and in Little Valley (Malheur RM 50). Data from these sites has been collected over many years and includes a wide range of analytes including nutrients, bacteria, total suspended solids, pH, and chlorophyll. These data form the basis for many of the 303(d) listings in the Lower Malheur. DDT and dieldrin listings are based on sampling performed in the Lower Malheur by the USGS in 1990 and 1991 (Rinella, et al., 1994). These data are stored in DEQ's LASAR database which accessible on the DEQ website at: http://www.deq.state.or.us/wq/wqlmaps/wqlmapshome.htm.

EPA's STORET database includes data from surface water samples collected at approximately 80 locations in the Malheur Basin by the United States Bureau of Reclamation (USBR), Malheur WSC, and Malheur SWCD. Samples collected by the WSC and SWCD were analyzed by the USBR laboratory. Analyses included nutrients and general water quality criteria. The data sets at many of the sites span 3-5 years of monthly or bimonthly sampling between 1999 and 2005. Sample locations include the USBR reservoirs (Bully, Beulah, and Warm Springs), the Malheur River and tributaries, irrigation canals, and newly constructed water treatment systems such as constructed wetlands. Based on concerns regarding natural and anthropogenic phosphorus loading in the Malheur Basin, the Malheur Experiment Station (Shock, et al., 2001) evaluated data from the sampling conducted by the Malheur Watershed Council (WSC) and Malheur Soil and Water Conservation District (SWCD) during the period between 1997 and 2001. The report concluded that phosphorous enrichment occurs throughout the Malheur River Basin, and generally increases downstream. Geologic as well as anthropogenic sources of phosphorus were discussed.

In 2003 and 2004, DEQ teamed with BLM and conducted further sampling throughout the Malheur Basin with the intent of determining source areas and background nutrient loading sources. Samples were analyzed from approximately 25 locations and all data were added to the LASAR database. This study (DEQ, 2004) resulted in a wide range of total phosphorus in tributary streams with some streams having phosphorus concentrations below the 0.07 mg/l total phosphorus limit required for the Malheur River by the Snake River Hell-Canyon Reach TMDL. Other tributaries showed dramatic increases in total phosphorus over short geographic distances. Land use factors, such as agricultural practices, may be a factor in these differences in total phosphorus loading. However, geologic factors have not been ruled out.

In general, the existing data from EPA STORET and DEQ LASAR databases support the 303(d) listings. These data indicate that moderate to high nutrient and bacteria loading starts in the upper Malheur River, above Warm Springs and Beulah Reservoirs. Significant increases in bacteria, phosphorus, nitrite/nitrate, and chlorophyll occur in the lower river below Bully and Willow Creeks. Similar dramatically increasing patterns of bacteria and nutrient loading occur in Bully Creek below Bully reservoir, and Willow Creek below Malheur Reservoir. The existing data also indicate low DO conditions in Summer from the mouth of the Malheur River as far upstream as Drewsey (RM 142) however, comparisons to appropriate DO criteria need to be made. Continuous temperature monitoring data from streams in the Upper Malheur Subbasin and a few streams in the Lower Malheur and Willow Creek Subbasins has been collected by the BLM and USFS. These data were the basis for temperature 303(d) listings. The USBR also maintains continuous flow and temperature monitoring stations above and below Beulah Reservoir (approx. RM 18 and RM 23) on the North Fork Malheur, above and below Warm Springs Reservoir (approx. RM 122 and 142) on the Upper Malheur, and near the mouth of the Malheur in Ontario. A USBR flow gauge is also located at the Nevada diversion Dam near Vale (approx. RM 20), and a USGS flow gauge is located on the Snake River near Nyssa (approx. RM 392).

2.5 TMDL SAMPLING ACTIVITIES

Three synoptic rounds of water quality sampling were performed in May, August and October 2006 in support of the TMDL development efforts described later in this document. Water samples were collected at 31 locations during each round. Analyses consisted of standard field and water quality lab parameters including chlorophyll a, total organic carbon (TOC), biological oxygen demand (BOD), total suspended solids (TSS), alkalinity, bacteria, nutrients, and flow. In addition, continuous monitoring of temperature, pH, conductivity, and dissolved oxygen was conducted at 11 of the sites over a 48-hour period during each of the sampling rounds. Pesticide analyses were conducted on water and sediment samples from six of the water quality sampling sites in order to determine the validity of the pesticide listing and measure the geographical extent of possible sources.

A biomonitoring project was also implemented in August 2006 as part of the TMDL sampling program. Twenty-four stream segment sites in the Malheur Basin were randomly selected and sampled. In addition to the collection of aquatic insects, water samples were collected and analyzed for basic water quality chemical parameters. Measurements of physical habitat, shade, stream channel width, riparian habitat description, and riparian vegetation buffer width and height were also made.

Continuous temperature monitoring was conducted during June through October 2006 at three locations in the Upper Malheur River above Warm Springs Reservoir, and one location approximately ½ mile below the Warm Springs dam. Additional continuous temperature monitoring was conducted in 2007 at six sites in the Malheur and North Fork Malheur Rivers below Warm Springs and Beulah dams.

Sampling information is described in detail in the Quality Assurance and Sampling Plan (QAPP) included in Appendix D.

2.6 REFERENCES

DEQ, 2004, Summary Report of Field and Analytical Work Completed for the Malheur River Nutrient Water Quality Monitoring Study – Fall 2003 and Spring 2004.

Rinella, Frank A., Mullins, William H., Schuler, Carol Ann; 1994, “Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota associated with Irrigation Drainage in the Owyhee and Vale Projects, Oregon and Idaho, 1990-91”, U.S. Geological Survey Water-Resources Investigations Report 93-4156, U.S. Geological Survey Earth Science Information Center Open-File Reports Section, Denver, Colorado.

Shock, Clinton, C., Nishihara, A., Pratt, K., Jones, R., 2001, Phosphorus Content of the Malheur River, OSU Malheur Experiment Station.

MALHEUR RIVER BASIN TMDL

CHAPTER 3: BASIN ASSESSMENT

Final
September 2010

State of Oregon
Department of Environmental Quality

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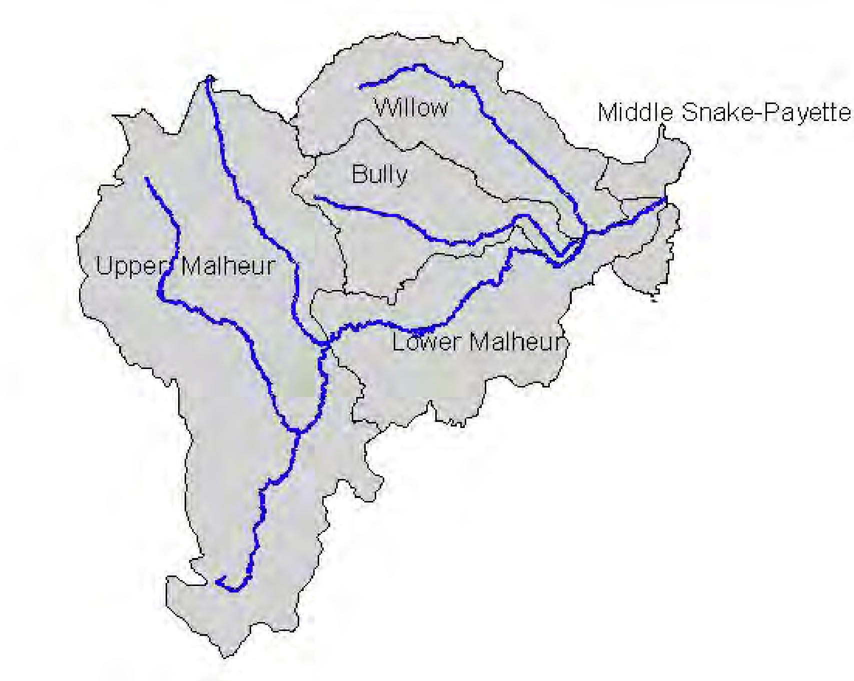
3.1 PHYSICAL SETTING

The Malheur River is a tributary of the Snake River located in southeast Oregon, which forms the border between Oregon and Idaho. The Malheur River Basin consists of the U.S. Geologic Survey 3rd field HUC 170501. For the purposes of efficient TMDL development, portions of the Middle Snake – Payette subbasin (USGS 4th field HUC 17050115) were added to the Malheur River Basin (**Figure 3-1**). Streams in the Middle Snake Payette subbasin drain directly into the Snake River.

The Malheur River Basin is approximately 4,700 square miles in size. Most of the Malheur River Basin is located in northern Malheur County, with the northern and western portions located in Baker, Grant, and Harney Counties. Elevations range from approximately 8,600 feet on the southern flank of Strawberry Mountain in the northwest portion of the basin, to approximately 2,100 feet at the confluence of the Malheur and Snake Rivers (Northwest Power and Conservation Council, 2004). The Middle Snake-Payette subbasin covers approximately 100 square miles in two low-elevation areas located north and south of the confluence of the Malheur and Snake Rivers in Oregon.

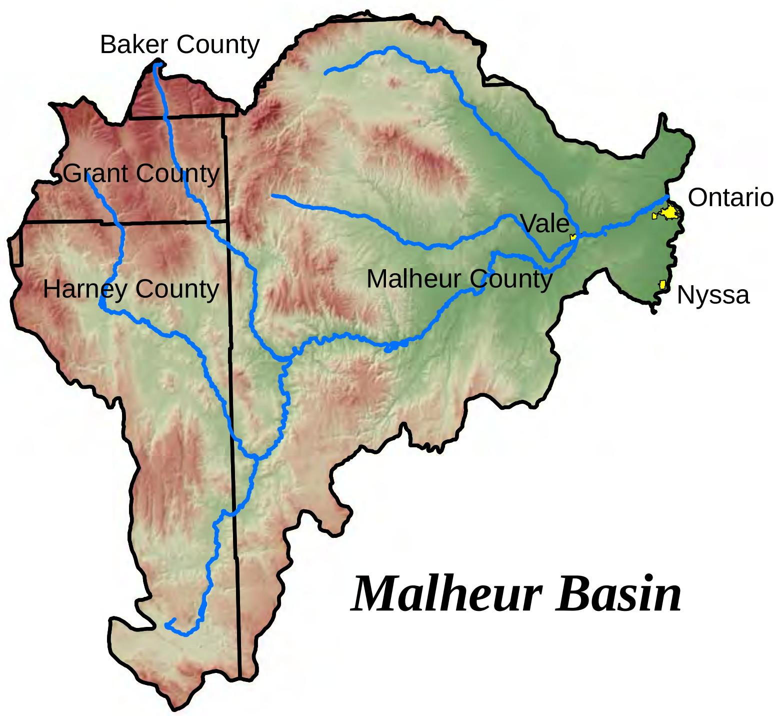
The Malheur River Basin is divided into four subbasins: Willow Creek, Bully Creek, Lower Malheur, and Upper Malheur, which includes the mainstem of the Malheur River as well as the North and South Forks (**Figure 3-1**).

Figure 3-1. Malheur River Basin TMDL Subbasins.



The cities of Ontario, Vale, and Nyssa are located within the Malheur River Basin and Middle Snake–Payette subbasin (**Figure 3-2**). Unincorporated population centers include Brogan, Creston, Drewsey, Grove, Harper, Ironside, Jamieson, and Juntura.

Figure 3-2. Malheur River Basin shaded relief map.



A majority of the land in the Malheur River Basin is public land managed by federal and state agencies (**Figure 3-3 and Table 3-1**). The Bureau of Land Management (BLM) manages almost one-half (approx. 48%) of the land area, with most of it located in the Vale District and a lesser portion in the Burns District. However, a significant amount of the land adjacent to major streams within BLM holdings is privately owned. The mixed private/BLM ownership can complicate riparian zone management. The U.S. Forest Service (USFS) manages approximately 12% of the land in the basin as part of the Malheur National Forest. This area is made up of the mountainous region in the northwest portion of the basin and includes the Upper and North Fork Malheur watersheds. The Bureau of Reclamation (BOR) manages land associated with its impoundment and water diversion projects located throughout most of the basin. The Federal Energy Regulatory Commission (FERC) controls several smaller land holdings along the Malheur River and the North Fork Malheur River. The State of Oregon Division of State Lands (DSL) manages a significant amount of state-owned land in the South Fork Malheur watershed, and the Oregon Department of Fish and Wildlife (ODF&W) owns approximately 4,000 acres along the Upper Malheur River between Riverside and Juntura (Northwest Power and Conservation Council, 2004).

Figure 3-3. Land ownership in Malheur River Basin (Northwest Power and Conservation Council, 2004).

Table 3-1. Property Ownership in the Malheur River Basin (Northwest Power and Conservation Council, 2004).

Watershed	Lower Malheur	Upper Malheur	Willow Creek	Bully Creek	North Fork Malheur	South Fork Malheur	Entire Malheur Basin
BLM	75.7%	41.2%	23.2%	65.4%	37.0%	41.6%	48.2%
BOR	0.3%	0.8%	0.1%	0.5%	1.1%	-	0.5%
FERC	0.2%	-	-	-	0.1%	-	0.04%
USFS	-	34.8%	0.6%	-	36.8%	-	12.3%
Private	20.8%	22.5%	75.7%	33.9%	23.9%	38.1%	34.9%
State Agencies	3.0%	0.8%	0.4%	0.2%	1.1%	20.2%	4.1%

The Burns-Paiute Tribe has recently become a significant property owner in the Malheur River Basin with the purchase of the 1,760-acre Logan Valley Ranch near the headwaters of the Malheur River, and the 6,385-acre Jones Ranch located on the Malheur River between Juntura and Harper. The Jones Ranch property also includes grazing allotments on 4,000 acres of state land, and 35,000 acres of BLM land (Malheur River Wildlife Mitigation Plan, BPT, June 2004b).

3.2 GEOLOGIC SETTING

The Malheur River Basin is located at the juncture of the Blue Mountains geologic province on the west and north and the Owyhee Uplands portion of the Basin and Range Province to the south and east (Orr, Orr, and Baldwin, 1992).

The Blue Mountains are a cluster of smaller mountain ranges of various orientations and structures. The Strawberry Range, located in the south-central Blue Mountains, forms the headwater region of the mainstem of the Malheur River near Logan Valley. The headwaters of the North Fork Malheur River and the Little Malheur River are located on the east side of this range. The rocks comprising the Strawberry Range are basalt flows of mid-Miocene age (approximately 12 million years old) similar to the more extensive Columbia River Basalt flows to the north. The Strawberry Volcanics cover and area of approximately 1500 square miles and are over 1 mile thick at Ironside Mountain in northern Malheur County (Orr, Orr, and Baldwin, 1992). The Strawberry Mountain Volcanics are underlain by older rocks of the Olds Ferry Terrane in northern Malheur County. The Olds Ferry Terrane is composed of a thick sequence of volcanic rocks and sediments which are believed to be associated with volcanic island chains similar to present day islands in the north and western Pacific. Thin beds of marine sandstones, siltstones, and limestones of late Triassic to middle Jurassic age are found between thicker layers of volcanic rocks (Orr, Orr, and Baldwin, 1992).

Glaciation occurred in eastern Oregon during the Pleistocene Epoch beginning approximately 2 million years ago and continuing intermittently until approximately 11,000 years ago. The ice age included several ice advances and retreats lasting 150 to 200 thousand years each. These alpine glaciers carved deep valleys before their final retreat and resumption of fluvial erosion (OR, Orr, and Baldwin, 1992). Deposits formed by end, basal and lateral moraines are present on the south side of Strawberry Mountain in the headwater valleys of the Malheur River (Walker and MacLeod, 1991).

The southern and western portions of the Malheur River Basin are located within the Owyhee Uplands area in an area where the High lava Plains Province and the Basin and Range Province intersect. This region is made up of deeply dissected plateaus underlain by large volumes of volcanic rock which include the Miocene Age Lake Owyhee Volcanic field. The lower Malheur River Valley near Ontario and Vale is underlain by the siltstone lakebed deposits of the Glenns Ferry Formation, which has been interpreted as Pliocene (5-2 million years) in age (Gannett, 1990). Deep wells in the Ontario area have revealed up to 4600 feet of fine sediments which consist of the Glenns Ferry Formation and likely older sediments of the underlying Miocene Chalk Hills Formation (Gannett, 1990).

The Bonneville Flood, a catastrophic flood event that occurred approximately 14,500 years ago due to the failure of a natural dam of Pleistocene Lake Bonneville, resulted in the deposition of fine-grained silty soils over much of the lower Malheur River Basin and downstream along the Snake River. The massive flood waters eroded a canyon over 500 feet deep and a mile wide in some areas. Large sediment structures and scoured and eroded scabland topography is still present along the Snake River (Link et al., 1999).

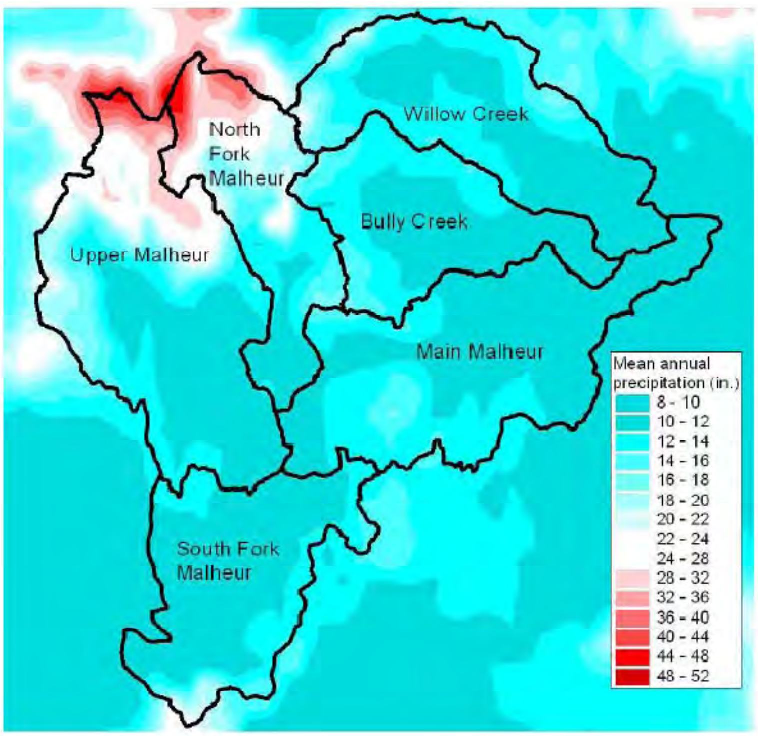
3.3 SOILS

The Malheur River Basin covers a large and varied region and contains diverse group of soil types. The northwest portion of the basin soil types range from productive volcanic ash soils on north-facing slopes (Mount Mazama ash from approx. 6,500 years ago), to underlying silt loam soil on less protected south slopes, and shallow residual soils on ridge tops. The Logan Valley soils located near the headwaters of the Malheur River contain soils which are shallow and contain a cemented hardpan (Malheur Basin WSC and BPT, 2004). In areas of the rolling hills that comprise a majority of the basin, soils often consist of a thin layer of wind deposited loess overlying lakebed sediments. Narrow floodplain deposits are found along streams in this area. Deeper floodplain soils are found in the lower portion of the basin, and are the basis for extensive agricultural activity. These soils are generally easily eroded and alkaline (Northwest Power and Conservation Council, 2004).

3.4 CLIMATE

The climate of the Malheur River Basin is semi-arid, and characterized by hot dry summers and cold winters. Mean annual precipitation in the basin varies with elevation between 49 inches in the high elevations in the northwest, to seven inches in the more arid lower elevations in the east (**Figure 3-4**). Precipitation in the Malheur River Basin is distributed more evenly through the year than in many other areas of Oregon, but November through June generally have the most precipitation. The driest month is generally July (Oregon Climate Service, 2004).

Figure 3-4. Mean annual precipitation in Malheur River Basin, 1961-1990 (Oregon Climate Service, 1998).



3.5 FLORA AND FAUNA

The abundance and distribution of native flora and fauna in the Malheur River Basin have been altered dramatically in the last 175 years. Changes in the basin started in the 1820's when large organized fur brigades came in search of beaver pelts. Each brigade trapped several thousand beaver in a given year. The journals of Peter Skene Ogden (Ogden 1826-1827), of the Hudson Bay Company document that Mr. Ogden and his brigade of 30-40 trappers traveled throughout the Malheur and Snake River Basins. On June 26, 1827, Ogden wrote that he had reached the source of the Malheur River and trapped 81 beaver, apparently within a day or two. Three-hundred more beaver were trapped over the next few weeks while proceeding down the Malheur River to the Snake River. Over the next decade, the various fur brigades trapped most of the beaver in the Pacific Northwest. Removal of beaver was the first major step in a series of modifications to the habitat and hydrology of the Malheur River. Loss of beaver in a watershed can cause major changes to riparian habitats and eventual reductions in the water table as well as the loss of sediment and nutrient storage areas affecting water quantity and quality. Naimen et al. 1998, Butler and Malansan 2005, Wolf et al. 2007, and Perisco and Meyer 2009, are examples of studies documenting the influence of beaver on geomorphology, vegetation and sediment production. TThe loss of beaver-related water storage in the Malheur River Basin has very likely contributed to an overall increase in the peaks and lows of stream flow.

By the 1860s, settlers entered southeast Oregon and began setting up scattered cattle ranches along the major rivers of the area. Cattle were brought in from western Oregon and from California. The California-based operations brought very large herds of cattle, as well as sheep in some areas, and set up very large ranches (Oregon History Project, 2002). Much of the Malheur River basin had been set aside as a reservation for the Northern Paiutes in the 1860s, but it was abolished after the 1878 “Bannock War”. When the Malheur Reservation was abolished, it opened approximately 2 million acres of land in the Harney Lake and Malheur River Basins for settlement. Large cattle and sheep operations were established in the area throughout the 1880s (Oregon History Project, 2002).

The sagebrush-steppe habitat, which was native to most of the mid- and low-level elevation portions of the Malheur River Basin, has been altered by 150 years of grazing, fire suppression, and invasive plant species. Most of the valleys, which included a mix of shrub steppe and other dry land plant communities, as well as riparian shrub, wet meadow, and other riparian habitat, were cleared for agriculture or pasture by the early 1900s. In the higher elevation, forested portions of the basin, grazing, logging and fire suppression starting in the early 1900s, has resulted in the conversion of open stands of fire-resistant large trees to insect and fire-prone stands of shade tolerant trees. Aspen and cottonwood stands which need fire for regeneration and are sensitive to grazing impacts, have been greatly reduced in abundance (Northwest Power and Conservation Council, 2004).

The 1920s and 1930s was the era of dam building throughout much of the country, including the Malheur River Basin. Much of the extensive irrigation system serving the intensive agriculture of the lower Malheur and Snake River basins was built in this period. These activities lead to the further conversion of upland and riparian wetland plant communities that were historically present along the Malheur River between Little Valley and Ontario and along the Snake River in Oregon and Idaho to irrigated agricultural areas (NW Habitat Institute, 2001). The former riparian wetland areas likely consisted of lowland willow and other riparian shrublands that grew in areas along streams that were subject to seasonal flooding. Surrounding areas of desert playa and salt scrub habitat were also converted to agricultural areas (NW Habitat Institute, 2001).

Mid-elevation areas of the Malheur River Basin historically contained dispersed areas of Black Cottonwood riparian habitats along with willow and other shrubs. Black Cottonwood and White Alder stands combined to form a multilayered canopy forming a mosaic of forest, woodland and shrubland patches along the Malheur and its tributaries. Ground cover likely consisted of steppe grasses and forbs (NW Habitat Institute, 2001). Higher altitude forested riparian areas transitioned to Mountain Alder-willow shrublands (NW Habitat Institute, 2001). All these riparian habitats tend to occur in areas affected by seasonal flooding, and are associated with particular stream dynamics and hydrology. Disturbances such as floods, rafted ice, use by wildlife, grazing and fire affect the distribution and stage of development. Various flood regimes and specific substrate conditions are required for re-establishment (NW Habitat Institute, 2001).

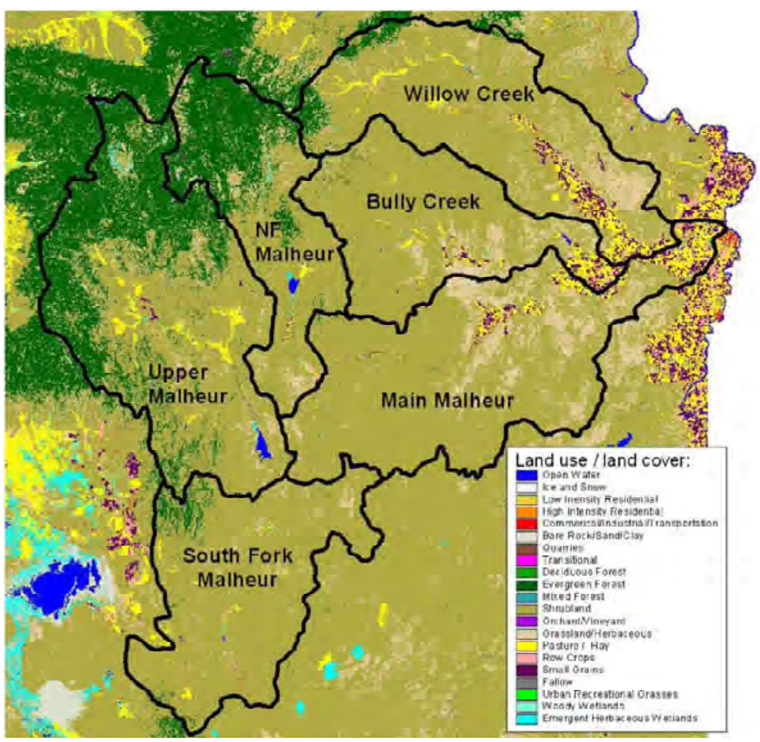
Quigley and Arbelbide, 1997, in a study of Northwest habitats, concluded that Cottonwood-willow habitats cover considerably less area in the Inland Northwest now than before 1900, reduced from approximately 2% of total land area to approximately 0.5%. They also concluded that loss of riparian shrublands and cottonwood trees has been greater at lower elevations. This pattern appears to have been repeated in the Malheur River Basin, but has been compensated to some extent by the establishment of new wetlands and riparian communities in irrigated areas.

3.6 CURRENT LAND USES/COVER

A majority of all land area in all subbasins within the Malheur River Basin is classified as “shrubland” according to GIS coverage used in the preparation of the Malheur River Subbasin Assessment and Management Plan for Fish and Wildlife Mitigation (**Figure 3-5**, Malheur WSC, BPT, 2004). It is assumed that the category of “shrubland” includes the shrub steppe habitats that are common in the basin consisting of native and introduced grasses, sagebrush and other shrubs. The amount of shrubland ranges from approximately 50% in the Main Malheur and North Fork watersheds to over 90% coverage in the South Fork watershed. Most of this area is used for seasonal livestock grazing. Evergreen forests (including areas of Western Juniper expansion) cover approximately 30-35% of the Middle Fork Malheur and North Fork watersheds, and less than 5% of the land area in the South Fork Malheur watershed, and Lower Malheur, Willow Creek, and Bully Creek subbasins.

The remainder of the land area in the Malheur River Basin consists of agricultural-related land uses such as row crops, small grains, pasture/hay and grasslands. Land area for these more intensive agricultural uses ranges from approximately 5% in the South Fork subbasin to approximately 25% in the Willow Creek subbasin. River and tributary valleys in the lower portion of the basin are dominated by intensive irrigated agriculture. The area is famous as a large producer of onions, potatoes, sugar beets, and other row crops. Valleys in the upper basin are used mainly for the production of hay and forage crops in irrigated fields along major water courses. Residential and commercial/industrial areas cover less than 0.1% of the Malheur River Basin (Northwest Power and Conservation Council, 2004).

Figure 3-5. Land Use/Land Cover in the Malheur River Basin (Northwest Power and Conservation Council, 2004).



3.7 FISHERIES

Sixteen species of native fish are known or suspected to have occurred in the Malheur River Basin (**Table 3-2**), (Northwest Power and Conservation Council, 2004). Several species of salmonids and a variety of other native fish inhabited the Malheur River and its tributaries. Anadromous species of salmonids included Chinook Salmon, Coho Salmon, and Steelhead. Pacific Lamprey, an anadromous eel, was also present in the basin. These species became extinct when they were blocked from their major spawning areas in the Upper Mainstem Malheur and North Fork Malheur watersheds by dams constructed in the early 20th century. The remaining resident salmonids consist of Redband Trout, Bull Trout, and Whitefish.

Table 3-2. Historic and Current Species of Native Fish in the Malheur River Basin (Northwest Power and Conservation Council, 2004).

Common Name	Scientific Name	ODF&W Management	Status	Known Habitat
Pacific Lamprey	Lampetra tridentate		Extinct	
Chinook Salmon	Oncorhynchus tshawytscha	Gamefish	Extinct	
Coho Salmon	Oncorhynchus kisutch	Gamefish	Extinct	
Steelhead	Oncorhynchus mykiss	Gamefish	Extinct	
Columbia River Redband Trout	Oncorhynchus mykiss	Gamefish	State Sensitive	Higher elevation areas of most subbasins
Bull Trout	Savelinus confluentus	Gamefish	Federal Threatened	Headwaters of North Fork and Logan Valley streams
Whitefish	Prosopium williamsoni	Gamefish		Lower sections of North Fork, Upper Malheur, and Lower Malheur
Northern Pike-minnow	Ptychoeilus oregonensis	Nongame		Lower sections of major subbasins
Chiselmouth	Acrocheilus alutaceus	Nongame		Lower Malheur River
Redside Shiner	Richardsonius balteatus balteatus	Nongame		Lower sections of major subbasins
Speckled Dace	Rhinichthys osculus	Nongame		Lower sections of major subbasins
Long-nosed Dace	Rhinichthys cataractae	Nongame		Lower sections of major subbasins
Largescale Sucker	Catostomus macrocheilus	Nongame		Larger river and reservoirs
Bridgelip Sucker	Catostomus columbianus	Nongame		Lower sections of major subbasins
Shorthead Sculpin	Cottus confusus	Nongame		Headwater areas of perennial streams
Mottled Sculpin	Cottus bairdi	Nongame		Headwater areas of perennial streams

The Malheur Subbasin Coalition which prepared the Malheur River Subbasin Assessment and Management Plan (Northwest Power and Conservation Council, 2004), identified Spring Chinook Salmon, Redband Trout, and Bull Trout as aquatic focal species for the Malheur River Basin based on their cultural, biological, and esthetic value.

Chinook Salmon along with all other runs of anadromous fish native to the Malheur River Basin are extinct. A major factor in their decline and extinction was related to blockage of migration pathways by dams in the Malheur River Basin and also on the Snake River and Columbia River. Construction of Warm Springs Dam on the upper Malheur River in 1919, and Agency Valley Dam on the North Fork

Malheur River in 1935 blocked access to what was likely the most productive spawning habitat in the Malheur River Basin. Subsequent dams on the Columbia and Snake rivers contributed to these impacts on Chinook salmon and other anadromous species. Construction of Brownlee Dam in 1958 on the Snake River completely blocked all anadromous fish from reaching the Malheur River (Northwest Power and Conservation Council, 2004). The Burns-Paiute Tribe has recently (2010) started a feasibility study regarding the possible reintroduction of Chinook Salmon in the Malheur River Basin.

Redband Trout are a variety of Rainbow Trout that are found primarily east of the Cascade Mountains in the northwestern United States. Redband trout are currently listed as a Sensitive Species under Oregon's Endangered Species Act. The overall health of the Redband Trout population in the Malheur River basin is unknown, but an interagency team is researching their condition (Northwest Power and Conservation Council, 2004).

Redband trout are the most prevalent native salmonid in the Malheur River Basin, and were identified in seventy-six streams in the basin (Hanson et al., 1990). Redband distribution includes tributaries of the South Fork Malheur and the Malheur River below Warm Springs Reservoir, the mainstem Malheur and North Fork Malheur above Warm Springs and Beulah Reservoirs, Bully Creek and its tributaries above Bully Reservoir, and the headwater tributaries of Willow Creek. Local fish and land managers presume that fluvial (migratory) redband trout currently use habitats of the lower Malheur River Subbasin for winter rearing and migration (Northwest Power and Conservation Council, 2004).

The U.S. fish and Wildlife Service (USF&W) listed Bull Trout in the Columbia River Basin, including the Malheur River, as threatened in June 1998. Two distinct local populations of Bull Trout have been identified in the Malheur River Basin; the Upper Malheur River population and the North Fork Malheur population. These two populations are considered to be local populations within one core population. They were isolated from each other by the construction of the Warm Springs Dam on the upper Malheur River in 1919, and the Agency Valley Dam on the North Fork in 1935. Neither dam has any fish passage facilities.

Bull trout currently inhabit portions of the North Fork Malheur and tributaries as well as the upper Malheur and tributaries above Drewsey. Spawning and rearing is restricted to specific headwater tributaries in both watersheds along with the upper North Fork Malheur River.

Bull Trout in the North Fork Malheur River are known to migrate downstream in the Fall and spend the winter in Beulah Reservoir. Some adult Bull Trout have been observed in the tailrace below Agency Valley Dam, indicating that they were washed over the dam or through the subsurface discharge pipes. These fish cannot return to the reservoir, and it is suspected that Bull trout that are present below the dam will not successfully spawn or rear due to lack of habitat and a highly altered seasonal hydrograph (Northwest Power and Conservation Council, 2004).

The Upper Malheur River Bull trout population occurs mainly in the headwater tributaries in Logan Valley and upstream. Brook trout are present in many of the same streams, and may be a significant competitive threat. Bull Trout/Brook Trout hybrids have also been documented by biologists working for the Burns-Paiute Tribe (BPT, 2004a). In 1955, an extensive Rotenone fish poisoning operation was performed on portions of the Middle Fork Malheur River and North Fork Malheur River by ODF&W. The project was done in hopes of removing Northern Pike Minnow and Bridge Lip Suckers to improve the local trout fishery. Bull Trout were not the target and no dead Bull Trout were observed (Ray Perkins, ODF&W pers. comm. 7/10/10).

Bull Trout do not appear to use Warm Springs Reservoir seasonally as they do at Beulah Reservoir.

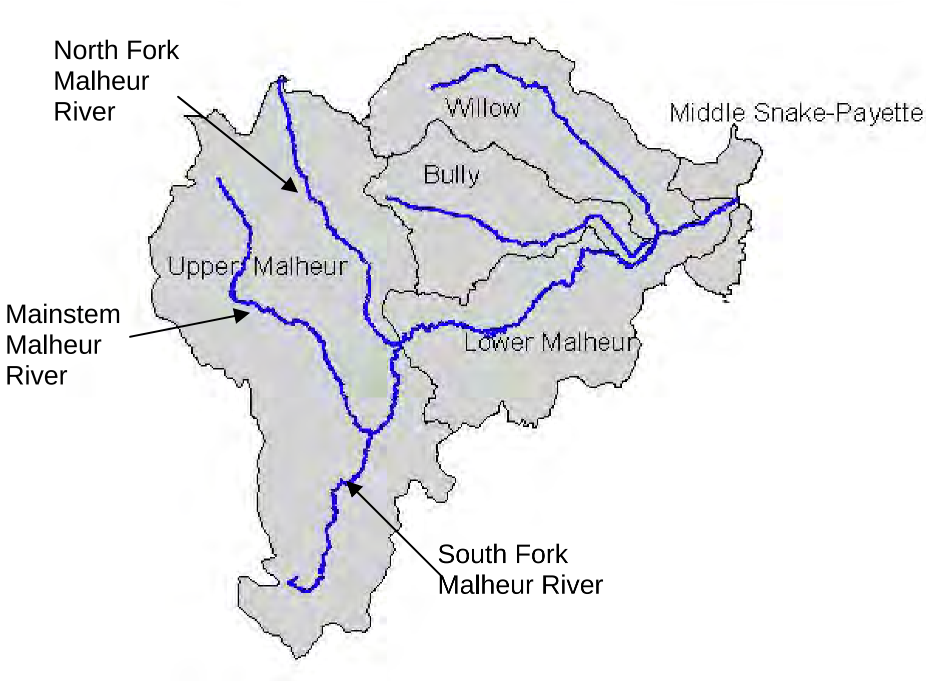
3.8 HYDROLOGY AND WATER USE

3.8.1 Surface Water

The Malheur River is a tributary of the Snake River located in southeastern Oregon. It enters the Snake River at approximately river mile 370, and has a drainage area of approximately 4,700 square miles. Elevations in the basin range from approximately 2,100 feet at the confluence with the Snake River in Ontario, to approximately 8,600 feet in its headwaters in the Strawberry Mountains (Northwest Power and Conservation Council, 2004).

The Malheur River Basin is divided into the Lower Malheur, Upper Malheur, Willow Creek, and Bully Creek Subbasins. The Middle Snake watershed includes two small areas located north and south of the mouth to the Malheur River which drain directly into the Snake River (**Figure 3-6**).

Figure 3-6. Tributaries and Subbasins of the Malheur River.

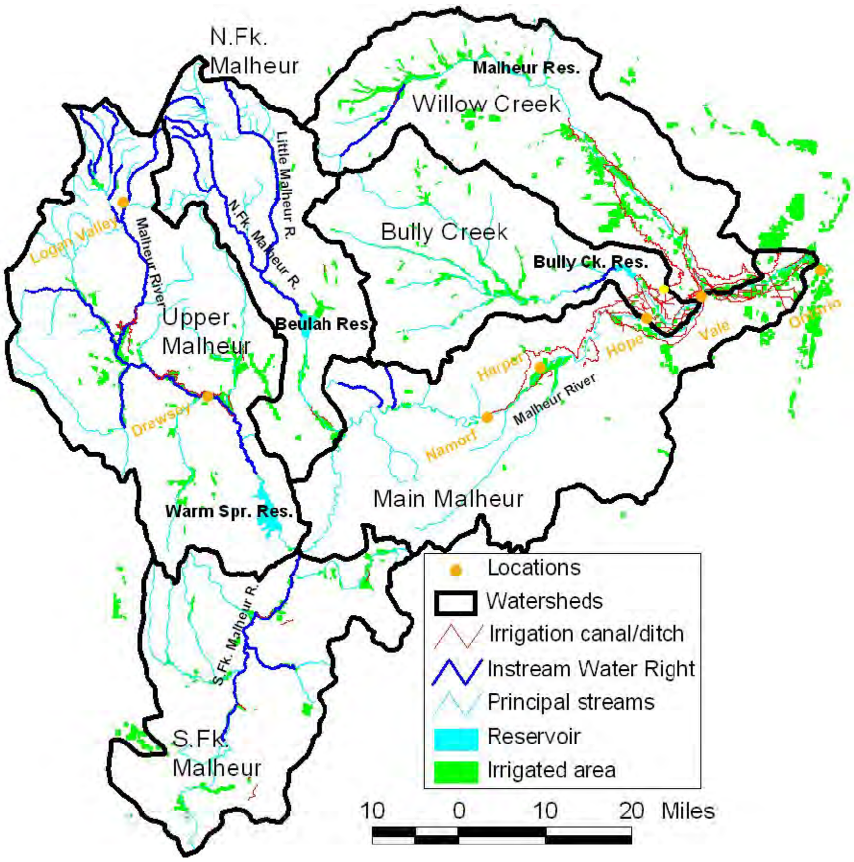


The Malheur River Basin includes approximately 6,500 miles of streams, including 1,400 miles of perennial streams, and 5,100 miles of intermittent streams. There are also hundreds of miles of irrigation canals located mainly in the Lower Malheur and Willow subbasins (Northwest Power and Conservation Council, 2004). Major tributaries include Willow and Bully Creeks in the lower basin, and the North Fork Malheur and South Fork Malheur in the upper basin.

3.8.2 Major Dams and Diversions

Over 1,100 impoundments have been identified in the Malheur River Basin. The most significant impoundments include the Warm Springs Reservoir on the mainstem of the upper Malheur River (~4,000 acres), Beulah Reservoir on the North Fork Malheur River (~1,800 acres), Bully Creek Reservoir on Bully Creek (~900 acres), and Malheur Reservoir on Willow Creek, (~500 acres) (**Figure 3-7**, Northwest Power and Conservation Council, 2004).

Figure 3-7. Major reservoirs and irrigated areas of the Malheur River Basin (Northwest Power and Conservation Council, 2004).



Most of the water flow in the Malheur River Basin is controlled by releases of stored water from reservoirs and by a complex system of diversions, canals, and siphons (**Figure 3-7**). The Vale Irrigation District Main Canal carries water east from a diversion dam on the Malheur River at Namorf (RM 67) to Little Valley, and then continues on to Bully Reservoir near Vale, and then north along the west side of the Willow Creek Valley. The Nevada Canal carries irrigation water east from the Nevada Dam on the Malheur River near Vale (RM 19) eastward to the south side of the lower Malheur River valley. Additional irrigation water is brought into the Lower Malheur Valley and areas along the Snake River from the Owyhee Dam on the Owyhee River, via the Owyhee Irrigation Company North Canal. The North Canal carries water north across the lower Malheur valley via the Malheur Siphon. On the north side of the Malheur valley, the North Canal branches east and west carrying irrigation water to the Oregon Slope north of Ontario, and the east side of the Willow Creek valley. A total of approximately 132,000 acres of land are irrigated in the Malheur River Basin (Northwest Power and Conservation Council, 2004).

The Nevada Dam, built in 1881, was the first major diversion dam built on the Malheur River. It is located at approximately RM 19, just below Vale. The Warm Springs Dam and Reservoir (**Figure 3-8**), located on the upper Malheur River above Juntura began operation in 1919. It was the first Bureau of Reclamation (BOR) dam constructed as part of the Vale Project. Following construction of Warm Springs Dam, numerous drainage canals were constructed by BOR in the lower Malheur Basin during the late 1920's in order to alleviate areas of water-logged soil caused by early irrigation activities. The Vale Main Canal was constructed by BOR between 1927 and 1935, and the Harper Diversion Dam at Namorf (RM67), which supplies water to the Vale Main Canal was completed in 1929. BOR completed the Agency Dam and Beulah Reservoir (**Figure 3-9**) on the North Fork Malheur River in 1935, and Bully Creek Reservoir Dam (**Figure 3-10**) was completed by BOR in 1963. Bully reservoir stores water from Bully Creek and water diverted from the Vale Main Canal via the Bully Creek Feeder Canal (BOR Vale Project website, 2007).

Figure 3-8. Warm Springs Dam and Reservoir (BOR Vale project website).

Figure 3-9. Agency Valley Dam and Beulah Reservoir on the North Fork Malheur River (BOR Vale project website).

Figure 3-10. Bully Creek Dam and Reservoir (BOR Vale project website).

The large dams on the Middle and North Forks of the Malheur River have profoundly altered the hydrograph of the rivers downstream of the Warmsprings and Agency Valley dams. The hydrograph of the rivers below the major dams is essentially “inverted”. Historically, high flows occurred in Winter during storms and Spring snowmelt. Summer was characterized by decreasing flows to a very low base level. High flows now occur all summer, as long as there is water in the reservoirs. Virtually no flow occurs from mid-October until approximately mid-April when the gates of the dams are closed for water storage, except for flows from the un-dammed South Fork Malheur River. The lower section of the Malheur River below Vale is an exception. It appears to have higher flow in fall and winter than upstream sections, likely due to flood irrigation return via groundwater. This effect is described in Section 3.8.3.

Steady year-round flows and vastly increased areas of shallow groundwater have increased areas of wetlands and riparian vegetation in some areas of the lower Malheur River where land use practices allow it to grow. Upstream of irrigated areas, the changes in the hydrograph are likely impairing riparian vegetation growth by disrupting the natural occurrence and magnitude of floods. Trees and shrubs such as cottonwoods and willows rely on floods to scour new areas for seed germination and growth from transported branches and root sections. Receding water levels in summer are required for further plant growth to reach the water table (Borman and Larson, 2002). Irrigation releases disrupt this part of the cycle.

The disruption of the movement of gravel and cobble size sediment material by dams also reduces the amount of gravel bar areas for woody riparian vegetation to colonize. Fine sediments may also be trapped by the dams, but much of it is discharged from the bottom release gates at the Warm Springs and Beulah Reservoirs. This mechanism can periodically provide cooler water downstream and reduce the rate of sedimentation in the reservoirs. However, it does not appear to retain enough fine sediment to reduce turbidity and phosphorus transport. During the irrigation season it has been reported that turbidity levels downstream of the dams is often higher than the levels in water entering the reservoirs.

3.8.3 Groundwater

Major aquifer units in the Malheur River Basin include the bedrock aquifers of the southern Blue Mountains, the Volcanic and Sedimentary aquifers of the Owyhee Uplands, and the Basin-fill and alluvial aquifers of structural basins in the area (Gonthier, 1985). The major groundwater development in the Malheur River Basin has taken place in the lower Malheur River Valley in the vicinity of Ontario and Vale. As discussed previously in the geology section, the lower Malheur River Valley in the vicinity of Ontario and Vale is underlain by the siltstone lakebed deposits of the Glenn’s Ferry Formation, which has been interpreted as Pliocene (5-2 million years) in age (Gannett, 1990). Deep wells in the Ontario area have revealed up to 4600 feet of fine sediments which consist of the Glenns Ferry Formation and likely older sediments of the underlying Miocene Chalk Hills Formation (Gannett, 1990). In the valleys of the lower Malheur River Basin, the Glenns Ferry Formation is overlain by recent sediments deposited by streams (alluvium). This material is referred to as Quaternary alluvium in geologic maps and reports of the area. The Quaternary alluvium consists of a lower layer of unconsolidated sand and gravel 10 to 40 feet thick, overlain by silt which ranges between 10 and 50 feet thick. In the surrounding uplands the Glenns Ferry formation is overlain by older gravel material (Gannett, 1990).

The three major water-bearing units in the Lower Malheur River Basin are: the unconsolidated Quaternary alluvium sand and gravel aquifer, saturated portions of the upland gravel deposits, and sand and gravel layers within the deeper Glenns Ferry Formation. The Quaternary sand and gravel aquifer is the most widely used source of water for irrigation and domestic water supply purposes (Gannett, 1990). **Figure 3-11** is a schematic diagram of the shallow groundwater flow system in the Ontario area of the Lower Malheur River Basin. This diagram depicts a shallow alluvial aquifer which is in direct connection with the ground surface. The unconfined nature of the shallow aquifer is demonstrated in many areas through the rapid rise in water levels during recharge events such as the start of irrigation season and snowmelt.It is also demonstrated by the the dewatering of fields and flooded basements through the pumping of groundwater from the shallow aquifer (Gannett, 1990).

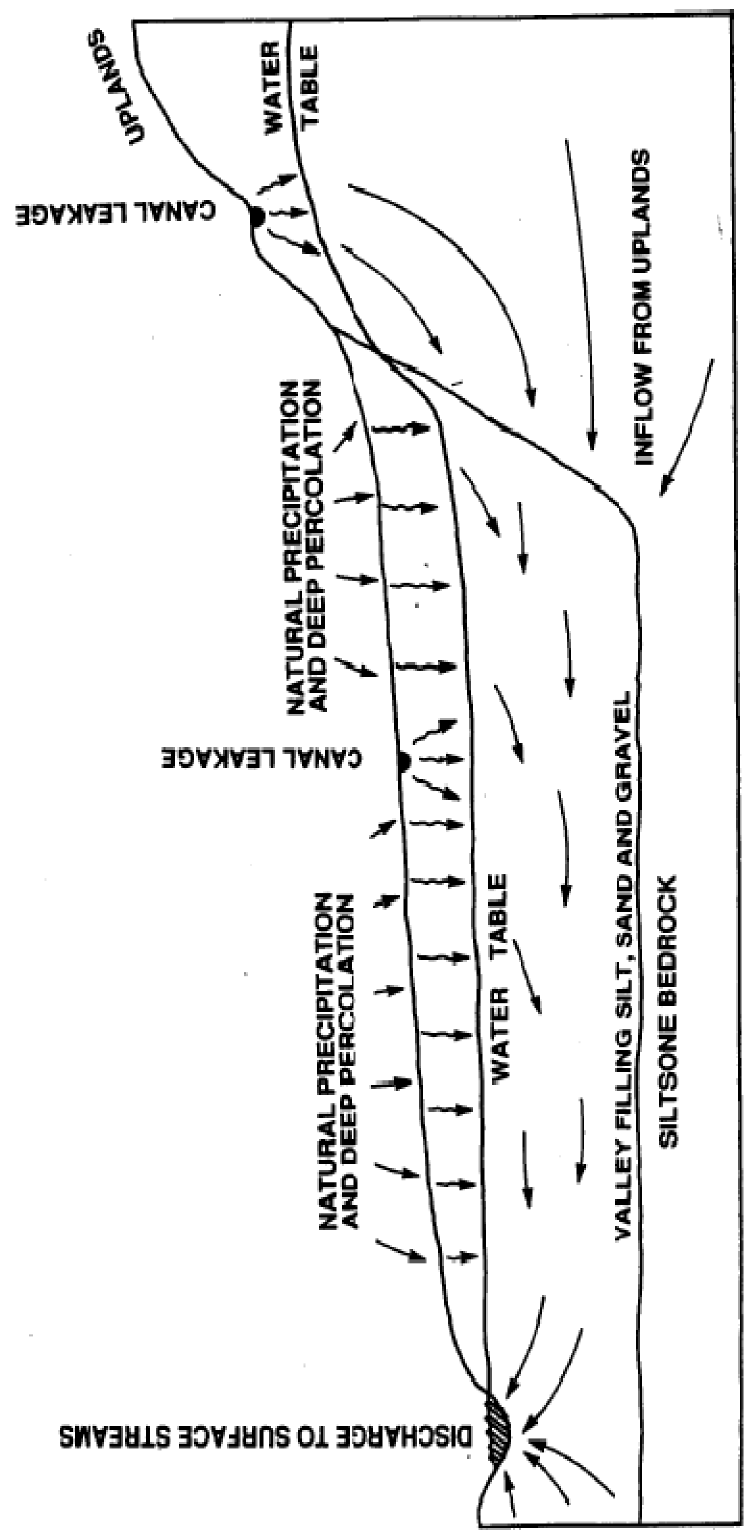


Figure 3-11. Conceptual diagram of the shallow groundwater flow system in the Ontario Area. (Gannett, 1990).

The shallow groundwater aquifer in the lower Malheur River Basin is recharged from several sources including precipitation, leakage from irrigation canals and ditches, infiltration of irrigation water applied to fields, and infiltration from intermittent streams. The shallow alluvial aquifer, by nature is located along the main Malheur River channel and major tributary streams such as Willow and Bully Creeks. This area is the location of intensive agricultural activity which frequently involves the use of flood irrigation. The primary source of groundwater recharge in this area is the conveyance, distribution and use of surface water for irrigation.

Owyhee Irrigation District records indicate an average loss of approximately 98,000 acre-feet per year from the North Canal over its 72 mile length during the period of 1981 to 1988 (Gannett, 1990). It is assumed that most of this loss is in the form of recharge to groundwater. It seems likely that other irrigation districts in the area experience similar losses. An irrigation return flow study conducted by the Oregon Water Resources Department estimated an irrigation efficiency of only 20% for a hay meadow located along the upper Malheur River above Warm Springs Reservoir (WRD, 1988). Efficiency estimates for other irrigated areas of the Malheur River Basin are in the range of 30 percent or less up to 50% or greater depending on the steepness of the land and the amount of water re-use (Malheur SWCD, 2006, Malheur Experiment Station, Clint Shock pers. Comm., July 2010).

Much of the water lost from inefficient irrigation practices is assumed to be returned to the river through groundwater seepage, and is available for use downstream. However, this return flow does not appear to supplement low flows in the upper basin during the period of late Summer and early Fall. During this period lows at the Drewsey stream gauge are often only a few cfs. Further study of practices in this area may identify methods for improving floodplain aquifer storage and increase late-season stream flows. Flows in the Lower basin, below Little Valley, appear to be supplemented by groundwater seepage during the Summer and Fall, as demonstrated by the significant flow in the lower river which persists in late Fall after flow from the reservoirs and irrigation ditches is turned off for the season. No water is released from Warm Springs Dam, Agency Dam, Bully Reservoir or Malheur Reservoir on Willow Creek during the most of Fall and Winter, yet the lower Malheur River flows at 100-300 cubic feet per second (cfs) during periods of little to no rainfall. Flow from the South Fork Malheur and drainage of irrigation canals also contribute to this late-season flow.

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MALHEUR RIVER BASIN TMDL

CHAPTER 4: POLLUTANT SOURCES

Final
September 2010

State of Oregon
Department of
Environmental
Quality

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Figures

4.1 NUTRIENTS/CHLOROPHYLL/DISSOLVED OXYGEN

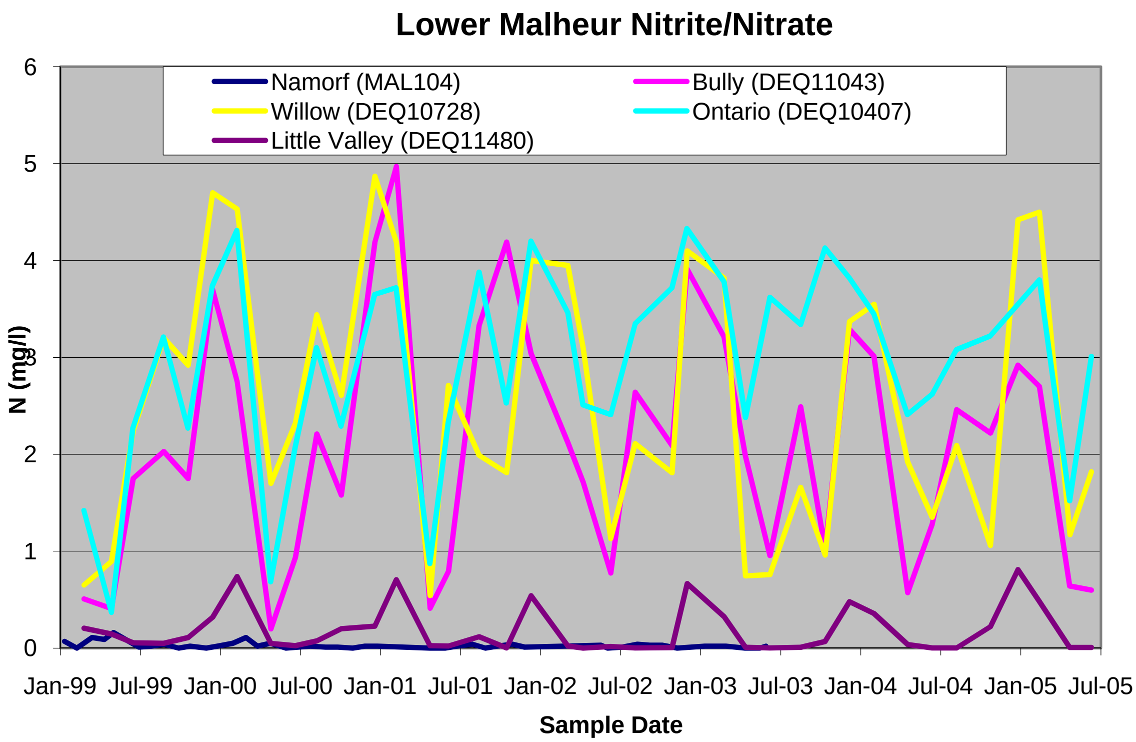
Excess nutrient loading is common throughout the Malheur River Basin and tends to increase in a downstream direction. Nutrients of concern include nitrogen and phosphorus. The lower 67 miles of the Malheur River, along with the lower portions of Bully and Willow Creeks, are 303(d) listed for excess levels of chlorophyll a related to algae growth in summer (**Figure 2-4 and Table 2-1**). Low dissolved oxygen listings occur on the entire mainstem Malheur River from RM 0 to RM 186.1 (**Figure 2-4 and Table 2-1**). It is likely that the low dissolved oxygen conditions are related to excess algae growth in the river. Algae growth is generally controlled by water temperature, nutrient concentrations, and sunlight. The following discussion focuses on nutrient sources.

4.1.1 Nitrogen Data

A review of water quality data from samples collected in the Malheur River Basin by the Malheur Watershed Council and DEQ between 1999 and 2005, indicate that nitrite/nitrate levels in the Malheur River increase very dramatically below Namorf (RM 67). Namorf is the location of the upper-most diversion structure which provides irrigation water to the extensive irrigated agricultural area located along the lower Malheur River and tributaries between Harper (RM 57) and the mouth of the Malheur at Ontario. Total nitrite/nitrate concentrations in samples collected at Namorf are generally well below 0.1 mg/l. Nitrite/nitrate concentrations in the Malheur River near the mouth, range from less than 1 mg/l to nearly 5 mg/l (**Figure 4-1**).

The data show strong seasonal peaks, which generally occur during the irrigation season and again during mid-winter. The nitrite/nitrate data from lower Willow Creek and lower Bully Creek, which both enter the Malheur River at approximately RM 20, show similar trends (**Figure 4-1**). Volk et al., 1972, attributed peaks in nitrate concentrations during the winter season to the higher proportion of groundwater in agricultural drains (and presumably the Malheur River) during the winter. When the irrigation system is shut off for the winter, along with virtually all surface water flow from the Upper Malheur and North Fork Malheur, the remaining water in the system is principally groundwater. The major exception to this assumption would be storm events. Groundwater in the Lower Malheur Basin is known to be high in nitrates, and has lead to the designation of the Northern Malheur County Groundwater Management Area (GWMA) by DEQ in 1991.

Figure 4-1. Nitrite/Nitrate Concentrations in Lower Malheur River.



Nitrite/nitrate data from samples collected in Willow Creek and Bully Creek also indicate significant increases in areas downstream of intensive agricultural areas (**Figure 4-2 and Figure 4-3**). The sample collected from the Brogan Canyon area of Willow Creek is upstream of most irrigated agricultural areas, and has a total nitrite/nitrate concentration which is generally well below 0.5 mg/l with one spike over 3 mg/l. Higher concentrations in the 1 mg/l to 5 mg/l range occur at downstream stations in Brogan, Dennis, and at the mouth of Willow Creek in Vale. These sample locations are located within the irrigated agricultural area of the lower Willow Creek Valley. The Bully Creek data indicate a strong increase in nitrite/nitrate in the vicinity of Bully Reservoir. The upstream sample location is located just upstream of the reservoir and the downstream sample location is located a few miles downstream of the dam at the Highway 20 crossing. The nitrite/nitrate concentrations range from a few tenths of a mg/l above the reservoir, to a high of 5 mg/l below the reservoir. It seems likely that management of the reservoir lands and downstream vicinity may be a strong controlling factor of nutrient concentrations in lower Bully Creek.

In a similar pattern to the Lower Malheur River and local irrigation ditches, the high nitrogen peaks during winter in both Willow and Bully Creeks are likely due to the influence of nitrate rich groundwater when surface water flows from upstream are shut of for the season.

Figure 4-2. Nitrite/Nitrate Concentrations in Willow Creek.

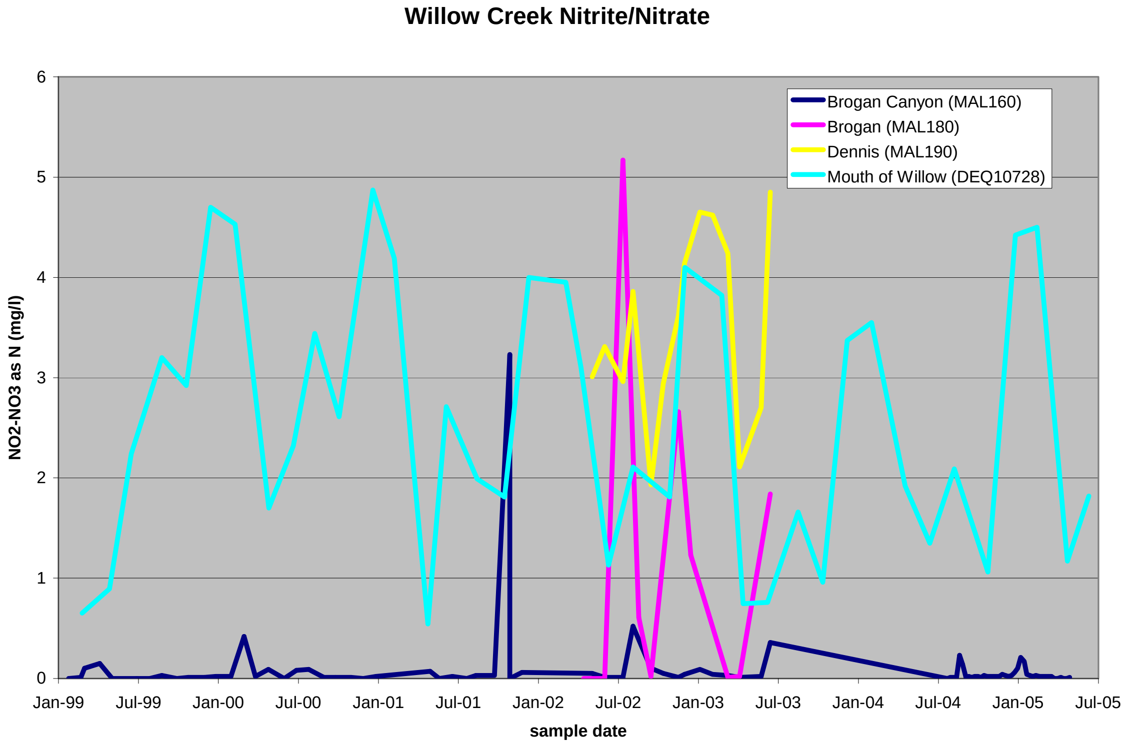
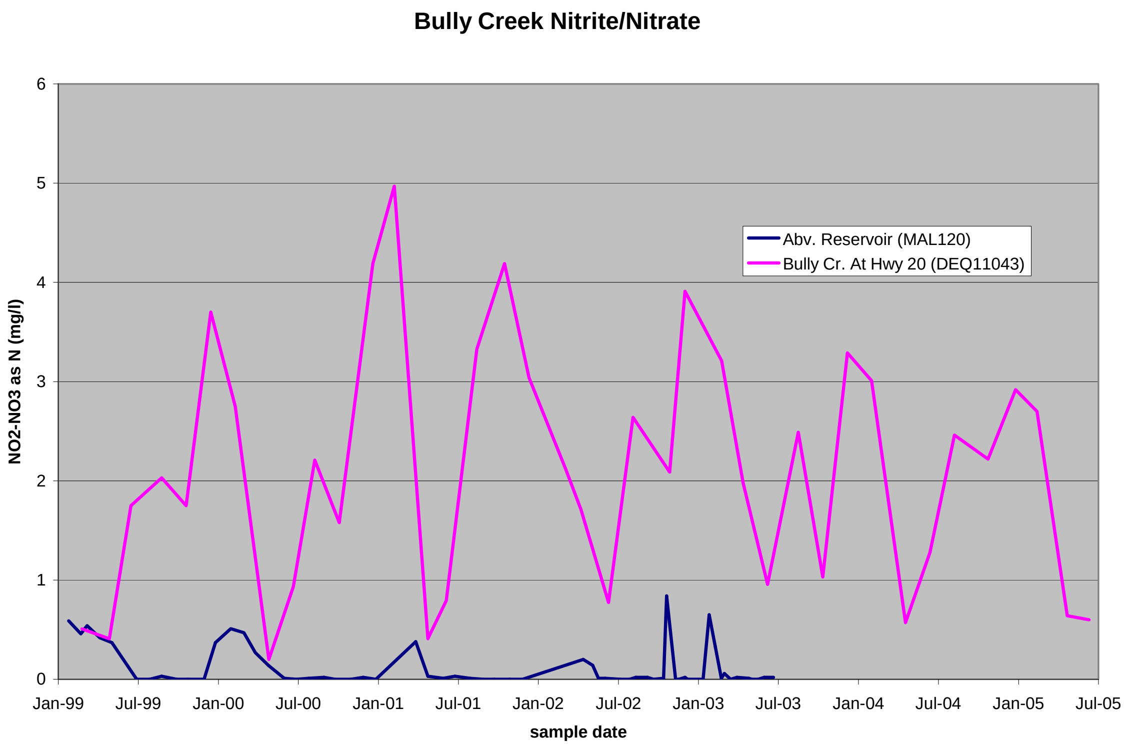


Figure 4-3. Nitrite/Nitrate Concentrations in Bully Creek.



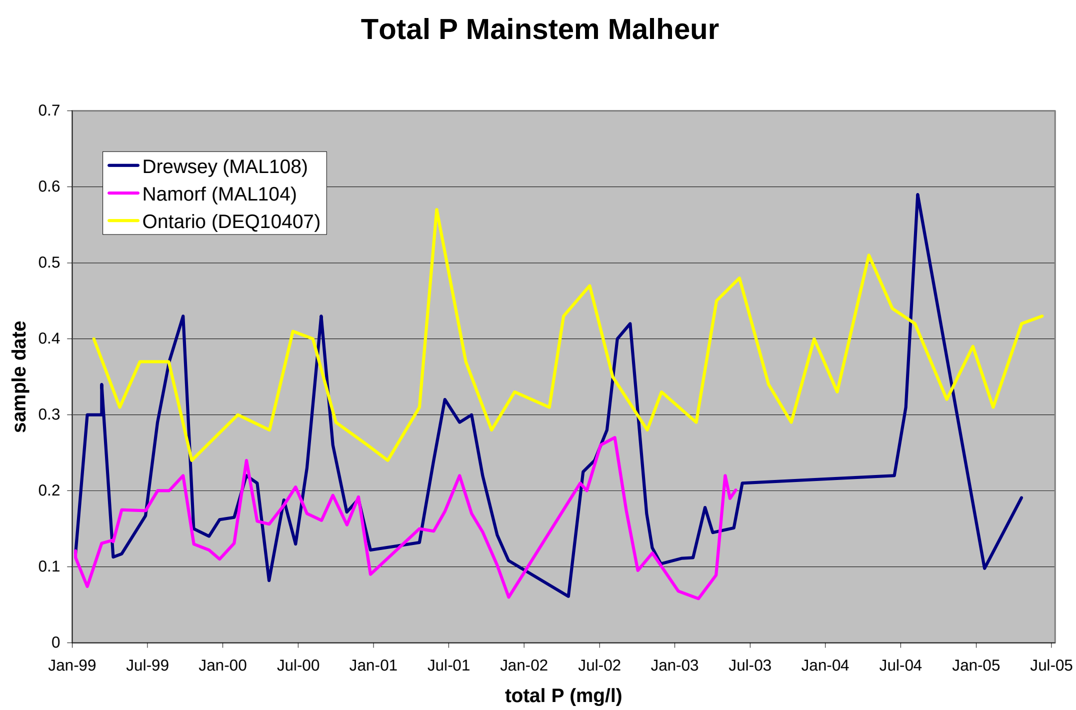
4.1.2 Phosphorus Data

Phosphorus data collected by the Malheur WSC and DEQ between 1999 and 2005 were also reviewed. In a similar pattern to the nitrate data, concentrations generally increase in the downstream direction (**Figure 4-4**). However, the phosphorus data are slightly less variable and include fairly high concentrations higher in the basin (i.e. Drewsey sample location). The data show a strong seasonal variation with the highest concentrations occurring generally during the summer irrigation season, and a steep decline at the end of the irrigation season.

There are also secondary peaks at the downstream locations during the winter months. The upstream sample location near Drewsey (RM 142), has strong phosphorus peaks during the irrigation season and generally low concentrations from late fall through early spring. The most significant phosphorus loading to Warm Springs Reservoir appears to occur during the early part of the irrigation season in May and June when flows to the reservoir are still fairly high and phosphorus concentrations are increasing. Higher total phosphorus concentrations occur in late summer, but flow levels entering the reservoir drop dramatically.

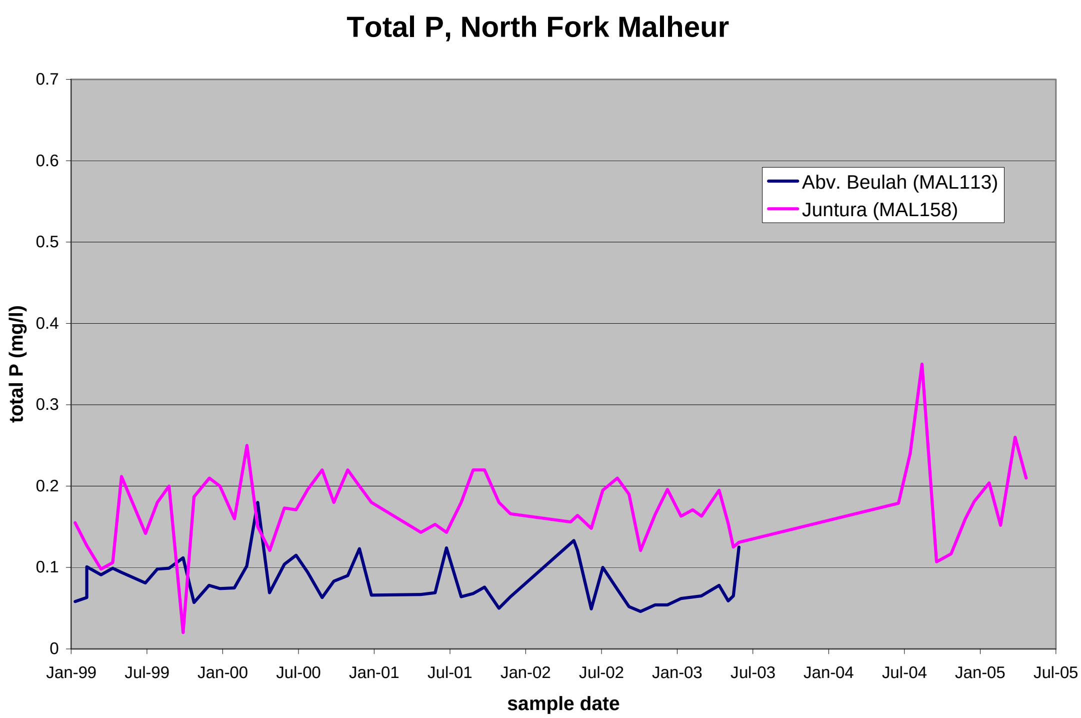
Management of irrigated hay meadows, which are common in the Drewsey area, may be a significant factor in the seasonal spike in phosphorus concentrations in the Upper Malheur River. These meadows are often grazed during the fall, and spring/summer flood irrigation can transport nutrients from livestock waste to the river. Geologic sources, such as phosphate-rich basalt and lakebed deposits have also been proposed (Shock, Nishihara, and Jones, 2001). However, it is likely that geologic sources of phosphorus would cause a higher year-round concentration increase or peaks that would occur during winter/early spring high flow events and their associated increased erosion. Sampling during storm events may aid in the determination of the significance of sources of phosphorus in the Upper Malheur River basin, however it may be difficult to differentiate between animal-related sources of phosphorus accumulated in pastures and along stream channels, and geologic sources of phosphorus. Both sources of phosphorus can be controlled through the application of best management practices (BMPs) which would limit movement of animal wastes and reduce erosion.

Figure 4-4. Total Phosphorus Concentrations in the Malheur River.



Total phosphorus data from the North Fork drainage indicate a significant amount of phosphorus loading below Beulah reservoir (**Figure 4-5**). Peaks in total phosphorus concentration often occur in the Spring and Summer both above and below the reservoir. These peaks may be related to flushing by high flows and irrigation activities. Extensive irrigated pastures are located in the vicinity of the reservoir and along the approximately 18 miles of river downstream to Juntura.

Figure 4-5. Total Phosphorus Concentrations in North Fork Malheur River.



The Bully Creek total phosphorus data also show a significant increase in phosphorus loading in the vicinity of Bully Reservoir (**Figure 4-6**). Phosphorus concentrations increase two to four times from sample location MAL120, located at the upstream limit of the reservoir, to sample location DEQ11043, located approximately three miles downstream of the dam at the Highway 20 bridge. The data do not show a very strong seasonal variation above or below the reservoir. Peaks in phosphorus concentrations at this location may be more strongly linked to total suspended solids levels which are likely linked to flow levels in Bully Creek (**Figure 4-7**). As mentioned in the discussion of nitrite/nitrate data, nutrient loading in the vicinity of Bully Reservoir appears to be significant.

Figure 4-6. Total Phosphorus Concentrations in Bully Creek.

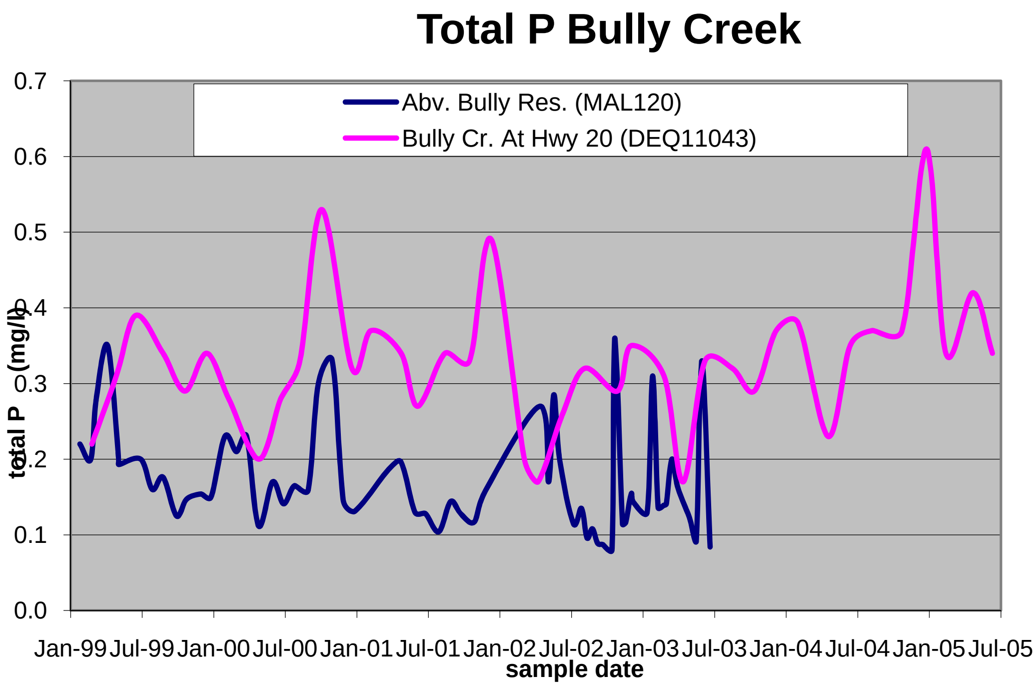
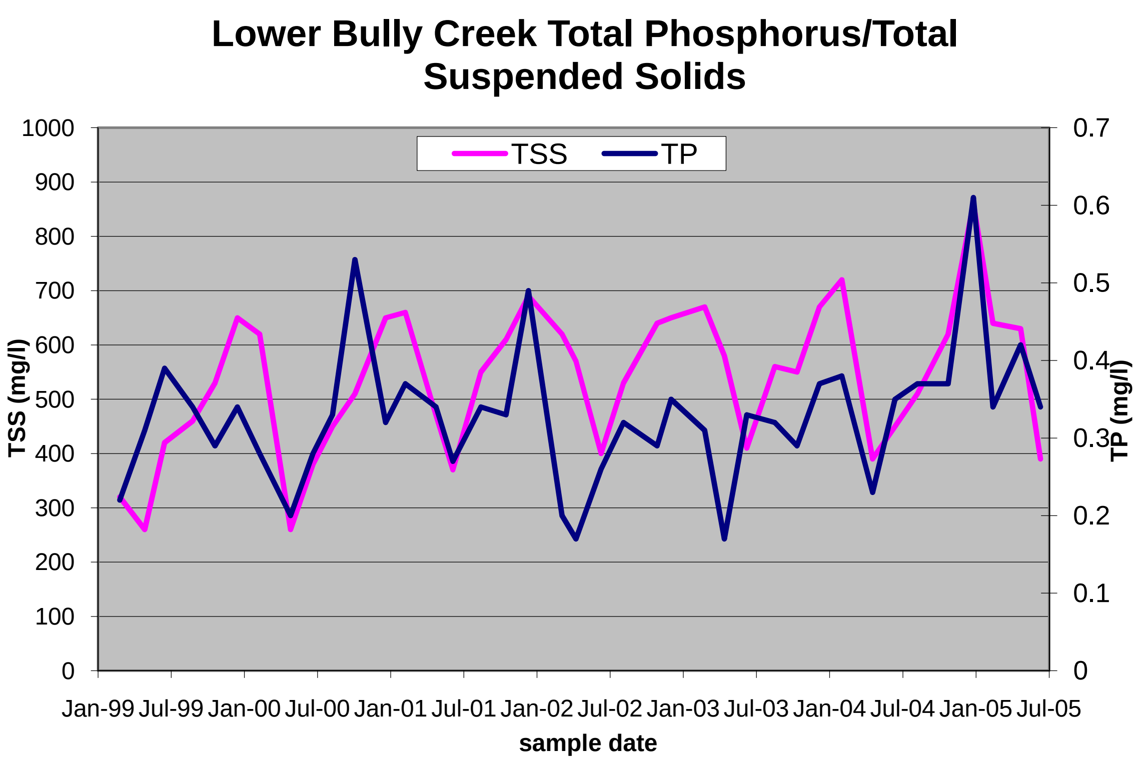


Figure 4-7. Total Phosphorus and Total Suspended Solids in Bully Creek @ Highway 20 (DEQ 11043).



Willow Creek has similar levels of total phosphorus as found in Bully Creek, but lower total suspended solids levels. Significant increases in total phosphorus occur below Brogan Canyon, which is the upper-most limit of a majority of the intensive irrigated agricultural area in the Willow Creek Subbasin (Figure 4-8). Levels of total phosphorus at the Brogan Canyon site indicate peaks during the summer irrigation season and a few more extreme peaks during some late winter/early spring sampling events (**Figure 4-8**). There are no TSS data at this location for comparison. Peaks in total phosphorus in lower Willow Creek tend to coincide with peaks in total suspended solids during the winter period, but secondary peaks in total phosphorus occur during the later portion of the irrigation season when TSS levels are low (**Figure 4-9**).

Figure 4-8. Total Phosphorus Concentrations in Willow Creek.

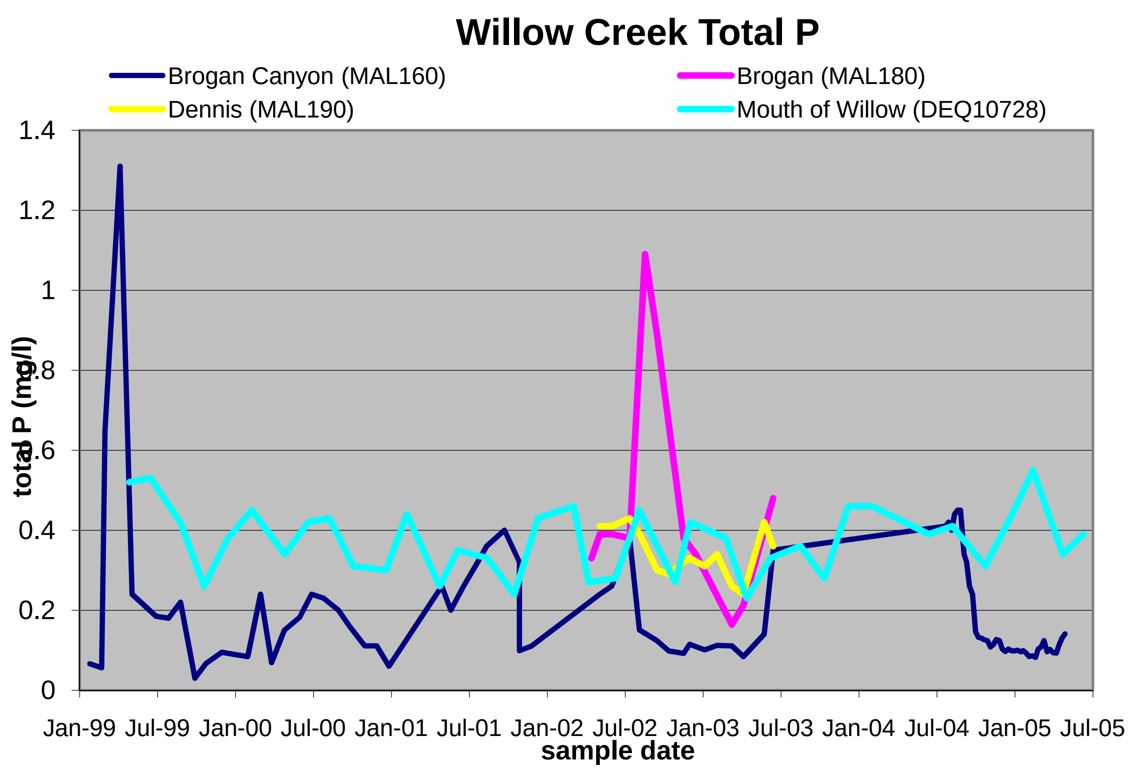
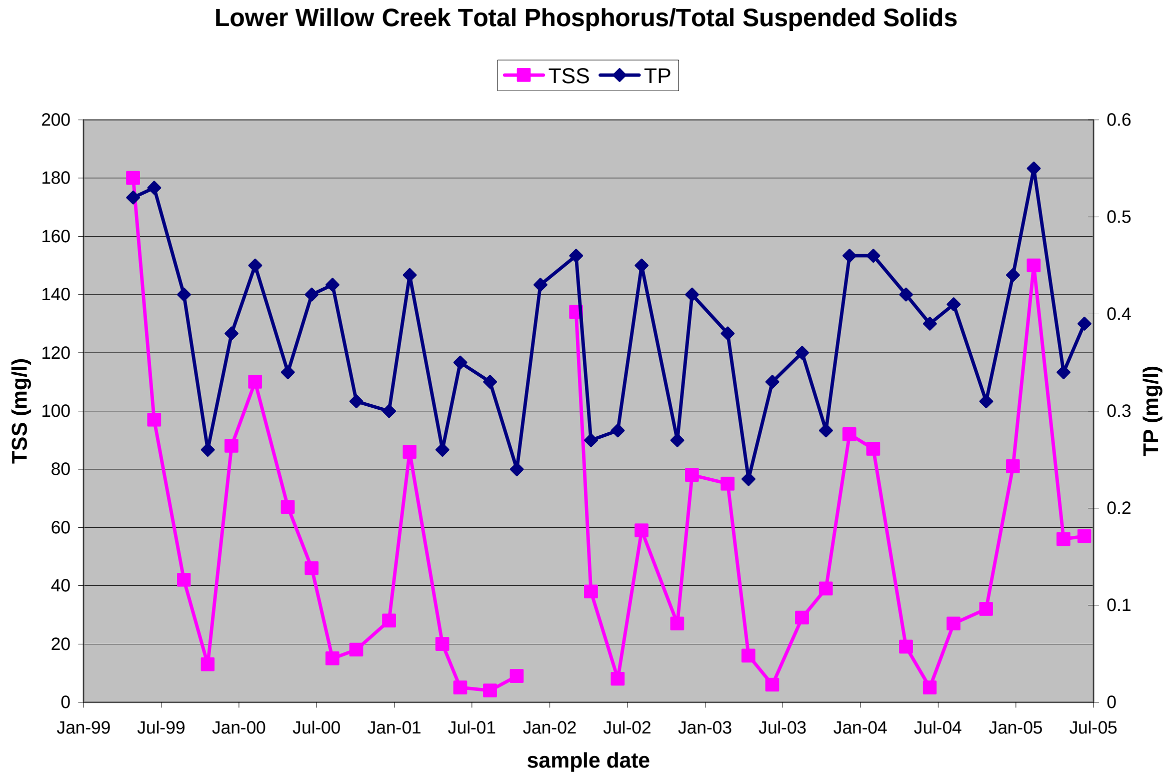


Figure 4-9. Total Phosphorus and Total Suspended Solids (TSS) Concentrations in Willow Creek @ mouth (DEQ 10728).



4.1.3 Sources of Nutrients in Upper Malheur River Basin

Significant grazing activity occurs in riparian areas throughout the Malheur River Basin including areas above the major dams. Livestock grazing on public and private lands in the headwater areas of the Malheur River is commonly practiced, providing critical Summer grazing for ranches located lower in the basin. Extensive irrigated hay meadows are located along the Middle and North Forks of the Malheur River in the vicinity of Juntura, Drewsey, and Beulah Reservoir (**Figure 4-10, Figure 4-11, and Figure 4-12**).

Many public land grazing allotments and private grazing lands are managed using rotational schedules which are adjusted based on forage and pasture availability to avoid over-grazing and preserve riparian areas. Many hay meadows are also managed to preserve resources including riparian vegetation zones. These areas are generally not significant sources of nutrients and bacteria in surface water. However, some grazing areas are characterized by a lack of riparian vegetation, intensive grazing in riparian areas with cattle present in streams, and stream bank erosion (**Figure 4-13**). Fall grazing of hay meadows (**Figure 14**), followed by spring/summer flood irrigation is common, with some areas receiving over 8 feet of irrigation water during the growing season (Oregon Water Resources Department, 1988). Heavy spring application of irrigation water has the potential to move soil and manure into waterways carrying nutrients and bacteria with it. Several local ranchers are pursuing grant funding for extensive riparian restoration projects, which should help to mitigate impacts to water quality. The uniform application of improved rotational grazing practices and the development of Best Management Practices for hay meadows by local agricultural researchers would be a significant step toward improving water quality in the Upper Malheur River Basin.

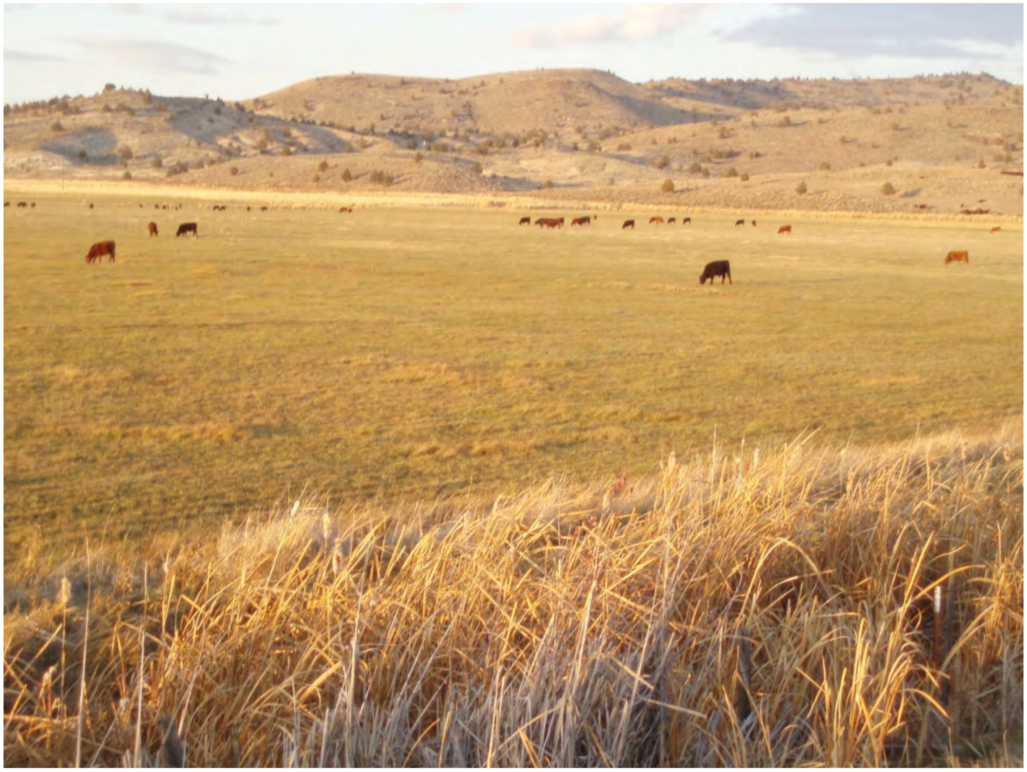
Figure 4-10. Aerial view of Juntura, Oregon located at confluence of Middle Fork and North Fork of the Malheur River.

Figure 4-11. Aerial view of Drewsey, Oregon, located along Middle Fork of Malheur River above Warm Springs Dam.

Figure 4-12. Aerial view of Beulah Reservoir on North Fork of Malheur River.

Figure 4-13. Lower North Fork Malheur River pasture Summer grazing (August 2006).

Figure 4-14. Middle Fork Malheur Irrigated Hay Meadow Fall Grazing.



As discussed previously in Section 4.1, phosphorus loading in the upper Malheur Basin peaks early in the irrigation season, with no significant winter loading, except with the possibility of extreme flood events. Nitrate loading appears to be minimal.

The extent of geologic sources of phosphorus loading in the upper Malheur River Basin remains unknown. However, the lack of observed peaks in phosphorus concentrations outside of the irrigation season in the upper basin suggest that geologic sources may not be very significant or is very episodic in nature. Animal manure is known to be an unbalanced fertilizer, often providing greater phosphorus concentrations than needed by plants which are growing at a rate which will remove the available nitrogen (Lory, 1999). This factor would explain the increase in phosphorus levels in the local streams while inorganic and organic nitrogen levels remain very low.

It is expected that improved riparian and stream channel conditions throughout the Malheur Basin would reduce both geologic and agricultural related phosphorus loading by reducing erosion and sediment transport. Development and application of grazing/fertilization and water management Best Management Practices should also be explored.

4.1.4 Sources of Nutrients in the Lower Malheur River Basin

Nutrient loading in the Lower Malheur Basin appears to be more complex. As discussed previously in Section 4.1, sediment and phosphorus loading often peaks in the lower basin during the Spring/Summer irrigation season and again during winter storm events. Conversely, nitrate concentrations are highest during the winter months when stream flow and agricultural drain flow is dominated by groundwater. In the lower basin cattle commonly have access to irrigation canals during irrigation season and are often turned out in crop residue fields in fall. Winter rains and spring/summer flood irrigation carry nutrients to drains and streams along with chemical fertilizers that have been applied to crops (**Figure 4-15 and Figure 4-16**). The Malheur Watershed Council has stated that the lower Willow Creek Valley may have some of the highest concentrations of cattle in the State of Oregon, including many feedlots.

Phosphorus sources, data, and load allocations are discussed further in **Section 6.0**.

Figure 4-15. Irrigated cropland in Lower Malheur River Basin near Vale.

Figure 4-16. "B" Irrigation Drain discharging to Lower Malheur River (May 2006).

4.2 BACTERIA

Portions of the Middle Fork Malheur River and North Fork Malheur River, along with upper Bully Creek and lower Willow Creek, appear on the 303(d) list due to elevated fecal coliform values (**Figure 3-3**). As shown in **Figure 4-17**, there has been a significant decrease in bacteria levels (fecal coliform) measured between 1970 and 2002 near the mouth of Malheur River., However elevated levels remain. The decrease in fecal bacteria contamination in the lower Malheur River can likely be attributed to the construction of a wastewater treatment plant in Ontario along with improvements in farming practices during the 1980s.

More recent data is a measurement *E. coli* concentrations rather than fecal coliform, and has resulted in an *E. coli* 303(d) listing in the lower 67 miles of the lower Malheur River (**Figure 3-3**). *E. coli* values in the lower Malheur River at Ontario (**Figure 4-18**), although likely lower than historic values, still exceed water quality standards (406 E. coli organisms per 100 ml for a single sample or a 30-day log mean of 126 E. coli organisms per 100 ml based on a minimum of 5 samples).

Bacteria inputs from the upper part of basin, measured at Namorf, appear to peak during the irrigation season between April and October with very low levels during winter. *E.coli* concentrations rarely exceed 100 organisms/100 ml at the Namorf sample location (**Figure 4-19**). Reservoirs on the Middle and North Forks may be functioning essentially as treatment lagoons, influencing the bacteria levels measured at Namorf. Bully and Willow Creeks have *E. coli* concentrations are considerably higher than those measured at Namorf (**Figure 4-19**), suggesting that those watersheds are significant sources of bacteria loading. *E. coli* concentrations in these tributaries often range from 100 to 1,000 organisms/100 ml. Bacteria data and load allocations are discussed in **Section 7.0**.

Figure 4-17. Fecal coliform bacteria levels measured in the Malheur River at the Highway 201 Bridge in Ontario, OR, 1970-2002.

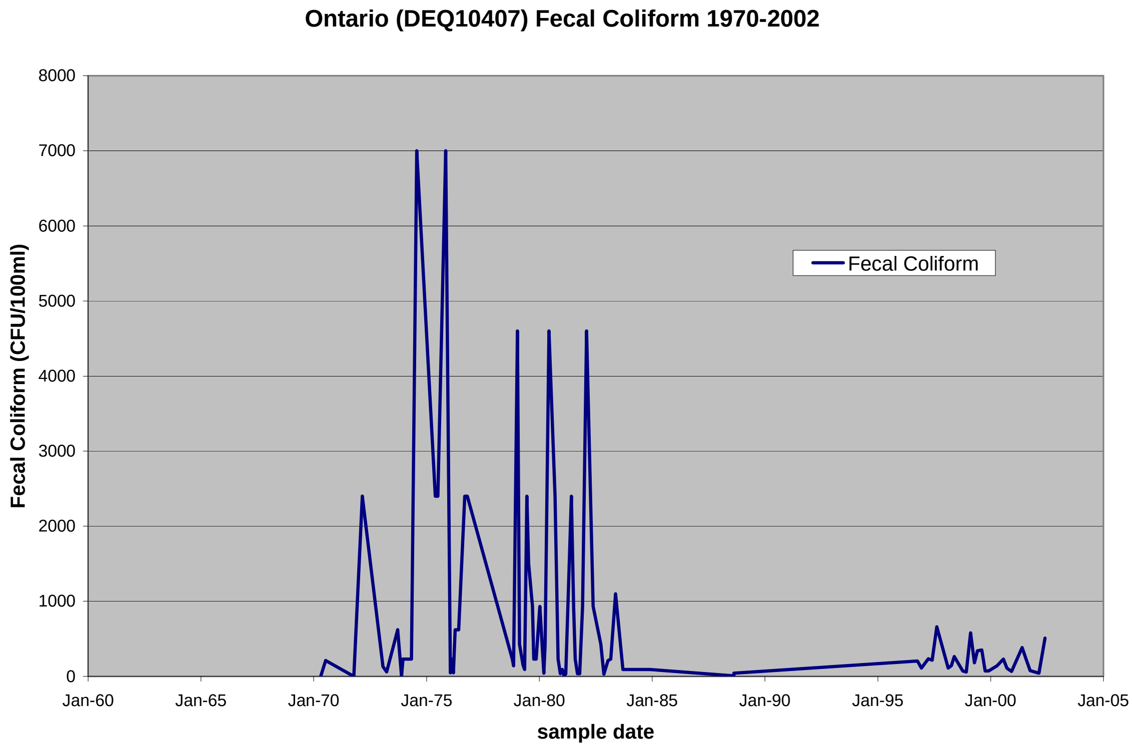


Figure 4-18. E.coli bacteria levels measured in the Malheur River at the Highway 201 Bridge in Ontario, OR, 1997-2005.

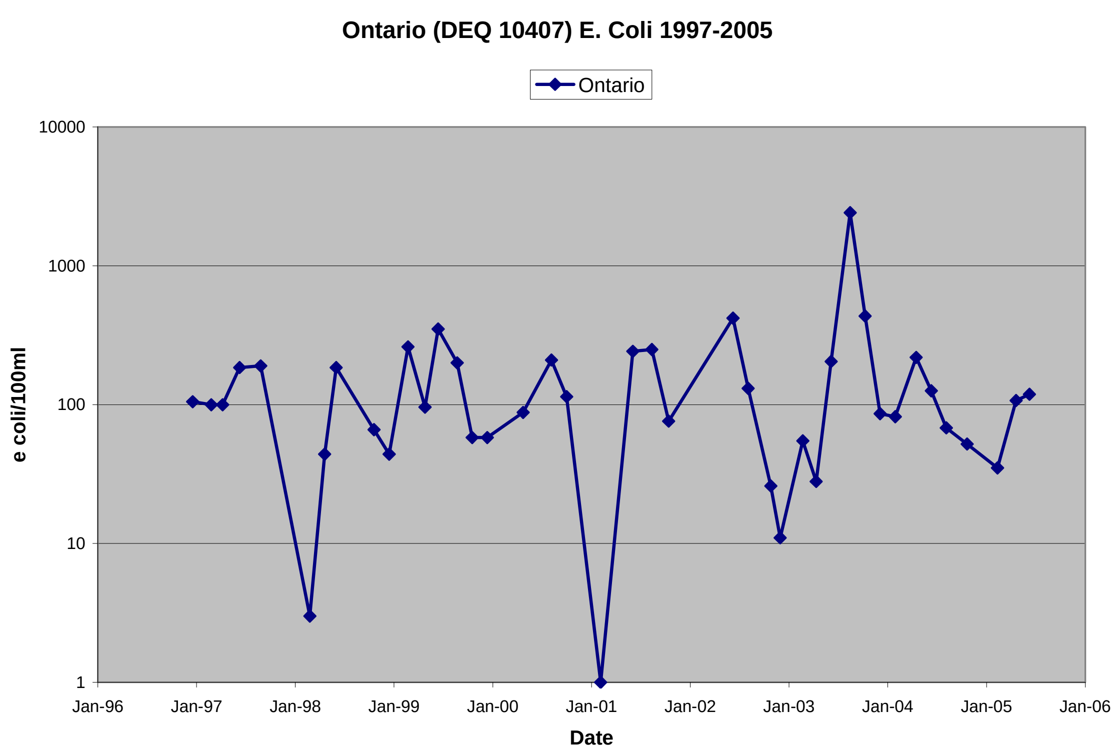
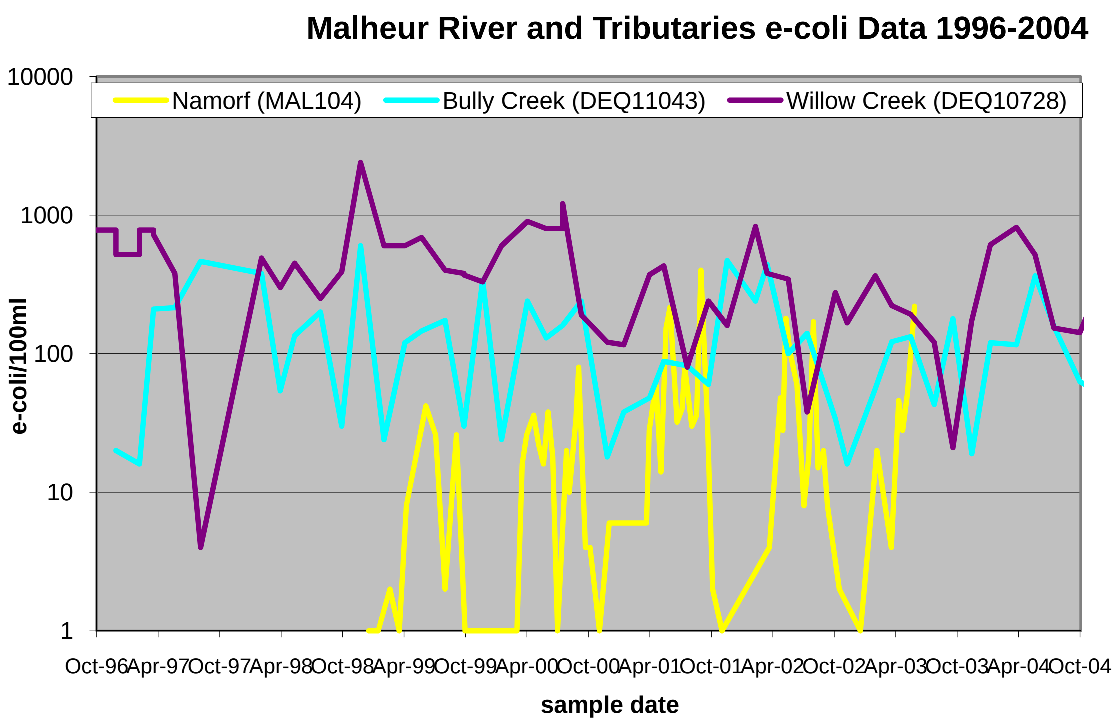


Figure 4-19. E. coli bacteria levels measured in the Malheur River at Namorf, lower Bully Creek and lower Willow Creek, 1997-2004.

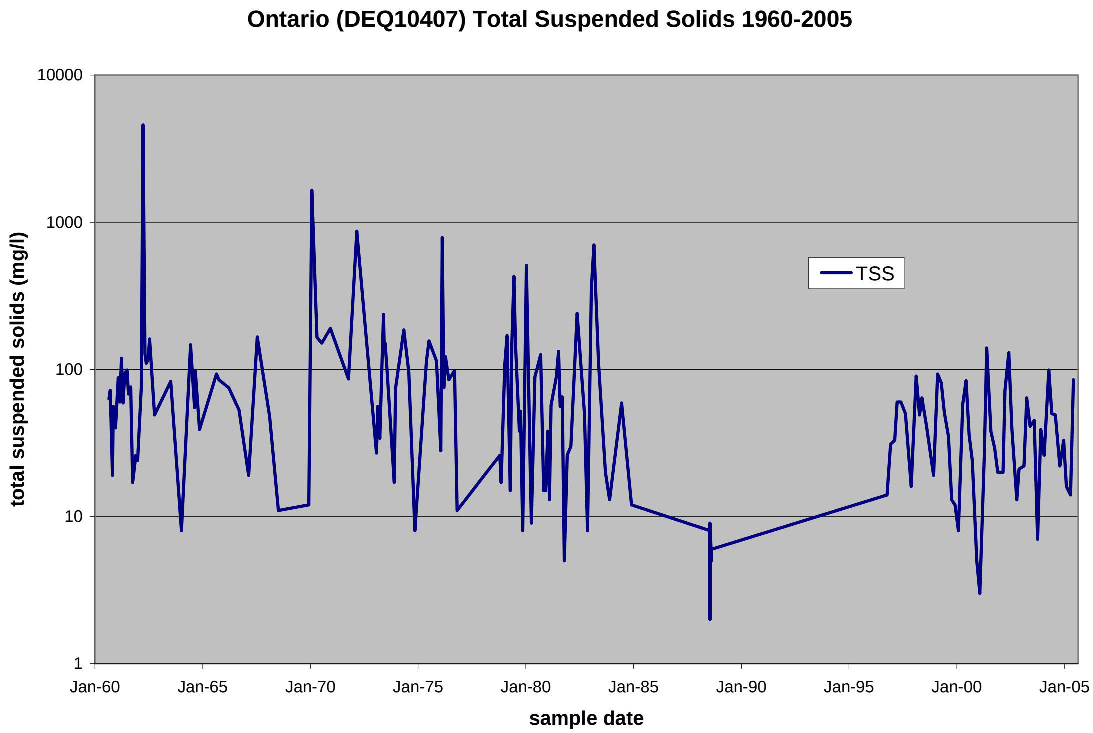


4.3 SEDIMENT

The Malheur River has historically had significant levels of sediment load. The sparse vegetation and sporadic precipitation patterns have contributed to these high levels of erosion. Agricultural practices have also contributed to the sediment load in the river. Furrow irrigation is used on a very widespread basis in the lower Malheur, and is a known source of significant sediment loading. Based on estimates, provided by the Malheur Watershed Council in a 2006 Oregon Watershed Enhancement Board grant proposal, soil loss from furrow irrigation can be as high as 15-20 tons per acre per year. The Malheur Experiment Station has reported soil loss levels as low as 131 pounds per acre in leveled irrigated wheat fields.

Total Suspended Solids (TSS) data from DEQ ambient water quality station 10407 located near the mouth of the Malheur River at the Highway 201 bridge, indicates a significant drop in TSS values since the 1980s (**Figure 4-20**). Improvements in ditch construction and the implementation of agricultural BMPs are likely factors in this improvement in water quality.

Figure 4-20. Total suspended solids concentrations measured in the Malheur River at the Highway 201 bridge in Ontario, OR, 1960-2005.



Sediment loads for the Malheur and other Snake River and other tributaries were estimated based on 1995, 1996 and 2000 data, during the development of the Snake River TMDL. A load allocation corresponding to a monthly average of 50 mg/l Total Suspended Solids (TSS) was assigned to the Malheur River. The Malheur River typically exceeds this value during the summer growing season. The TSS load for this period was estimated at 92,870 kg/day. In order for the Malheur River to meet the Snake River TMDL load allocation of 42,062 kg/day (50 mg/l at average flows for the season) a 55% further reduction in TSS will be required.

Reductions in phosphorus loading required by the Snake River-Hells Canyon TMDL will require the implementation of BMPs which will reduce sediment loading and should result in compliance with both the total phosphorus and TSS criteria. Phosphorus data and load allocations are described in **Section 6.0**.

4.4 PESTICIDES

The lower Malheur River (RM 0-67) was placed on the 303(d) list due to contamination by the pesticides DDT and Dieldrin, based on water samples collected in the Vale and Ontario areas by the U.S. Geological Survey in 1990 (Rinella, et al., 1994). Three water samples with a range of 0.001 – 0.004 µg/l exceeded the DDT fresh water chronic criteria (0.001 µg/l), and the water and fish ingestion criteria (0.024 ng/l). The same three water samples also contained dieldrin at concentrations ranging between 0.003 and 0.010 µg/l, exceeding the Dieldrin fresh water chronic criteria for water and fish ingestion. Significant levels of DDT (1.6 – 15 mg/kg) and Dieldrin (1.7- 43 mg/kg) were also detected in sediment samples collected in the Malheur River, Bully Creek, and Willow Creek near Vale, the Malheur River near Ontario, and the D-drain located between Vale and Ontario. The highest levels of DDT and Dieldrin were detected in the lower Bully Creek sediment sample. These pesticides have been banned by EPA and can no longer be used legally in the United States. It is assumed that they are legacy contaminants which are present in soil and sediment in the Malheur Basin, and are being transferred to the water column.

In 1998 and 1999 researchers at Oregon State University (OSU) conducted water and sediment sampling in the lower Malheur River as well as several upstream locations such as upper Willow Creek, North Fork Malheur, and Cottonwood Reservoir near Drewsey (Johnson and Anderson, 1999). The intent of the OSU study was to follow-up on the pesticide sampling conducted by USGS in 1990 (Rinella, et al. 1994) and expand the sample area to include upstream locations. The upstream locations were added as an attempt to define the potential contribution of persistent pesticides from the upper basin, particularly the Malheur National Forest, which was a known area of historic DDT applications. Sampling of water and sediment was performed at a total of eight locations.

The OSU study concluded that concentrations of DDT and one of its break-down compounds, DDD, along with Dieldrin have decreased 30-70% since the USGS sampling event in 1990. DDE (another break-down product of DDT) concentrations appeared to be relatively stable since 1990. DDT and its break-down products were found in all samples collected in the Malheur River Basin. The highest concentrations were detected in the lower Malheur River in the vicinity of Vale and Ontario. A large increase in pesticide concentrations in the Ontario area was attributed to a possible hotspot or point source. A relatively small, but previously unidentified, source of the DDT loading was attributed to sources in the upper Malheur River Basin.

Pesticide data are discussed further in **Section 8.0**.

4.5 TEMPERATURE

The Malheur River and several of its tributaries above Warm Springs Dam, the North Fork Malheur and several of its tributaries above Beulah Reservoir, Cottonwood Creek, and Pole Creek (tributaries of the Lower Malheur), and Basin Creek (tributary of Willow Creek) are listed as water-quality limited for temperature on the 303(d) list (**Figure 3-4 and Table 3-1**). Most of these streams are classified as Redband Trout habitat with a seven-day-average maximum temperature standard of 20 degrees Celsius (68.0 degrees Fahrenheit). Portions of the upper Middle Fork Malheur are designated as core cold water habitat with a seven-day-average maximum temperature standard of 16 degrees Celsius (60.8 degrees Fahrenheit), and headwater portions of the Middle Fork Malheur, North Fork Malheur, and their tributaries are classified as Bull Trout Spawning and Rearing habitat with a seven-day-average maximum temperature standard of 12 degrees Celsius (53.6 degrees Fahrenheit) (**Figure 3-2**).

Previous studies of the Malheur River Basin such as the Malheur Basin Action Plan (Malheur WSC, 1999), and the Malheur River Subbasin Assessment and Management Plan for Fish and Wildlife Mitigation (Northwest Power and Conservation Council, 2004), have identified loss of riparian vegetation and natural stream channel form as widespread conditions in the basin (**Figure 4-21, Figure 4-22, Figure 4-23, and Figure 4-24**). These conditions are well known causes of increased water temperature, are likely having that effect in the upper Malheur River Basin. Local landowners along with State and Federal agencies have begun to address the issue through stream restoration projects and changes in livestock grazing management.

Temperature data and load allocations are discussed in **Section 9.0**.

Figure 4-21. Location of proposed riparian vegetation restoration project on Lower Pine Creek, August 2006.

Figure 4-22. BLM grazing allotment on Black Canyon Creek near Jonesboro, Oregon prior to implementation of changes in grazing management, 2001.

Figure 4-23. BLM grazing allotment on Black Canyon Creek near Jonesboro, Oregon four years after changes in grazing management, 2005.

Figure 4-24. BLM grazing allotment on Lower Pole Creek after implementation of changes in grazing management, 2005.

The Warm Springs Dam on the Middle Fork Malheur River and Agency Valley Dam (Beulah Reservoir) on the North Fork Malheur River release water from the bottom of their respective reservoirs, and based on 2005 data, generally provide a cooling effect to downstream waters (**Figure 4-25 and Figure 4-26**). However, during the early fall both reservoirs may periodically release water which is warmer than the water entering from upstream as shown in the plots of the 2005 temperature data **Figure 4-25 and Figure 4-26**.

Figure 4-26 also includes a temperature plot of data collected at the USBR flow gauge station located at 36th Street in Ontario, approximately one mile from the mouth of the Malheur River. Based on the 2005 data, the water temperature at this site rarely exceeds 70 degrees F, and during late summer and early fall it is generally cooler than water released from the Warm Springs Dam. It is likely that these late season flows in the lower Malheur River are dominated by cooler groundwater flow, which is increased by extensive flood irrigation and leaky irrigation canals.

Figure 4-25. Water Temperature measurements made at U.S. Bureau of Reclamation flow gauges MABO located above Agency Valley Dam, and Station BEUO at Agency Valley Dam spillway.

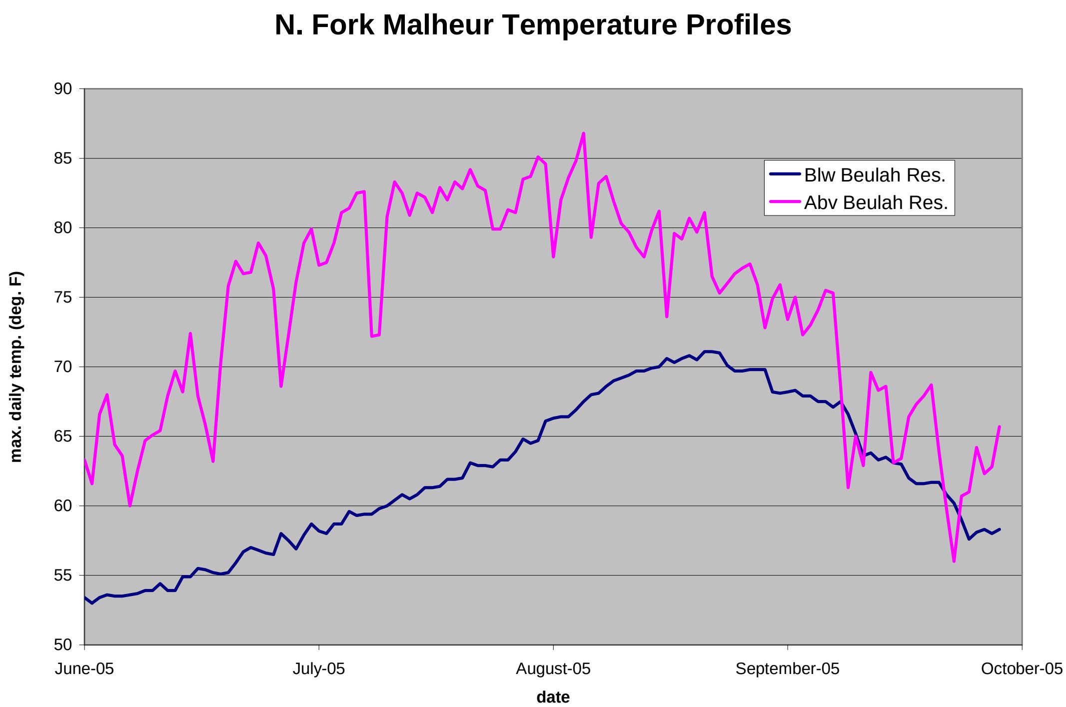
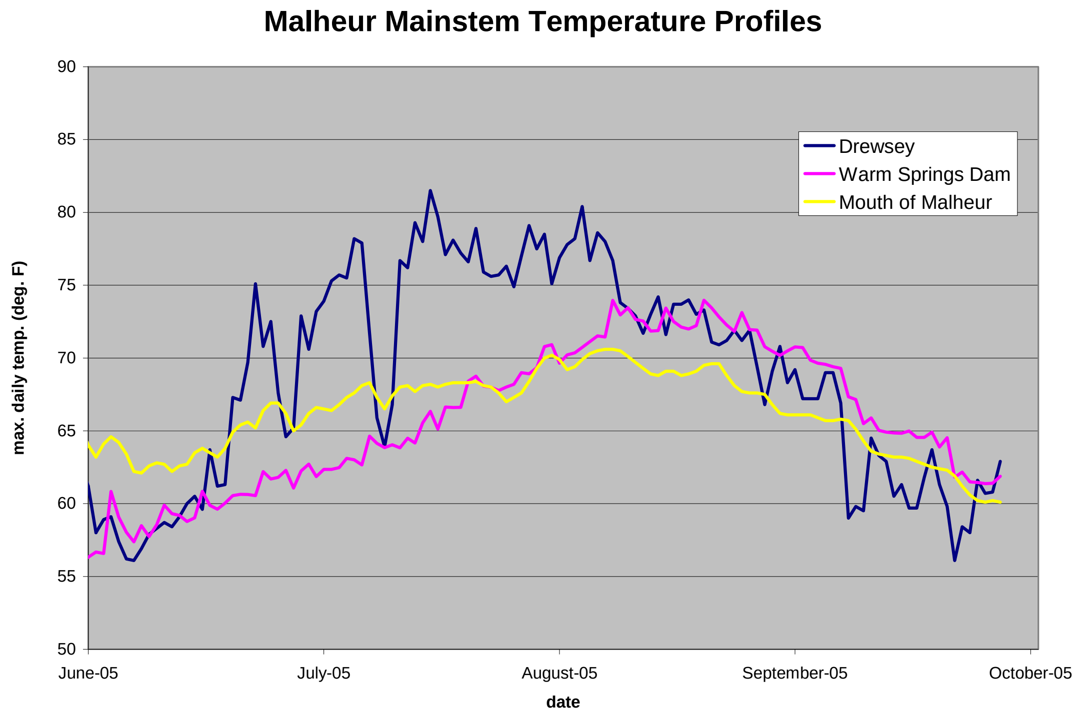


Figure 4-26. Water Temperature measurements made at U.S. Bureau of Reclamation flow gauges MADO located above Warm Springs Dam near Drewsey, Station WARO located below Warm Springs Dam, and MALO located at the 36th Street bridge in Ontario.



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MALHEUR RIVER BASIN TMDL

CHAPTER 5: SUMMARY OF CURRENT AND PAST POLLUTION CONTROL EFFORTS

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Various organizations and stakeholders in the Malheur River Basin have been working to address water quality issues related to excess nutrients, sediment, and bacteria for several decades. Best Management Practices for irrigated agriculture have been developed and implemented on a wide scale. In addition, irrigation systems have been improved by installing concrete-lined irrigation ditches, and piped water delivery systems. Wetlands and sediment ponds have been constructed to trap sediment and reduce nutrient and bacteria concentrations. As described in Section 4.0 of the TMDL document, these actions have resulted measurable reductions in sediment and bacteria concentrations. Reductions in nutrient concentrations have been difficult to document, but the work continues.

Examples Best Management Practices for Flood Irrigated Lands are listed below, further information can be found at the OSU Malheur Experiment Station website:
http://www.cropinfo.net/bestpractices/mainpagebmp.html

Irrigation Schedule Optimization
Sediment Basin and Tail Water Recovery (Pump-Back Systems)
Polyacrylamide (PAM)
Mechanical Straw Mulching
Water Conservation Methods
Filter Strips
Gated Pipe
Surge Irrigation
Laser Leveling
Turbulent Fountain Weed Screens
Underground Outlets for Field Tail Water
Nutrient Management
Improved Confined Animal Feeding Operation (CAFO) Practices

Information regarding constructed wetlands in the Malheur River Basin can be found at the Oregon Department of Agriculture website: http://www.oregon.gov/oda/swcd/malheur_wetlands.shtml

The following sections summarize some of the major efforts and milestones to identify pollution sources and plan for their mitigation. Additional project information is included in Section 5.0 of the Water Quality Management Plan.

5.1 IRRIGATION RUNOFF WATER QUALITY STUDY, VOLK ET AL. 1972

Water quality studies conducted by Volk, Rath, Henninger, Hoffman and Bailey, 1972, documented the extent of surface water pollution in the Malheur and lower Owyhee Rivers providing evidence of the need for water quality improvements. The major conclusions of this work were as follows:

1. Nitrate nitrogen levels in surface drains were relatively low, less than 3 ppm, during the irrigation season, however, nitrate nitrogen levels in surface drains during the Winter did reflect higher nitrate levels. These higher Winter levels of nitrate nitrogen were attributed to higher proportions of groundwater being present in the ditches when the irrigation water is shut off for the Winter.
2. Orthophosphate, nitrate, calcium, magnesium, sodium levels do increase in waters as a result of furrow irrigation.
3. In comparison to nutrients – nitrogen, phosphorus, calcium, magnesium, sodium, sediments represent a larger problem in surface runoff waters, especially early in the irrigation season.
4. Non-irrigated land contributes a large portion of the salt content observed in stream flow waters.
5. Sufficient nitrogen and phosphorus does occur in the irrigation return flows to cause lake eutrophication under the right conditions.

Volk et al. also suggested that sediment transport is higher during the irrigation season than in winter, when flows in the Malheur River are generally low. Obvious exceptions to this observation would occur during storm events. Based on the review of historic sediment load data in **Section 4.4**, significant reductions in sediment loading have occurred in the last 20-30 years.

5.2 MALHEUR COUNTY WATER QUALITY MANAGEMENT PLAN, MALHEUR COUNTY COURT, 1981

Growing nation-wide water quality concerns in the 1960s and early 1970s lead to the passage of the federal Clean Water Act (CWA) in 1972. Oregon DEQ was designated as the agency responsible for implementing the CWA in Oregon. DEQ began by identifying water quality problems and developing water quality management plans for each river basin in Oregon.

In 1976, DEQ proposed a water quality management plan for the Malheur Basin. In response to this plan, the Malheur County Court applied for a grant from DEQ to perform further investigation of the water quality in Malheur County, with considerable emphasis on the Malheur Basin. The Malheur County Court was awarded a grant to study non-point source water quality issues. The objectives of the program were as follows:

1. gather information on present surface water quality
2. identify water quality problems
3. develop Best Management Practices
4. develop an implementation program
5. provide sufficient information to reevaluate the established beneficial uses and water quality standards
6. involve the public in all phases of the program

In order to accomplish the objectives listed above, the Malheur County Court organized a Water Resources Committee, along with regional subcommittees which assisted with the evaluation of sampling data and identifying water quality problems. The newly formed Malheur County Non-point source Water Quality Management Planning Program started water quality monitoring in the basin in 1978. After two years of monitoring, the Malheur County Water Quality Management Plan was completed (Malheur County, 1981). The management plan includes a description of the sampling program including pollutant concentrations, loading rates, loads per acre drained, beneficial uses, and identification of problem areas. The plan also describes best management practices, implementation, and environment assessment of the impacts of adopting the water quality management plan. Responsibility for BMP development, technical assistance, and funding were tasked to the Malheur SWCD, Malheur Experiment Station, OSU Extension Service, and other state and local agencies.

A review of water quality data from the DEQ ambient water quality station (DEQ 10407) located near the mouth of the Malheur River in Ontario, indicates significant reductions in bacteria, phosphorus and total suspended solids during the early to mid 1980s. It appears likely that implementation of best management practices after the preparation of the Malheur County Water Quality Management Plan have had a role in the reduction of these pollutants. Development and implementation of BMPs is an on-going process conducted by the Oregon State University Malheur Experiment Station. Additional information is available at: http://www.cropinfo.net/

5.3 MALHEUR BASIN ACTION PLAN, MALHEUR-OWYHEE WSC, 1999

The Malheur-Owyhee Watershed Council (MOWC) formed in 1995 in order to address soil and water issues in Malheur County on a watershed/ecosystem basis. The watershed council originally represented agricultural producers, industries and organizations, urban residents and small business owners, environmental groups, irrigation districts, the cities of Vale and Ontario, Malheur County, Bureau of Reclamation, Idaho Power, Treasure Valley Community College, and the Burns-Paiute Tribe. Over the years the membership has changed somewhat and the council has evolved into the Malheur Watershed Council and the Owyhee Watershed Council.

In 1999, the MOWC developed the Malheur Watershed Action Plan in response to multiple 303(d) listings in the Malheur River Basin. The watershed plan is intended to provide guidance for attaining desired ecological goals and highlights the council's struggle with the regulatory framework surrounding water quality issues. Seven watershed goals and strategies for improving water quality are presented along with a monitoring strategy and preliminary monitoring data.

The Malheur-Owyhee Watershed Council proposed the following goals in its action plan:

1. Achieve Proper Functioning Condition (PFC) in streams and waterways in the Malheur basin
2. Reduce soil loss from croplands
3. Remove streams/waterways from the 303(d) list
4. Improve or maintain rangeland condition
5. Reduce the proliferation of noxious weeds in the Malheur River watershed
6. Encourage upstream non-structural water storage
7. Meet standards for urban (Ontario Storm Water Master Plan) runoff

Strategies for meeting each of the proposed goals were described in detail. Appendices included sections describing Proper Functioning Condition (PFC) of streams, soil conditions, vegetation, fish and wildlife, cultural resources, federal land management, resource condition assessments, Oregon water quality parameters, and water quality data collected by the MOWC in 1998 and 1999.

5.4 MALHEUR RIVER BASIN AGRICULTURAL WATER QUALITY MANAGEMENT AREA PLAN, ODA, 2001

In February 2001, the Oregon Department of Agriculture ODA completed the Malheur River Basin Agricultural Water Quality Management (AgWQM) Area Plan with the assistance of the Malheur River Basin Agricultural Water Quality Local Advisory Committee, and the Malheur County Soil and Water Conservation District. This Agricultural Water Quality Management Area Plan is intended to identify strategies that will reduce water pollution from agricultural lands. Methods include educational programs, suggested land treatments, management activities, and monitoring.

The AgWQM Area Plan includes five water quality objectives:

1. Pollution Control and Waste Management Objective – Reduce waste discharge to the maximum extent that is practical.
2. Irrigation Return Flow Objective – Control irrigation surface water return flows so they minimize adverse water quality impact on the stream into which they flow.
3. Riparian area Management Objective – Encourage riparian vegetation to provide sufficient root mass for stream bank stability and shading to reduce the solar heating rate of surface water.
4. Streambank Stability Objective – Develop riparian systems in healthy condition to withstand a 25-year event with minimal damage.
5. Rangeland and Pasture Management Objective – Protect and improve range conditions.

5.5 MALHEUR RIVER SUBBASIN ASSESSMENT AND MANAGEMENT PLAN FOR FISH AND WILDLIFE MITIGATION, NORTHWEST POWER AND CONSERVATION COUNCIL, MALHEUR WATERSHED COUNCIL, BURNS PAIUTE TRIBE, 2004

In 1980, the Pacific Northwest Power Act directed the Northwest Power Planning Council (NWPPC) to prepare a program to protect, mitigate and enhance fish and wildlife of the Columbia River Basin that have been affected by the construction and operation of hydroelectric dams. In 2000, the NWPPC revised the Fish and Wildlife Program around a comprehensive framework of scientific and policy principals. The Malheur River Subbasin Assessment was submitted to the NWPPC to provide specific objectives and measures for the Malheur River Subbasin which are consistent with the Council's Year 2000 comprehensive framework. The plan is intended to provide a foundation for specific projects recommended by the Council to Bonneville Power Administration for funding and implementation.

The Malheur River Subbasin Assessment includes sections which provide purpose and scope, vision for the subbasin, physical setting, aquatic assessment, terrestrial assessment and strategies for achieving goals. Supporting appendices provide a subbasin overview, aquatic assessment, terrestrial assessment, and program inventory. The aquatic assessment appendix includes a detailed discussion of aquatic habitat limiting factors. The primary limiting factors identified and the actions/conditions affecting each are described below:

1. Riparian condition
    - Roads (forest and highway) and railroads have eliminated riparian vegetation along some sections of stream. Of particular concern is the probable loss of cottonwood along the larger mainstem rivers.
    - Farming practices have limited the functional riparian zone to a narrow band along many streams, and changed the composition and density of riparian species.

- Grazing by livestock and wildlife has changed riparian species composition and density, resulting in fewer large wood recruitment opportunities, and reduced riparian shade. It should be noted that changes in grazing management along some streams has resulted in re-establishment of sedge meadows and woody vegetation.
- Exotic vegetation has replaced or reduced native plant communities in some locations.
- Loss of beaver and beaver dam complexes from most streams and meadows has eliminated productive riparian and floodplain habitat important to salmonids. In some cases, push-up dams and flood irrigation may mimic beaver dams with respect to locally raising water tables, thereby encouraging development of riparian and wetland vegetation.
- Recent large flood events (e.g., in the lower Cottonwood Creek in the Main Malheur watershed) has eliminated woody riparian vegetation in areas.
- Past timber harvest operations have removed riparian vegetation or limited it to a narrow band along some streams, and changed composition and density of riparian species. It is expected that current forest practices rules and agency policies will prevent this impact from occurring in the future.
- Channelization and straightening of streams has lowered water tables and eliminated wet meadow systems.
- Wildfire, particularly in the headwaters of the North Fork Malheur, has set riparian vegetation back to an earlier successional phase.

2. Loss of Channel stability (or form)
   - Roads (highways and forest roads) and railroads are encroaching on floodplains and stream channels and limiting lateral channel migration and the development of natural channel habitat sequences.
   - Streams have been relocated and channelized for the purpose of maximizing pasture and tillable lands
   - Loss of beaver and beaver dam complexes from most streams and meadows.
   - Mechanical damage to streambeds and banks from livestock and wildlife grazing.
   - Construction of dikes and flood control structures.
   - Incision due to upland practices that have changed flow regime and sediment dynamics.
   - Legacy impacts from hydraulic and placer mining (Willow Creek watershed).
   - Utilization of stream channels as irrigation conveyance (lower Malheur River, Bully Creek and Willow Creek).

3. Low Flows
   - Irrigation withdrawals directly reduce in stream flows.
   - Channels that have been negatively impacted (as described above) often have lower effective summertime flows due to sub-surface flow.
   - Dam operations have changed in stream low flows. In many cases the utilization of channels as irrigation conveyance downstream of dams has resulted in higher low flows than optimum (e.g. North Fork below Beulah). Conversely, in some areas (e.g. lower Willow creek) reservoir releases travel through off-channel canals, with little water released directly to the stream channel, and return flow reenters the channel far downstream.
   - Loss of beaver and beaver dam complexes from most streams and meadows has eliminated water storage, resulting in lower summertime base flows. In some cases, push-up dams and flood irrigation may mimic this effect.
   - Channelization and straightening of streams has lowered water tables and eliminated wet meadow systems, resulting in decreased water storage and lower summertime base flows.
   - Inter-basin or inter-watershed transfers have reduced low-flows in some portions of the subbasin (e.g. Malheur River below Namorf).

4. Obstructions
   - Dams directly blocking fish passage.
   - Direct passage blockage from irrigation infrastructure associated with irrigation withdrawals.

- Channels that have been negatively impacted, having subsurface of extremely low flows that prevent fish passage.
- Road and railroad culverts that directly block upstream passage.
- Low water levels associated with dam operations.
- Extremely low flows that result from irrigation diversions.

The Malheur River Subbasin Report closes with a discussion of strategies and actions needed to address the limiting factors and achieve biological objectives. Guidance documents are discussed and strategies are presented in a table form.

5.6 SNAKE RIVER TMDL REQUIREMENTS FOR MALHEUR RIVER AND MIDDLE SNAKE-PAYETTE BASINS, OREGON DEQ/IDAHO DEQ, 2004

The TMDL for the Snake River-Hells Canyon reach was completed in July 2003, and amended in May 2004. It includes load allocations for phosphorus, sediment, and temperature for the Malheur River and point sources within the Middle Snake-Payette watershed. These allocations will be addressed the Malheur TMDL.

Nutrients
The Snake River-Hells Canyon Reach TMDL assigned a total phosphorus load of 61 kg/day for the Malheur River (87% reduction from 461 kg/day). The allocation was based on calculated average flow levels and a **total phosphorus concentration of 0.07 mg/l at the mouth of the Malheur River.** The goal of this reduction is to reduce algae growth and improve dissolved oxygen conditions in the Snake River.

Waste load allocations were also assigned for phosphorus point sources located in the Middle Snake-Payette Basin. These sources discharge directly to the Snake River. Point sources in Oregon include: City of Nyssa, Amalgamated Sugar, Heinz Frozen Foods, and City of Ontario (does not discharge during critical Summer period). No significant point sources of phosphorus or other nutrients which discharge directly to the Malheur River have been identified.

Sediment
Tributaries of the Snake River were assigned a TSS concentration of **no more than 50 mg/l as a monthly average.** This equates to a sediment load for Malheur River of 46,735 kg/day (current load estimated at 92,870 kg/day). It is assumed that measures taken to limit the loading of nutrients such as phosphorus will also help to reduce overall sediment loading.

Temperature
The Malheur River and other tributaries of the Snake River in the Snake River-Hells Canyon (SR-HC) TMDL reach were **each assigned a total anthropogenic temperature load allocation of less than 0.14 degrees C.** This load applies at the inflow to the SR-HC reach during periods when the site potential temperature in the Snake River is greater than 17.8 degrees C.

5.7 REFERENCES

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MALHEUR RIVER BASIN TMDL

CHAPTER 6: DISSOLVED OXYGEN, CHLOROPHYLL A, pH, AND PHOSPHORUS

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Tables

6.1 INTRODUCTION

Waterbodies in the Malheur River Basin were listed as water quality limited due to failure to meet applicable dissolved oxygen, and chlorophyll a water quality criteria. These factors indicate high levels algae growth. The dissolved oxygen 303(d) listing includes the mainstem Malheur River from its mouth to its headwaters in Logan Valley (RM 0-186.1). The chlorophyll a listings include the lower Malheur River (RM 0-67), lower Willow Creek (RM 0-27.4), and lower Bully Creek (RM 0-12.8) (**Figure 6-1**). The dissolved oxygen listing occurs all year, while the chlorophyll a listings are for the Summer season only. Water Quality 303(d) listings are discussed in Section 6.2, and applicable water quality standards and criteria are discussed in Section 6.5. TMDL components are listed in **Table 6-1.**

Detailed review of monitoring data and applicable water quality criteria performed during TMDL development indicate that despite high nutrient concentrations and eutrophic conditions, applicable dissolved oxygen criteria are actually being met throughout the year. Past data analysis did not account for the use of Warm-Water dissolved oxygen criteria in the lower Malheur River Basin. This standard allows for the lower dissolved oxygen concentrations found in warmer water. Dissolved oxygen data are discussed in Section 6.6, and sample locations are shown on **Figure 6-2**. **Based on the analysis of available dissolved oxygen data, it is recommended that the entire Malheur River from RM 0 to RM 186.1 be removed from the DEQ dissolved oxygen 303(d) list.**

Review of chlorophyll a data performed during TMDL development also indicate that chlorophyll a criteria are being met the vast majority of the time during the critical Summer period in the Malheur River and tributaries. The historic data used for the chlorophyll a 303(d) listings were not corrected for the presence of dead algal matter and led to the conclusion that chlorophyll a criteria were being exceeded. Chlorophyll a data is discussed in Section 6.7.

There are currently no pH 303(d) listings in the basin, and continuous monitoring data from 2006 indicate that the pH standard of 9.0 pH units is being met with a few minor exceptions. Observed pH values increase after the irrigation season ends in the Fall. The pH increases appear to be tied to the level of water clarity and nutrients which foster algae growth and increase pH through the consumption of carbon dioxide in the water column. Similar results were found in Willow and Bully Creeks with higher pH levels found downstream of reservoirs. Most of the pH data is characterized by prominent diurnal variation which strengthens the argument for the control of pH by the level of algae growth. The diurnal variation is dampened in the Fall, presumably by cooler water temperatures and shorter periods of daylight. These data are discussed in Section 6.8.

Significant Summer diurnal dissolved oxygen and pH concentration swings indicate that eutrophic conditions occur in the Lower Malheur River and tributaries. These conditions are likely caused by high phosphorus concentrations which encourage algae growth. The algae growth appears to be moderated during the Summer irrigation season when water clarity is reduced due to sediment loading. This factor appears to allow dissolved oxygen and chlorophyll a standards to be met during most of the Summer. However, the high phosphorus loads in the Lower Malheur River Basin are contributing to algae blooms when water clarity improves at the end of each irrigation season. This late season algae bloom is evident in the chlorophyll data collected during the Fall, Winter, and early Spring by the Malheur Watershed Council (Section 6.7). It was determined that phosphorus is a good surrogate parameter for chlorophyll and that efforts to reduce phosphorus will reduce chlorophyll a concentrations further and address the few instances where chlorophyll a concentrations exceed the seasonal water quality standard. Controlling phosphorus loading is also strongly related to control of sediment loading due to its affinity to bind to fine soil particles.

Phosphorus is also a factor in algae growth downstream in the Snake River. The Malheur River was allocated a phosphorus load to the Snake River based on a total phosphorus concentration of 0.07 mg/l in the 2004 Snake River-Hells Canyon TMDL. Allocations within the Malheur River basin are based on this concentration limit. Background conditions and potential sources of phosphorus in the Malheur River basin are discussed in **Section 6.9**. Flow duration curves and phosphorus load allocations are discussed in **Section 6.10**. Efforts to reduce non-point sources of phosphorus are discussed in **Section 5.0** of the Water Quality Management Plan attached to this document.

Figure 6-1. Chlorophyll, Dissolved Oxygen and Temperature 303(d) Listings.

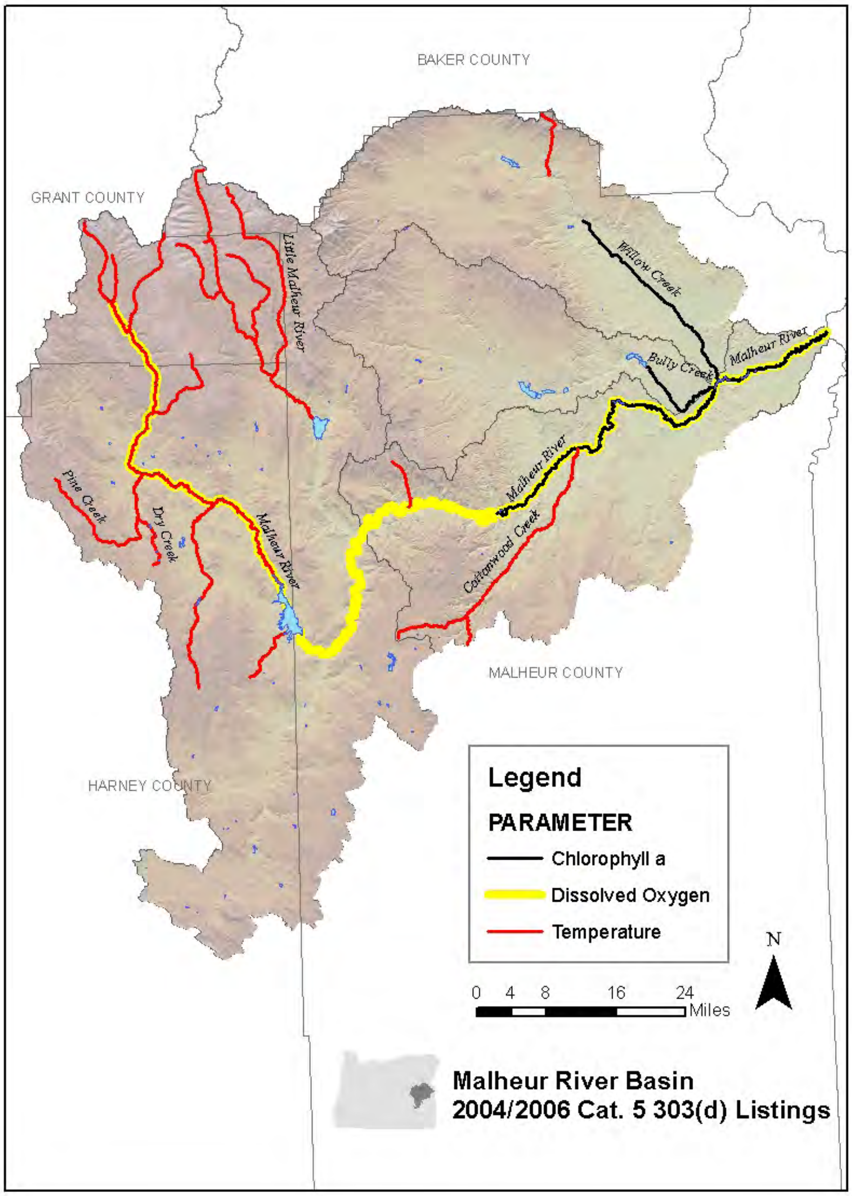


Table 6-1. TMDL Components.

Water Bodies	Malheur River Basin, Hydrologic Unit Code 17050116, Middle Snake-Payette Subbasin Hydrologic Unit 17050115
Pollutant Identification **OAR 340-042-0042(4)(b)**	Low dissolved oxygen and excess chlorophyll caused by high nutrient loading and algae growth.
Water Quality Standards **OAR 340-041-009 (DO)**	Warm Water criteria – > 5.5 mg/l or 5.5 mg/l 30day mean, 4.0 mg/l min. Cool Water Criteria – >6.5 mg/l 30 day mean or 5.5 mg/ 7 day mean and > 4.0 min. Core Cold Water Criteria- > 8.0 mg/l or > 90% saturation. Bull Trout Spawning and Rearing Criteria - > 11.0 mg/l or > 9.0 mg/l if inter-gravel is > 8.0 mg/l
Water Quality Standards **OAR 340-041-009 (chlorophyll)**	Nuisance Phytoplankton Growth Chlorophyll a Criteria of 0.015 mg/l (applies in Summer only).
Water Quality Standards **OAR 340-041-0207(pH)**	Malheur River Basin-Specific Criteria - 7.0-9.0 pH units
Beneficial Uses **OAR 340-042-0040(4)(c)**	The most sensitive beneficial uses of surface water in the Malheur River Basin and Middle Snake-Payette Subbasin affected by the DO/chlorophyll a conditions are the aquatic species present in the various river reaches.
Loading Capacity **OAR 340-42-0040(4)(d)** **CWA 303(d)(1)**	Phosphorus load capacity from Snake River-Hell's Canyon TMDL was determined based on a total phosphorus concentration of 0.07 mg/l.
Excess Load **OAR 340-42-0040(4)(e)**	The difference between the actual pollutant load in a waterbody and loading capacity of that waterbody.
Sources **OAR 340-42-0040(4)(f)** **CWA 303(d)(1)**	Phosphorus sources may include livestock, rural residential septic systems, urban runoff, wildlife, and natural geologic sources.
Load Allocations **OAR 340-042-0040(4)(h)**	Phosphorus load allocations for non-point sources, and waste load allocations for point sources were set by the Snake River- Hell's Canyon TMDL. Allocations apply during the Summer season.
Surrogate Measures **OAR 340-042-0040(5)(b)** **40 CFR 130.2(i)**	Where appropriate, a phosphorus load was used as a surrogate for dissolved oxygen and chlorophyll a.
Margin of Safety **OAR 340-042-0040(4)(i)** **CWA 303(d)(1)**	13% MOS was applied in Snake River-Hell's Canyon TMDL when determining 0.07 mg/l total phosphorus target concentration.
Seasonal Variation **OAR 340-042-0040(4)(j)** **CWA 303(d)(1)**	Phosphorus allocations apply during summer season based on the Snake River-Hell's Canyon TMDL.
Reserve Capacity	None for non-point sources of phosphorus.

Table 6-1. TMDL Components, Continued.

Water Quality Standard Attainment Analysis **CWA 303(d)(1)**	Dissolved oxygen standards currently being met. Seven out of 191 water samples collected in the Summer season between 1996 and 2007 exceeded the Oregon chlorophyll a water quality criterion of 15 µ/l. Phosphorus reductions are intended to meet the Snake River-Hells Canyon TMDL requirements, and attain chlorophyll a criteria in the Malheur River Basin.
Water Quality Management Plan **OAR 340-041-0040(4)(l)** **CWA 303(d)(1)**	The Water Quality Management Plan attached to this TMDL document provides the framework of management strategies to meet and maintain water quality standards. The framework is designed to work in conjunction with detailed plans and analyses provided in implementation plans prepared by designated management agencies.

6.2 DISSOLVED OXYGEN AND CHLOROPHYLL A 303(D) LISTINGS

The Malheur River from mouth to river mile 186.1 is included on the 303(d) list due to apparent violations of State of Oregon water quality standards for dissolved oxygen (DO) **(Table 6-2)**. The listing is a Category 5 status listing, which indicates that a TMDL is needed to address the standards violations. Key sample locations are shown in **Figure 6-2.** The dissolved oxygen 303(d) listings were based upon a comparison of the data to the Cool-water dissolved oxygen criteria, which is not applicable in most of the Lower Malheur Subbasin. A further discussion of applicable dissolved oxygen criteria is included in Section 6.5.1. Dissolved oxygen data is discussed in Section 6.6.

The Malheur River from mouth to river mile 67 is also included on the 303(d) list due to State of Oregon water quality standards for chlorophyll a, a component of algae **(Table 6-3)**. Further discussion of the chlorophyll a criteria is included in Section 6.5.2. A discussion of the chlorophyll a data is included in **Section 6.7**.

Figure 6-2. Key water sampling locations in the Malheur River Basin used by DEQ and the Malheur Watershed Council.

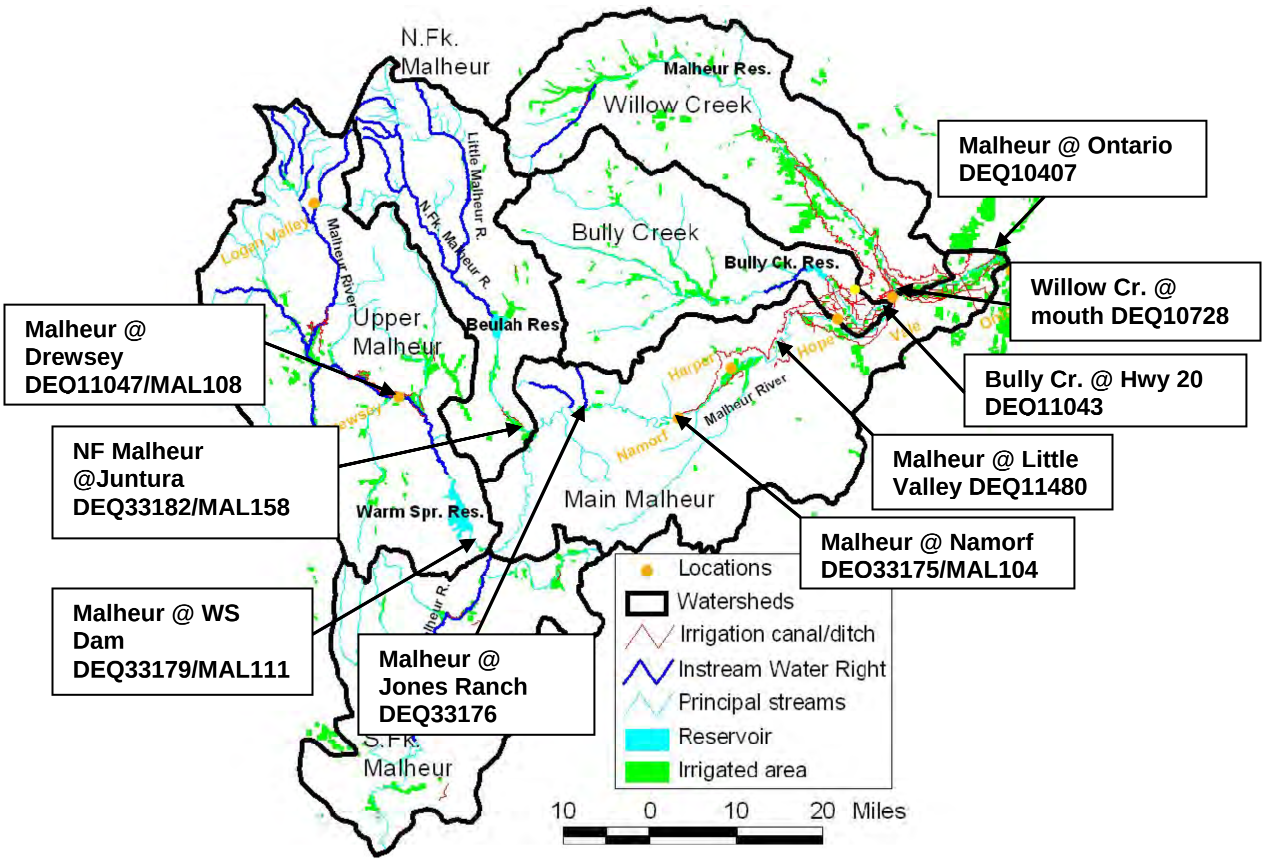


Table 6-2. Malheur River 303(d) Listings for Dissolved Oxygen.

Name LLID River Mile	Parameter	Season	Criteria	Beneficial Uses	Status	Assessment: Year Action
Malheur River 1169731440585 0 to 186.1	Dissolved Oxygen	Year Around (Non-spawning)	Cool water: Not less than 6.5 mg/l	Cool-water aquatic life	Cat 5: Water quality limited, 303(d) list, TMDL needed	2004 Added to database

Name LLID River Mile	[Data Source] Supporting Data
Malheur River 1169731440585 0 to 186.1	2004 Data: LASAR 10407 River Mile 0.1: From 6/10/1997 to 8/20/2003, 2 out of 14 samples (14%) < 6.5 mg/l and applicable % saturation. LASAR 10407 River Mile 0.1: From 10/16/1996 to 12/9/2003, 0 out of 30 samples (0%) < 6.5 mg/l and applicable % saturation. LASAR 11480 River Mile 45.6: From 6/11/1997 to 8/20/2003, 0 out of 14 samples (0%) < 6.5 mg/l and applicable % saturation. LASAR 11480 River Mile 45.6: From 10/16/1996 to 12/10/2003, 0 out of 29 samples (0%) < 6.5 mg/l and applicable % saturation. LASAR 11047 River Mile 139.1: From 10/2/2003 to 10/2/2003, 1 out of 1 samples (100%) < 6.5 mg/l and applicable % saturation.

Table 6-3. Malheur River 303(d) Listings for Chlorophyll a.

Name **LLID** **River Mile**	Parameter	Season	Criteria	**Beneficial Uses**	**Status**	**Assessment: Year** **Action**
Malheur River 1169731440585 0 to 67	Chlorophyll a	Summer	Reservoir, river, estuary, non-thermally stratified lake: 0.015 mg/l	Aesthetics Fishing Livestock watering Water contact recreation Water supply	Cat 5: Water quality limited, 303(d) list, TMDL needed	2004 No status change

Name **LLID** **River Mile**	**[Data Source] Supporting Data**
Malheur River 1169731440585 0 to 67	2004 Data: LASAR 10407 River Mile 0.1: From 6/10/1997 to 9/7/1997, average Chlorophyll a of 0.014 for 2 samples in 2 months. LASAR 11480 River Mile 45.6: From 8/15/2001 to 9/30/2001, average Chlorophyll a of 0.02 for 1 samples in 1 months. Previous Data: USBR Data (4 Sites: MAL006, MAL102, MAL103, MAL104; RM 0.5, 20, 49, 67.2): 87% (27/31); 65% (20/31); 19% (6/31); 6% (2/31) Summer values respectively exceeded chlorophyll a standard (15 ug/l) with 3 month average exceeding each year in lower R from WY 86-95. Previous Assessment Year: 1998

6.3 POLLUTANT IDENTIFICATION

A detailed review of the data from DEQ's LASAR database, indicate that the Malheur River and tributaries actually meet the dissolved oxygen criteria assigned to them. The chlorophyll a criterion was only exceeded in 7 samples out of 191 collected during the Summer between 1996 and 2007. However, the excess phosphorus load from the Malheur River is contributing to algae growth downstream in the Snake River, and causing impacts to beneficial uses. The impact to beneficial uses in the Snake River has resulted in phosphorus being identified as a pollutant in the Malheur River Basin. The Snake River Hell's Canyon TMDL allocated a total phosphorus load for the Malheur River at its mouth which was calculated based on a total phosphorus concentration of 0.07 mg/l. Reductions in phosphorus loading should also have the benefit of reducing algae growth and pH values in the Lower Malheur River and its tributaries.

6.4 BENEFICIAL USE IDENTIFICATION

The beneficial uses of surface water in the Malheur River Basin as listed in ORS 340-41-0201:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Fish and Aquatic Life
- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality

Fish and aquatic life is considered one of the most sensitive beneficial uses in the Malheur River Basin. The fish use designation for the lower 65 miles of the Malheur River, along with the lower portions of Willow and Bully Creeks is Cool Water Species (no salmonid use). The headwaters of the mainstem Malheur River, North Fork Malheur River, and Little Malheur River are designated either Bull Trout Spawning and Rearing or Core Cold-Water Habitat. The remaining streams in the basin are designated Redband or Lahontan Cutthroat Trout habitat, however, Lahontan Cutthroat are not know to exist in the basin **(Figure 6-3)**.

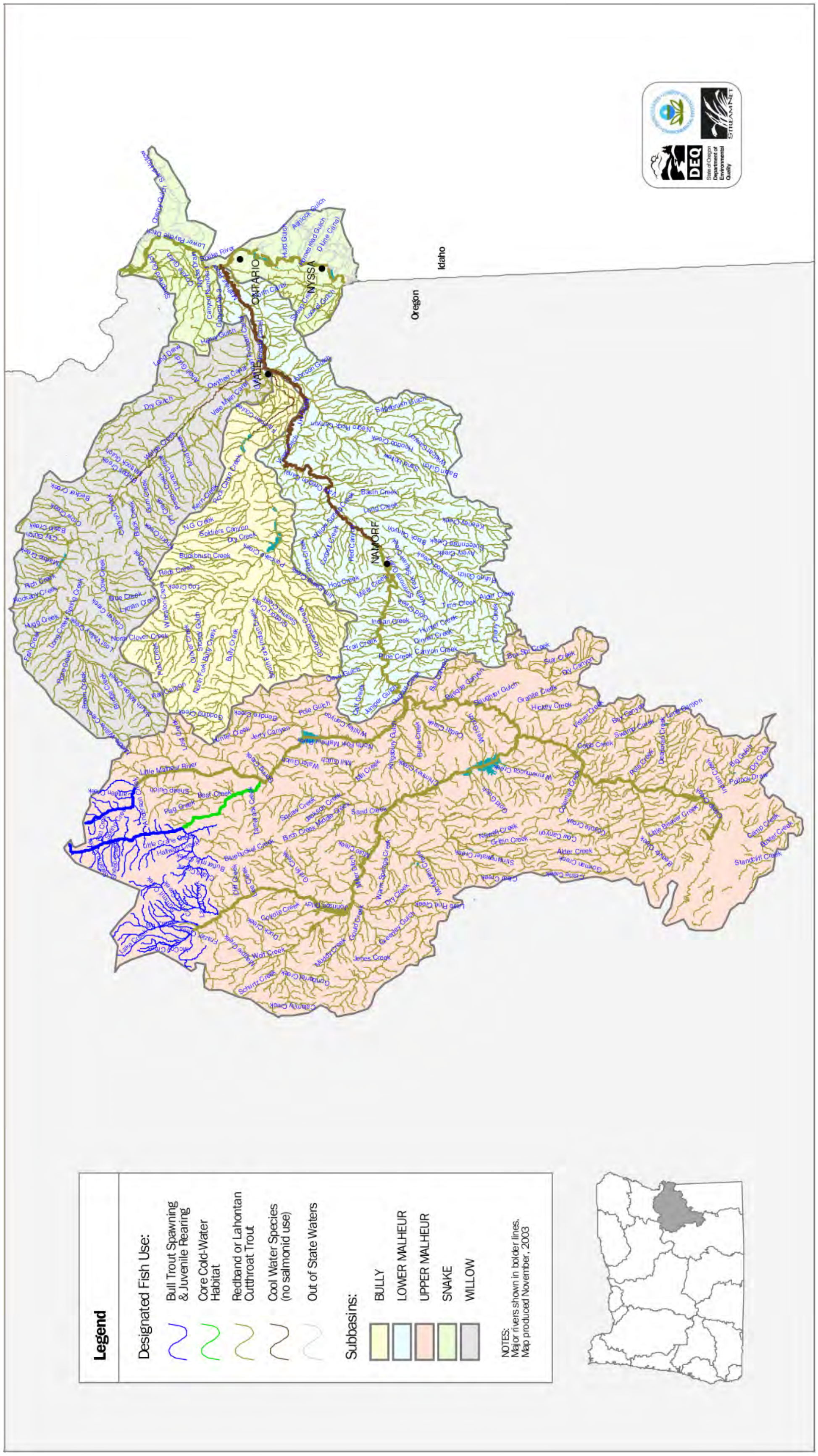


Figure 6-3. Fish Use Designations, Malheur River Basin ORS 340-41-0201.

The beneficial uses of surface water in the Mainstem Snake River as listed in ORS 340-41-0120:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Fish and Aquatic Life
- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality
- Hydro Power
- Commercial Navigation & Transportation

As in the Malheur River Basin, fish and aquatic life is considered one of the most sensitive beneficial uses in the Mainstem Snake River. The fish use designation for the Snake River from the Hell's Canyon Dam at RM 247.5 to the Idaho border at river mile 409 is Redband or Lahontan Cutthroat Trout habitat.

6.5 WATER QUALITY STANDARDS

6.5.1 Dissolved Oxygen Criteria

Warm-water dissolved oxygen criteria

The Fish Use Designations map for the Malheur River Basin Figure 201A (DEQ, 2003) (http://www.deq.state.or.us/wq/rules/div041/fufigures/figure201a.pdf) identifies three reaches with the designated fish use of Cool Water Species (no salmonid use): Malheur River from Namorf (RM 67) to mouth, Willow Creek from Brogan (RM 26.5) to mouth, and Bully Creek from reservoir (RM 14) to mouth. The June 22, 1998 standards clarification letter from Michael Llewelyn of ODEQ to Phillip Millam of EPA Region 10 specifies that "warm-water [dissolved oxygen] criteria is applied to waters where Salmonid Fish Rearing and Salmonid Fish Spawning are not a listed beneficial use in Tables 1-19 with the exception of Table 19 (Klamath Basin) in which the cool water dissolved oxygen criteria will be applied." The clarification letter further specifies that warm-water dissolved oxygen criteria be applied to Malheur River (Namorf to mouth; RM 67 to 0), Willow Creek (Brogan to mouth; RM 26.5 to 0), and Bully Creek (Reservoir to mouth; RM 14 to 0). The letter is included as Appendix 3 of the Assessment Methodology for Oregon's 2004/2006 Integrated Report on Water Quality Status (DEQ, 2006) (web site: http://www.deq.state.or.us/WQ/assessment/docs/methodology0406.pdf).

The applicable dissolved oxygen criteria for lower reaches of the Malheur River, Willow Creek, and Bully Creek are the warm-water criteria, as follows:

> "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)." (340-041-0016 (4))

Cool-water dissolved oxygen criteria

The June 22, 1998 standards clarification letter from Michael Llewelyn of ODEQ to Phillip Millam of EPA Region 10 specifies that cold-water dissolved oxygen criteria will be applied to the Blue Mountains Ecoregion and cool-water dissolved oxygen criteria will be applied to the remainder of Eastern Oregon Ecoregions which are considered Redband or Lahontan Trout habitat.

The Fish Use Designations map for the Malheur River Basin Figure 201A (DEQ, 2003) (http://www.deq.state.or.us/wq/rules/div041/fufigures/figure201a.pdf) indicates that the designated fish use of Willow Creek upstream from Brogan (RM 26.5), Bully Creek upstream from reservoir (approximately RM 18), and the Malheur River upstream from Namorf (RM 67) is Redband or Lahontan Cutthroat Trout.

Bully Creek above RM 18 and below RM 45 near Westfall, the Malheur River above RM 67 at Namorf and below RM 170, and the North Fork Malheur River from RM 0 in Juntura to RM 10, are within the Snake River Basin/High Desert Ecoregion and Redband or Lahontan Trout habitat, where the cool-water DO criteria apply (Figure 6-3).

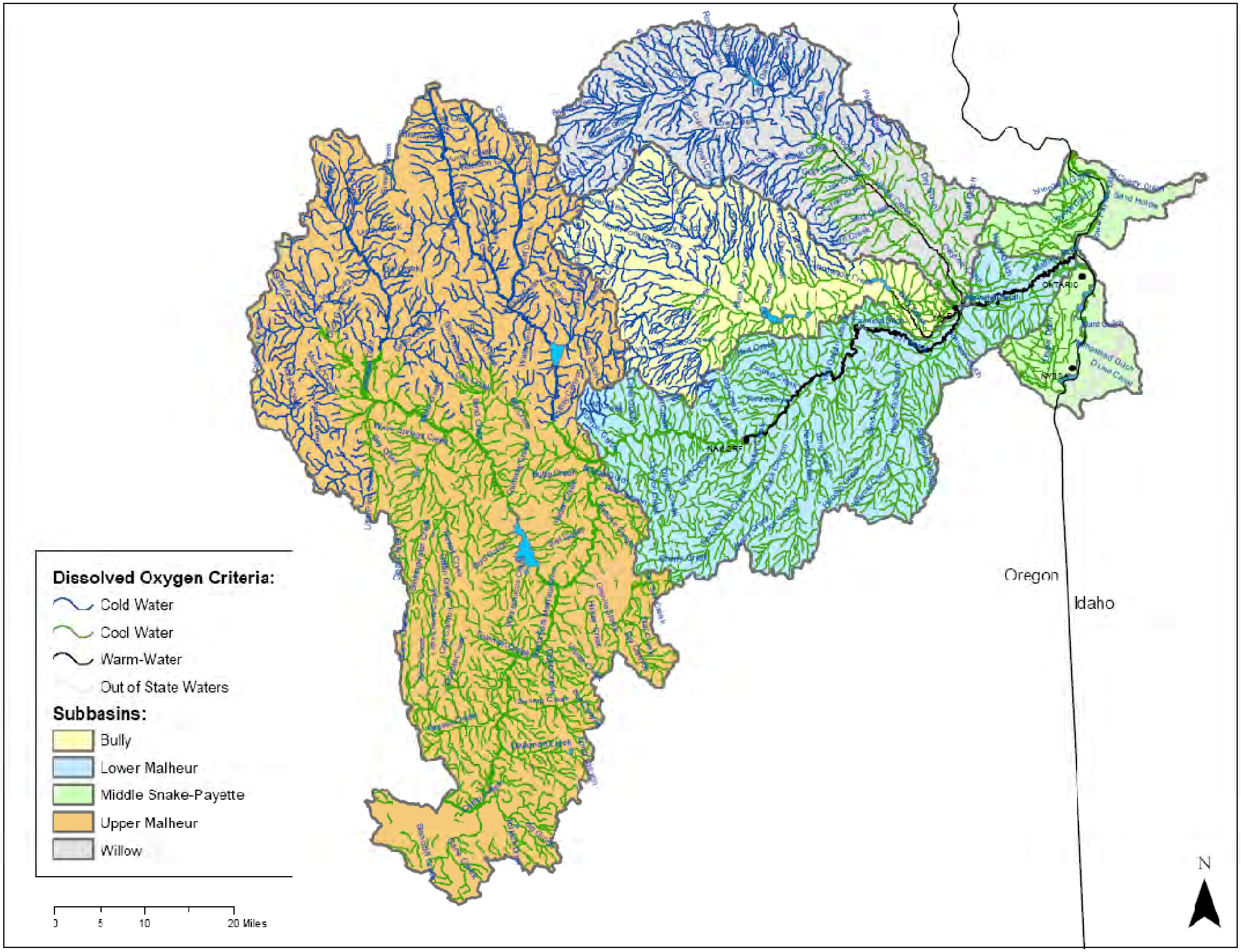
The applicable dissolved oxygen criteria for reaches of the Malheur River, North Fork Malheur River, and Bully Creek within the Snake River/High Desert Ecoregion and where the designated fish use is Redband or Lahontan Cutthroat Trout are the cool-water criteria, as follows:

> "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)." (340-041-0016 (3))

Cold-water dissolved oxygen criteria

The Malheur River and tributaries above RM 170, the North Fork Malheur River above RM 10, Bully Creek and tributaries above RM 45 near Westfall, and Willow Creek and tributaries above RM 26.5 at Brogan are within the Blue Mountain Ecoregion, where the Cold Water Dissolved Oxygen Criteria apply (8.0 ppm minimum), except in headwater areas of the Malheur and North Fork Malheur where resident trout spawning dissolved oxygen criteria (11.0 ppm minimum) apply due to the presence of Bull Trout Spawning and Rearing Habitat (**Figure 6-4**).

Figure 6-4. Malheur River Basin Dissolved Oxygen Criteria.



6.5.2 Chlorophyll a Criteria

OAR 340-041-0019(1): The following values and implementation program must be applied to lakes, reservoirs, estuaries and streams, except for ponds and reservoirs less than ten acres in surface area, marshes and saline lakes:

(a) The following 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;

The data should be corrected for dead algae matter known as pheophytin, as outlined in DEQ lab procedure SM 1002 G.

The preceding rule language may guide DEQ's actions. DEQ uses this criterion as an action level that triggers further investigation. This document presents information related to chlorophyll a concentrations. However, the TMDL is not written to demonstrate compliance with the criterion of 0.015 mg/l for chlorophyll a. DO and pH are parameters which more directly affect aquatic life than chlorophyll a and achieving these criteria will be protective of that beneficial use.

6.5.3 pH Criteria

The pH standard for the Malheur river Basin states that pH shall remain between 7.0 and 9.0 (OAR 340-041-0207). The TMDL will target "no measurable increase" in pH above natural conditions or above the numeric standard. No measurable increase for pH is defined as no more than 0.3 pH units. This definition is based on the 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 units.

6.6 DISSOLVED OXYGEN DATA

Based on the following analysis of available dissolved oxygen data, it is recommended that the entire Malheur River from RM 0 to RM 186.1 be removed from the DEQ dissolved oxygen 303(d) list.

Grab data - Malheur River – Mouth to Namorf (RM 67)

In the Malheur River from Namorf (RM 67), to the river mouth, the applicable dissolved oxygen criterion is warm-water aquatic life. The 303(d) listing appears to have been based on a comparison to the cool-water criterion of 6.5 mg/l. A comparison of grab dissolved oxygen at the two DEQ Malheur River ambient monitoring stations; Malheur River at Highway 201 (RM 0.5), and Malheur River Near Little Valley (RM 49.0), to the 5.5 mg/L DO criteria suggests that the river meets water quality standards for dissolved oxygen at these locations. Only one measurement, a concentration of 5.1 mg/L measured on June 11, 2003 at 8:40 AM, did not meet the 5.5 mg/l criterion. None of the results were below the absolute minimum criterion of 4.0 mg/l **(Figure 6-5 and 6-6)**.

Grab data from LASAR for the remaining Malheur sites at or downstream from RM 67 (stations other than 10407 and 11480) also suggest that the river meets the applicable warm-water criteria for dissolved oxygen **(Figure 6-7)**.

Figure 6-5. Dissolved Oxygen Grab Sample Data, DEQ Ambient Water Quality Sampling Location 10407, Malheur River at Highway 201, Ontario, 1970-2007.

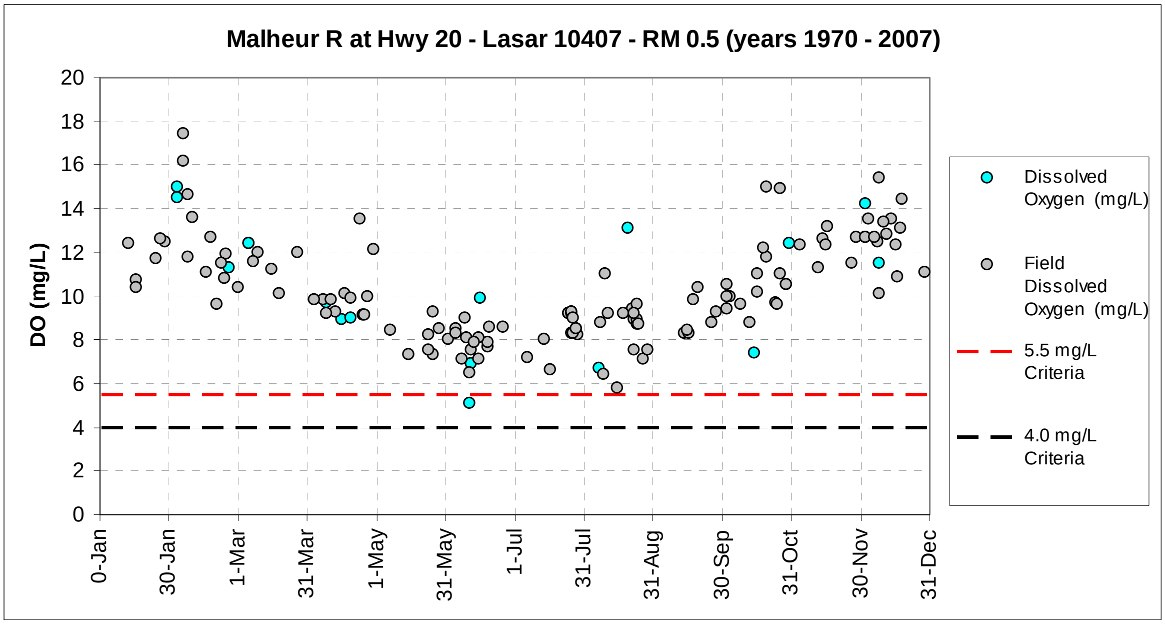


Figure 6-6. Dissolved Oxygen Grab Sample Data, Malheur River at Little Valley, 1970-2007.

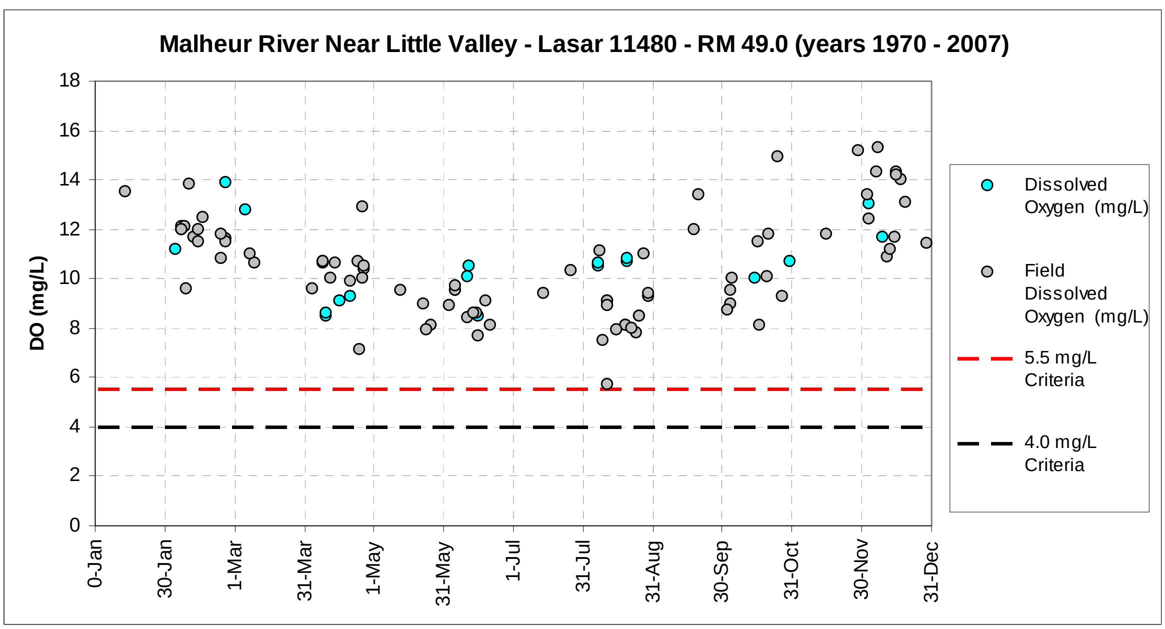
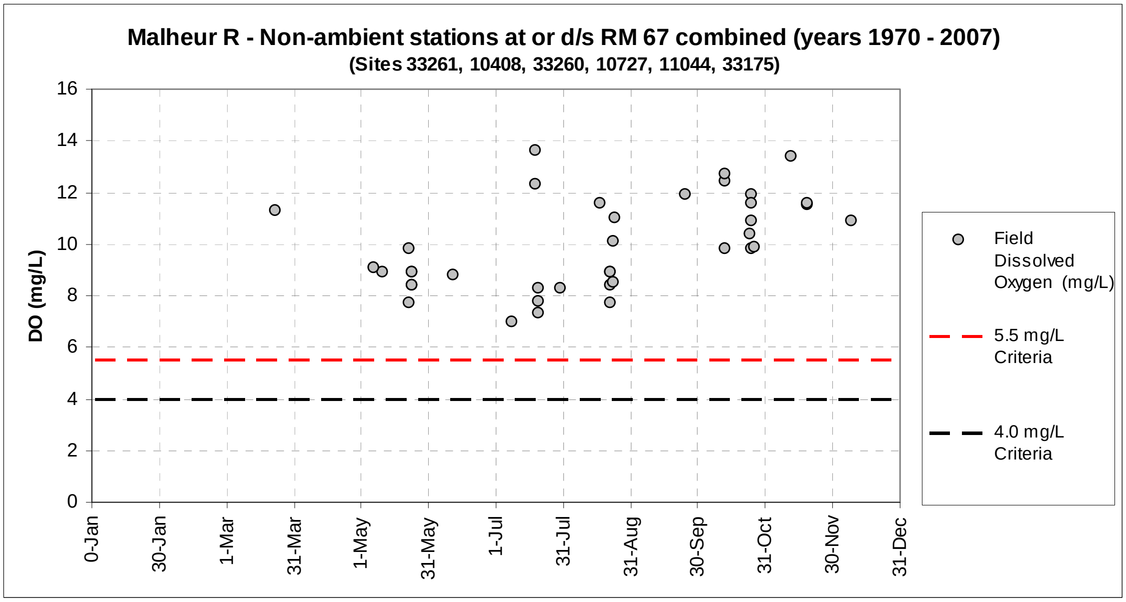


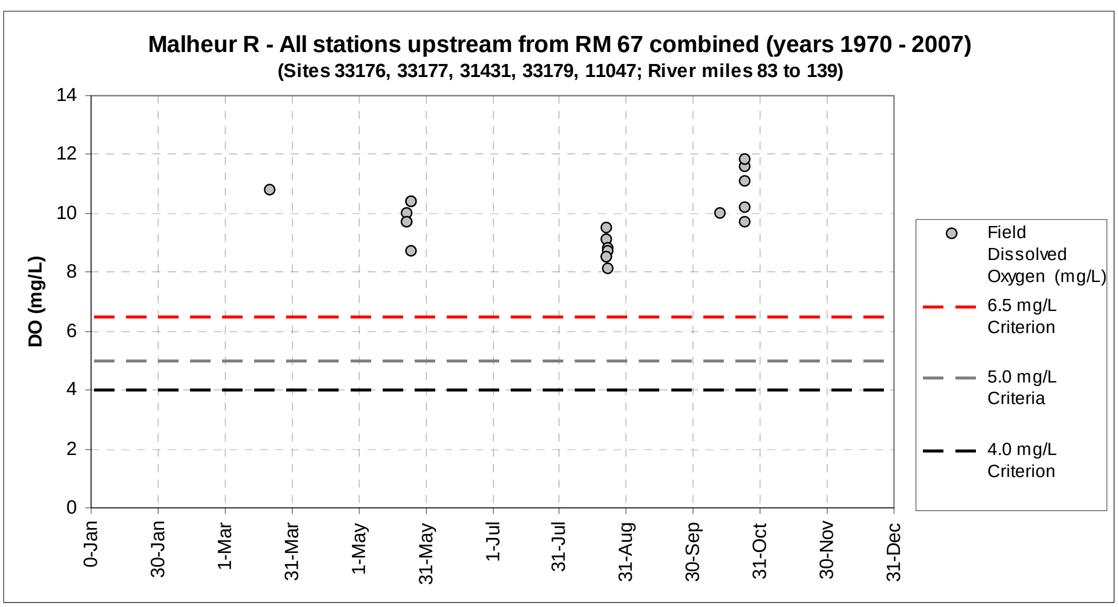
Figure 6-7. Dissolved Oxygen Grab Sample Data, Malheur River below Namorf (RM 67), 1970-2007.



Grab data - Malheur River – Upstream from Namorf (RM 67)

Upstream from Namorf (RM 67), the applicable dissolved oxygen criterion for the Malheur River is cool-water aquatic life. Grab data from LASAR for all Malheur sites upstream from RM 67 suggests that the river meets the cool-water dissolved oxygen criterion **(Figure 6-8)**. One sample collected on October 2, 2003 had a dissolved oxygen concentration of 6.1 mg/l, which is slightly below the 6.5 mg/ criterion, but well above the 7-day minimum mean concentration of 5.0 mg/l and the absolute minimum of 4.0 mg/l.

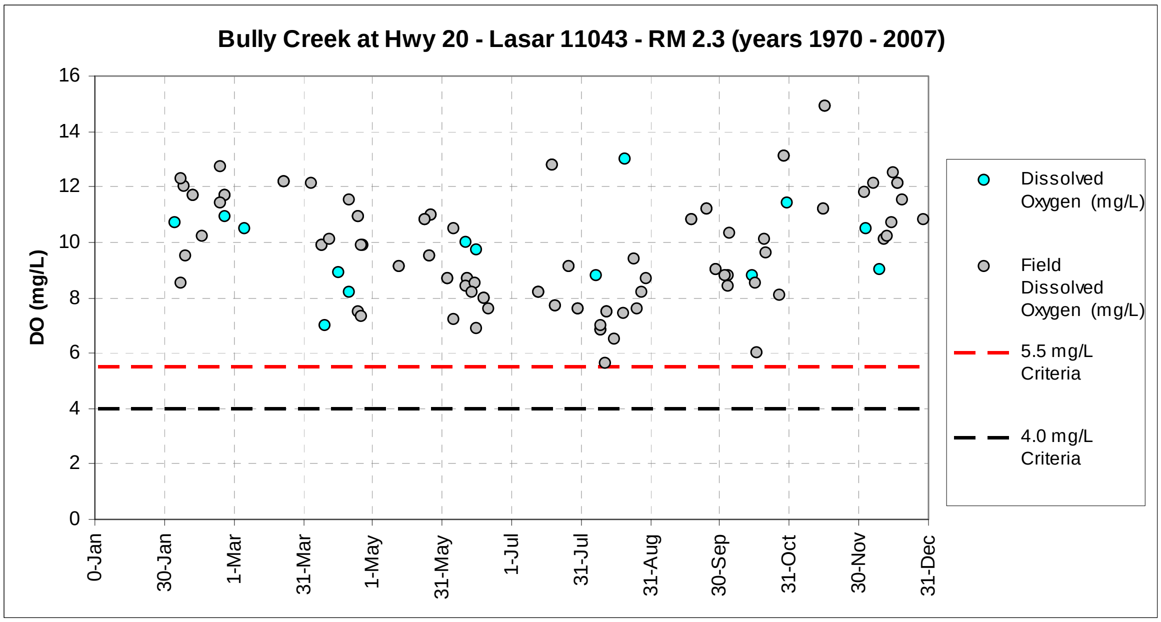
Figure 6-8. Dissolved Oxygen Grab Sample Data, Malheur River above Namorf (RM 83-139), 1970-2007.



Grab data – Bully Creek – Mouth to Bully Creek Reservoir Dam (RM 14)

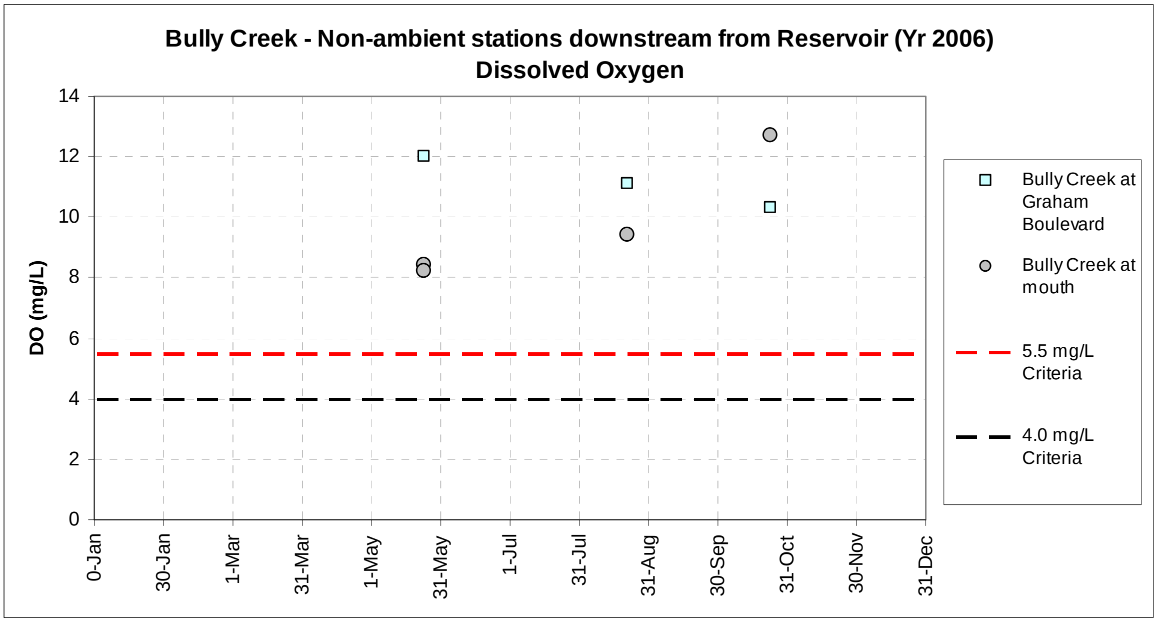
Bully Creek is not included on the 303(d) List for DO as a Category 5 water body in need of a TMDL. However, it is included for Chlorophyll a and has elevated pH in the Summer. Data from the Bully Creek ambient monitoring station at Highway 20, LASAR 11043, RM 2.3, indicate that the warm-water DO criteria is met at this location **(Figure 6-9)**.

Figure 6-9. Dissolved Oxygen Grab Sample Data, Bully Creek, Below Bully Creek Reservoir near Vale (RM 2.3), 1970-2007.



Data is also available for two other sites downstream from Bully Creek Reservoir (RM 15). These measurements comprise the field audits for the 2006 continuous DO monitoring presented below. These data also suggest that the applicable warm-water criterion for DO is being met in this reach **(Figure 6-10)**.

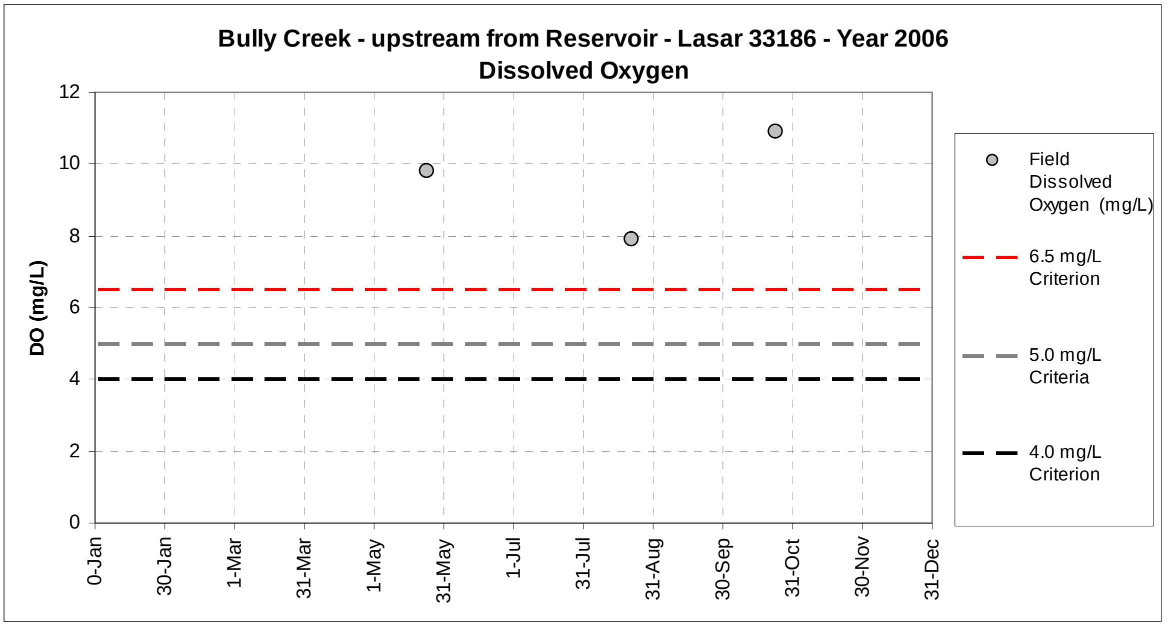
Figure 6-10. Dissolved Oxygen Grab Sample Data, Bully Creek, Below Bully Creek Reservoir (RM 0-11), 2006.



Grab data – Bully Creek – Upstream from Bully Creek Reservoir

A limited amount of data was also collected in 2006 at a site upstream Bully Creek Reservoir at RM 18 during the months of May, August and October. These data suggest that the cool-water criterion for DO is being met at this location **(Figure 6-11)**.

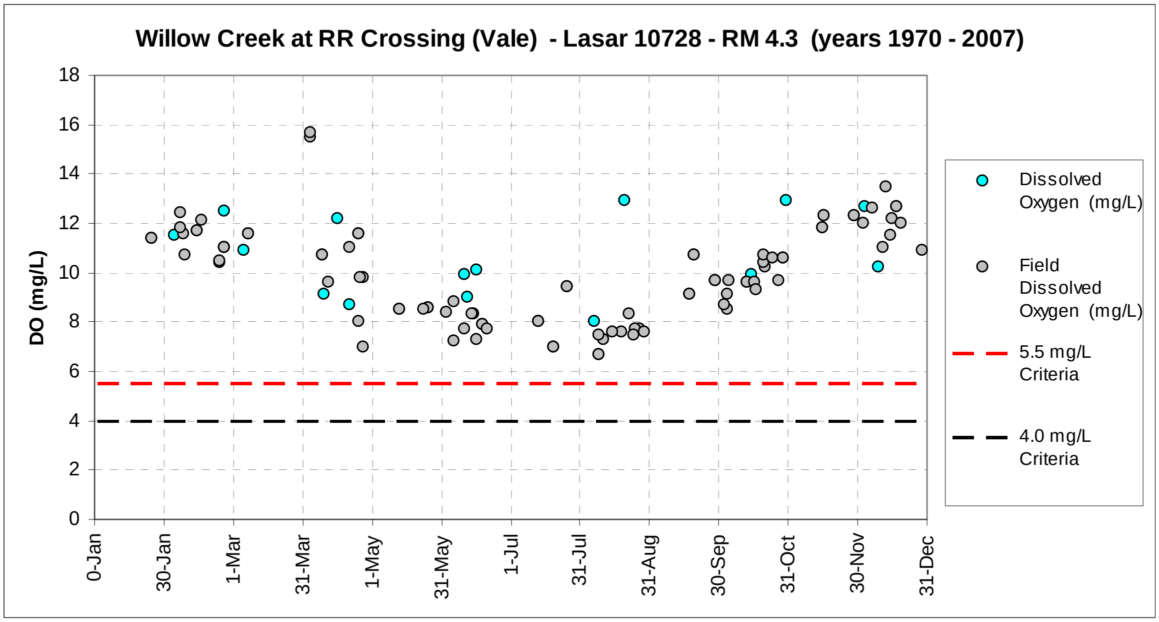
Figure 6-11. Dissolved Oxygen Grab Sample Data, Bully Creek Above Bully Creek Reservoir at RM 18, 2006.



Grab dissolved oxygen data – Willow Creek – Mouth to Brogan (RM 26.5)

Willow Creek is not included on the 303(d) List for DO as a Category 5 water body in need of a TMDL. However, it is included for Chlorophyll a, and has elevated pH in the Summer. Data from the Willow Creek ambient monitoring station at Vale, LASAR 10728, RM 0, suggests that the warm-water DO criteria of 5.5 mg/l is being met at this location **(Figure 6-12)**.

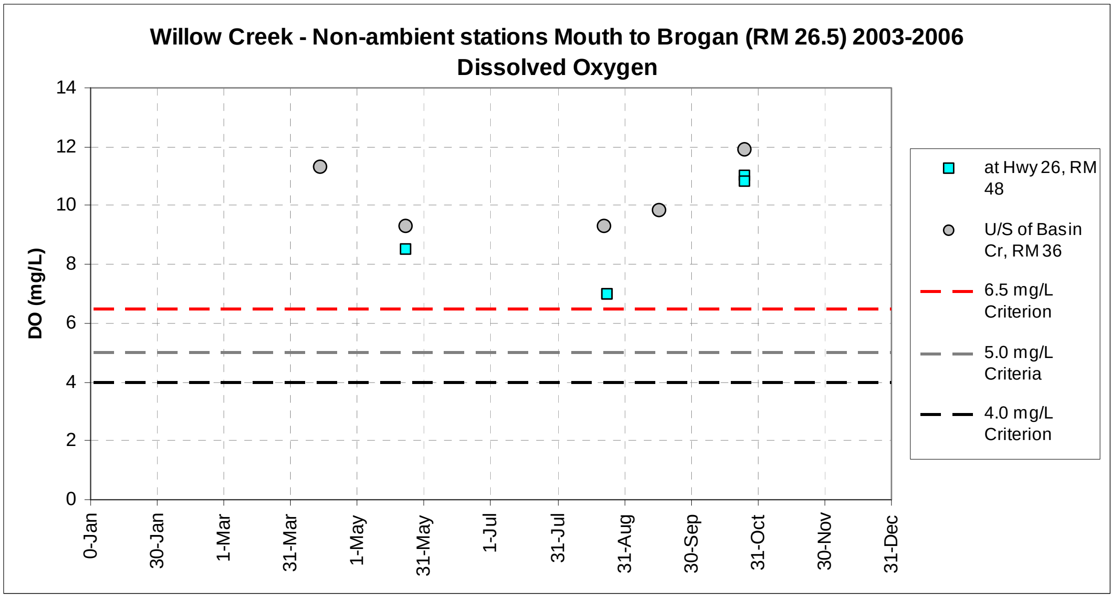
Figure 6-12. Dissolved Oxygen Grab Sample Data, Willow Creek at mouth in Vale, Oregon.



Grab dissolved oxygen data – Willow Creek – Upstream from Brogan (RM 26.5)

Limited available data also suggests that the DO standard is also being met upstream Brogan (RM 26.5) where the applicable criterion is cool-water, 6.5 mg/L **(Figure 6-13)**.

Figure 6-13. Dissolved Oxygen Grab Sample Data, Willow Creek at Brogan, Oregon.



Continuous Dissolved Oxygen Data

Datasondes which continuously measure water quality parameters were deployed by DEQ in the Malheur River, Willow Creek, and Bully Creek during Spring, Summer, and Fall, 2006. Each deployment lasted approximately three days. The datasondes continuously monitored temperature, conductivity, dissolved oxygen, and pH. Monitoring results are reported in the following DEQ Laboratory Division Analytical Reports:

- Malheur River TMDL – Spring Continuous Data, Sampling Event 20060464, May 23 to 25, 2006
- Malheur River TMDL – Summer Continuous Data, Sampling Event 20061049, August 21 to 24, 2006
- Malheur River TMDL – Fall Continuous Data, Sampling Event 20061261, Oct 23 to 26, 2006

Minimum measured dissolved oxygen concentrations for each period are presented below **(Table 6-4)**. The quality of the data is described as “known quality”, “suspect quality”, or “unknown quality”. The data suggests that the Malheur River and Willow Creek meet applicable water quality criteria for dissolved oxygen at all locations. The data suggest that Bully Creek might not meet water quality standards for DO. The lowest measured DO on Bully Creek was 5.0 mg/L measured on August 22, 2006 at RM 11 (LASAR No. 33262, Hwy 20). This is less than the 5.5 mg/L warm-water criteria that applies at this location, but higher than the absolute minimum criteria of 4.0 mg/l.

Table 6-4. Summary of Continuous Dissolved Oxygen Data, Malheur River Basin, 2006.

Spring DO data

LASAR#	Site Name	River Mile	Minimum measured DO concentration and Date of measurement
10407	Malheur River at HWY 20 (Mouth) (Ambient Station)	0.5	
33261	Malheur R. just d/s of Irrigation Pump opposite of Ontario WWTP ponds	2	8.1 mg/L 5/25/2006 (suspect quality)
33260	Malheur R. 100 yards u/s of Willow Cr. near Vale WWTP	20	8.0 mg/L 5/25/2006 (suspect quality)
11480	Malheur River at Little Valley (Ambient Station)	49.0	8.6 mg/L 5/24/2006 (suspect quality)
33175	Malheur River at Namorf	67	9.2 mg/L 5/25/2006 (known quality)
33176	Malheur River at Jones Ranch	83	8.6 mg/L 5/25/2006 (suspect quality)
33177	Malheur River at Juntura, OR	100	8.8 mg/L 5/24/2006 (known quality)
33184	Bully Creek at mouth	0	No data due to unit failure
33262	Bully Creek at Graham Blvd.	11	6.4 mg/L 5/23/2006 (known quality)
10728	Willow Creek at RR Crossing, Vale, OR (Ambient Station)	4.3	7.7 mg/L 5/24/2006 (suspect quality)
33266	Willow Creek at Diversion Weir just N. of Jamieson, OR	20	8.7 mg/L 5/24/2006 (known quality)
30435	Willow Cr. u/s of Basin Cr. S. of Huntington Junction	36	8.8 mg/L 5/24/2006 (known quality)

Summer DO data

LASAR#	Site Name	River Mile	Minimum measured DO concentration and Date of measurement
10407	Malheur River at HWY 20 (Mouth) (Ambient Station)	0.5	
33261	Malheur R. just d/s of Irrigation Pump opposite of Ontario WWTP ponds	2	6.8 mg/L 8/23/2006 (unknown quality)
33260	Malheur R. 100 yards u/s of Willow Cr. near Vale WWTP	20	5.8 mg/L 8/23/2006 (suspect quality)
11480	Malheur River at Little Valley (Ambient Station)	49.0	6.2 mg/L 8/23/2006 (unknown quality)
33175	Malheur River at Namorf	67	No data due to unit failure
33176	Malheur River at Jones Ranch	83	7.5 mg/L 8/23/2006 (suspect quality)
33177	Malheur River at Juntura, OR	100	7.0 mg/L 8/22/2006 (suspect quality)
33184	Bully Creek at mouth	0	6.4 mg/L 8/23/2006 (suspect quality)
33262	Bully Creek at Graham Blvd.	11	**5.0 mg/L** 8/22/2006 (suspect quality)
10728	Willow Creek at RR Crossing, Vale, OR (Ambient Station)	4.3	6.8 mg/L 8/22/2006 (suspect quality) 7.2 mg/L 8/24/2006 (known quality)
33266	Willow Creek at Diversion Weir just N. of Jamieson, OR	20	6.5 mg/L 8/21/2006 (unknown quality) 6.7 mg/L 8/22/2006 (known quality)
30435	Willow Cr. u/s of Basin Cr. S. of Huntington Junction	36	7.3 mg/L 8/21/2006 (unknown quality)

Table 6-4 Continued.

Fall DO data

LASAR#	Site Name	River Mile	Minimum measured DO concentration and Date of measurement
33261	Malheur R. just d/s of Irrigation Pump opposite of Ontario WWTP ponds	2	10.2 mg/L 10/26/2006 (suspect quality)
33260	Malheur R. 100 yards u/s of Willow Cr. near Vale WWTP	20	9.4 mg/L 10/25/2006 (suspect quality) 9.6 mg/L 10/25/2006 (known quality)
11480	Malheur River at Little Valley (Ambient Station)	49.0	8.3 mg/L 10/25/2006 (suspect quality)
33175	Malheur River at Namorf	67	10.2 mg/L 10/25/2006 (suspect quality)
33176	Malheur River at Jones Ranch	83	9.3 mg/L 10/25/2006 (known quality)
33177	Malheur River at Juntura, OR	100	No data due to unit failure
33184	Bully Creek at mouth	0	No data due to unit failure
33262	Bully Creek at Graham Blvd.	11	7.7 mg/L 10/25/2006 (suspect quality) 8.3 mg/L 10/26/2006 (known quality)
10728	Willow Creek at RR Crossing, Vale, OR (Ambient Station)	4.3	9.8 mg/L 10/25/2006 (suspect quality)
33266	Willow Creek at Diversion Weir just N. of Jamieson, OR	20	9.1 mg/L 10/23/2006 (unknown quality)
30435	Willow Cr. u/s of Basin Cr. S. of Huntington Junction	36	No data due to unit failure

Mean Minimum DO Analysis – Bully Creek

A further analysis was performed to estimate if the 5.5 mg/L criterion was met in Bully Creek on a 30-day mean minimum basis. The DO standard specifies that, 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. Generally, continuous DO monitoring is considered adequate information for this portion of the standard to be applied. Important definitions are as follows:

- "Monthly (30-day) Mean Minimum" for dissolved oxygen means the minimum of the 30 consecutive-day floating averages of the calculated daily mean dissolved oxygen concentration. 340-041-0002 (39)
- "Daily Mean" for dissolved oxygen means the numeric average of an adequate number of data to describe the variation in dissolved oxygen concentration throughout a day, including daily maximums and minimums. For the purpose of calculating the mean, concentrations in excess of 100 percent of saturation are valued at the saturation concentration. 340-041-0002 (15)

Note: because “daily mean” caps DO concentrations at saturation, "Monthly (30-day) Mean Minimum" is not the same as a 30-day average.

Due to the lack of 30-days of continuous DO and temperature data, it is not possible to calculate a monthly (30-day) mean minimum. Long-term data sets are rarely available for continuous DO because the membranes of DO measurement probes become contaminated over time and require ongoing field maintenance and periodic field audits. However, “daily means” calculated on a rolling 24-hour basis provide an indication of whether the Monthly (30-day) Mean Minimum would be met. The substitution of daily means for the Monthly (30-day) Mean Minimum requires that conditions during the days monitored are representative of the 30-day period in question. To calculate “daily means”, concentrations in excess of 100 percent of saturation are valued at the saturation concentration. Resultant regulatory “daily means” are plotted for Bully Creek at RM 11 (Graham Blvd) along with measured DO concentrations and field audit grab DO concentrations on **Figure 6-14, Figure 6-15, and Figure 6-16**. As shown, even for the August 2006 **(Figure 6-**

15) period when minimum DO concentrations drop below 5.5 mg/L, regulatory “daily mean” concentrations remain at least 1.3 mg/L greater than 5.5 mg/L. DEQ considers the DO standard to have been met at this location.

Figure 6-14. Bully Creek at Graham Boulevard (RM 11), Continuous Dissolved Oxygen, May 23-26, 2006.

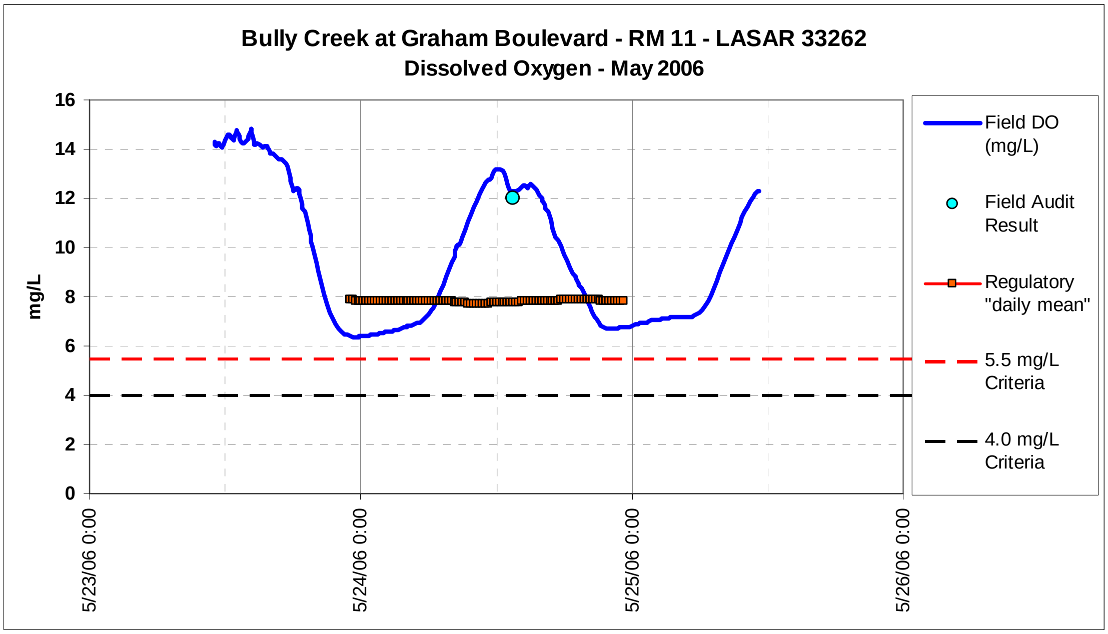


Figure 6-15. Bully Creek at Graham Boulevard (RM 11), Continuous Dissolved Oxygen, August 22-25, 2006.

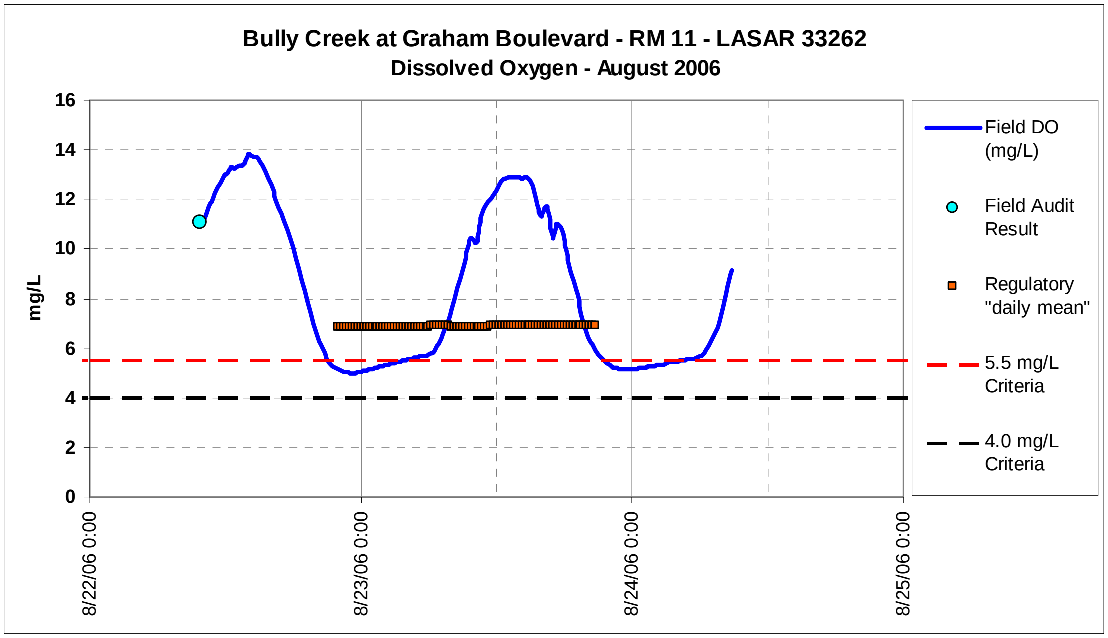
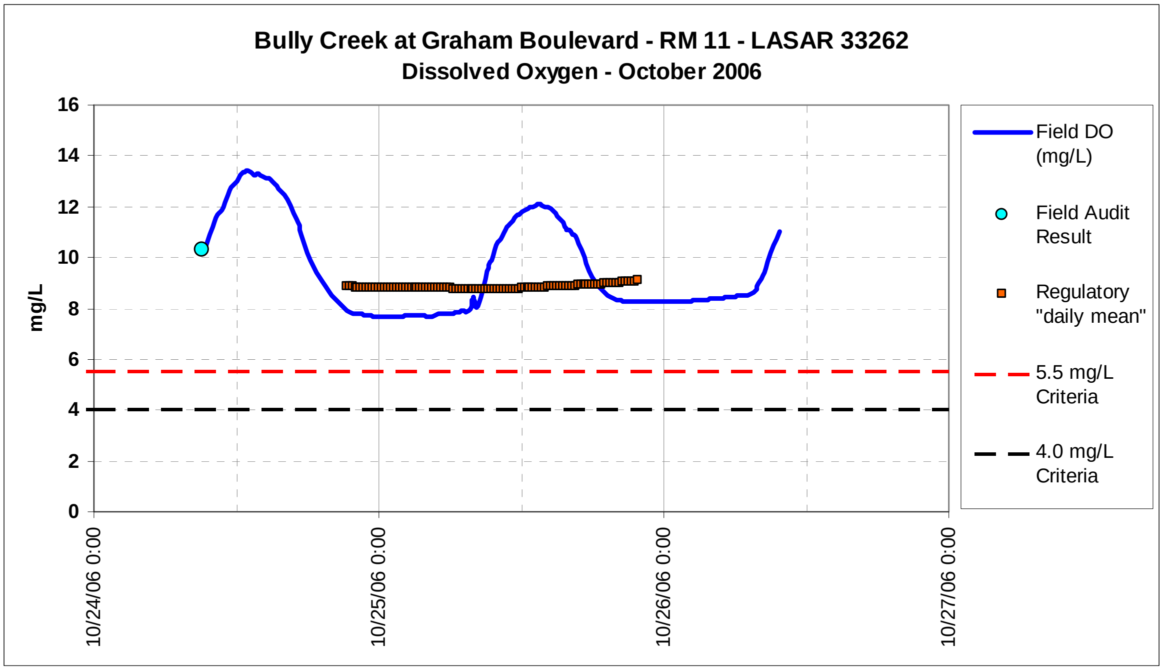


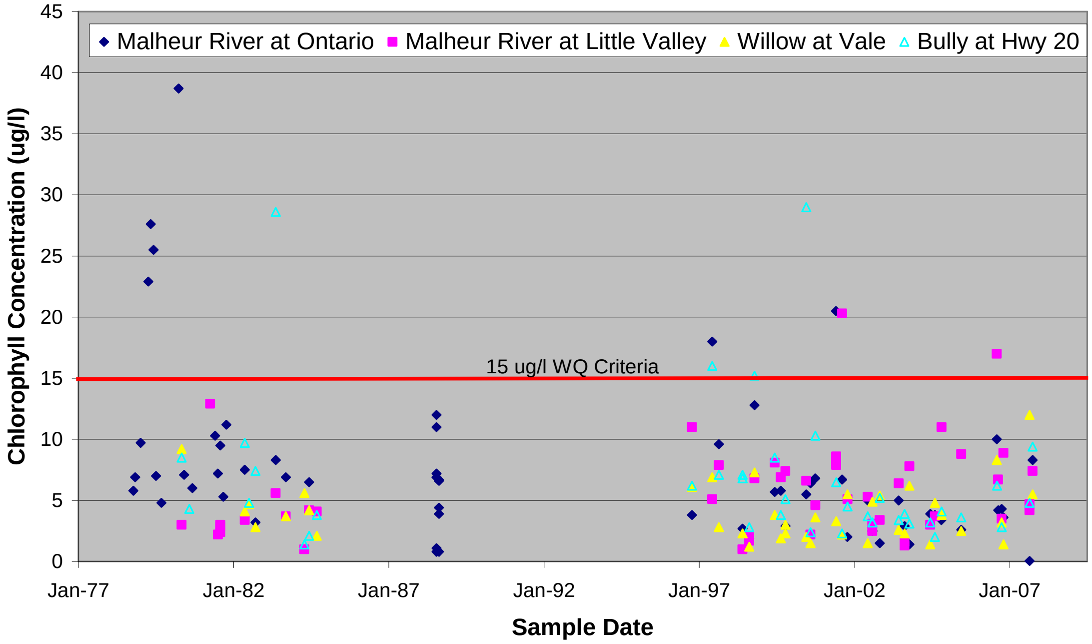
Figure 6-16. Bully Creek at Graham Boulevard (RM 11), Continuous Dissolved Oxygen, October 24-27, 2006.



6.7 CHLOROPHYLL A DATA

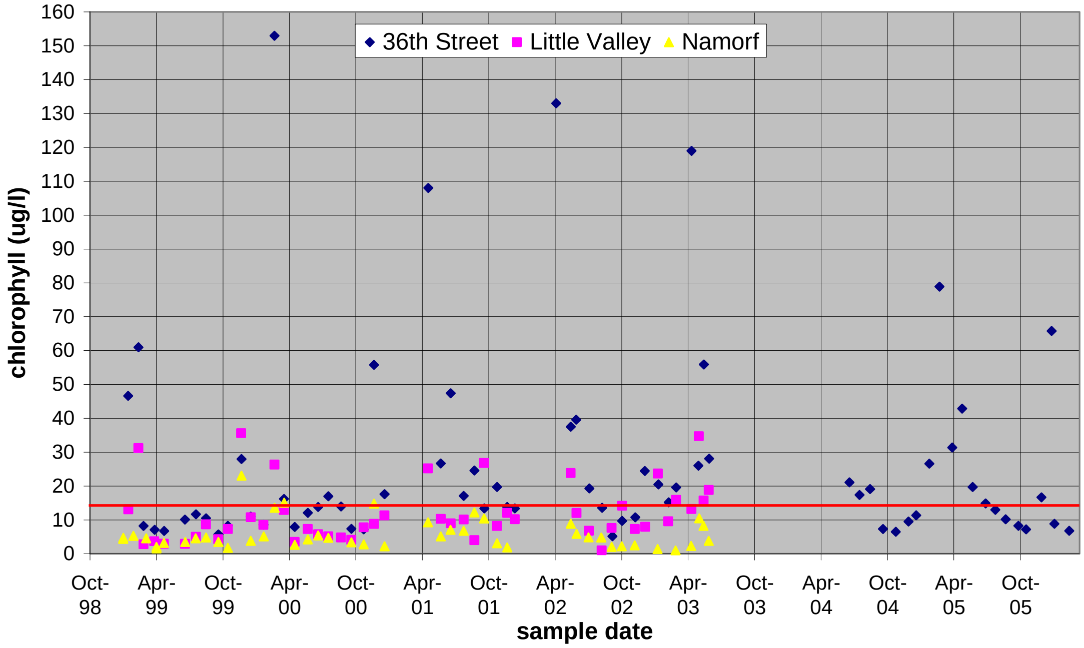
Chlorophyll a results from analyses performed between 1978 and 2007 on water samples collected at the DEQ ambient water quality monitoring stations in the Malheur River are presented in **Figure 6-17**. Sample locations include the Malheur River at Highway 201 in Ontario, Malheur River at Little Valley, Willow Creek at Vale, and Bully Creek at Highway 20 West of Vale. Water samples for chlorophyll analysis were collected mainly during the summer months, and all samples since 1996 have been collected during the months of June, August and October. The results presented in **Figure 6-17** are corrected for the chlorophyll break-down product, pheophytin a. Only 6 out of 191 samples corrected for pheophytin during the summer between 1996 and 2007 exceeded the Oregon chlorophyll a water quality action level of 15µg/l **(Figure 6-17)**.

Figure 6-17. Chlorophyll a Results (corrected for pheophytin) from DEQ Malheur River Basin Ambient Water Quality Sites 1978-2007.



Chlorophyll a data from the EPA STORET database for the Malheur River, Willow Creek, and Bully Creek were reported in the Snake River-Hell's Canyon TMDL document (2004). The mean chlorophyll a concentration for the Malheur River was reported as 55 µg/l. The results are reported as total chlorophyll a, uncorrected for pheophytin a. Uncorrected results from samples collected from 1986 to 1995 and analyzed by the Bureau of Reclamation, were the basis for the Malheur River Basin 303(d) listings for chlorophyll a. Pheophytin a levels were not measured in these samples, so it is not possible to correct them. Samples collected between 1999 and 2006 by the Malheur Watershed Council throughout the calendar year and analyzed by the Bureau of Reclamation are presented in **(Figure 6-18)**.

Figure 6-18. Chlorophyll a Results (uncorrected for pheophytin a) from Malheur River BOR STORET sample locations 1999-2006.



The chlorophyll a values from the STORET database are highest during the Winter and Spring seasons. These data include the chlorophyll a break-down product pheophytin a, and are likely the result of higher algae growth occurring in the shallow, clear, stagnant water that occurs in the Malheur River and tributaries after the irrigation flow is shut off in the Fall. April values are particularly high, and may be the result of flushing of dead algal matter from stream channels and reservoirs when the irrigation flows resume in the Spring. This flushing of algae may be a significant process involved in the cycling and movement of phosphorus in the Malheur River Basin. The chlorophyll values for samples collected at Namorf (RM 67) are consistently low, and rarely exceed the chlorophyll criteria of 15 ug/l. Chlorophyll concentrations increase downstream at Little Valley (RM 50), and increase further at Ontario (36th Street Bridge, RM 3).

Based on the corrected DEQ ambient water quality data (**Figure 6-17)**, the summer exceedances of the chlorophyll action level in the Malheur River, Bully Creek, and Willow Creek are rare (6 out of 191 samples collected between 1996 and 2007). However, the BOR data indicate that significant algae growth and accumulation occurs outside of the summer season and it may be a factor in the cycling and transport of phosphorus in the Malheur River and tributaries.

Chlorophyll concentrations in water samples collected from the DEQ Ambient Water Quality stations in the Malheur River Basin were compared to variety of parameters including nutrients, TSS, and pH in a regression analysis (see Appendix E). The only significant correlations were between chlorophyll a and total phosphorus, which had correlation coefficients ranging from 0.60 in July-September and 0.74 in April-June, and chlorophyll a and ammonia in April-June. A moderate negative correlation between chlorophyll a and dissolved orthophosphate (-0.21 in August and -0.60 in June) was also evident. This analysis suggests that algae growth is consuming dissolved orthophosphate. Based on this information it was determined that phosphorus is a good surrogate parameter for chlorophyll a. Actions to reduce phosphorus will reduce chlorophyll a concentrations and address the few instances where chlorophyll a concentrations exceed the water quality action level. Phosphorus data are discussed in **Section 6.9**.

6.8 pH DATA

Continuous pH data were collected in the Malheur River at seven sites from below the Warm Springs Dam at Riverside, downstream to Ontario, during the period of May 23-25, 2006. All pH measurements met the State of Oregon Malheur River Basin pH criteria range of 7.0-9.0 pH units **(Figure 6-19)**. Continuous pH measurements made in five sites in Willow Creek and Bully Creek during the same time period also resulted in no exceedances of the pH criteria **(Figure 6-20)**. Two locations: Willow Creek at Huntington Junction and Bully Creek at Graham Boulevard had significant diurnal swings in pH. Both locations are a few miles downstream of major reservoirs (Malheur Reservoir and Bully Reservoir respectively).

Continuous pH monitoring of the Malheur River at six sites from Juntura downstream to Ontario, during the period of August 22-24, 2006 resulted slight exceedances of the upper pH criterion at Little Valley **(Figure 6-21)**. Continuous pH measurements made in five sites in Willow Creek and Bully Creek during the same time period resulted in no exceedances of the pH criteria **(Figure 6-23)**. The pH measurements made during the August sampling period had much larger diurnal variation than the May results. The largest variations occurred at upstream locations.

Continuous pH monitoring of the Malheur River at five sites from Juntura downstream to Ontario during the period of October 23-26, 2006, resulted in widespread increases of measured pH values over previous results, with only slight exceedances of the upper pH criterion at the Juntura location **(Figure 6-24)**. The river conditions were generally low and clear during the sample period, as flow from the reservoirs had been turned off for the season. In a repeat of the results from August 2006, continuous pH measurements made in five sites in Willow Creek and Bully Creek during the October time period resulted in no exceedances of the upper pH criterion (**Figure 6-25**). Diurnal variation of pH values was more pronounced in the data from the tributaries and at upstream locations.

Based on this analysis of available pH data, DEQ concludes that the few instances where the pH criteria are exceeded will be corrected as total phosphorus levels in the Malheur River are reduced to meet the phosphorus load allocations. The exceedances of the pH criterion occurred when turbidity is moderate to low, and nutrient levels are high, allowing algae to bloom. These conditions occur more frequently in the area of the Malheur River between Juntura and Little Valley in late summer and fall.

During the time of water sample collection in August 2006, the pH at Little Valley exceeded the pH criteria of 9 units (**Figure 6-21**). During this same time period, dissolved oxygen saturation at Little Valley was nearly 150% (**Figure 6-22**). Comparisons of Figures 21 and 22 indicates that dissolved oxygen saturation strongly correlates with pH at all the sample locations on the Malheur River in August 2006, Both peaks in dissolved oxygen and pH may be related to algae growth, which simultaneously increase DO by producing oxygen and increase pH by consuming carbon dioxide. Conditions at Little Valley and Juntura during the sampling period appear to have been ideal for growing algae. The turbidity at these locations was measured at 17 and 18 NTU respectively, compared to 49 NTU at Ontario. Total phosphorus was high at all locations: 0.25 mg/l at Little Valley, 0.22 mg/l at Juntura and 0.45 mg/l at Ontario. Higher turbidity appears to have limited algae growth and pH increases downstream at Ontario by reducing light penetration. These data suggest that water clarity and nutrient concentrations are important factors controlling algae growth in the Lower Malheur River. This observation is consistent with studies performed throughout the United States which show that algae growth is strongly dependent on adequate light (relating to water clarity), optimum current velocity, and phosphorus concentrations (US EPA, 2000).

Figure 6-19. Continuous pH measurements in Malheur River, May 2006.

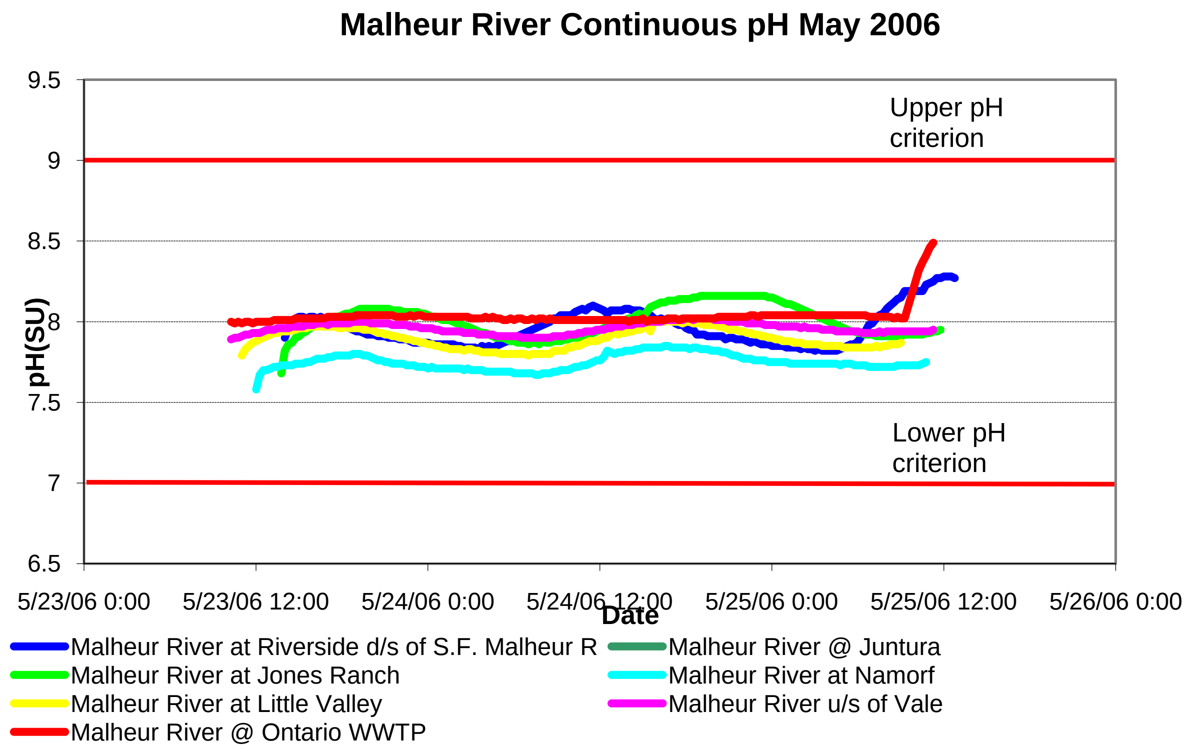


Figure 6-20. Continuous pH measurements in Willow and Bully Creeks, May 2006.

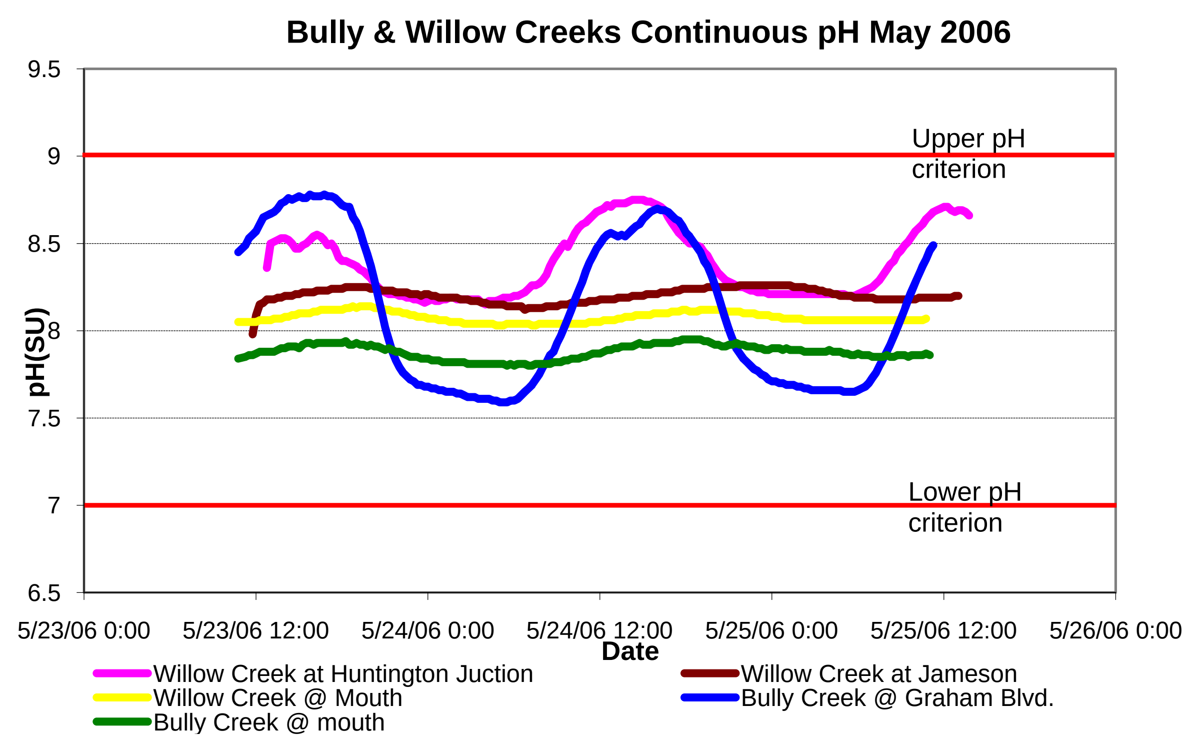


Figure 6-21. Continuous pH measurements in Malheur River, August 2006.

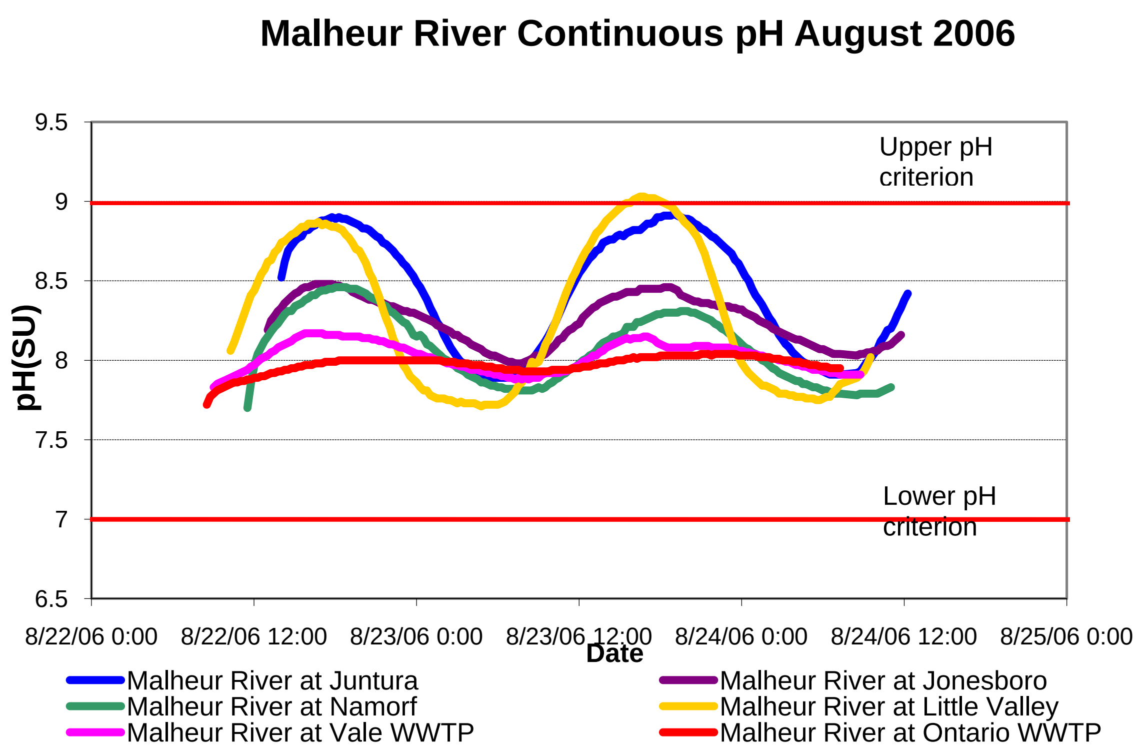


Figure 6-22. Continuous DO saturation measurements in Malheur River, August 2006.

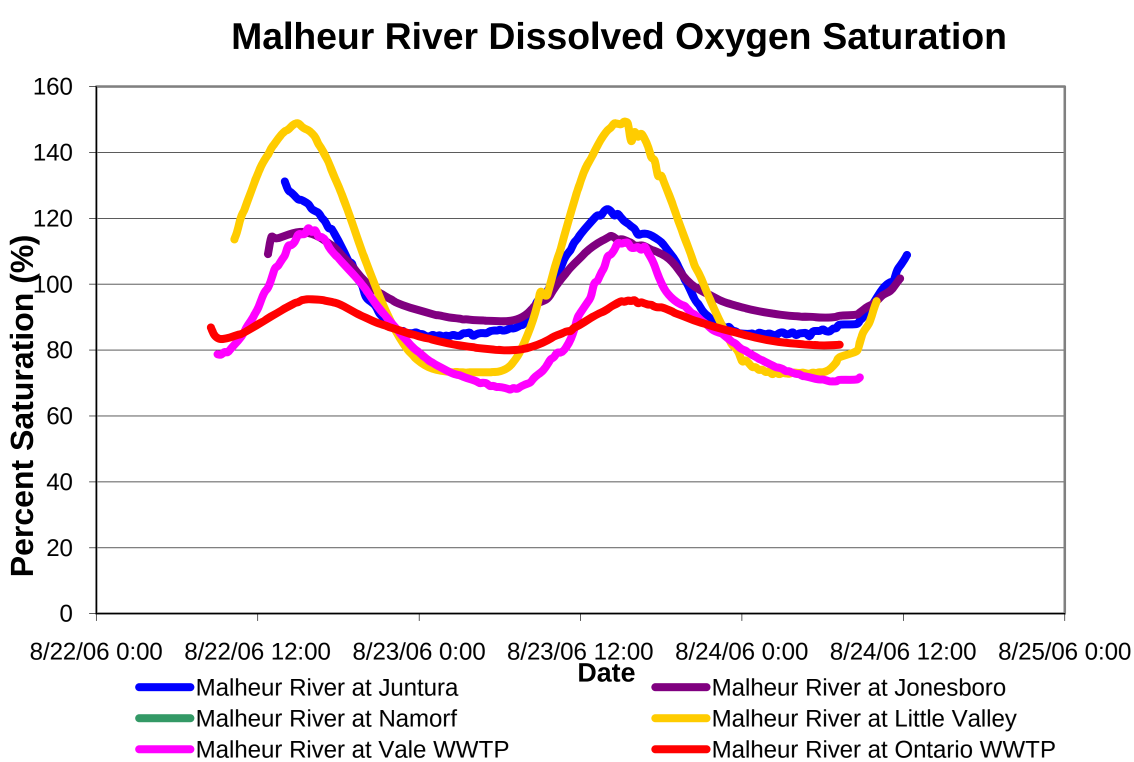


Figure 6-23. Continuous pH measurements in Willow and Bully Creeks, August 2006.

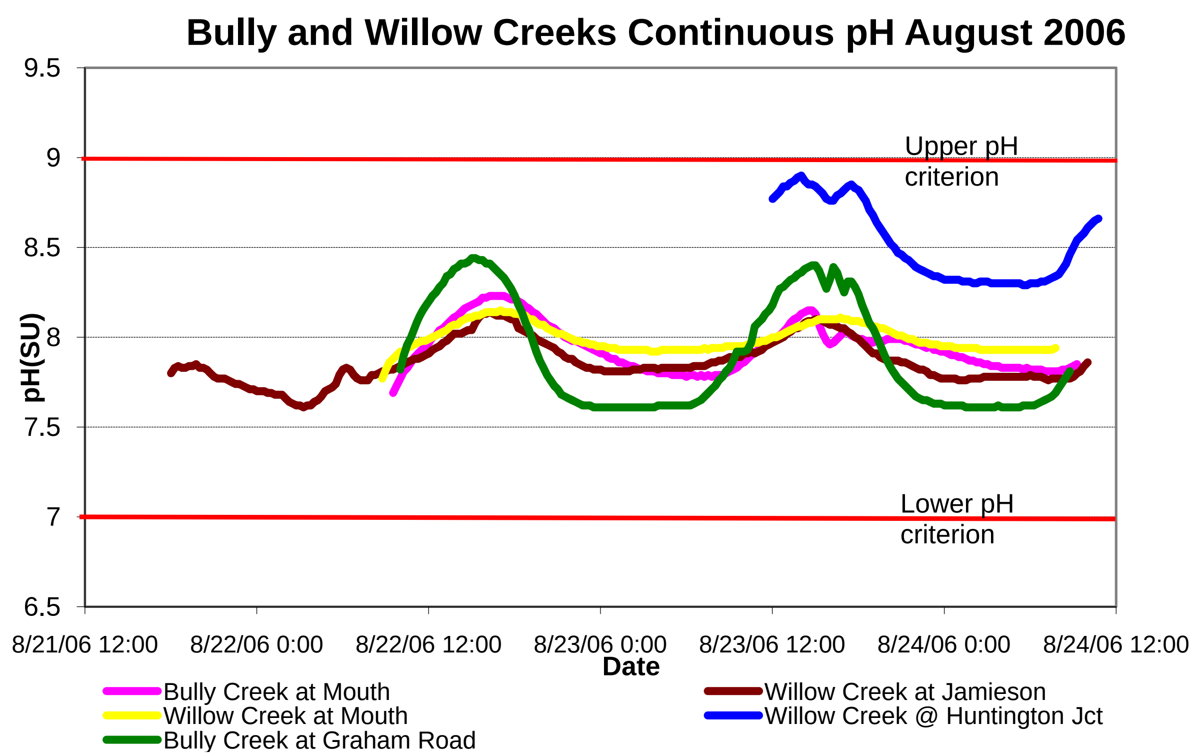


Figure 6-24. Continuous pH measurements in Malheur River, October 2006.

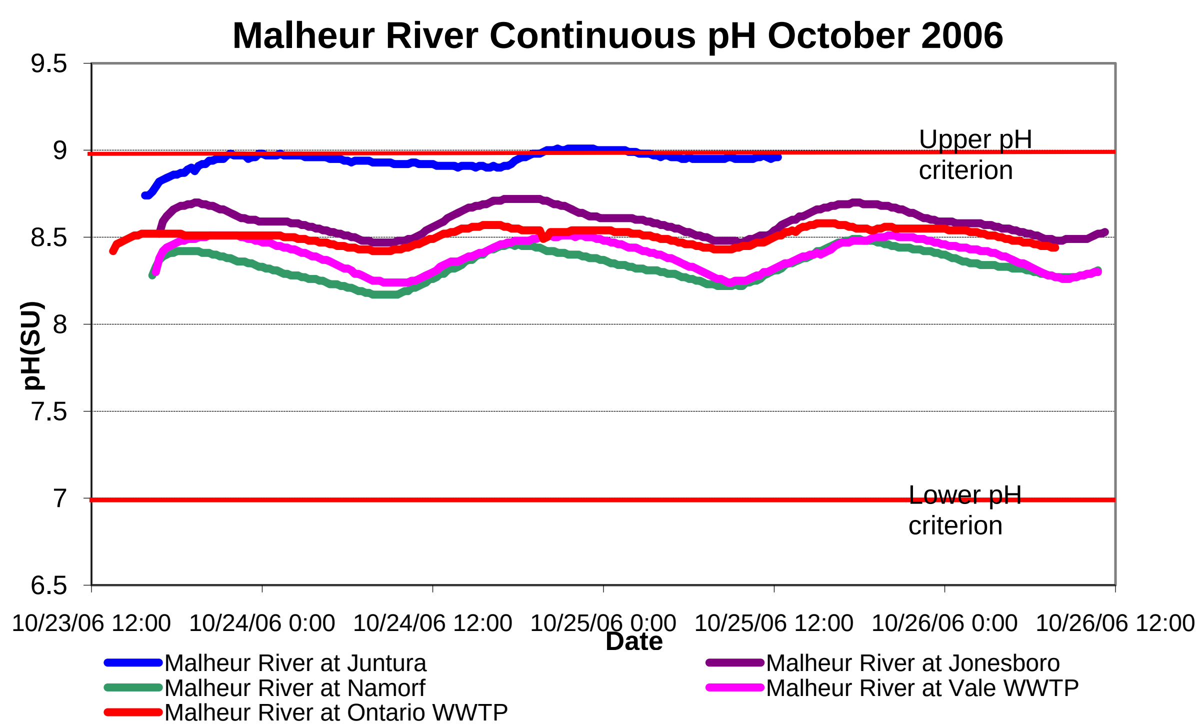
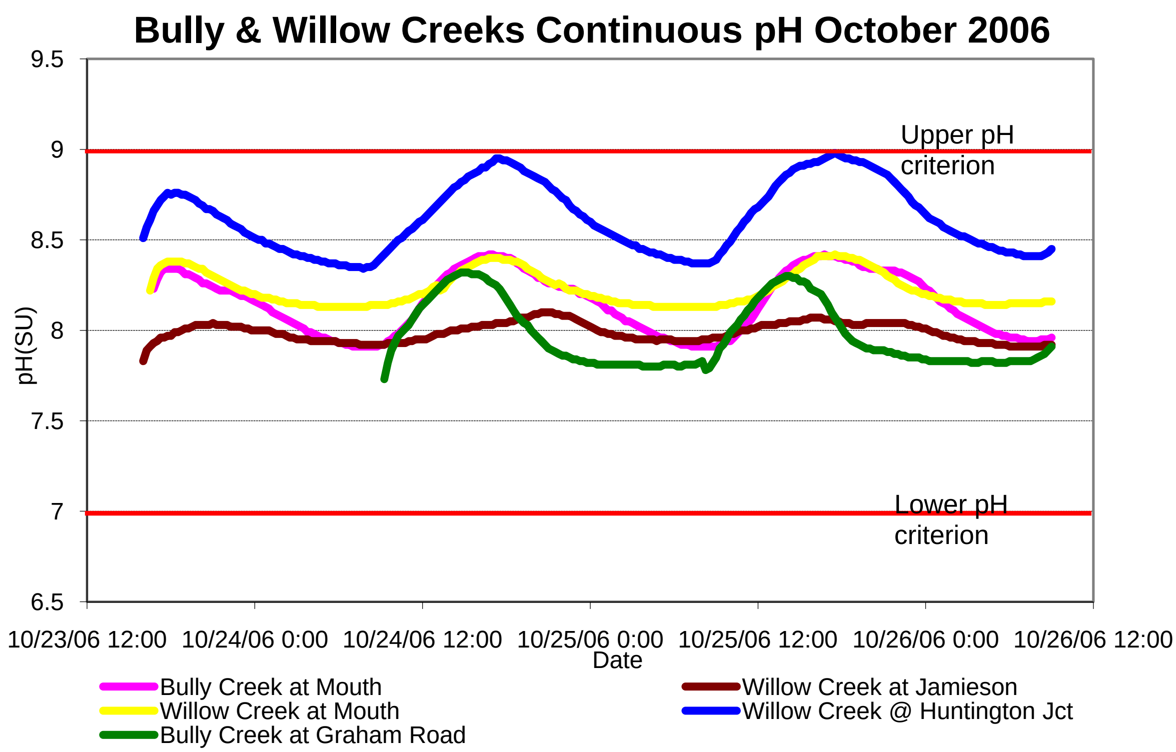


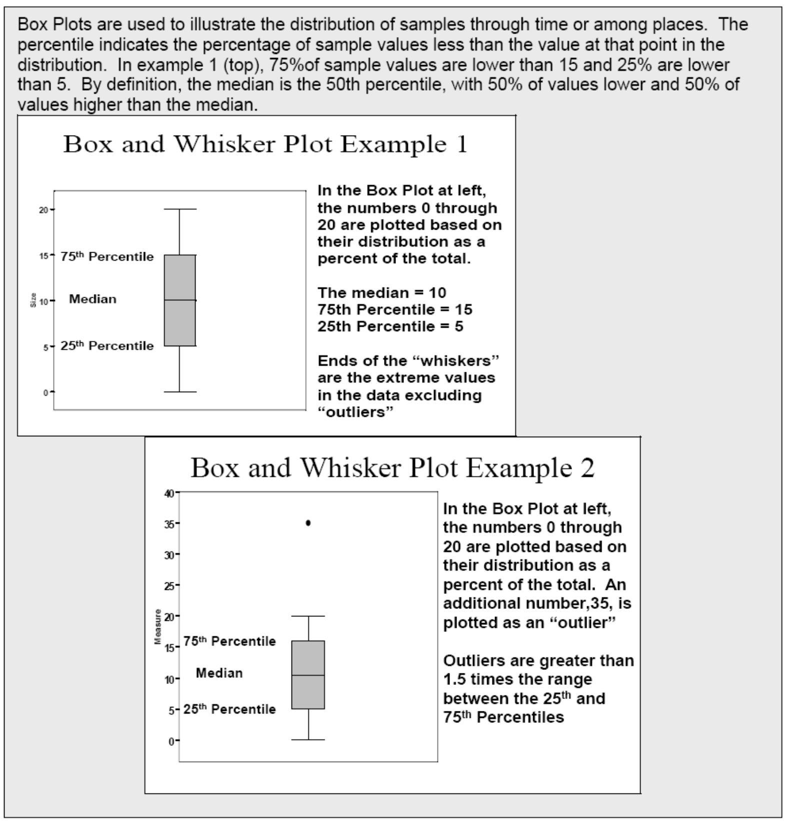
Figure 6-25. Continuous pH measurements in Willow and Bully Creeks, October 2006.



6.9 PHOSPHORUS SOURCE ASSESSMENT

Several water sampling efforts have been conducted in the Malheur River Basin over the last 10 years in an attempt to characterize water quality and determine areas of bacteria and nutrient loading (see Sections 4 and 5 of this document). Particular attention has been paid to phosphorus, which was assigned a load allocation in the Snake River-Hell's Canyon TMDL (2004) which requires significant reductions. The Snake River-Hell's Canyon TMDL called for an 87% reduction in total phosphorus to meet a May through September concentration limit of 0.07 mg/l at the mouth of the Malheur River in Ontario. Total phosphorus data from various reaches of the Malheur River and North Fork Malheur River are presented as box and whisker plots (see **Figure 6-26** for example) in **Figure 6-27, Figure 6-29,** and **Figure 6-31**. The data are presented as box plots with the upper boundary of the box representing the 75th percentile and the lower boundary representing the 25th percentile. The black line within the box represents the median concentration and the red dashed line represents the average concentration. The whisker lines extending vertically from the box give the full range of the data set. The number of samples (n) is given at the top of the graph. Sample Locations are shown in **Figure 6-28, Figure 6-30, and Figure 6-32.**

Figure 6-26. Box and Whisker Plot Example.



Total phosphorus data from water samples collected in the Upper Malheur River and its tributaries above Warm Springs Reservoir between 1999 and 2006 are presented in **Figure 6-26**. The Middle Fork Wolf Creek and Calamity Creek sites are located on the Malheur National Forest in headwater stream areas **(Figure 6-27)**. The Lower Pine Creek and Muddy Creek sample locations are in lower elevation streams which drain a mixture of public and private rangelands west of Drewsey. The limited tributary data indicate possible background total phosphorus concentrations ranging from approximately 0.05 mg/l to approximately 0.14 mg/l. The much larger data set for the downstream Malheur River Drewsey sampling location has a median total phosphorus concentration of approximately 0.18 mg/l. This sample location is in the Middle Fork of the Malheur River at the Highway 20 crossing, downstream of Drewsey (RM 140). It is located downstream of extensive irrigated hay meadows which are often used for late-season high density grazing. These data suggest fairly substantial phosphorus loading in the area between the Malheur National Forest and Drewsey.

Figure 6-27. Box plot of total phosphorus in the Upper Malheur River and tributaries.

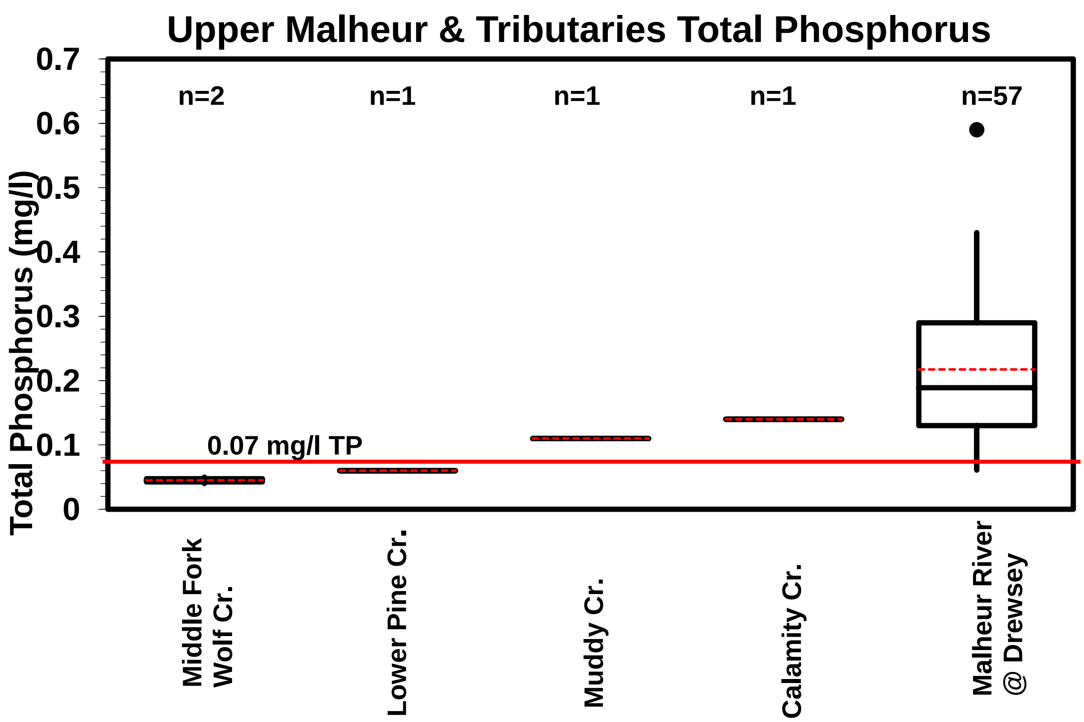
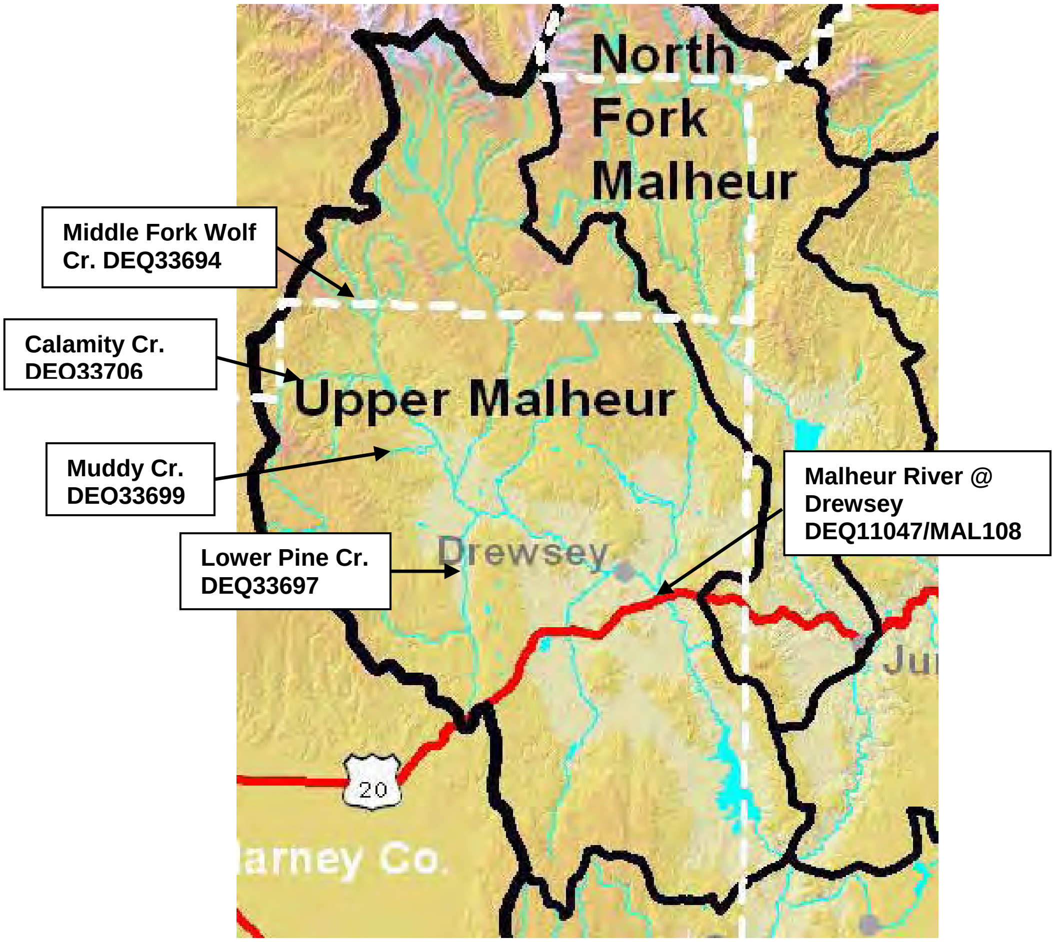


Figure 6-28. Upper Malheur Subbasin DEQ and Malheur Watershed Council phosphorus sampling locations with DEQ LASAR and EPA STORET sample location numbers 1999-2006.



Total phosphorus data from water samples collected in the North Fork Malheur River and its tributaries above Beulah Reservoir between 1999 and 2006 are presented in **Figure 6-29**. The Little Malheur River at Camp Creek, North Fork Malheur River upstream of Forest Service Road 16 and North Fork Malheur River downstream of Crane Creek sample locations are in higher elevation forested areas of the North Fork Malheur River watershed in the Malheur National Forest **(Figure 6-30)**. The North Fork Malheur River above the Little Malheur River sample location is located in the North Fork Malheur River just above the confluence with the Little Malheur. The Little Malheur at Mouth sample location is nearby in the Little Malheur River. This confluence is approximately 8 miles above Beulah Reservoir in an area of public and private rangelands. The North Fork Malheur River above Beulah Reservoir sample location is just upstream of where the North Fork Malheur River enters the northwest arm of Beulah Reservoir. The Bendire Creek sample location is in lower Bendire Creek approximately 2.5 miles above the northeast arm of Beulah Reservoir.

The total phosphorus data from the North Fork Malheur River and tributaries above Beulah Reservoir indicate that the SRHC TMDL target is met in this area with the exception of the lower Little Malheur River. The Little Malheur River downstream of the southern boundary of the Malheur National Forest is located in an area of heavy livestock grazing with reaches that lack most riparian vegetation, making it a likely source area for sediment and phosphorus. The lower

Bendire Creek valley and lands adjacent to the northeast arm of the reservoir are used as irrigated hay meadows. The upper reservoir lands are used for summer grazing when the reservoir is partially drained and vegetation grows in the formerly submerged land. These two areas in the upper portion of Beulah Reservoir are likely sources of phosphorus related to manure application and increased soil erosion.

Figure 6-29. Box plot of total phosphorus in the Upper North Fork Malheur River and tributaries.

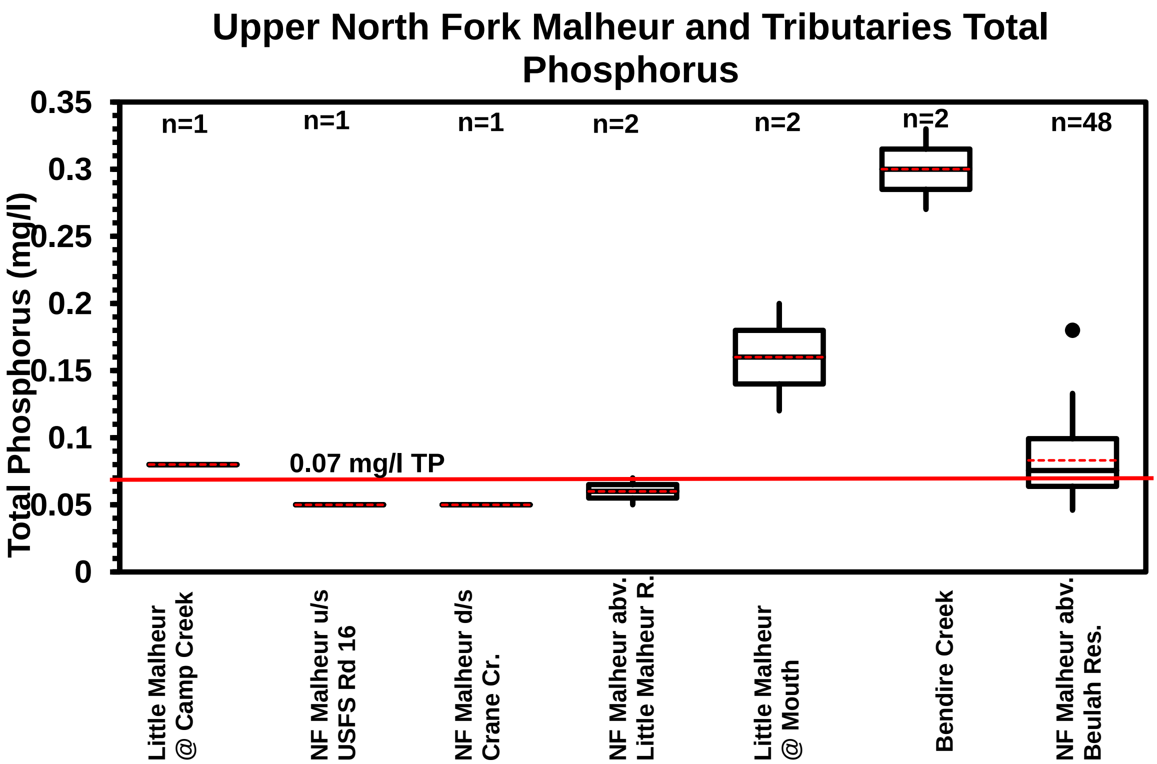
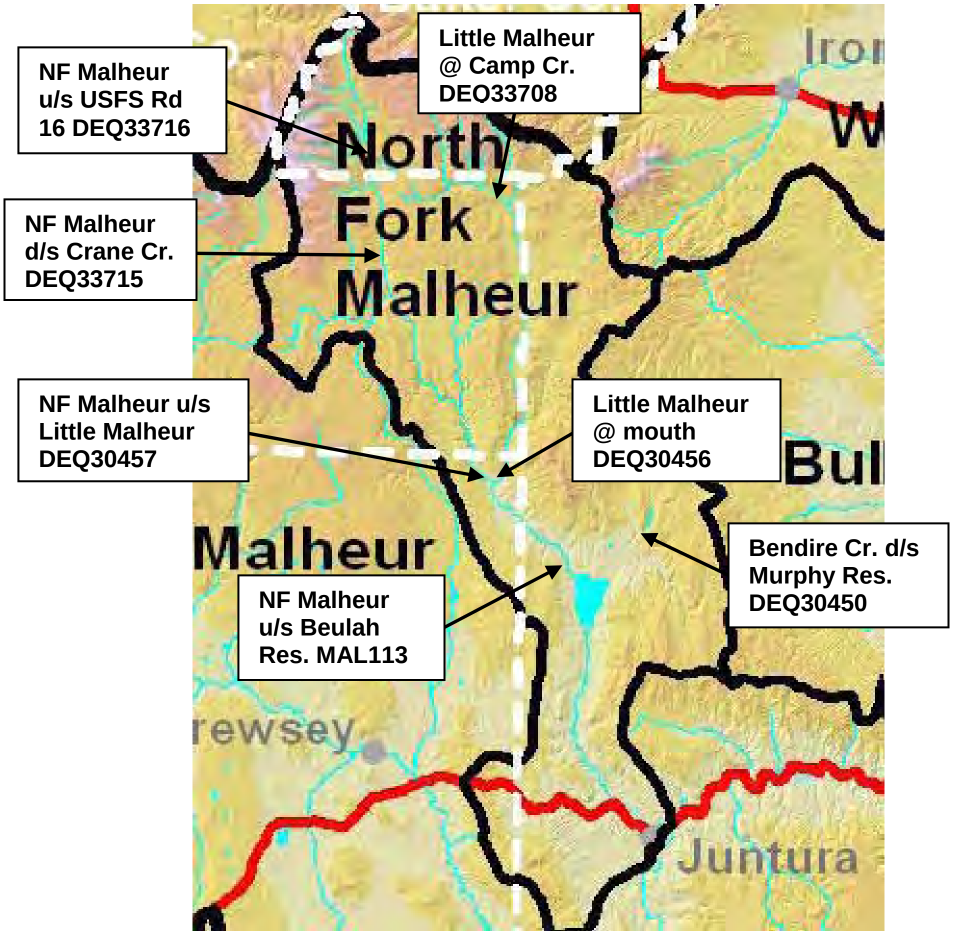


Figure 6-30. Upper Malheur Subbasin DEQ and Malheur Watershed Council phosphorus sampling locations 1999-2006 with DEQ LASAR and EPA STORET sample location numbers 1999-2006.



Total phosphorus data from water samples collected in the Malheur River from the Riverside area below Warm Springs Reservoir downstream to Ontario, and the North Fork Malheur River near its mouth at Juntura are presented in **Figure 6-30**. These sample locations are shown in **Figure 6-31**. The Riverside, Juntura and Namorf sample locations are in reaches of the Malheur River characterized by a mix of public and private rangelands with long rocky canyon sections. The section of the North Fork Malheur below Beulah Reservoir is characterized by increasing areas of irrigated meadows from the dam downstream to Juntura, where it joins the Malheur River. Below Namorf, the Malheur River flows out of its canyon into irrigated floodplains near Harper and Little Valley. The valley widens further below Little Valley down to Ontario. The lower Malheur Valley contains extensive areas of flood-irrigated row crops such as onions, beets and potatoes.

Total phosphorus levels in the Malheur River below Warm Springs Reservoir at Riverside **(Figure 6-31)** are very similar to the levels observed above the reservoir at Drewsey with a median value of approximately 0.18 mg/l **(Figure 6-27)**. This observation suggests that significant increases in total phosphorus do not occur in the Warm Springs reservoir reach. However, seasonal data analyses shown in Section 4 suggest that the reservoir is storing early Spring irrigation season phosphorus loading from the Upper Malheur River and releasing it downstream throughout the irrigation season.

Total phosphorus levels at the mouth of the North Fork Malheur River near Juntura are very similar to levels in the Malheur River at Riverside **(Figure 6-31)**, but considerably higher than the levels in the North Fork Malheur entering Beulah Reservoir **(Figure 6-29)**. This observation suggests that significant phosphorus loading is occurring in the vicinity of Beulah Reservoir and/or the reach of the North Fork Malheur River between Beulah Reservoir and Juntura. This is the same reach which has elevated bacteria levels described in Section 7.

Total phosphorus concentrations in the Malheur River decrease slightly in the reach between Riverside and Namorf. This observation suggests that phosphorus is consumed by plant uptake faster than it is being introduced to the river. At Little Valley, total phosphorus levels increase sharply and continue to increase down to the mouth of the river in Ontario **(Figure 6-31)**.

Figure 6-31. Box plot of total phosphorus in the Lower Malheur River and Lower North Fork Malheur River.

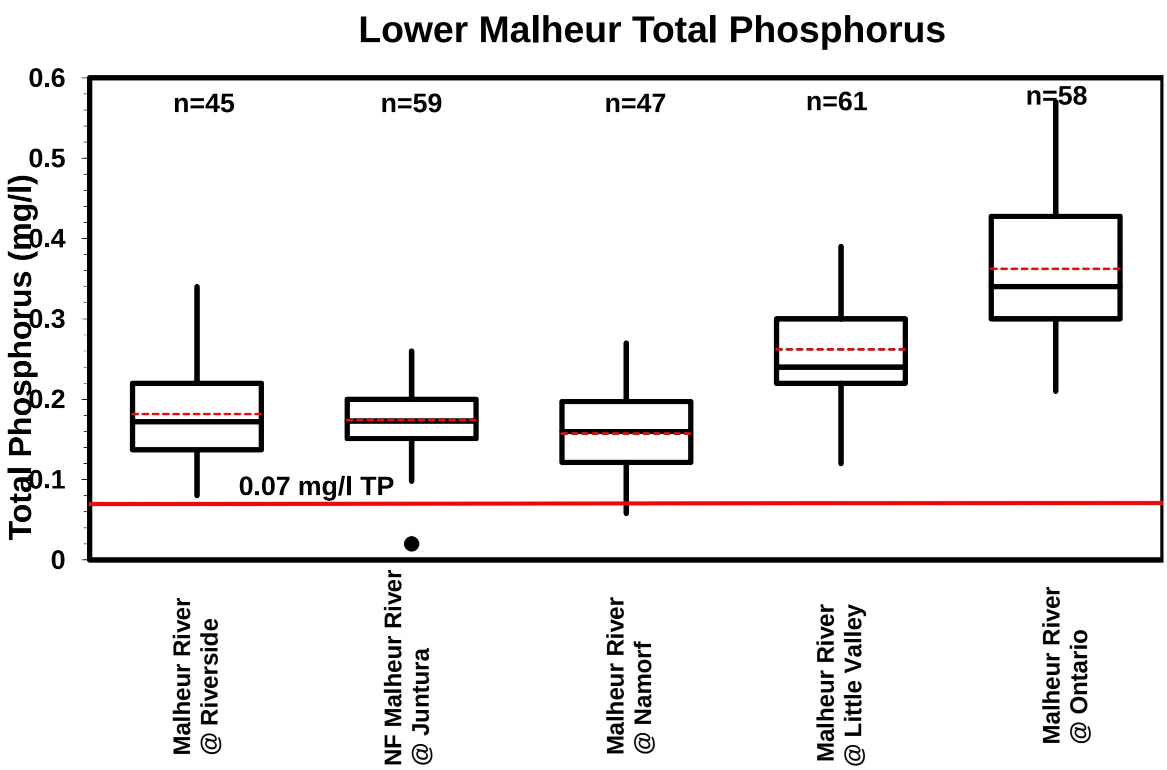
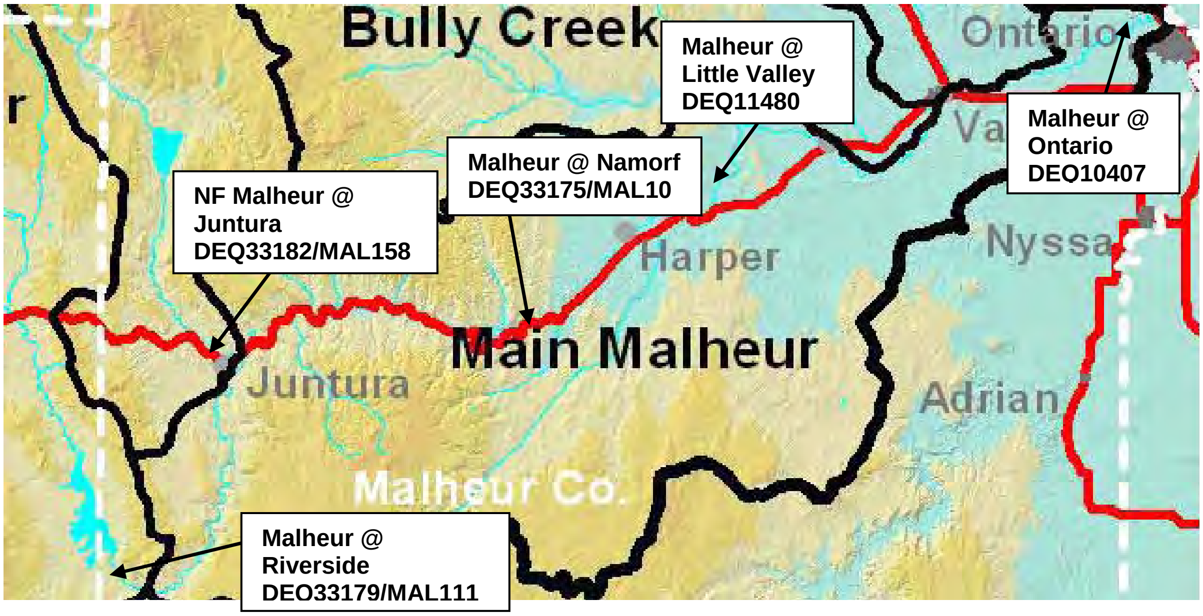


Figure 6-32. Lower Malheur Subbasin DEQ and Malheur Watershed Council phosphorus sampling locations 1999-2006 with DEQ LASAR and EPA STORET sample location numbers 1999-2006.



6.9.1 Correlation of Phosphorus Data with Other Water Quality Parameters

In August 2006, DEQ collected data from 24 randomly selected sites across the Malheur River Basin to assess the ecological condition of perennial, wadeable streams (**Appendix C – Baseline Beneficial Use Status of the Malheur River Basin)**. Streams were sampled for water chemistry, physical habitat, and macroinvertebrate assemblages. Nearly all targeted stream kilometers (91%) were ranked as most disturbed condition for temperature stress, while 54% were ranked as most disturbed condition for fine sediment stress. Despite such a high extent of the resource showing higher temperature stress scores than regional reference sites, fine sediment stress scores in the Malheur basin were more highly correlated with overall biological condition as measured by PREDATOR aquatic insect taxa loss **(Table 6-5)**.

Biological indices showed strong relationships to riparian condition, nutrients, and physical chemistry indicators. The strongest relationship between biological condition and stressors appears to be related to riparian condition. All riparian indicators of stress showed moderate or strong correlations to biological indices. Riparian cover was shown to be correlated most strongly with nutrients and suspended sediments. Overall, sites with a larger riparian buffer and shade had lower nutrients and suspended sediments.

Correlations between the various physical parameters were also examined **(Table 6-6)**. Total phosphorus concentrations were shown to have a strong negative correlation with biological condition (measured by aquatic insect presence, abundance, and diversity) and riparian vegetation buffer condition. Total phosphorus concentrations also have strong positive correlations with turbidity, total suspended solids, ammonia, total organic carbon, and organic nitrogen.

Implementation of the TMDL will involve improvements in riparian vegetation condition and reductions in soil erosion. These actions will have significant benefits that include reductions in sediment, nutrients, bacteria, and pesticide loading, improvements in stream habitat, and reductions in stream temperatures, which will protect sensitive beneficial uses such as fish and aquatic life.

Table 6-5. Correlations among Biological Indicators, Water Quality, and Physical Habitat Indicators for the Malheur River Basin, August 2006.

Indicator Type	PREDATOR (Taxa Loss)	Temperature Stress	Fine Sediment Stress
Biological Indicators			
PREDATOR (Taxa loss)	--	**-0.39**	**-0.51**
Temperature stress	**-0.39**	--	**0.66**
Fine sediment stress	**-0.51**	**0.66**	--
Stream size			
Width	0.02	0.21	**-0.38**
Bankfull width	-0.02	**0.31**	-0.28
Riparian Cover			
Buffer height	**0.37**	**-0.76**	**-0.75**
Buffer width	**0.59**	**-0.43**	**-0.56**
% Coniferous riparian	**0.44**	**-0.60**	**-0.71**
% Deciduous riparian	**0.34**	**-0.38**	**-0.33**
Solar pathfinder (mean)	**0.58**	**-0.70**	**-0.63**
Center densiometer (mean)	**0.53**	**-0.79**	**-0.53**
Bank densiometer (mean)	**0.48**	**-0.61**	**-0.31**
Bedded sediments			
% Fines	0.03	-0.25	0.18
% Gravel	0.27	**-0.36**	-0.21
% Cobble	-0.14	**0.32**	-0.17
% Boulder	-0.01	0.23	0.16
% Big substrate	-0.14	**0.39**	-0.10
Suspended Sediments			
Turbidity	**-0.56**	0.27	**0.35**
Total suspended solids	**-0.51**	0.28	**0.47**
Physical Chemistry			
Dissolved oxygen	**0.36**	0.23	-0.21
Dissolved oxygen (saturation)	**0.34**	0.29	-0.10
pH	-0.06	**0.31**	0.18
Temperature (grab)	**-0.40**	**0.66**	**0.63**
Conductivity	**-0.36**	**0.39**	**0.72**
Alkalinity	**-0.44**	**0.51**	**0.79**
Nutrients			
Ammonia	**-0.40**	**0.40**	**0.47**
Nitrate/Nitrite	-0.13	0.26	0.10
Total Kjeldahl nitrogen	**-0.68**	**0.54**	**0.68**
Total phosphorus	**-0.67**	**0.45**	**0.49**
Total organic carbon	**-0.53**	**0.68**	**0.56**

Pearson's correlation coefficients (r) ≥ 0.50 are displayed in red, and 0.30 ≤ (r) < 0.50 are displayed in blue. Positive and negative correlations are denoted by the sign.

Table 6-6. Correlations Among Field Parameters for Malheur River Basin, August 2006.

	Ammonia	Nitrate/Nitrite	Total Kjeldahl nitrogen	Total phosphorus	Total organic carbon
Physical chemistry					
Dissolved oxygen	-0.27	0.24	-0.40	-0.30	-0.08
Dissolved oxygen saturation	-0.23	0.14	-0.35	-0.31	-0.06
pH	-0.09	0.04	-0.08	0.12	0.10
Temperature	0.32	0.00	0.35	0.26	0.39
Conductivity	0.50	0.20	0.40	0.37	0.29
Alkalinity	0.58	0.26	0.49	0.52	0.39
Nutrients					
Ammonia		0.47	0.68	0.64	0.61
Nitrate/Nitrite	0.47		0.14	0.47	0.25
Total Kjeldahl nitrogen	0.68	0.14		0.79	0.85
Total phosphorus	0.64	0.47	0.79		0.70
Total organic carbon	0.61	0.25	0.85	0.70	
Suspended sediments					
Turbidity	0.50	0.35	0.70	0.82	0.54
Total suspended solids	0.57	0.21	0.62	0.69	0.46
Stream size					
Width	-0.05	0.43	-0.03	0.11	0.17
Bankfull width	0.00	0.43	0.02	0.12	0.26
Riparian cover					
Buffer height	-0.30	-0.05	-0.47	-0.40	-0.50
Buffer width	-0.40	-0.15	-0.54	-0.64	-0.52
% Coniferous	-0.43	-0.28	-0.44	-0.44	-0.43
% Deciduous	-0.34	-0.08	-0.44	-0.42	-0.48
Center densiometer (mean)	-0.34	-0.19	-0.64	-0.60	-0.60
Bank densiometer (mean)	-0.24	-0.24	-0.42	-0.58	-0.40
Solar pathfinder cover (mean)	-0.39	-0.16	-0.65	-0.54	-0.54
Bedded sediments					
% Boulder	0.13	-0.20	0.24	0.00	0.49
% Cobble	-0.05	0.17	0.06	0.14	0.28
% Gravel	-0.41	-0.09	-0.49	-0.49	-0.59
% Fines	0.24	0.03	0.08	0.12	-0.19

Pearson's correlation coefficients (r) ≥ 0.50 are displayed in red, and 0.30 ≤ (r) < 0.50 are displayed in blue. Positive and negative correlations are denoted by the sign.

6.10 PHOSPHORUS ALLOCATIONS

The 2004 Snake River-Hells Canyon TMDL allocated the Malheur River a phosphorus load to the Snake River based on a total phosphorus concentration of 0.07 mg/l. Allocations within the Malheur River Basin are based on this concentration limit. Background conditions and potential sources of phosphorus in the Malheur River Basin are discussed in **Section 6.9** of the Malheur River Basin TMDL document. Flow duration curves, phosphorus load allocations, and efforts to reduce non-point sources of phosphorus are discussed in the following sections.

Phosphorus load duration curves were prepared based on data from three locations in the Malheur River Basin: Malheur River at Ontario, North Fork Malheur River at Juntura, and Malheur River near Drewsey **(Figures 6-33, 6-34, and 6-35)**. The Ontario phosphorus load duration curve was prepared using Oregon DEQ monitoring data from Lasar database station 10407, located at the Highway 201 Bridge over the Malheur River in Ontario at approximately RM 0.5. The flow data used in this plot came from the USBR MALO flow gauge located at the 36th Street Bridge in Ontario at approximately RM 3.5. The North Fork Malheur River phosphorus load duration curve was prepared using mainly Malheur Watershed Council/Bureau of Reclamation data from sample site MAL158 and some data from the collocated DEQ Lasar site 33182 (RM 1.5 near Juntura). Flow data for the North Fork Malheur load duration curve came from the USBR BEUO flow gauge below the Agency Valley Dam at RM 18. The Malheur River Drewsey phosphorus load duration curve was prepared using mainly Malheur Watershed Council/Bureau of Reclamation data from sample site MAL108 and some data from the collocated DEQ Lasar site 11407 (approximately RM 142). Flow data used to make this plot is from the nearby USBR MADO flow gauge at RM 142.

The load duration plots for the Ontario, Juntura and Drewsey locations were used to calculate phosphorus allocations for a range of flow conditions. Phosphorus loads (red squares) within a flow range were averaged and compared to an average of values from a segment of blue line representing load capacity at a concentration of 0.07 mg/l total phosphorus. This calculation allowed a determination of the amount of total phosphorus load reduction needed to meet the total phosphorus concentration limit. The results of these comparisons are reported in **Tables 6-7, 6-8, and 6-9.**

The calculated reduction in total phosphorus load in the Malheur River at Ontario ranges between 81% and 87% **(Table 6-7)**. There is very little variation of the level of reduction needed between flow ranges at this location. The calculated reduction in total phosphorus in the North Fork Malheur at Juntura ranges between 52% and 64% (**Table 6-8**) with the amount of required reduction generally increasing with increased flow. The calculated reduction in total phosphorus in the Malheur River at Drewsey ranges between 18% and 87% (**Table 6-9**), and generally increases with a reduction in flow. The high value of 87% was calculated for extremely low flow periods typical of late irrigation season, when the phosphorus load in this reach of the Malheur River would be very small. The 18% reduction was calculated for the highest flow events, typical of early spring, prior to the start of irrigation season. The mid-range flow intervals have calculated reductions ranging between 58% and 62%. These flow rates are more typical of early irrigation season flows.

An explicit margin of safety was not used in the calculation of the percent reduction required to meet the total phosphorus criterion. A 13% explicit margin of safety was used to calculate the total phosphorus allocation assigned to the Malheur River in the Snake River-Hell's Canyon TMDL (concentration of 0.07 ppm total phosphorus). This allocation was the basis for calculating the percent reduction needed.

Based on USBR flow estimates made during the development of the Snake River-Hell's Canyon TMDL, the total phosphorus concentration limit of 0.07 mg/l corresponds to a load allocation of 61 kg/day at the mouth of the Malheur River in Ontario. This allocation relied on a calculated average summer flow estimate of 357 cfs for Ontario. The flow estimate was based on 1990's data from a flow gauge in Vale, Oregon (RM 20). In 2000, the MALO flow gauge was installed at 36th Street in Ontario (RM 3). Based on MALO flow gauge data, average daily May-September flow for the years 2000-2008 was 235 cfs. This flow measurement results in an average May-September phosphorus load of 40 kg/day, which is a 34% reduction in phosphorus loading from the load calculated in the Snake River-Hell's Canyon TMDL.

Figure 6-33. Phosphorus load duration curve, Malheur River at Ontario. Water quality data from DEQ Lasar site 10407, located at Hwy 201 Bridge, Ontario; Flow data from USBR flow gauge MALO, located at 36th Street Bridge, Ontario Oregon.

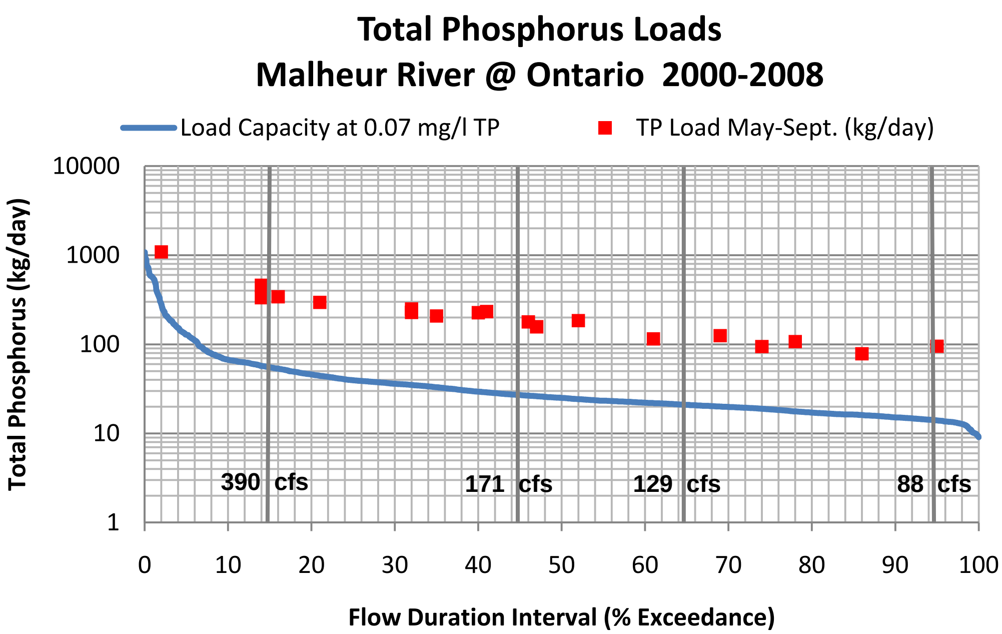


Table 6-7. Level of total phosphorus reduction needed in Malheur River at Ontario to meet Snake River-Hells Canyon TMDL. Malheur River total phosphorus allocation based on TP concentration of 0.07 mg/l.

Flow % Exceedance Interval	Avg. TP Load Capacity (kg/day)	Avg. TP Load (kg/day)	% Reduction
0-10%	209	1089	81
10-40%	43	293	85
40-60%	25	188	87
60-90%	19	104	82
90-100%	14	95	86

Figure 6-34. Phosphorus load duration curve, North Fork Malheur River near Juntura. Water quality data from DEQ Lasar site 33182/USBR MAL158, located at Beulah Road Bridge, north of Juntura; Flow data from USBR flow gauge BEUO, located below Agency Valley Dam.

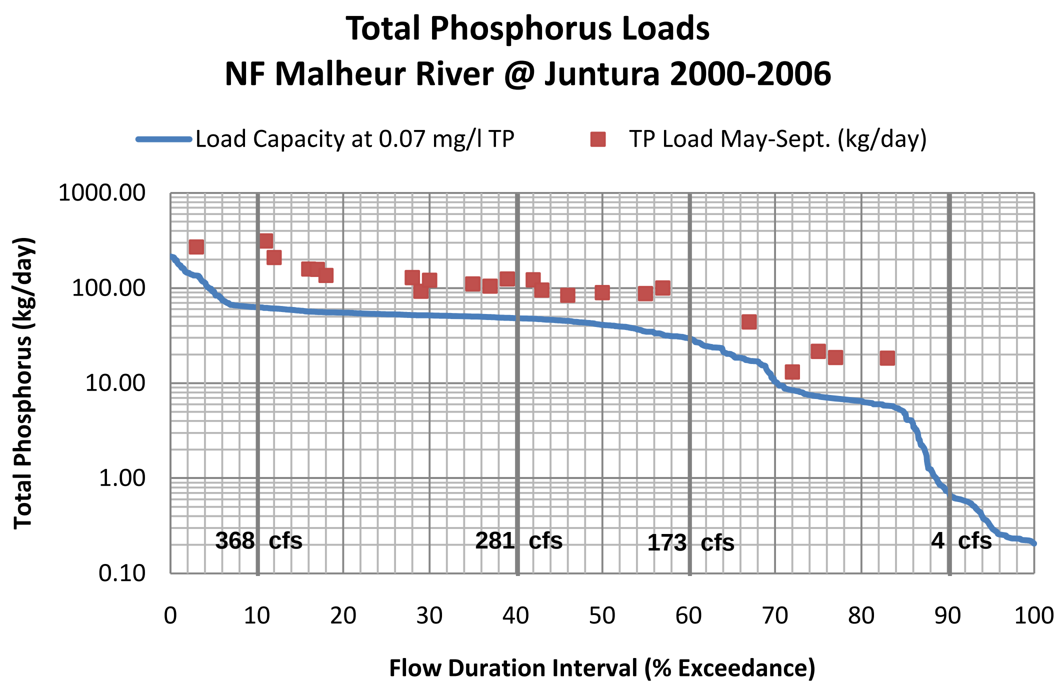


Table 6-8. Level of total phosphorus reduction in needed North Fork Malheur River at Juntura to meet Snake River-Hells Canyon TMDL. Malheur River total phosphorus allocation based on concentration of 0.07 mg/l.

Flow % Exceedance Interval	Avg. TP Load Capacity (kg/day)	Avg. TP Load (kg/day)	% Reduction
0-10%	107	271	61
10-40%	54	151	64
40-60%	40	96	58
60-90%	11	22	52
90-100%	0.4	NA	NA

Figure 6-35. Phosphorus load duration curve, Malheur River near Drewsey. Water quality data from DEQ Lasar site 11407/USBR MAL108, located at Highway 20 Bridge, south of Drewsey; Flow data from nearby USBR flow gauge MADO.

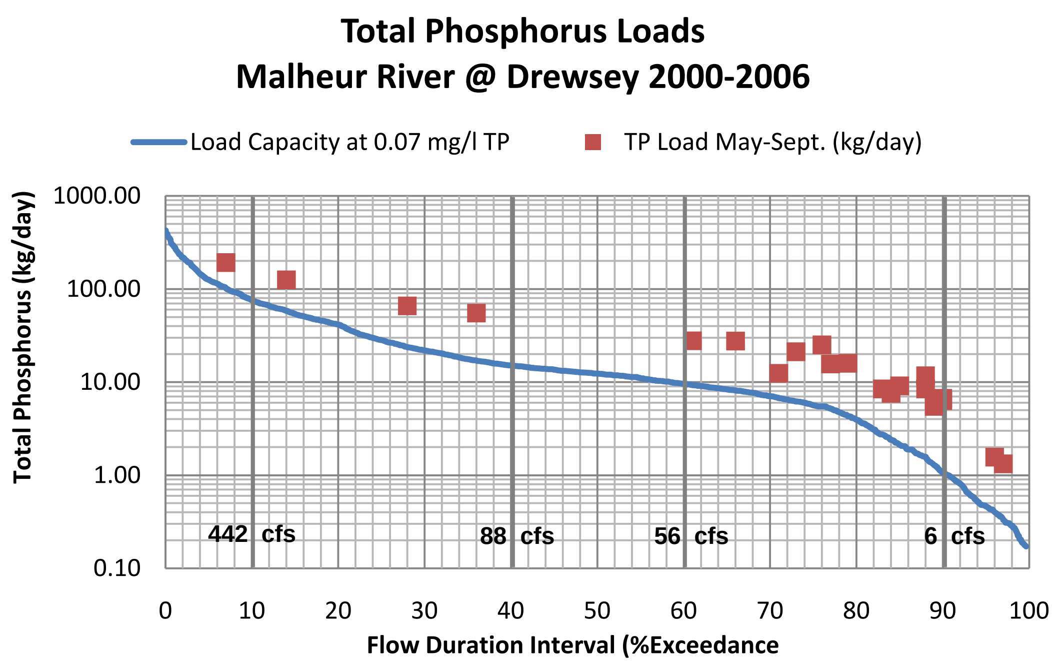


Table 6-9. Level of total phosphorus reduction needed in Malheur River at Drewsey to meet Snake River-Hells Canyon TMDL Malheur River. Total phosphorus allocation based on concentration of 0.07 mg/l.

Flow % Exceedance Interval	Avg. TP Load Capacity (kg/day)	Avg. TP Load (kg/day)	% Reduction
0-10%	158	192	18
10-40%	34	82	58
40-60%	12	NA	NA
60-90%	5	14	63
90-100%	0.5	4	87

6.11 MARGIN OF SAFETY

OAR 340-042-0040(4)(i)

An explicit margin of safety was not used in the calculation of the percent reduction required to meet the total phosphorus criterion. A 13% explicit margin of safety was used to calculate the total phosphorus allocation assigned to the Malheur River in the Snake River-Hell's Canyon TMDL. This allocation was the basis for calculating the percent reduction needed.

6.12 SEASONAL VARIATION

OAR 340-042-0040(4)(j)

Box plots of total phosphorus data shown in **Figure 6-26**, **Figure 6-28**, and **Figure 6-30** include data collected all year and reflect total phosphorus concentrations along longitudinal profiles of the Malheur River, North Fork Malheur River and their tributaries. However, the total phosphorus allocation for the Malheur River from the Snake River-Hells Canyon TMDL applies during the critical time period defined as May through September. Increased variation in oxygen levels have been documented during summer, and the chlorophyll 303(d) listing for the Lower Malheur River and its tributaries applies during summer. Based on consideration of these seasonal factors, May-September total phosphorus data were used to calculate the required reductions in total phosphorus.

6.13 RESERVE CAPACITY

OAR 340-042-0040(4)(k)

There is no reserve capacity for total phosphorus in this TMDL. Future point sources will be required to meet the water quality criterion for phosphorus. Additional non-point sources of phosphorus will not be allowed to cause total phosphorus loading to exceed the loading capacity.

6.14 REFERENCES

DEQ, 2003, Fish Use Designations Map for the Malheur River Basin, Oregon Administrative Rules, Chapter 340, Division 41, Figure 201A.

DEQ, 2004, Snake River-Hell's Canyon Total Maximum Daily Load, Tributary Total Phosphorus Load Allocations, p. 447.

DEQ, 2006, Assessment Methodology for Oregon's 2004/2006 Integrated Report on Water Quality Status, Appendix 3.

US EPA. 2000. EPA 822-B00-001. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs, First Edition. United States Environmental Protection Agency Office of Water, Washington DC July 2000 and EPA 822-B-00-002. Nutrient Criteria Technical Guidance Manual: Rivers and Streams.US EPA Office of Water, Washington DC, July 2000.

MALHEUR RIVER BASIN TMDL

CHAPTER 7: BACTERIA

Final
September 2010

DEQ
State of Oregon
Department of
Environmental
Quality

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7.1 INTRODUCTION

Waterbodies in the Malheur River Basin are water quality limited due to fecal coliform and *E. coli* bacteria concentrations which affect water contact recreation and other beneficial uses. Identified waterbodies of concern include the Upper Malheur River, Lower Malheur River, Lower Willow Creek, portions of Bully Creek, and the lower North Fork Malheur River **(Figure 7-1)**. Portions of Shepherd Gulch and South Fork Jacobsen Gulch in the adjacent Middle Snake-Payette Subbasin are also included on the 303(d) list for fecal coliform bacteria. The 303(d) listings for bacteria occur in the summer period, with the exception of Willow Creek, which is listed all year. Analysis of the bacteria data conducted during development of the TMDL indicate that bacteria criteria are exceeded in Willow Creek, Bully Creek, the Malheur River, and the North Fork Malheur River year round, with reduced impacts during the non-irrigation season of late fall through early spring. The bacteria TMDL information is summarized in **Table 7-1**, and 303(d) listings are described in **Table 7-2**.

Based on the analysis of bacteria data conducted during the development of this TMDL, it is recommended that the Malheur River from RM 96.2 at the confluence of the North Fork Malheur River to RM 119.9 below Warm Springs Dam be removed from the 303(d) list for bacteria. The bacteria data review also indicated that Bully Creek from RM 0 to RM 15.9, and the Malheur River from RM 129 at the upper end of Warm Springs Reservoir to RM 170 above Wolf Creek, do not meet applicable *E. coli* bacteria water quality criteria. The water quality impairments in these un-listed stream segments are addressed by the bacteria TMDL.

Fecal coliform and *E. coli* bacteria sources may include wildlife, livestock waste, failing residential septic systems, waste water treatment plant malfunctions, rural residential runoff and urban runoff. There are no permitted point sources of bacteria in the basin, and the generally sparse residential development restricts potential septic and non-permitted point sources to localized areas. Confined Animal Feeding Operations (CAFOs) are considered to be point sources which are not allowed to discharge to waters of the state. CAFOs were given a zero allocation in this TMDL. The major developed areas of the basin such as Ontario and Vale do not discharge waste water to any Malheur River Basin surface waterbodies (Ontario discharges to the Snake River in winter) and there are no plans to do so in the future, therefore no reserve capacity was allocated. Fecal coliform bacteria loading in the Malheur River Basin appear to be dominated by non-point sources. Nonpoint source pollution comes from diffuse sources such as agriculture, wildlife and urban runoff. Stream flow based allocations have been developed for nonpoint sources and apply year-round. The components of the Malheur River Basin bacteria TMDL are summarized in **Figure 7-1**.

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Figure 7-1. Bacteria 303(d) Listings Malheur River Basin, Middle Snake-Payette Subbasin.

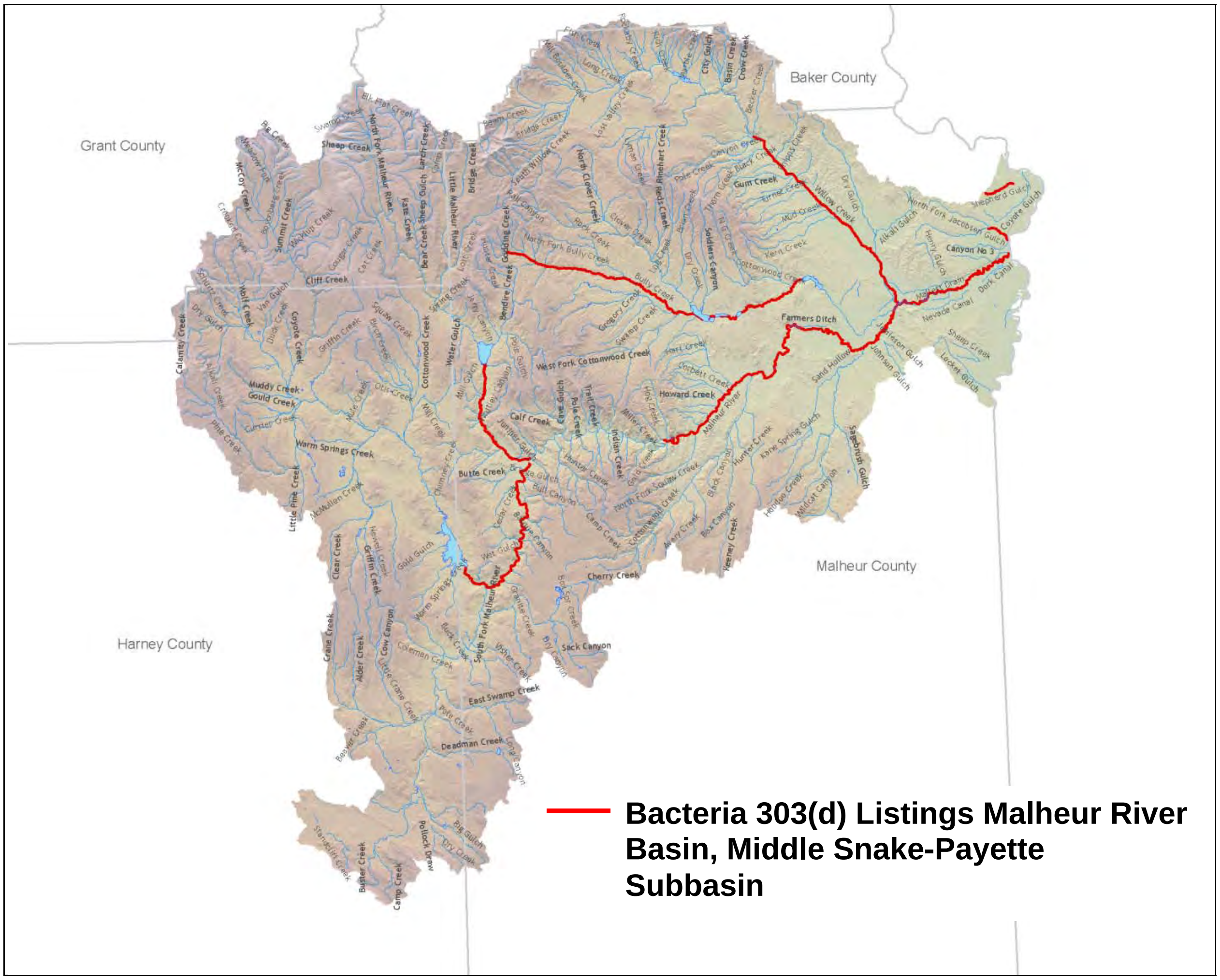


Table 7-1. Bacteria TMDL Summary Information.

Water Bodies	Malheur River Basin, Hydrologic Unit Code 17050116, Middle Snake-Payette Subbasin Hydrologic Unit 17050115
Pollutant Identification **OAR 340-042-0042(4)(b)**	Human pathogens associated with fecal contamination.
Water Quality Standards **OAR 340-041-009 (Bacteria)**	Freshwater criteria – log mean 126 counts/deciliter *E.coli* (targeted explicitly), instantaneous 406 counts/deciliter *E.coli* (targeted explicitly)
Beneficial Uses **OAR 340-042-0040(4)(c)**	The most sensitive beneficial uses of surface water in the Malheur River Basin and Middle Snake-Payette Subbasin is water contact recreation.
Loading Capacity **OAR 340-42-0040(4)(d)** **CWA 303(d)(1)**	Loading Capacity was determined using load duration curves which account for the range of observed flows and the applicable water quality standard.
Excess Load **OAR 340-42-0040(4)(e)**	The difference between the actual pollutant load in a waterbody and loading capacity of that waterbody. In this TMDL, the excess load is expressed in the percent load reductions.
Sources **OAR 340-42-0040(4)(f)** **CWA 303(d)(1)**	Fecal bacteria sources may include livestock, rural residential, urban runoff, and wildlife.
Load Allocations **OAR 340-042-0040(4)(h)**	The TMDL is divided into allocations to nonpoint sources (load allocations), and a margin of safety (MOS) for each flow regime. Allocations apply year round and are based on stream flow.
Surrogate Measures **OAR 340-042-0040(5)(b)** **40 CFR 130.2(i)**	Where appropriate, a percent reduction of the seasonal log mean load was used as a surrogate measure for meeting the 30-day log mean standard.
Margin of Safety **OAR 340-042-0040(4)(i)** **CWA 303(d)(1)**	Five percent reduction in log mean concentration to meet the log mean criterion of 126 counts /deciliter. No MOS used in calculations for single sample criteria of 406 counts/deciliter.
Seasonal Variation **OAR 340-042-0040(4)(j)** **CWA 303(d)(1)**	Seasonal variation is addressed by segregating data into irrigation season (April 16-October 15) and non-irrigation season (October 16 – April 15). Allocations apply year round and are flow based.
Reserve Capacity **OAR 340-042-0040(4)(k)**	None. Future point sources will be required to meet water quality criteria at the point of discharge. Additional nonpoint source contribution may not cause total loading to exceed the loading capacity.
Water Quality Standard Attainment Analysis **CWA 303(d)(1)**	Load duration curves have been used to determine loading at all observed flows. The implementation of flow-based reductions will result in the attainment of water quality standards. Further discussion can be found in the Malheur TMDL Water Quality Management Plan.
Water Quality Management Plan **OAR 340-041-0040(4)(l)** **CWA 303(d)(1)**	The Water Quality Management Plan provides the framework of management strategies to meet and maintain water quality standards. This framework is designed to work with TMDL Implementation Plans prepared by Designated Management Agencies (DMAs) as required by Oregon's TMDL Rule.

7.2 BACTERIA 303(D) LISTINGS

The Malheur River basin contains waterbodies where the concentration of fecal coliform and/or *E. coli* bacteria have been measured at concentrations which exceed the water quality standard. These waterbodies are recorded on a list that is required by Section 303(d) of the Clean Water Act. **Table 7-2** lists the Malheur River Basin streams that are on the 303(d) list for bacteria, and **Figure 7-1** shows their location in the basin. The indicator bacterium used by DEQ for assessing bacterial contamination for recreational waters changed in 1996 from the general class of fecal coliform bacteria to *E. coli*. This change was made in part because *E.coli* is a more direct reflection of contamination from sources that also carry pathogens harmful to humans. Most of the listings in the Malheur River Basin are based on the pre-1996 Fecal Coliform standard. The load allocations in this TMDL are based on *E. coli*, but are intended to address both the general Fecal Coliform and *E. coli* bacteria 303(d) listings.

Table 7-2. Bacteria 303(d) listings Malheur River Basin, Middle Snake-Payette Subbasin.

Malheur River.

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
13552	Malheur River	0 to 67	E Coli	Summer	303(d)	2004
2431	Malheur River	0 to 67	Fecal Coliform	Summer	303(d)	1998
2250	Malheur River	93.4 to 119.9	Fecal Coliform	Summer	303(d)	1998

Willow Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2434	Willow Creek	0 to 27.4	Fecal Coliform	Fall/Winter/Spring	303(d)	1998
2254	Willow Creek	0 to 27.4	Fecal Coliform	Summer	303(d)	1998
9098	Willow Creek	0 to 0.2	E Coli	Fall/Winter/Spring	303(d)	2004
9097	Willow Creek	0 to 0.2	E Coli	Summer	303(d)	2004

Bully Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2253	Bully Creek	15.9 to 57.1	Fecal Coliform	June 1 - September 30	303(d)	1998

Upper Malheur Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2251	North Fork Malheur River	0 to 18	Fecal Coliform	Spring/Summer	303(d)	1998

Table 7-2, Continued.

Middle Snake-Payette Subbasin

Record ID	Water Body	River Miles	Parameter	Season	Status	List Date
2256	Shepherd Gulch	0 to 3.6	Fecal Coliform	Spring/Summer	303(d)	1998
2255	South Fork Jacobsen Gulch	0 to 3	Fecal Coliform	Spring/Summer	303(d)	1998

7.3 POLLUTANT IDENTIFICATION

OAR 340-042-0042(4)(b)

The pollutant of concern is a group of fecal-related microorganisms which cause disease in humans. Fecal coliform and Escherichia coli (*E.coli*) bacteria are produced in the digestive system of warm-blooded vertebrate animals. Their presence indicates the likely presence of pathogens which can produce disease. Fecal coliform and *E.coli* have been measured in water bodies in the Malheur River Basin. The target indicator for this TMDL is *E. coli*.

7.4 BENEFICIAL USE IDENTIFICATION

OAR 340-042-0040(4)(c)

For water quality purposes, designated beneficial uses of surface water in the Malheur River Basin are listed in ORS 340-41-0201:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Fish and Aquatic Life
- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality

The bacteria TMDL is designed to protect the most sensitive designated beneficial uses that include human contact with surface waters such as fishing and water contact recreation. Bacteria are considered to impair the recreational use of surface water if concentrations exceed those determined through epidemiological studies to cause illness through body contact at a rate of 8 or more cases per 1,000 swimmers.

7.5 WATER QUALITY STANDARDS

OAR 340-041-009

The bacteria TMDL for the Malheur River Basin is based on the current bacteria standard, which was adopted in 1996 and is based on *E.coli* as an indicator organism. *E.coli* is a species contained within the larger group of fecal coliform bacteria. Prior to 1996, the standard was based on fecal coliform concentrations, and as stated previously, most of the 303(d) listings were based on fecal coliform analyses. The bacteria standard was reorganized and revised as OAR 340-41-0009 in 2003. Applicable numeric and narrative criteria for this standard are as follows:

(1) Numeric Criteria: Organisms of the coliform group commonly associated with fecal sources (MPN or equivalent membrane filtration using a representative number of samples) may not exceed the criteria described in paragraphs (a) and (b) of this paragraph:
   (a) Freshwaters and Estuarine Waters Other than Shellfish Growing Waters:
      (A) A 30-day log mean of 126 *E.coli* organisms per 100 milliliters, based on a minimum of (5) samples;
      (B) No single sample may exceed 406 *E.coli* organisms per 100 milliliters.
(2) Raw Sewage Prohibition: No sewage may be discharged into or in any other manner be allowed to enter the waters of the State, unless such sewage has been treated in a manner approved by the Department or otherwise allowed by these rules;
(3) Animal Waste: Runoff contaminated with domesticated animal wastes must be minimized and treated to the maximum extent practicable before it is allowed to enter waters of the State;
(4) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health may not be allowed;

A log mean is also called a geometric mean, and is a type of average which tends to dampen the effect of very high or low values which might bias the result if a conventional average/mean were used. The practical expression of a log or geometric mean is the average of the logarithmic values of a data set, converted back to a base 10 number.

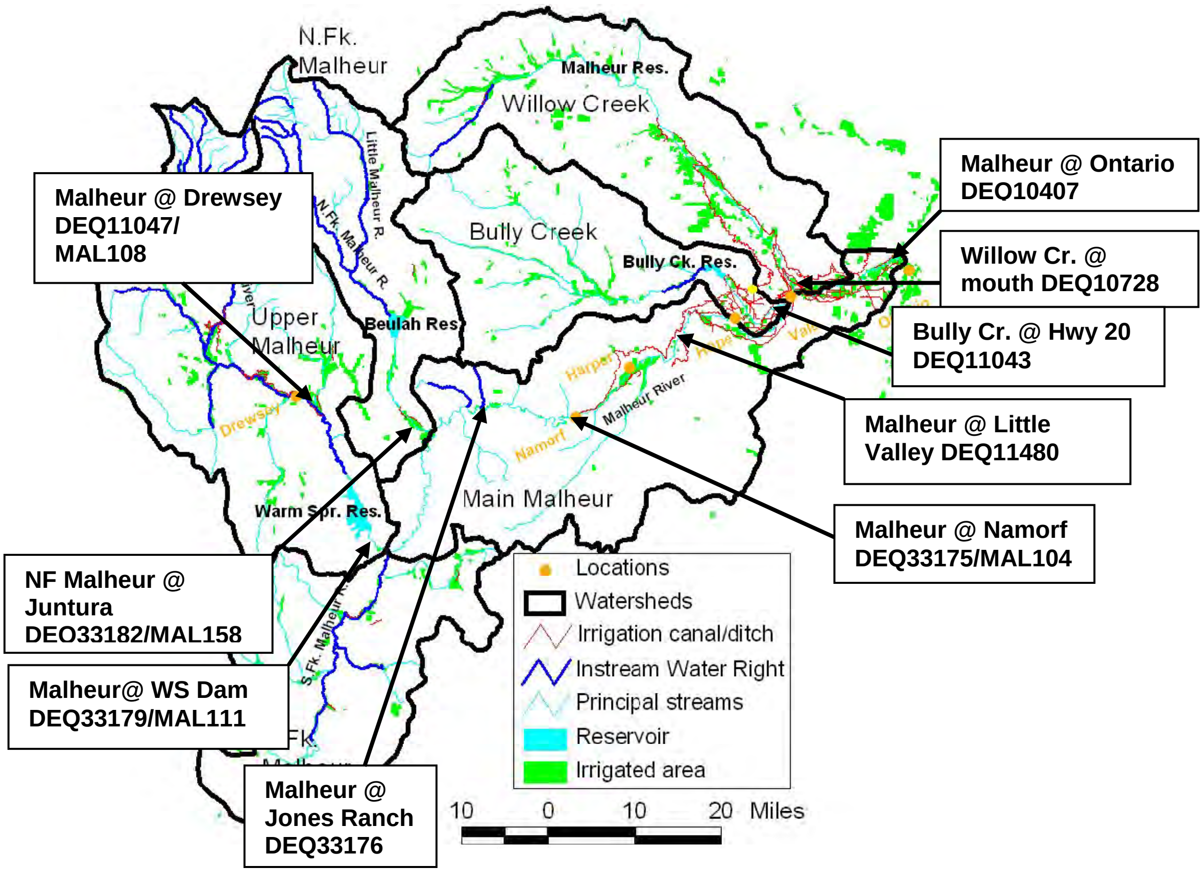
The numeric bacteria standard given above contains a 30-day log mean criteria of 126 E.coli organisms/100 milliliters based on a minimum of (5) samples, and a single sample criteria of 406 organisms per 100 milliliters. A water body is considered water quality limited if the 30-day log mean is greater than 126 organisms per 100 ml or more than 10% of the samples exceed the 406 organisms per 100 ml with a minimum of at least two occurrences. **The TMDL is written to address both the log mean and daily maximum criteria. Best Management Practices (BMP) that control *E.coli* bacteria need to implemented to target both criteria of the standard.**

7.6 BACTERIA SOURCE ASSESSMENT

OAR 340-42-0040(4)(f)

There are four DEQ ambient water quality sampling locations in the Lower Malheur Basin. Water samples are collected on a bi-monthly basis from these four sites: Malheur River in Ontario, Willow Creek at the mouth in Vale, Bully Creek at Highway 20 west of Vale, and the Malheur River at Little Valley (Figure 7-2). The bi-monthly water samples from the four DEQ ambient sites have been analyzed for E.coli from 1996 to the present. All except the Bully Creek location were also sampled during the three TMDL sampling events in 2006. The TMDL Bully Creek sample location was at the mouth of Bully Creek in Vale. Four other sample locations have been used by the Malheur Watershed Council from approximately 1999-2003 and were sampled again during the three TMDL sampling events in 2006. These sites are located in the Malheur River at Namorf, Malheur River below the Warm Springs Dam, Malheur River at Highway 20 south of Drewsey, and the North Fork Malheur River near Juntura. A fifth Malheur River site was added at Jones Ranch (RM 83) during the TMDL sampling events **(Figure 7-2)**. The watershed council generally collected samples on a monthly basis, and analyses included *E.coli*. The TMDL samples were collected in May, August, and October of 2006 and were also analyzed for *E.coli*.

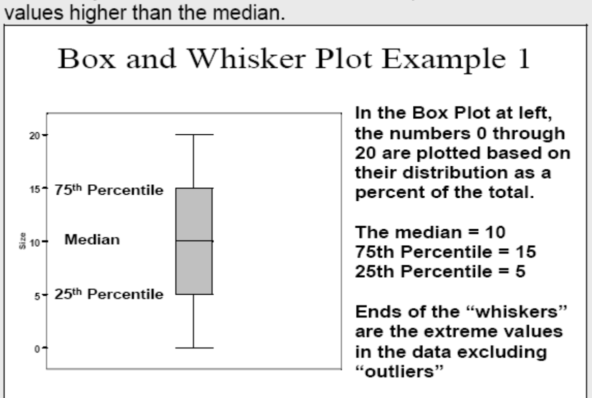
Figure 7-2. E.coli sample locations 1996-2007 (data presented in Figure 7-3).



The *E. coli* data summarized from locations presented on **Figure 7-2** are represented graphically in **Figure 7-3**, which is a box plot of the data, arranged longitudinally from upstream to downstream along the Malheur River. Bacteria data from tributaries such as the North Fork Malheur River, Bully Creek, and Willow Creek were included for comparison to data from the Malheur River. The bacteria data were not divided seasonally for this presentation.

The box plot shows moderately elevated *E.coli* concentrations in the Upper Malheur River near Drewsey, with a sharp decrease below Warm Springs Reservoir. Below the reservoir bacteria levels increase in the downstream direction with contributions from the North Fork Malheur River, Bully Creek, and Willow Creek.

Box Plots are used to illustrate the distribution of samples through time or among places. The percentile indicates the percentage of sample values less than the value at that point in the distribution. In example 1 (top), 75%of sample values are lower than 15 and 25% are lower than 5. By definition, the median is the 50th percentile, with 50% of values lower and 50% of values higher than the median.



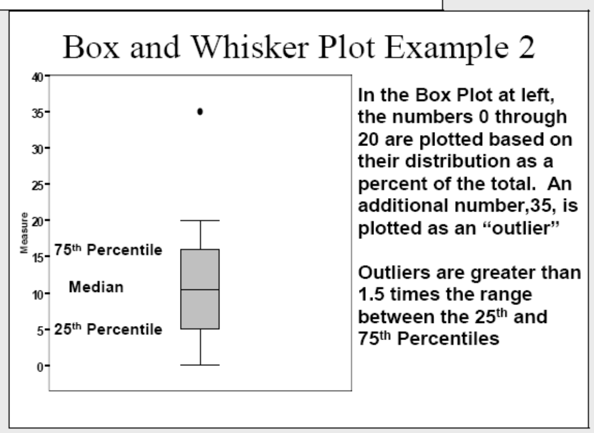
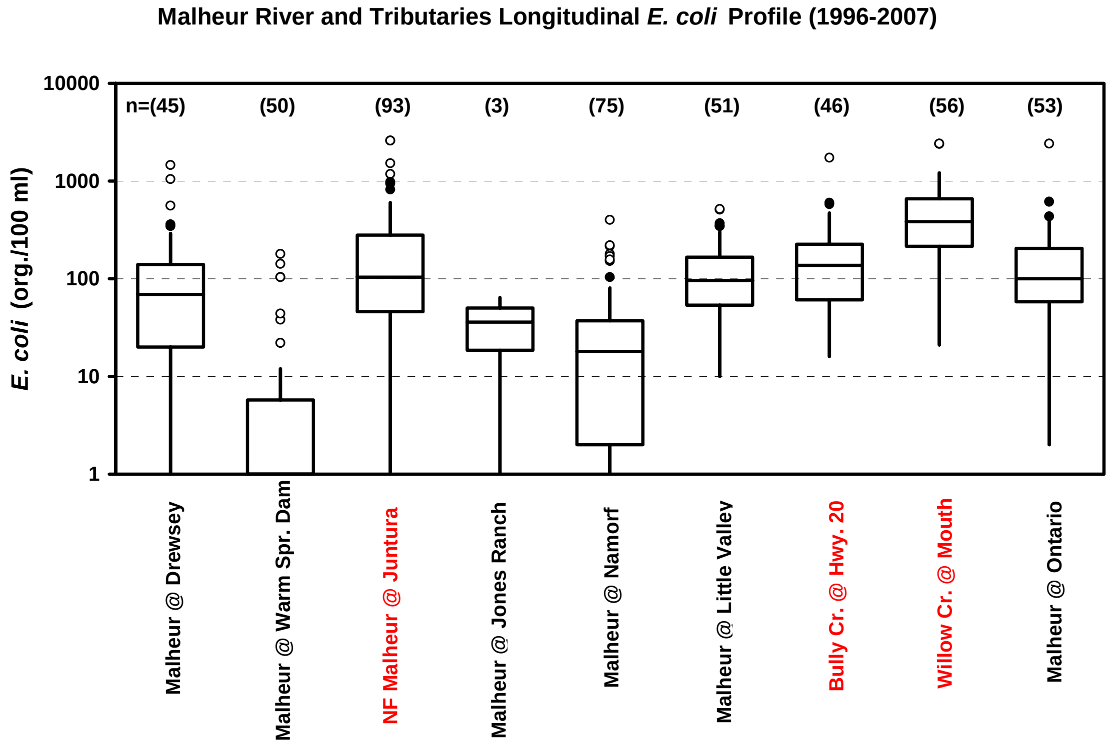
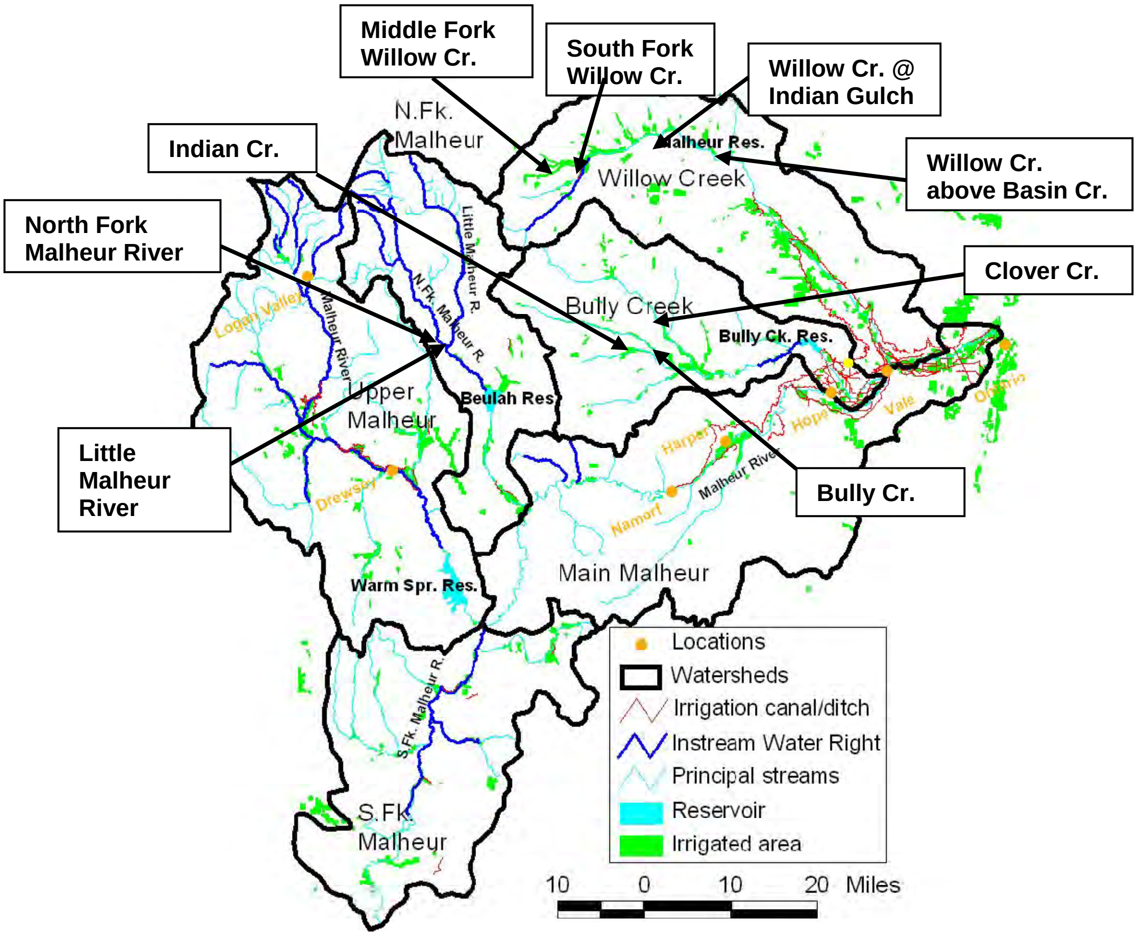


Figure 7-3. Malheur River Basin Longitudinal *E. coli* box/whisker plot.



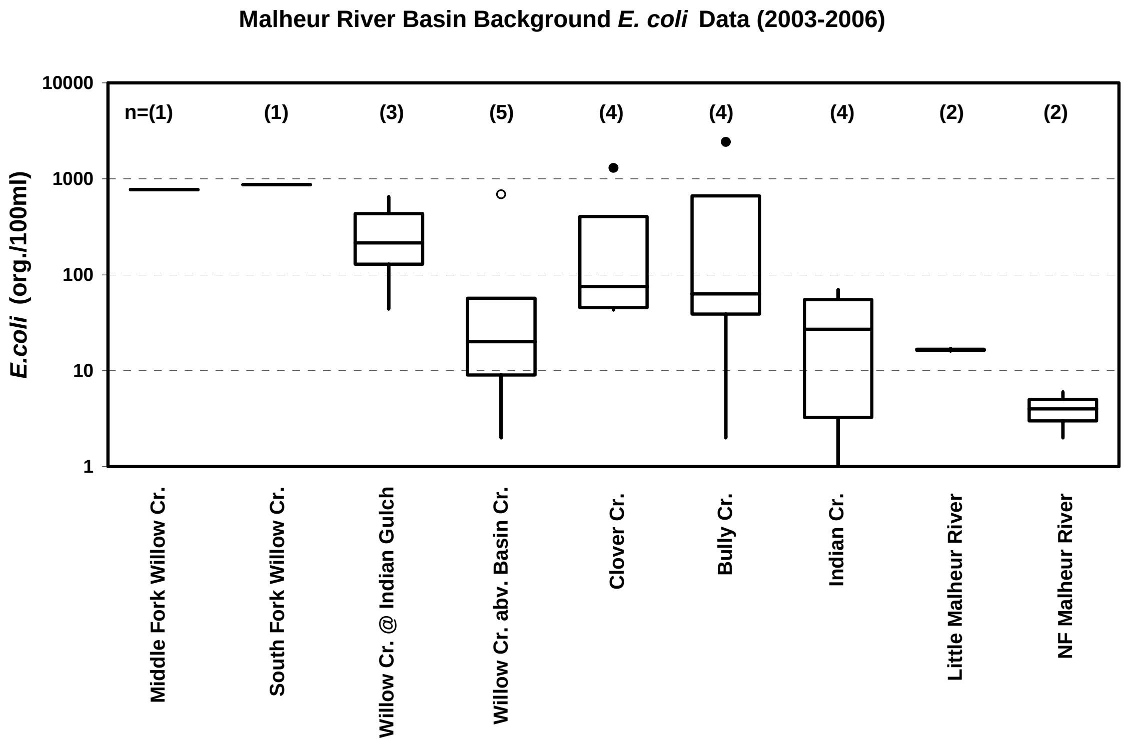
In the Fall of 2003 and the Spring of 2004 DEQ and the Vale District Bureau of Land Management (BLM) collected surface water samples at a total of 20 sites with the intention of characterizing background water quality in the Malheur River Basin. Analyses included nutrients such as nitrite/nitrate and phosphorus, as well as *E. coli* bacteria. Four of these sites were sampled again during the TMDL sampling events in 2006 (Bully Creek, Indian Creek, Clover Creek, and Willow Creek above Basin Creek), and are shown on Figure 7-4. Three additional sites show on Figure 7-4 in the Upper Willow Creek watershed, were added to the TMDL sampling events in 2006 (Middle Fork Willow Creek, South Fork Willow Creek, and Willow Creek at Indian Gulch). Two sites from the 2003-2004 DEQ/BLM sampling events which were not sampled in 2006 (Little Malheur River and North Fork Malheur River) are also shown on **Figure 7-4**.

Figure 7-4. Background E.coli sample locations 2003-2006.



The *E. coli* data summarized from locations presented on **Figure 7-4** are represented graphically in **Figure 7-5**, which is a box plot of the data. Upper Willow Creek *E. coli* concentrations are elevated (median concentrations in the 100 to 1000 org./100ml range) at locations above Malheur Reservoir. The location below Malheur Reservoir (Willow Creek above Basin Creek) is characterized by low *E. coli* concentrations (median well below 100 org./100ml). Similar to other reservoirs in the Malheur River Basin, Malheur Reservoir appears to function as a treatment cell where bacteria die-off occurs. The upper Bully Creek watershed samples (Clover Creek, Bully Creek, and Indian Creek) have variable *E. coli* concentrations with medians below 100 org./100ml). *E. coli* concentrations measured in the North Fork Malheur River and Little Malheur River were low, ranging from 2 to 17 org./100 ml.

Figure 7-5. Malheur River Basin Background E. coli Data (2003-2006).



The data presented in **Figure 7-5** indicate that E. coli concentrations in upper watershed areas of the Malheur River Basin can be quite variable. The North Fork Malheur River above the confluence with the Little Malheur River has similar *E.coli* concentrations to those found in other upper watershed streams in eastern Oregon **(Figure 7-6)**. Water samples from Willow Creek below Malheur Reservoir (Willow Creek above Basin Creek site), Indian Creek, and the Little Malheur River have moderately elevated *E. coli* concentrations, and Upper Willow Creek, Clover Creek and Bully Creek have higher levels. It is likely that local land uses account for these differences.

Figure 7-6. Upper watershed E coli data from various watersheds in Eastern Oregon.

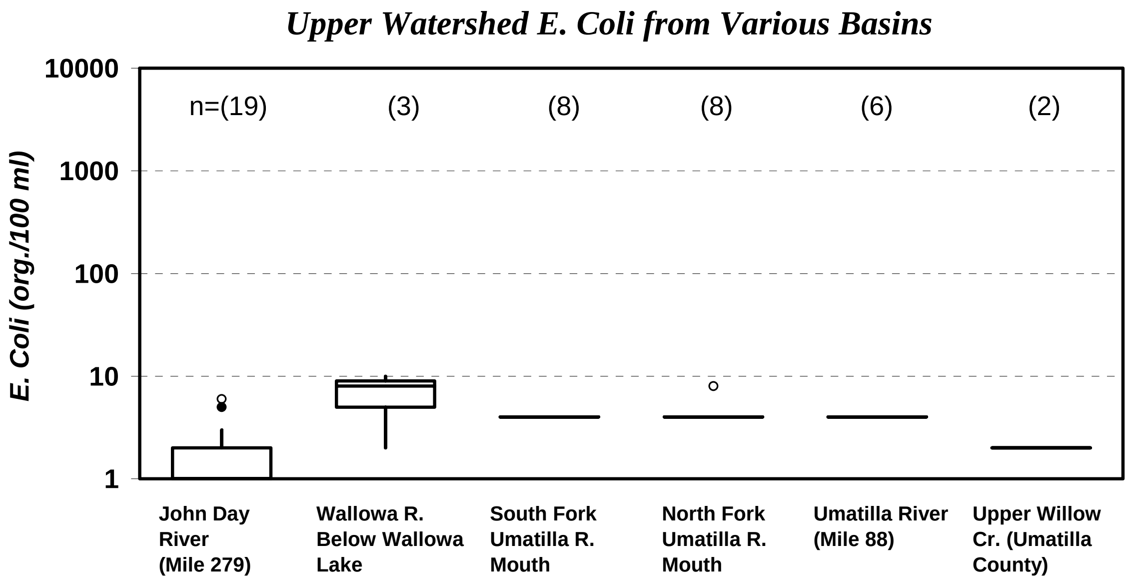


Table 7-3 summarizes the *E.coli* sample results from DEQ and the Malheur Watershed Council from 1999-2007 (locations shown in **Figure 7-2**). Due to the fact that five *E.coli* samples are rarely collected within 30 days at a given sample site, values over a 6-month season are used as a surrogate for the 30-day period in determining the log mean. The data are divided by irrigation season verses non-irrigation season.

Table 7-3. Summary of Malheur River Basin E.coli data 1996-2007.

		Irrigation Season (April 16- October 15)					Non- Irrigation Season (October 16 – April 15)			
Station Name	**River Mile**	**Number of Samples**	**Log Mean**	**Max.**	**% > 406**		**Number of Samples**	**Log Mean**	**Max.**	**% > 406**
Malheur @ Ontario	0	29	**181**	**>2419**	**17%**		24	49	260	0%
Willow Cr. @ mouth	0	30	**469**	**>2419**	**63%**		26	**257**	**2400**	**23%**
Bully Cr. @ Hwy. 20	2	28	**152**	**1733**	**7%**		18	102	**600**	**17%**
Malheur @ Little Valley	50	29	113	**517**	**7%**		22	61	370	0%
Malheur @ Namorf	67	48	29	400	0%		27	2	20	0%
Malheur @ Jones Ranch	83	2	48	64	0%		1	1	1	0%
Malheur @ Warm Spr. Dam	122	25	3	180	0%		25	3	142	0%
Malheur @ Drewsey	140	28	76	**1460**	**11%**		17	29	160	0%
NF Malheur @ Juntura	1	57	**142**	**>2600**	**14%**		36	41	**2600**	**6%**

Notes:
E-coli results reported in organisms/100ml., shaded results exceed E.coli water quality criteria.
Non-detect results reported as 1 org/100 ml in calculations
Results that exceeded the Quantification Limit (QL) reported at the QL in calculations.

Malheur River at Ontario

The log mean E.coli concentration at the mouth of the Malheur River at Ontario during the irrigation season was 181 org./100 ml., which exceeds the 30-day log mean criteria of 126 org./100 ml. In addition, 17% of the samples exceeded the single sample criteria of 406 org./100 ml. During the non-irrigation season, the log mean concentration was well below the 30-day log mean criteria, and the single sample criterion was not exceeded **(Table 7-1)**. These data indicate that irrigation season bacteria loading is the most significant problem in the Lower Malheur River.

Willow Creek
E.coli concentrations in Willow Creek were elevated all year. The irrigation season log mean concentration was 469, and 63% of samples greater were than the daily maximum of 406 org./100 ml . During the non-irrigation period the log mean concentration was 257 org./100ml., and 23% of samples exceeded the single sample maximum criteria. These results indicate that while the irrigation season bacteria concentrations are higher, **significant exceedances of bacteria standards occur in Willow Creek all year.**

Bully Creek
During the irrigation season Bully Creek had a log mean E.coli value of 152 and 7% of samples exceeded 406 org./100 ml. The 30-day log mean *E.coli* criteria of 126 org./100 ml was not exceeded during the non-irrigation season, but the single sample maximum criteria was exceeded in 17% of the samples. These data suggest that **bacteria problems in Bully Creek are more significant during the irrigation season, but episodic bacteria loading events also occur during the non-irrigation season. An additional reach of Bully Creek from RM 0 to RM 15.9 was identified as not meeting water quality standards for bacteria.**

Malheur River Warm Springs to Little Valley
E. coli concentrations in the Malheur River are lower upstream of Vale at the Little Valley site (RM 50), with the irrigation season log mean concentration at 113 (below the 30-day log mean criteria of 126 org./100 ml.) and 7% of the samples exceeding 406 org./100 ml. **Neither the 30-day log mean or single sample criteria were exceeded at Little Valley in the non-irrigation season. E. coli concentrations were even lower further upstream at Namorf (RM 67) and Warm Springs Dam (RM 123), with neither the 30-day log mean or single maximum criteria being exceeded. It is recommended that the Malheur River from RM 96.2 at the North Fork Malheur confluence to RM 119.9 below Warm Springs Dam be removed from the 303(d) list for bacteria.**

Malheur River at Drewsey
E.coli concentrations above the Warm Springs Reservoir at Drewsey are moderately elevated with an irrigation season log mean concentration of 76 and 11% of the samples exceeding the single sample maximum criteria. Bacteria criteria were not exceeded at the Drewsey location during the non-irrigation season. **These data suggest that bacteria loading occurs in the Upper Malheur above Warm Springs Reservoir during the irrigation season, but large scale die-off of bacteria occurs as the water travels through the reservoir. It is recommended that the An additional reach of the Malheur River from RM 129 at the upper end of Warm Springs Reservoir to RM 170 above Wolf Creek was identified as not meeting water quality standards for bacteria.**

North Fork Malheur River
The North Fork sample location had an irrigation season log mean *E.coli* concentration of 142 and 14% of the samples exceeded the single sample maximum criteria. The log mean criterion was not exceeded during the non-irrigation season, but the single sample maximum criterion was exceeded in 6% of the samples. These data suggest that the **North Fork Malheur is a significant source of bacteria loading to the upper Malheur River during the irrigation season and periodically during non-irrigation season high flow events.**

Based on the three 2006 TMDL sampling results, the effect of bacteria loading from the North Fork Malheur to the Lower Malheur River at RM 96 appears to be diminished by the time the Malheur River reaches Jones Ranch (RM 83). *E.coli* concentrations measured at the Jones Ranch location, ranged from a low of < 1 org/100 ml during the non-irrigation season to a high of 64 org/100 ml during the irrigation season.

7.7 LOADING CAPACITIES, ALLOCATIONS, AND SURROGATE MEASURES

OAR 340-42-0040(4)(d), OAR 340-042-0040(4)(h), and OAR 340-042-0040(5)(b)

Flow-based loading capacity and allocations were determined using load duration curves at locations where there were extensive flow and *E.coli* data. This method segregates data by flow regime, allowing for flow-based source assessment, graphical display of the range of data, and the determination of the critical period for water quality. See Appendix A for a technical explanation of load duration curves and the methods used to determine surrogate load allocations. Load allocations apply year around and therefore address all bacteria 303(d) listings. There are no individual NPDES permitted discharges in the Malheur River Basin, and permitted discharges within the Middle Snake-Payette Subbasin discharge to the Snake River and were addressed in the Snake River-Hells Canyon TMDL. CAFOs are considered to be point sources which are not allowed to discharge to Waters of the State, and were given a zero allocation in this TMDL. **Therefore, all load allocations in the Malheur River Basin and Middle Snake-Payette Subbasin TMDLs apply to nonpoint sources, and no reserve capacity has been allocated.**

Lower Malheur River

Malheur River *E.coli* data collected by DEQ at the Highway 201 bridge in Ontario (Malheur @ Ontario in **Figure 7-2 and Table 7-4**), and flow data from the U.S. Bureau of Reclamation (USBOR) MALO flow gauge located at the 36th Street bridge in Ontario (approximately 2 miles upstream) were used to create a load duration curve for the Lower Malheur River **(Figure 7-7)**. Thirty-four *E.coli* samples were collected at this location between April 2000 and December 2006. Data collected previous to 2000 were not used because flow data at the 36th Street location were not available until 2000, when the gauge was installed. It is assumed that if water quality standards are met at this site, it is likely that water quality standards will be met along a significant portion of the Lower Malheur River.

The daily flow-based loading capacity curves for the Malheur River were determined within the period of record by multiplying the target criteria (126 org./100 ml and 406 org./100ml) by flow and expressing in terms of organisms/day, and plotting it against the percent of days the flow was exceeded (also known as flow duration interval). The range of observed flows was separated into five categories ranging from very low to high.

Figure 7-7. Load duration curve with measured daily loads and flow ranges, Malheur River in Ontario. Sample location is Hwy 201 bridge near mouth of river and flow gauge is at 36th Street Bridge, approximately two miles upstream.

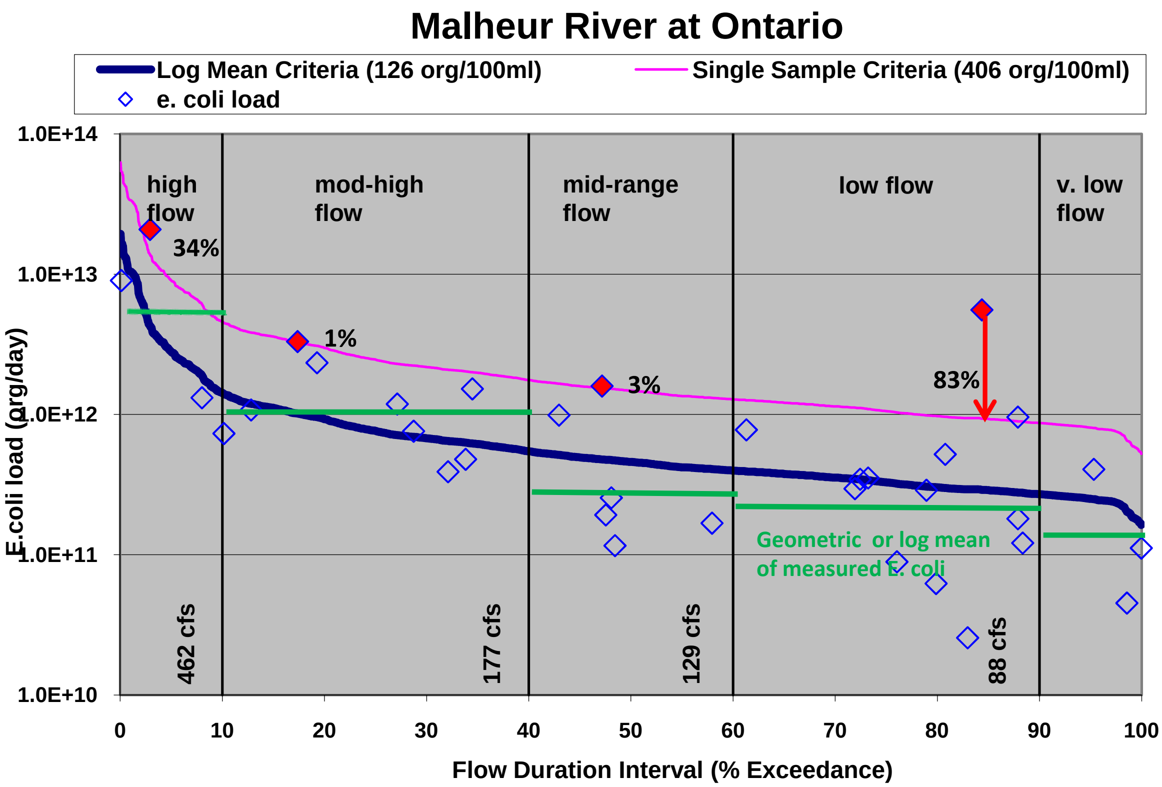


Table 7-4. Bacteria TMDL by Range of Flows at Ontario.

126 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity (org./day)	3.40E+12	7.94E+11	4.57E+11	3.31E+11	2.40E+11
Current Load (org./day)	**6.28E+12**	**1.05E+12**	3.38E+11	2.14E+11	1.27E+11
5% Margin of Safety (org./day)	1.70E+11	3.97E+10	2.29E+10	1.66E+10	1.20E+10
Load Allocation (org./day)	**3.23E+12**	**7.54E+11**	4.34E+11	3.14E+11	2.28E+11
% Reduction to meet126 org/100ml.	**49%**	**28%**	0	0	0

406 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity (org./day)	1.38E+13	3.27E+12	1.54E+12	9.43E+11	8.02E+11
Current Load (maximum of E.coli loads)	**2.08E+13**	**3.31E+12**	**1.59E+12**	**5.56E+12**	4.06E+11
Percent Reduction to meet 406 org/100ml.	**34%**	**1%**	**3%**	**83%**	0

The load allocation needed to meet the 30-day log-mean standard of 126 org./100ml was calculated based on the data presented in **Figure 7-7**. A generalized log-mean loading capacity for each of the five flow ranges was calculated by taking the log-mean of the calculated daily loading capacities based within that flow category **(Table 7-4)**. Measured daily loads were plotted as points on the graph, and the log-mean of the observed *E.coli* loading within each of the flow ranges was compared to the load allocation (loading capacity minus a 5% margin of safety) for that flow period. This provides a surrogate load allocation to meet the 126 org/100ml log-mean criterion. The 5% explicit margin of safety was judged to be sufficient due to the fact that compliance is based on the log mean of 5 samples, and the data set used in this analysis covers a long period of record.

In the Lower Malheur River at Ontario, a 49% reduction in bacteria load is necessary to meet the 30-day log-mean criterion during high flows, and a 28% reduction is needed during moderately high flows. Based on the seasonal data analysis, it was determined that the violations of the 30-day log-mean *E.coli* criterion at this sample location occur during the irrigation season. The load allocations are assigned to nonpoint sources of bacteria collectively including agriculture, wildlife, urban and rural residential land uses.

In the case of the 406 org/100ml single sample maximum criterion, the maximum observed *E.coli* value for a given flow range was compared to the loading capacity for the day of sampling. When the maximum observed load exceeded the loading capacity, a percent reduction needed to meet the criterion was calculated **(Table 7-4)**. Due to the conservative use of the maximum observed bacteria concentration in calculating the surrogate load allocation needed to meet the single sample *E.coli* criterion, an explicit margin of safety was not used.

In the Lower Malheur River at Ontario, the most significant bacteria reduction needed to meet the single sample criterion (83%) occurs during low flow periods. A 34% reduction is needed during high flow periods and reductions of 1% and 3% respectively are needed to meet the single sample criterion during moderately high and mid range flows (Figure 7-7 and Table 7-4). As with the 30-day log-mean data analysis, violations of the single sample maximum criterion occur during the irrigation season. The load allocations are assigned to non-point sources of bacteria collectively including agriculture, wildlife, urban and residential land uses.

Large bacteria contributions to the Lower Malheur River occur in Vale (RM 20) where Bully Creek and Willow Creek discharge to the Malheur River, along with significant contributions from irrigation return drains in the area. During the three TMDL sampling events in 2006, water samples were collected from the 6th Ave. Drain which discharges into lower Willow Creek, and the A-Drain and B-Drain which discharge into the Malheur River in Ontario. Flow measurements were made at the Mouth of Bully Creek and Mouth of Willow Creek sample locations on August 23, 2006, and the Malheur River USBOR flow gauge at 36th Street in Ontario. Flows from the 6th Avenue, A Drain and B Drain were visually estimated, and the allocations for these three drains should be considered informational only. The *E.coli* and flow data collected on August 23, 2006 from the drains, Bully Creek, Willow Creek, and the Malheur River near its mouth in Ontario, were used to calculate bacteria loads and loading capacities and percent reductions needed to meet load capacities, which are presented in **Table 7-5**. No reserve capacity was established.

Table 7-5. Source Assessment – Malheur River and Tributaries *E.coli* Loads and Loading Capacities. All data are from 8/23/06, except Bully Cr. above Bully reservoir, which was sampled on 1/28/03.

Sample location	*E.coli* concentration (org./100 ml)	Flow (cfs)	*E. coli* Load (org./day)	Loading Capacity** @126 org/100ml (org./day)	% Reduction needed to meet 126 org/100ml	Loading Capacity @406 org/100ml (org./day)	% Reduction needed to meet 406 org/100ml
Mouth Bully Cr.	461	46	$5.18\text{x}10^{11}$	1.35E+11	**74%**	$4.57\text{x}10^{11}$	**12%**
Bully Cr. Above. Reservoir (MAL120)	1620	85	$3.38\text{x}10^{12}$	2.62E+11	**NA*** **		**75%**
Mouth Willow Cr.	727	68	$1.21\text{x}10^{12}$	2.0E+11	**84%**	$6.76\text{x}10^{11}$	**69%**
6th Ave. Drain	>2420	10*	$5.92\text{x}10^{11}$	2.97E+10	**95%**	$9.93\text{x}10^{10}$	**83%**
A Drain	>2420	5*	$2.96{*}10^{11}$	1.46E+10	**95%**	$4.97\text{x}10^{10}$	**83%**
B Drain	272	20*	$1.33\text{x}10^{11}$	5.86E+10	**56%**	$1.99\text{x}10^{11}$	**0%**
Malheur@ Ontario	411	329	$3.31\text{x}10^{12}$	9.60E+11	**71%**	$3.27\text{x}10^{12}$	**1%**

* estimated flow value allocations informational only
** Loading Capacity includes a 5% MOS
***Log mean criteria met based on 63 samples collected between 1/24/99 and 6/24/03.

The bacteria loads calculated for these sources are significant when compared to the log-mean criteria load capacity of the Malheur River **(Table 7-5)**. The bacteria load from Willow Creek actually exceeds the load capacity for the Malheur River in Ontario, and Bully Creek had a bacteria load which was approximately ½ the load capacity of the Malheur River. The loads calculated for the three drain locations are based on visual estimations of flow, and were intended to be conservative. They are also very significant when compared to the loads in their receiving streams. For instance, the 6th Ave Drain has a bacteria load which is equivalent to approximately one-half (½) of the load measured at the mouth of Willow Creek, and actually exceeds the load capacity for Willow Creek. The A-Drain and B-Drain data indicate that they each supply bacteria loads which are at least 10% of the load capacity of the Malheur River. With the high variability of flow and bacteria concentrations, their contribution could be much higher. These data highlight the significance of irrigation drain discharges with respect to the concentration of bacteria in the Lower Malheur River, Bully Creek and Willow Creek. Projects which are intended to reduce bacteria loading to the Lower Malheur River should target Willow Creek, Bully Creek, and irrigation return drains which contribute to these tributaries as well as the Malheur River.

<u>Snake River Tributaries in Middle Snake-Payette Subbasin</u>

Thirty-four water samples were collected in two small tributary drainages to the Snake River located north of Ontario by U.S. EPA from 1978-1980. Fecal coliform analyses were performed on the samples and flow was measured during most of the sampling events. These water samples contained very high levels of fecal coliform bacteria, and resulted in the listing of Jacobson gulch and Shepherd Gulch on the 303(d) list for this parameter.

The fecal coliform results from the EPA analyses were transformed into estimated *E.coli* values using a conversion equation proposed in a publication by Cude, 2005. Loads were calculated and the log mean load for each drainage was compared to the log-mean load capacity and a percent reduction needed to meet the log-mean criterion of 126 org./100 ml. and the single sample criterion of 406 org./100 ml. **(Table 7-6)**.

Table 7-6. Source Assessment, Snake River Tributaries, E.coli Loads and Loading Capacities, 1978-1980.

Sample location	Mean Flow (cfs)	Log-mean *E. coli* Load (org./day)	Log-mean Loading Capacity* @126 org/100ml (org./day)	Reduction needed to meet 126 org/100ml	*E.coli* Load @ maximum concentration	Loading Capacity @406 org/100ml (org./day)	Reduction needed to meet 406 org/100ml
Jacobson Gulch @ Hwy 201	26	6.31E+11	5.72E+10	**91%**	5.25E+12	1.46E+11	**97%**
Shepherd Gulch @ Mosquite Road	30	6.76E+11	7.20E+10	**89%**	4.67E+13	4.27E+11	**99%**

*Loading Capacity includes a 5% MOS

Upper Malheur River

A load duration curve **(Figure 7-8)** was also prepared for the sample location near Drewsey, which is located at Bureau of Reclamation flow gauge MADO (Malheur @ Drewsey, **(Figure 7-2)**. This site was selected as representative of conditions in the Upper Malheur. Forty-four *E. coli* samples collected by the Malheur Watershed Council and DEQ from January 2000 to October 2006 were available at this location and a load duration curve was prepared using the same methodology as described above for the Ontario location.

Figure 7-8. Load duration curve with measured daily loads and flow ranges, Upper Malheur River near Drewsey. Sample/flow measurement location is at Hwy 20 bridge at RM 142.

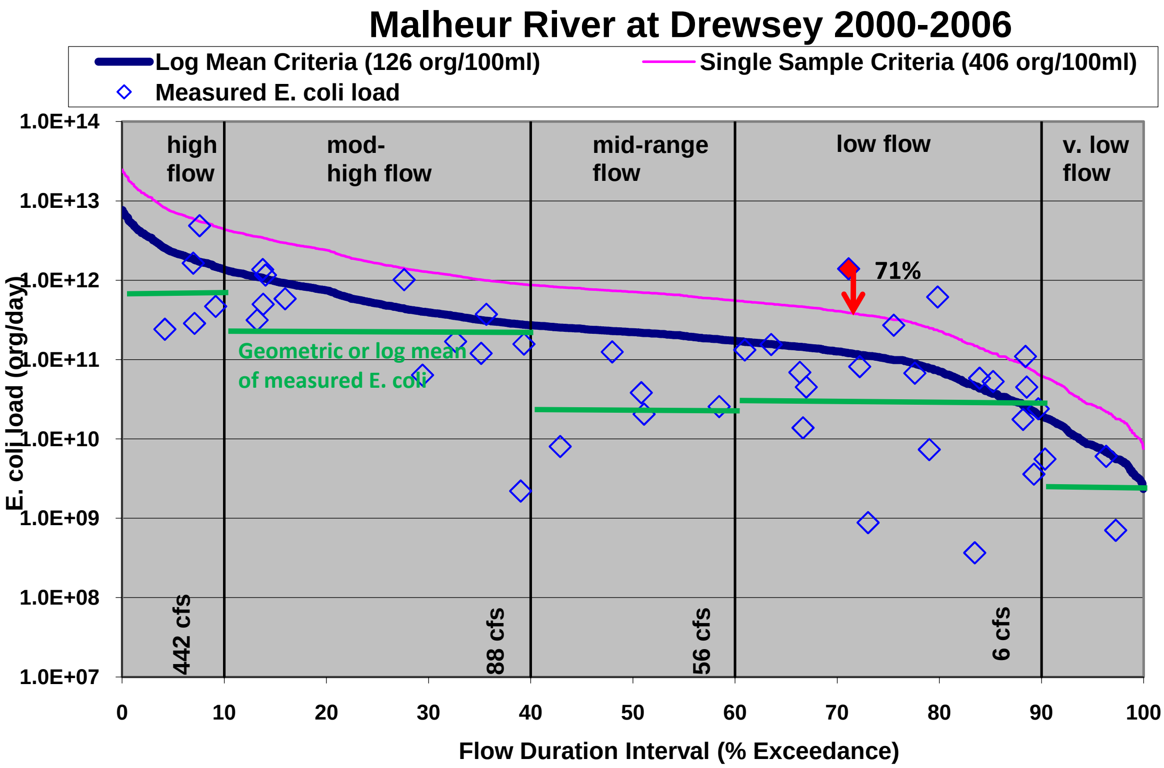


Table 7-7. Bacteria TMDL by Range of Flows at Drewsey.

126 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity (org./day)	2.51E+12	5.50E+11	2.19E+11	8.32E+10	8.13E+09
Current Load (org./day)	7.62E+11	2.32E+11	2.89E+10	3.88E+10	2.87E+09
Margin of Safety (org./day)	1.26E+11	2.75E+10	1.10E+10	4.16E+09	4.07E+08
Load Allocation (org./day)	2.38E+12	5.23E+11	2.08E+11	7.90E+10	7.72E+09
% Reduction	0%	0%	0%	0%	0%

406 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity @ 406 E.coli/100ml. (org./day)	5.48E+12	3.46E+12	7.37E+11	4.06E+11	2.19E+10
Current Load (maximum of E.coli loads)	4.86E+12	1.36E+12	1.25E+11	1.39E+12	6.03E+09
Percent Reduction to meet 406 E.coli/100ml.	0%	0%	0%	**71%**	0%

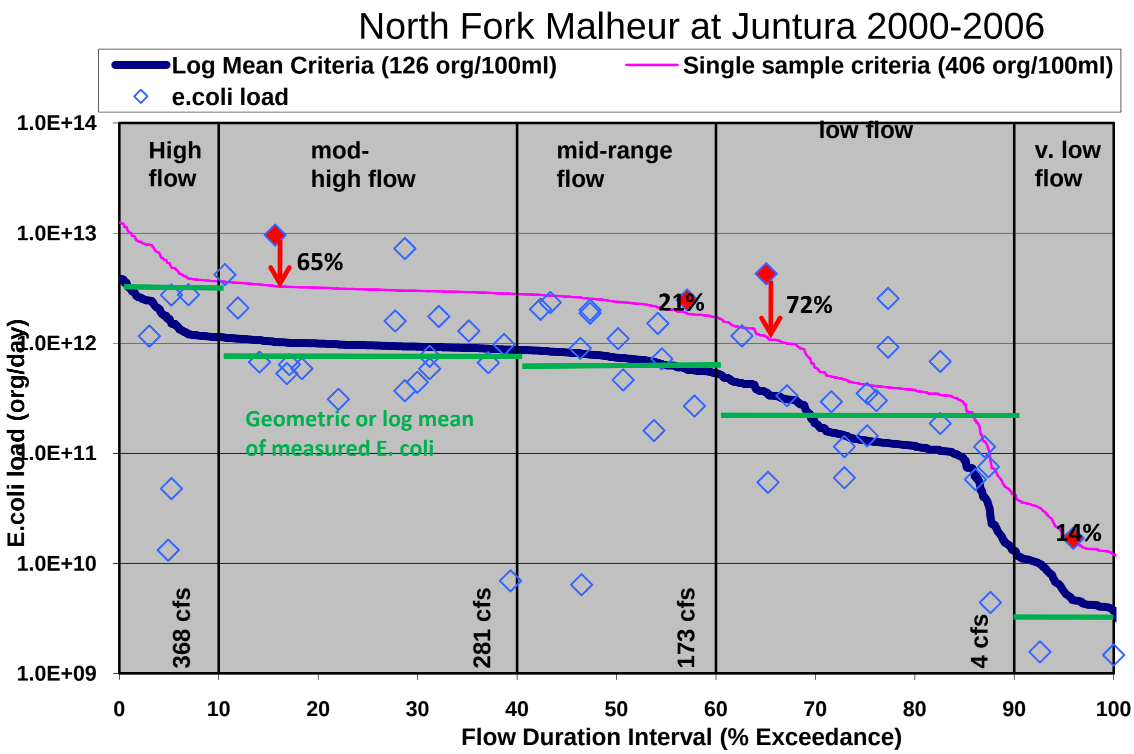
No reductions in *E.coli* loading were needed to meet the 30-day log-mean criterion at any of the flow ranges based on the load duration curve methodology. However, there were several exceedances of the single sample maximum criteria during low flow periods, and a 71% reduction in E.coli concentration would be needed to reduce the maximum value to the single sample maximum criterion concentration (Figure 7-8 and Table 7-7).

Monitoring data indicate that some loading of *E. coli* bacteria occurs in the Upper Malheur River. Data collected near Drewsey (RM 140) indicate that the log mean *E. Coli* concentration for the irrigation season and the non-irrigation season do not exceed the 30 day log mean criterion, but the single maximum criterion is exceeded in 11% of the samples collected during the irrigation season **(Table 7-3).** The load duration plot for Drewsey **(Figure 7-8)** indicates that these high levels of bacteria occur during low flow periods in the Malheur River. Due to the low flow conditions, the bacteria loading to Warm Springs Reservoir appears to be relatively small. Monitoring data from the Malheur River just below Warm Springs Dam (RM 122) indicate that very low levels of bacteria are generally present **(Table 7-3)**. It appears that virtually all of the bacteria that enter Warm Springs Reservoir die off by the time the water is discharged from the dam. Efforts to reduce bacteria loading to the Malheur River above Warm Springs Reservoir should target irrigation season loading.

North Fork Malheur River

The load duration curve **(Figure 7-9)** prepared for the North Fork Malheur River was based on bacteria data collected by DEQ and the Malheur Watershed Council at the Beulah Road bridge located approximately 1 mile north of Juntura near RM 1 (NF Malheur @ Juntura, **Figure 7-2 and Table 7-3)**. The flow data were collected at the Bureau of Reclamation flow gauge BEUO, located below the Agency Valley dam on the North Fork Malheur River at RM 18. There are some moderate-sized un-gauged diversions between the flow gauge and the water sample collection point, so the flow data should be considered somewhat qualitative in nature. Fifty-eight *E. coli* samples collected from February 2000 to October 2006 by DEQ and the Malheur Watershed Council were available at this location and a load duration curve was prepared using the same methodology as described above for the Ontario and Drewsey locations.

Figure 7-9. Load duration curve with measured daily loads and flow ranges, North Fork Malheur River near Juntura. Sample location is at Beulah Road bridge at RM 1, flow measurement location is located below Agency Valley Dam at RM 18.



Figure

Table 7-8. TMDL for North Fork Malheur @ Juntura.

126 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	v. low flow
Loading Capacity (org./day)	1.77E+12	9.67E+11	7.20E+11	1.41E+11	6.13E+09
Current Load (org./day)	3.53E+11	8.31E+11	6.75E+11	**2.23E+11**	3.39E+09
Margin of Safety (org./day)	8.85E+10	4.84E+10	3.60E+10	7.05E+09	3.06E+08
Load Allocation (org./day)	1.68E+12	9.19E+11	6.84E+11	1.34E+11	5.82E+09
% Reduction	0	0	0	**40%**	0

406 org/100ml criteria	high flow	mod-high flow	mid-range flow	low flow	very low flow
Loading Capacity @ 406 E.coli/100ml. (org./day)	3.86E+12	3.34E+12	1.94E+12	1.18E+12	1.45E+10
Current Load (maximum of E.coli loads)	2.76E+12	9.59E+12	2.47E+12	4.28E+12	1.69E+10
Percent Reduction to meet 406 E.coli/100ml.	0%	**65%**	**21%**	**72%**	**14%**

A 40% reduction in bacteria load is necessary to meet the 30-day log-mean criterion during low flows, which tend to occur during the early irrigation season in April, and the late irrigation season in late Summer and early Fall. The single sample maximum criterion was exceeded in samples collected during all flow intervals except high flow. The reductions needed to meet this criterion range between 14% and 72% (Figure 7-9 and Table 7-8).

7.8 MARGIN OF SAFETY

OAR 340-042-0040(4)(i)

An explicit 5% margin of safety (MOS) was used in the calculation of percent reductions needed to meet load allocations based on the log-mean *E.coli* criterion of 126 org/100ml. No explicit MOS was used in the calculation of percent reduction needed to meet the load allocations based on the single sample maximum criterion of 406 org./100ml (**Section 7.7**).

7.9 SEASONAL VARIATION

OAR 340-042-0040(4)(j)

Table 7-3 summarizes the *E.coli* sample results from DEQ and the Malheur Watershed Council from 1999-2007 (locations shown in **Figure 7-2)**. The data are divided by irrigation season verses non-irrigation season. Analysis of the bacteria data conducted during development of the TMDL indicate that bacteria criteria are exceeded in Willow Creek, Bully Creek, the Malheur River, and the North Fork Malheur River year round, with reduced impacts during the non-irrigation season of late Fall through early Spring. Stream flow based allocations have been developed for nonpoint sources and apply year-round.

7.10 RESERVE CAPACITY

OAR 340-042-0040(4)(k)

Due to the rural character of the watershed and the lack of existing or proposed point sources, no reserve capacity has been assigned. Future point sources will be required to meet water quality criteria at the point of discharge. Additional nonpoint source contribution may not cause total loading to exceed the loading capacity of receiving surface water bodies.

7.11 REFERENCES

Cude, C.G., February 2005, Accommodating Change of Bacterial Indicators in Long Term Water Quality Data Sets, Journal of American Water Resources Association, pp. 47-54.

MALHEUR RIVER BASIN TMDL

CHAPTER 8: PESTICIDES

Final
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8.1 INTRODUCTION

Portions of the Lower Malheur River in the Malheur River Basin are designated as water quality limited under Section 303(d) of the federal Clean Water Act due to toxic contaminants (pesticides) that can affect sensitive aquatic life. The affected area encompasses the lower 67 miles of the Malheur River below Namorf (Figure 8-1) and the 303(d) listing for toxics is effective year-around. These pollutants are considered to be from legacy diffuse non-point sources. No point sources have been identified.

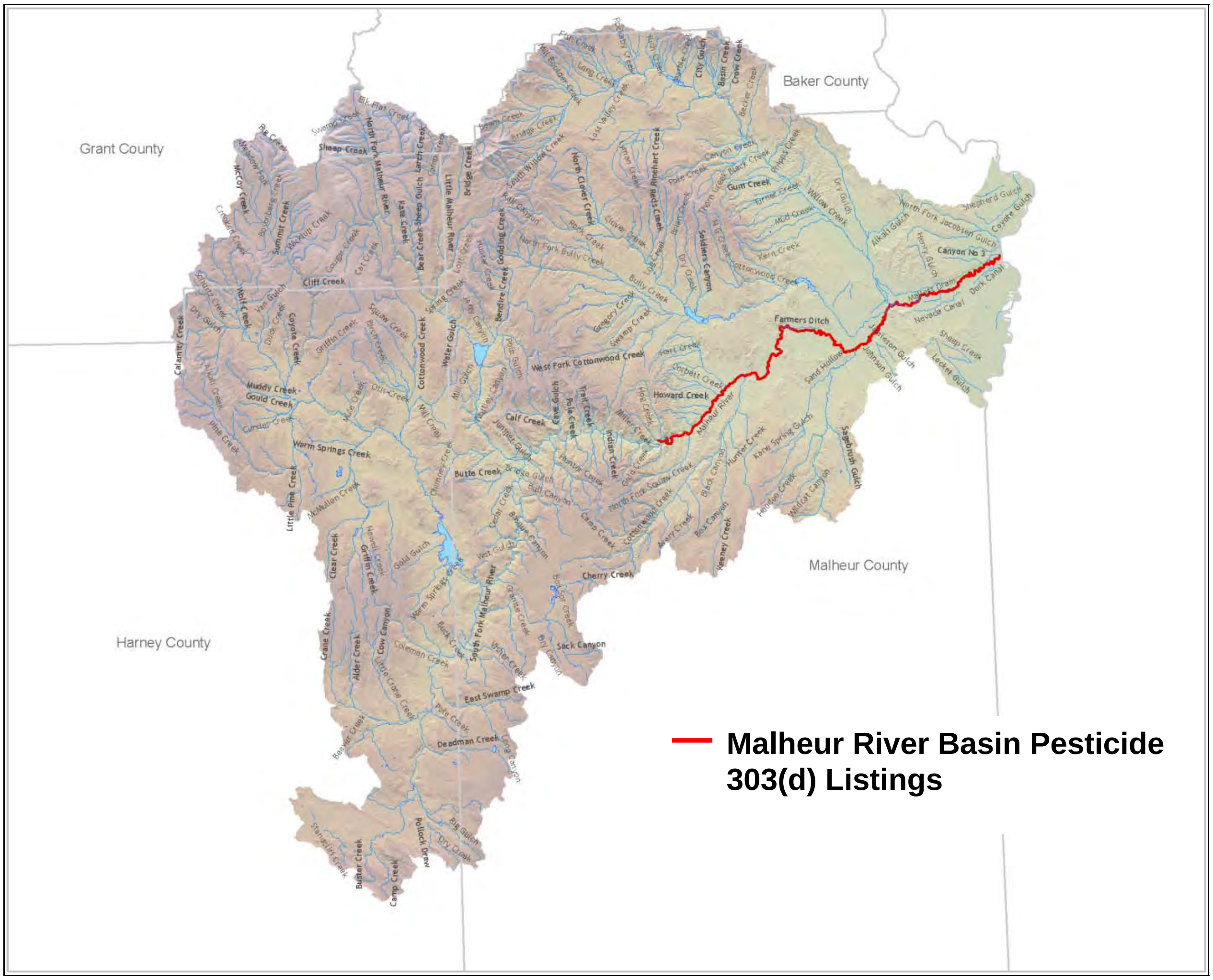
Total Maximum Daily Loads (TMDLs) are developed for streams included on the 303(d) List as water quality limited; however, a toxics TMDL was not developed for the Malheur River Basin that would address the DDT and Dieldrin listings in the Lower Malheur River. **The decision not to calculate specific TMDLs for DDT and Dieldrin was due to the lack of data to develop a defensible load allocation, and the expectation that measures taken to control other pollutants will control pesticide loading.** The existing data indicate that a majority of the pesticide loading occurs from Vale downstream to Ontario, with Bully and Willow Creeks being significant source areas. Due to the strong affinity of DDT and Dieldrin to bind to soil particles, it is recommended that stabilization and erosion control of upland and riparian areas be used to control pesticide loading to streams. These efforts should fit in well with proposed efforts to reduce nutrient and bacteria loading, and to restore riparian vegetation. Further sampling of surface water and sediment, especially during the irrigation season, should be conducted to verify that progress is being made to reduce pesticide loading.

Sediment loads for the Malheur and other Snake River and other tributaries were estimated based on 1995, 1996 and 2000 data, during the development of the Snake River TMDL. A load allocation corresponding to a monthly average of 50 mg/l Total Suspended Solids (TSS) was assigned to the Malheur River. The Malheur River typically exceeds this value during the summer growing season. The TSS load for this period was estimated at 92,870 kg/day. In order for the Malheur River to meet the Snake River TMDL load allocation of 42,062 kg/day (50 mg/l at average flows for the season), a 55% further reduction in TSS will be required. Reductions in sediment loading are a significant part of the implementation of the phosphorus and bacteria TMDLs and will result in significant reductions in loading of pesticides that will likely allow pesticide water qulaility criteria to be met.

8.2 PESTICIDE 303(D) LISTINGS

Concentrations of the banned pesticides DDT and Dieldrin have exceeded water quality standards in some samples collected in the lower Malheur River (RM 0 to RM 67). This waterbody was designated as water quality limited on a list required by Section 303(d) of the Clean Water Act based on results from water samples collected in the Vale and Ontario areas by the U.S. Geological Survey in 1990 (Rinella, et al., 1994). Three water samples with a range of 0.001 – 0.004 µg/l exceeded the DDT fresh water chronic criteria (0.001 µg/l), and the water and fish ingestion criteria (0.024 ng/l). The same three water samples also contained dieldrin at concentrations ranging between 0.003 and 0.010 µg/l, exceeding the Dieldrin fresh water chronic criteria for water and fish ingestion. **Figure 8-1** shows the location of the affected river reach.

Figure 8-1. Malheur River Basin Pesticide 303(d) Listings.



8.3 POLLUTANT IDENTIFICATION

DDT (dichlorodiphenyltrichloroethane) and Dieldrin are organochlorine pesticides. These two compounds were historically used on an extensive basis as agricultural, domestic, and silvicultural insecticides, and to control disease vectors such as mosquitoes. Both compounds are slow to break down in soil and are toxic to animals. They are also very hydrophobic (having a low affinity to dissolve in water), and have a high affinity to bind to soil and fatty tissues of animals such as fish. Due to their widespread use and persistence, DDT and Dieldrin are very common in the environment, and have been detected in virtually all media (water, soil, tissue, etc.). Both compounds are carcinogens and suspected endocrine disruptors that may affect reproduction or development of aquatic organisms and wildlife by interfering with natural hormones. DDT was banned from use in the United States in 1972. The use of Dieldrin was restricted in 1970 and all uses of products containing Dieldrin were banned in 1983 (Joy, 2002).

DDT is known to break down over time to form the metabolites DDE and DDD, which also have toxicological effects. These compounds preferentially bind to soil and sediment particles. Release to water is mainly via transport of particles in runoff. Both DDT and DDE bioaccumulate in organisms, and concentrations tend to increase dramatically as the compounds move up the food chain.

Dieldrin is a persistent breakdown product of the organochlorine pesticide Aldrin. Aldrin quickly breaks down into dieldrin in organisms or the environment. Concentrations of Dieldrin are the result of the use of both Aldrin and Dieldrin. Like DDT, Dieldrin is very persistent and subject to bioaccumulation, increasing in concentration as it moves up the food chain. Dieldrin has a weaker affinity for bonding to soil and sediment than DDT, but soil/sediment transport is still an important transport mechanism.

8.4 BENEFICIAL USE IDENTIFICATION

The beneficial uses of surface water in the Malheur River Basin as listed in ORS 340-41-0201 include:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Fish and Aquatic Life
- Wildlife and Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality

Numeric and narrative water quality standards are designed to protect these beneficial uses, and DEQ generally applies the criteria to protect the most sensitive of these uses. In the Malheur River Basin the most sensitive beneficial surface water uses are the support of fish and aquatic life and their consumption by humans. Public and private drinking water supplies in the basin are generally provided by groundwater, No surface water drinking water supplies were identified during the TMDL investigation.

8.5 WATER QUALITY STANDARDS

The criteria in **Table 8-1** are a mixture of values from Table 20 and Table 33A from the Oregon Administrative Rules Section 340-41. Until the U.S. Environmental Protection Agency (EPA) acts to approve the new criteria adopted by the Oregon Environmental Quality Commission in May 2004, the most stringent criteria from both tables must be used for Clean Water Act purposes. Selected values for regulatory purposes depend on the most sensitive beneficial use to be protected and what level of protection is necessary for aquatic life and human health. **Table 8-1** shows the water quality criteria for DDT and Dieldrin. Criteria provided for the protection of both water and fish ingestion are the most stringent that may be considered.

Table 8-1. Statewide Water Quality Criteria for DDT and Dieldrin.

Compound	Fresh Water Acute	Fresh Water Chronic	Water and Fish Ingestion[1]
DDT[2]	1.1 micrograms per liter (Table 20)	0.001 micrograms per liter (Table 20)	0.024 nanograms per liter (Table 20)
Dieldrin	0.24 micrograms per liter (Table 33A)	0.0019 micrograms per liter (Table 20)	0.052 nanograms per liter (Table 33A)

[1]Water and Fish Ingestion Human Health Criteria were calculated using a fish consumption rate of 17.5 grams/day.
[2]Total DDT and metabolite (DDD and DDE) concentrations are used to determine compliance with the DDT criterion.

The chronic fresh water criterion is protective of resident aquatic species and is evaluated based upon a 24-hour average. Surface water concentrations of toxic pollutants should not exceed the acute criterion at any time. The Water and Fish Ingestion Human Health Criteria values represent the maximum ambient water concentration for consumption of both water and fish or other aquatic organisms using a fish consumption rate of 17.5 grams/day. In 2008, Oregon DEQ adopted a fish consumption rate of 175 grams/day. Based on this increased consumption rate, it is likely that future water quality standards for DDT and Dieldrin will be more stringent than the current standards.

DEQ has developed conditions to interpret and apply the water quality criteria and determine impact on a beneficial use:

A. Water Quality Criteria violations occur if:
    1. The freshwater chronic criteria for protection of aquatic life contained in Table 20 are violated more than 10% of the time and for a minimum of two values.
    2. The chemical is found in sediments at levels which analytical models demonstrate that water quality standards are violated. The analysis and modeling must be reviewed and approved by DEQ.

B. Measurement of impairment of a Beneficial Use:
    1. A fish or shellfish consumption advisory or recommendation issued by the Oregon State Health Division specifically refers to this chemical.
    2. The chemical has caused a biological impairment via a field test of significance such as a bioassay. The field test must involve comparison to a reference condition.

    3. The chemical has been detected in more than 10% of available fish tissue samples, and the population mean of the sample concentrations exceeds a screening value derived from Table 20. The screening value is developed as follows:

       Fish Tissue Screening Value (mg/kg) = Table 20 Criteria for Protection of Human Health (ng/l)xBCF (1/kg)x(mg/10^6 ng)

       Where BCF = Bioconcentration Factor. BCFs are obtained from the USEPA Region VIII Criteria Chart (July 1993)

8.6 PESTICIDE SOURCE ASSESSMENT

As discussed in Section 8.2, the lower Malheur River (RM 0-67) was placed on the 303(d) list due to contamination by the pesticides DDT and Dieldrin, based on water samples collected in the Vale and Ontario areas by the U.S. Geological Survey in 1990 (Rinella, et al., 1994). The USGS surface water and sediment sample locations referenced are shown on **Figure 8-2**. Three water samples collected from the Malheur River near Ontario contained DDT and total DDT concentrations (sum of DDT, DDD and DDE) which met or exceeded the DDT fresh water chronic criteria (0.001 ug/l), and the water and fish ingestion criteria (0.024 ng/l). The same three water samples also contained Dieldrin at concentrations ranging between 0.003 and 0.010 ug/l, exceeding the Dieldrin fresh water chronic criteria (0.0019 ug/l) and the water and fish ingestion criteria (0.052 ng/l). Two additional water samples collected from the D-Drain, which enters the Malheur River between Vale and Ontario, also had concentrations of DDT and Dieldrin which exceeded the Fresh Water Chronic Criteria for these compounds **(Table 8-2)**.

Figure 8-2. Surface water and sediment pesticide sample locations, USGS, 1990.

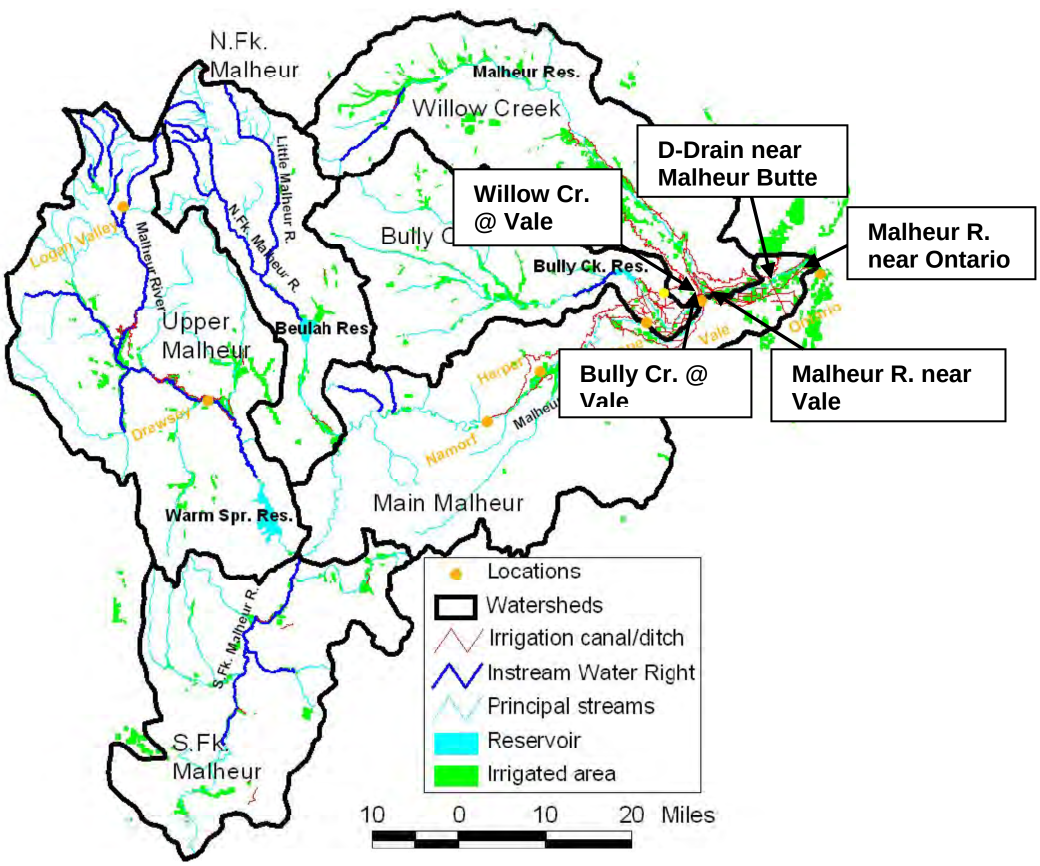


Table 8-2. Pesticides in Water, USGS, 1990 (micrograms/liter)

Location	Date	DDT	DDE	DDD	Dieldrin
D-Drain	8/23/90	**0.001**	**0.002**	**0.004**	**0.007**
D-Drain	10/18/90	<0.010	**0.014**	**0.008**	**0.009**
Malheur R. nr. Ontario	4/16/90	**0.004**	**0.007**	**0.001**	**0.008**
Malheur R. nr. Ontario	8/3/90	**0.003**	**0.008**	**0.003**	**0.010**
Malheur R. nr. Ontario	10/15/90	**0.001**	**0.004**	**0.002**	**0.003**

Results in bold text meet or exceed the Fresh Water Chronic Criteria (DDT and metabolite totals were compared to DDT criteria)

In 1998 and 1999 researchers at Oregon State University (OSU) conducted water and sediment sampling in the lower Malheur River as well as several upstream locations including upper Willow Creek, North Fork Malheur River, and Cottonwood Reservoir near Drewsey (Johnson and Anderson, 1999). The OSU sample locations are shown on **Figure 8-3**. The intent of the OSU study was to follow-up on the pesticide sampling conducted by USGS in 1990 (Rinella, et al. 1994) and expand the sample area to include upstream locations. The upstream locations were added as an attempt to define the potential contribution of persistent pesticides from the upper basin, particularly the Malheur National Forest, which was a known area of historic DDT applications. Sampling of water was performed at a total of eight locations **Table 8-3**. The water analyses were conducted using semi-permeable membrane devices which were left in the water column at the sample locations for approximately one month.

Figure 8-3. OSU surface water and sediment pesticide sample locations 1998, 1999.

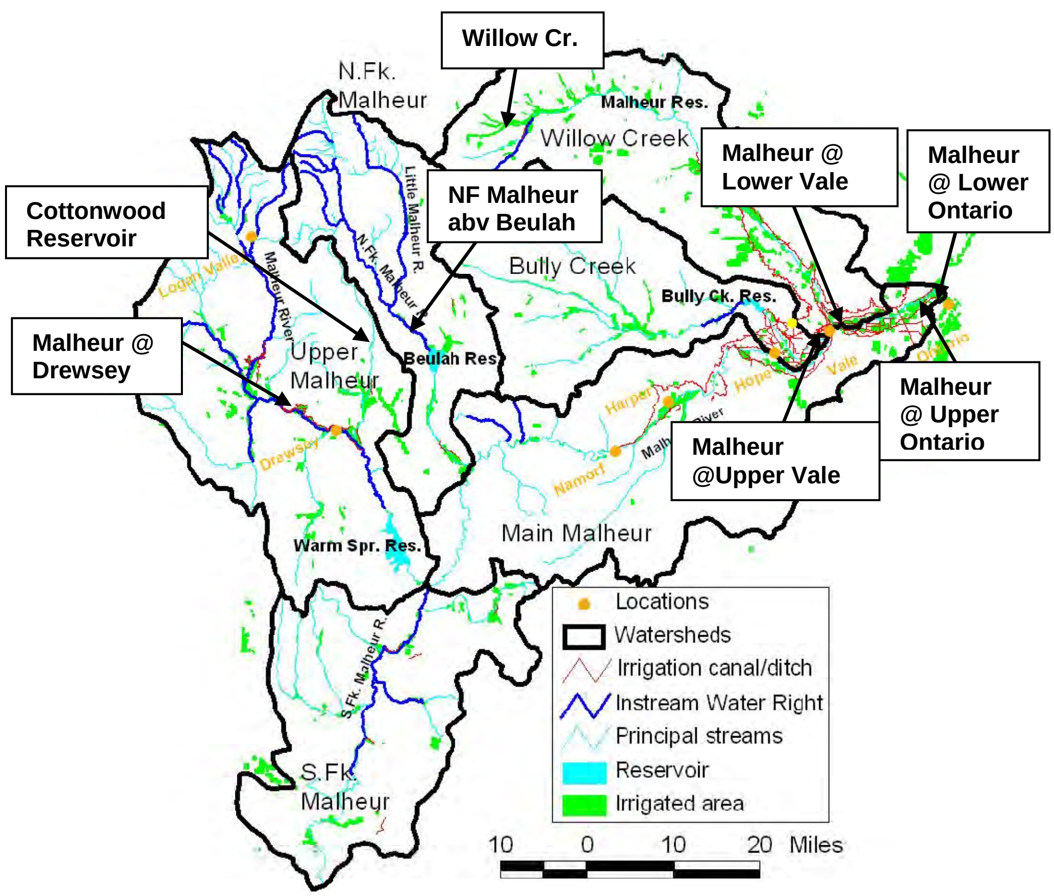


Table 8-3. Pesticides in Water, OSU, 1998/1999 (micrograms/liter)

Location	Date	DDT	DDE	DDD	Dieldrin
Lower Ontario (Malheur R.)	10/98	**0.00072**	**0.004**	**0.00053**	0.0009
Lower Ontario (Malheur R.)	10/99	**0.00061**	**0.0043**	**0.00081**	0.00097
Upper Ontario (Malheur R.)	10/98	**0.00014**	**0.002**	**0.0028**	0.0005
Lower Vale (Malheur R.)	10/98	**0.00013**	**0.0015**	**0.00023**	0.0007
Upper Vale (Malheur R.)	10/98	**0.00019**	**0.002**	**0.00035**	0.0005
Upper Vale (Malheur R.)	10/99	**0.00025**	**0.0019**	**0.00093**	0.0009
Willow Cr.	10/99	0.00011	0.00014	0.00004	<0.00001
Beulah (NF Malheur R.)	10/99	0.00014	0.0002	<0.00001	<0.00001
Cottonwood Reservoir nr Drewsey	10/99	0.00007	0.00003	0.00003	<0.00001
Drewsey (Malheur R.)	10/99	0.00009	0.00025	<0.00001	<0.00001

Results in bold text meet or exceed the Fresh Water Chronic Criteria (DDT and metabolite totals were compared to DDT criteria)

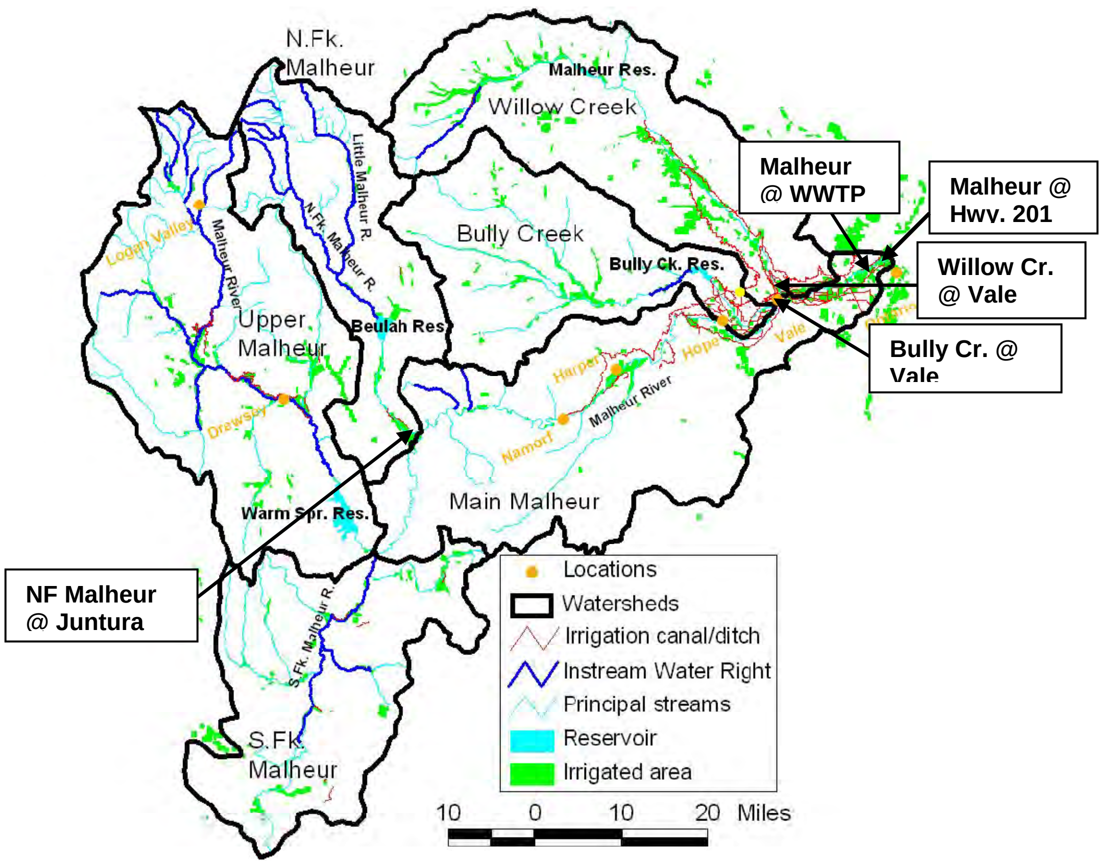
DDT and its metabolite products were found in all water samples collected by OSU in the Malheur River Basin, and Dieldrin was detected in water samples collected from Vale downstream to Ontario. The highest pesticide concentrations were detected in the lower Malheur River in the vicinity of Vale and Ontario, and total DDTexceeded the Fresh Water Chronic Criteria in this area. Dieldrin was not detected at concentrations exceeding the Fresh Water Chronic Criteria. The OSU study concluded that concentrations of DDT and one of its metabolite compounds, DDD, along with Dieldrin have decreased 30-70% since the USGS sampling event in 1990. However, it should be noted that the OSU sampling events occurred in the Fall, after the irrigation season had ended and sediment loading was reduced. The USGS water samples were collected in the Spring, Summer and Fall, with the lowest pesticide levels occurring in the Fall (October) sampling event. OSU attributed a significant increase in pesticide concentrations in the Ontario area to a possible hotspot or point source. A relatively small, but previously unidentified source of DDT loading was attributed to sources in the upper Malheur River Basin.

The five surface water samples collected by DEQ in October 2006 resulted in no detections of DDT, DDE, DDD or Dieldrin which were above their respective Fresh Water Chronic Criteria (**Table 8-4**). However, it is possible that the total of DDT, DDD and DDE concentrations that were below the detection limit of 0.001 micrograms per liter could exceed the DDT water quality standard. As with the OSU data, it should be noted that the sampling event occurred in the Fall after the conclusion of the irrigation season and the subsequent reduction in sediment loading. DEQ pesticide sample locations are shown on **Figure 8-4.**

Table 8-4. Pesticides in Water, DEQ, 2006 (micrograms/liter)

Location	Date	DDT	DDE	DDD	Dieldrin
Malheur R nr Juntura	10/22/06	<0.001	<0.001	<0.001	<0.001
Bully Cr @ Vale	10/22/06	<0.001	<0.001	<0.001	<0.001
Willow Cr @ Vale	10/22/06	<0.001	<0.001	<0.001	<0.001
Malheur R @ Ontario WWTP	10/22/06	<0.001	<0.001	<0.001	<0.001
Malheur R @ Hwy 201	10/22/06	<0.001	<0.001	<0.001	<0.001

Figure 8-4. DEQ pesticide sample locations, 2006.



Due to the strong affinity of organochlorine pesticides such as DDT and Dieldrin, for soil particles, sediment data may be a better indicator of source areas than the water data. However, the State of Oregon does not have any sediment standards for these contaminants. Significant levels of DDT (1.6 – 15 mg/kg) and Dieldrin (1.7- 43 mg/kg) were detected in the sediment samples collected by the USGS in the Malheur River, Bully Creek and Willow Creek near Vale, the Malheur River near Ontario, and the D-drain which enters the Malheur River between Vale and Ontario. The highest levels of DDT and Dieldrin were detected in the lower Bully Creek sediment sample (**Table 8-5**).

The OSU sediment data also suggest significant source areas of both DDT and Dieldrin in areas below the confluences of the Malheur River and Willow and Bully creeks in Vale, downstream to Ontario. Pesticide levels in sediment are generally 1-2 orders of magnitude higher downstream of Vale than upstream of Vale (**Table 8-6**). Most sediment pesticide values are significantly less than those detected in the USGS sampling event.

The DEQ sediment samples collected in October 2006 also indicate that the significant source areas of chlorinated pesticides in the basin are located in the lower basin. No chlorinated pesticides were detected in the upstream sediment sample that was collected from the Malheur River approximately 2 miles upstream of Juntura. DDT was detected in the sediment sample collected near the Ontario wastewater treatment plant, and DDE was detected in all samples with the exception of Juntura (**Table 8-7**). As with the OSU data, most of the pesticide levels detected in sediment were significantly less than those detected in the 1990 USGS sampling event. The sediment samples collected by the USGS and OSU were sieved prior to analysis and the less-than 2mm fraction was analyzed for chlorinated pesticides. The sediment samples collected by DEQ were not sieved prior to analysis. This difference in analytical technique would likely bias the DEQ results low when compared to the USGS and OSU data. This is due to the affinity for DDT and Dieldrin to bond to soil/sediment particles, and the increased surface area available for bonding that is present in fine grained materials.

Table 8-5. Pesticides in Sediment, USGS, 1990 (micrograms/kilogram)

Location	Date	DDT	DDE	DDD	Dieldrin
Bully Cr. nr. Vale	8/22/90	15	55	16	43
Malheur R. nr. Vale	8/22/90	1.6	17	4.9	5.9
Willow Cr. nr. Vale	8/22/90	4.5	3.1	1.3	1.7
D-Drain nr Malheur Butte	8/23/90	4.8	21	8.0	3.8
Malheur R nr Ontario	8/3/90	4.7	23	9.9	3.7
Malheur R nr Ontario	8/3/90	5.9	29	12	4.4

Table 8-6. Pesticides in Sediment, OSU, 1999 (micrograms/kg)

Location	Date	DDT	DDE	DDD	Dieldrin
Lower Ontario (Malheur R.)	10/99	0.750	3.90	0.830	0.420
Upper Ontario (Malheur R.)	Not sampled	---	---	---	---
Lower Vale (Malheur R.)	10/99	0.470	8.20	1.60	0.44
Upper Vale (Malheur R.)	10/99	0.320	1.40	0.270	0.220
Willow Cr.	10/99	0.010	0.070	0.200	0.020
Beulah (NF Malheur R.)	10/99	<0.010	0.040	0.010	0.010
Cottonwood Reservoir nr Drewsey	10/99	0.030	0.260	0.070	0.020
Drewsey (Malheur R.)	10/99	<0.010	0.030	0.020	0.020

Table 8-7. Pesticides in Sediment, DEQ, 2006 (micrograms/kg)

Location	Date	DDT	DDE	DDD	Dieldrin
Malheur R nr Juntura	10/22/06	<1 est.	<1	<1 est.	<1 est.
Bully Cr @ Vale	10/22/06	<1 est.	2 est.	<1 est.	<1 est.
Willow Cr @ Vale	10/22/06	<2 est.	1 est.	<2 est.	<2 est.
Malheur R @ Ontario WWTP	10/22/06	3	1 est.	<3 est.	<3 est.
Malheur R @ Hwy 201	10/22/06	<1	1 est.	<1 est.	<1 est.

Note: est. indicates estimated value

8.7 DISCUSSION AND RECOMMENDATIONS

The water and sediment data collected by USGS, OSU, and DEQ between 1990 and 2006, may suggest a decrease in chlorinated pesticide concentrations in surface water and sediment over time. However, the difficulty of reproducing results when sampling heterogeneous media such as sediment, along with differences in sampling, sample locations, and analytical techniques, should be taken into account when making this conclusion.

Significant levels of the breakdown products DDE and DDD (often at higher levels than DDT) indicate that breakdown is occurring. The more recent OSU and DEQ data suggest that concentrations of DDT and Dieldrin are decreasing. After decades of lack of use, and their continued breakdown, the concentrations of DDT, Dieldrin, and their related residues should continue to decrease. The reduction of soil erosion as part of actions required under phosphorus and bacteria TMDLs will also have the benefit of reducing DDT and Dieldrin loading to the Malheur River and its tributaries during the irrigation season, and should lead to attainment of water quality standards. Efforts in the Lower Malheur Subbasin will likely have the biggest benefit. TMDL implementation efforts should include further pesticide monitoring to provide assurance that these actions are sufficient to attain water quality standards. In addition to chlorinated pesticides, monitoring should include total suspended solids, total organic carbon, and flow where possible.

8.8 REFERENCES

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Joy, J. 2002, Upper Yakima River Basin Suspended Sediment and Organochlorine Pesticide Total Maximum Daily Load Evaluation. Washington State Department of Ecology publication number 02-03-012, April 2002.

Rinella, Frank A., Mullins, William H., Schuler, Carol Ann; 1994, “Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota associated with Irrigation Drainage in the Owyhee and Vale Projects, Oregon and Idaho, 1990-91”, U.S. Geological Survey Water-Resources Investigations Report 93-4156, U.S. Geological Survey Earth Science Information Center Open-File Reports Section, Denver, Colorado.

MALHEUR RIVER BASIN TMDL

CHAPTER 9: TEMPERATURE

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Definitions

7DADA: The seven day rolling average of the daily average temperature.

7DADM: The seven day rolling average of daily temperature maximums.

Anthropogenic Nonpoint Source Heat Load: Heat load caused by human activities.

Anthropogenic Nonpoint Source Load Allocation: The amount of heat that anthropogenic nonpoint sources may contribute to a stream without exceeding the applicable criteria. For temperature TMDLs it includes the human use allowance of 0.3 °C.

Assimilative Capacity: The amount of heat above the background level that a waterbody can receive without exceeding water quality standards. Assimilative capacity is divided amongst nonpoint source load allocations and point source waste load allocations.

Background Heat Load: The amount of heat that a stream would naturally receive in the absence of all anthropogenic impacts. It includes heat load from natural disturbances.

Critical Condition: Time of year when maximum stream temperatures are observed.

Current Total Heat Load: The amount of heat load a stream currently receives from all sources; including anthropogenic nonpoint sources, point sources, and background (including natural disturbance).

Diel: Refers to a 24-hour period involving a day and a night. In this document, a common usage is referring to the daily swings in temperature between the early morning lows and the late afternoon highs, e.g. diel variability.

Effective Shade: The percent reduction of potential daily solar radiation load delivered to the stream surface.

Heat Flux: The amount of heat per unit time per unit area (e.g. watts per square meter) measured at the stream surface.

Heat Load: The amount of heat received per 24-hour period by the stream (e.g. megawatts). It is calculated by multiplying the stream surface area by the solar heat flux.

Human Use Allowance: Allowable anthropogenic heat load equivalent to a cumulative 0.3^{o}C increase above the applicable criteria at the point(s) of maximum impact.

Nonpoint Source Loading Capacity: The amount of heat that a stream can receive from nonpoint sources (natural and anthropogenic) without exceeding the applicable criteria.

Site Potential Vegetation: The near stream vegetation that can grow and reproduce on a site given natural plant biology, site elevation, soil characteristics, local climate, channel morphology, hydrology, and natural disturbance regime.

9.1 INTRODUCTION

Human activities and aquatic species protected by water quality standards are called “beneficial uses”. Water quality standards are developed to protect the most sensitive beneficial use within a waterbody. Oregon’s stream temperature standard is designed to protect cold water fish (salmonids) rearing and spawning as the most sensitive beneficial use.

Oregon’s stream temperature standard is both numeric and narrative. Numeric criteria are based on temperatures that protect various salmonid life stages. Narrative triggers specify conditions that deserve special attention, such as outstanding resource waters and dissolved oxygen violations.

When stream temperature data indicate a criteria violation, the waterbody is designated as water quality limited and placed on the 303(d) list. Total Maximum Daily Loads (TMDLs) must then be completed for the 303(d) listed waterbodies.

This temperature TMDL addresses year round impairments to all perennial and intermittent streams and rivers within the Malheur River Basin. All land uses and ownerships are included in this TMDL: lands managed by the State of Oregon, U. S. Bureau of Reclamation (USBR), U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), private forestlands, agricultural lands, irrigation districts, rural residences, transportation uses, and urbanized areas.

Allocations within this TMDL apply to all temperature listings as well as all other perennial and intermittent streams. They apply to these streams because temperature impacts are cumulative are not contained to just human activities within the reaches that are impaired. Human activities in upstream tributaries or higher in the watershed can influence stream temperatures downstream. For this reason the EQC has developed standards protecting waters not listed (see TMDL **section 9.4.3** – **section 9.4.7**). In particularly, intermittent streams are important for temperature because they can:

(1) Be “dry” but still retain residual pools primarily fed by groundwater. There is at least one published study in Oregon documenting the presence of fish in these pools over the entire summer (Wiginton et al 2006). Residual pools and the aquatic life that use them (eg. bull trout) must be protected from temperature increases.

(2) Influence temperature directly during the time in which they flow. Though this typically is not during the annual “thermal peak”, there are other times of year when temperature is a critical concern, such as at the beginning or end of the summer when downstream temperatures are still warmer than the biological criteria.

(3) Be sources of increased sediment loading where they are modified through land and vegetation disturbance. High sediment loading often causes stream channels to widen and shallow, increasing solar heating. Stream temperature is influenced by channel shape, which is in turn influenced by upland and headwater sediment loading. Restoration and maintenance of healthy riparian condition provides for stream bank stabilization, and reduces runoff.

(4) Be flowing subsurface because they are currently degraded. In Eastern Oregon there are examples of degraded intermittent streams becoming perennial after restoration. Restoring the riparian vegetation will allow the system to aggrade raising the water table and returning flow to the surface (Elmore and Beschta 1987).

If resource managers have data which demonstrates that conditions in a non-perennial stream does not affect downstream perennial or fish bearing stream water quality for which the TMDL has been developed then DEQ can consider alternative management on those non-perennial streams. DEQ can work with DMAs on this during the development of TMDL Implementation Plans.

Nonpoint source load allocations use site potential vegetation and effective shade as a surrogate measure and are protective year-round. Point source waste load allocations have not been calculated because there are no point sources on temperature listed streams. The **Malheur River Basin**

Temperature TMDL Appendix E contains more detailed information regarding data sources, analytical methods, and simulation results.

Temperature Issues in the Malheur River Basin

Salmonids, often referred to as cold water fish, some amphibians, and macroinvertebrates are highly sensitive to temperature. In particular, Bull Trout (*Salvelinus confluentus*) and Redband Trout (*Oncorhynchus mykiss ssp.)* are among the most temperature sensitive of the cold water fish species in the Malheur River Basin (ODEQ 1995). Excessive summer water temperatures have been recorded in a number of tributaries. These high summer temperatures are reducing the quality of migration and spawning habitat and are one of the contributing factors Bull Trout are listed as threatened under the U.S. Endangered Species Act. The causes of high water temperatures in the Malheur River Basin include the effects from legacy and current overgrazing of domestic livestock, agricultural land use within riparian areas, reservoir management, water withdrawals and irrigation water return flows, forest management within riparian areas, and road construction and maintenance.

Applying Oregon's Temperature Criteria

Oregon's water temperature criteria employ a logic that relies on using salmonids' life cycles as the indicator. If temperatures are protective of these indicator species, other species will share in this protection. The reduction in heat loading needed to meet the water quality criteria for temperature is evaluated in this TMDL. Attainment of the temperature criteria relies on restoring degraded natural riparian vegetation and channel morphology conditions. This will require a modification to current human activities or management in the riparian area and in some uplands areas. This chapter describes the rational and modeling used to support this conclusion.

Temperature TMDL Overview

Potential heat pollutants identified include human-caused increases in solar radiation due to changes in riparian vegetation and channel morphology, warm water discharges due to dams, flow modification, water withdrawals, and Western Juniper management. The resultant TMDL loading capacities are expressed as pollutant loading limits plus a Human Use Allowance (HUA) for nonpoint sources of pollution (see **Table 9-1** for summary). The human use allowance is a cumulative increase of no greater than 0.3^{o}C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact (OAR 340-041-0028 (12)(b)(B)). The 0.3^{o}C cumulative increase is distributed between nonpoint sources, reserve capacity, and margin of safety. An allowance for point sources was not given because there are no point sources on temperature impaired streams. Allocations take the form of numeric loads as well as percent effective shade and site potential vegetation types. Since streams in their natural state, without human caused impacts, may at times exceed the biological temperature criteria, ODEQ rules state that the naturally warm temperatures become the standard (OAR 340-041-0028 (8)). By achieving natural site potential vegetation conditions and measures outlined in this TMDL, listed streams will be considered in compliance with the TMDL.

Table 9-1. Temperature TMDL Component Summary based on Oregon Administrative Rule (OAR), federal Clean Water Act (CWA) and Code of Federal Regulations (CFR) requirements.

Waterbodies OAR 340-042-0040(4)(a)	All perennial and intermittent streams within the Malheur River Basin. Specifically, this TMDL includes areas in Oregon within the Middle Snake-Payette Subbasin (Hydrologic Unit Code [HUC] 17050115), Lower Malheur Subbasin (HUC 17050117), Bully Subbasin (HUC 17050118), Willow Subbasin (HUC 17050119), and Upper Malheur Subbasin (HUC 17050116).
Beneficial Uses OAR 340-041-0271, Table 201A	Beneficial uses impaired include fish and aquatic life.
Pollutant Identification OAR 340-042-0040(4)(b)	*Pollutants:* Human caused temperature increases from (1) warm water discharge to surface waters (2) increased solar radiation loading, and (3) flow modification that affects natural thermal regimes.

Target Identification Applicable Water Quality Standards OAR 340-041-0028(4)(a) OAR 340-041-0028(4)(b) OAR 340-041-0028(4)(c) OAR 340-042-0040(4)(c) ***CWA §303(d)(1)***	OAR 340, Division 41 provides numeric and narrative temperature criteria. **Figure 201A** specifies where and when the criteria apply. Biologically based numeric criteria applicable to the Malheur River Basin, as measured using the seven day average of the daily maximum stream temperature include: 12.0°C during times and at locations of Bull Trout spawning and juvenile rearing uses. 16.0°C during times and at locations of salmon and trout rearing and migration designated as core cold water habitat 20.0°C during times and at locations of Redband Trout use. No increase in temperature that would impair cool water species during times and locations where cool water species uses occur
Existing Sources OAR 340-042-0040(4)(f) ***CWA §303(d)(1)***	<u>Nonpoint sources</u> include excessive inputs of solar radiation due to the removal or reduction in stream side vegetation and widening of channels. Water withdrawals, reservoirs, irrigation districts, and dam operations are considered nonpoint sources that influence the quantity and timing of heat delivery to downstream river reaches.
Seasonal Variation OAR 340-042-0040(4)(j) ***CWA §303(d)(1)***	Peak temperatures typically occur in mid-July through mid-August. In rivers where Redband or Lahontan Cutthroat Trout use occur, the period of exceedances of the water quality standard and applicability of allocations is from May 1 – September 30. In waters where Bull Trout spawning and juvenile rearing uses occur, the period of exceedances of the water quality standard and applicability of allocations is from May 1– October 31.
TMDL Loading Capacity and Allocations OAR 340-042-0040(4)(d) OAR 340-042-0040(4)(e) OAR 340-042-0040(4)(g) OAR 340-042-0040(4)(h) OAR 340-042-0040(4)(k) ***40 CFR 130.2(f) 40 CFR 130.2(g) 40 CFR 130.2(h)***	*<u>Loading Capacity</u>:* Oregon Administrative Rule 340-041-0028 (12)(b)(B) states that all anthropogenic sources of heat may cumulatively increase stream temperature no more than 0.3ºC (0.5 ºF) above the applicable criteria at the point of maximum impact. Loading capacity is the solar load received by the stream that corresponds to site potential vegetation conditions and natural channel morphology. In the Malheur and North Fork of the Malheur River, the solar loading capacity is 368.4 megawatts. *<u>Excess Load</u>*: The difference between the actual pollutant load and the loading capacity of the waterbody is the excess heat load. In the Malheur and North Fork of the Malheur Rivers, the excess solar loading is 95.1 megawatts. *<u>Load Allocations (Agriculture, Forestry, Transportation, Urban, and Irrigation Districts)</u>*: The load allocation for nonpoint sources: agricultural, and forestry, in the Malheur River Basin consists of the sum of the natural background loads from solar radiation. For transportation, urban, and irrigation districts the load allocation is the sum of natural background sources plus the heat load that corresponds to 0.1ºC of the Human Use Allowance (HUA) above the criteria at the point of maximum impact. The heat load corresponding to the human use allowance has been allocated to these source activities to address anthropogenic heat loads in excess of background rates due to existing structures such as roads and buildings. *<u>Load Allocations (Reservoir Operations)</u>*: Load allocations for the reservoir/dam operations within the Malheur River Basin are allocated background loads with no additional heat load above the applicable criteria at the point of maximum impact. *<u>Waste Load Allocations (NPDES Point Sources)</u>*: All NPDES permitted point sources in the in the Malheur River Basin combined are not allowed a heat load equivalent to an increase in temperate of more than 0.05ºC above the applicable criteria at the point of maximum impact during the season of impairment: May 1 – September 30. *<u>Reserve Capacity</u>*: A heat load equivalent to a portion of the human use allowance is allocated for future growth and new or expanded sources except dams. This heat load allowance is equivalent to a total of 0.025ºC increase in temperatures at the point of maximum impact above the applicable temperature criteria.

Surrogate Measures **OAR 340-042-0040(5)(b)** ***40 CFR 130.2(i)***	Surrogate measures: Effective shade targets translate nonpoint source solar radiation loads into measurable stream side site potential vegetation conditions.
Margins of Safety **OAR 340-042-0040(4)(i)** ***CWA §303(d)(1)***	*Margins of Safety* are explicit through the allocation of 0.025ºC from the human use allowance.
Water Quality Management Plan **OAR 340-042-0040(4)(l)** ***CWA §303(d)(1)***	The Water Quality Management Plan (WQMP) provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans.

9.2 TEMPERATURE 303(D) LISTINGS

OAR 340-042-0040(4) (a)

This element describes the geographic area for which the TMDL is developed and applies to the following stream segments of the Malheur River Basin

Section 303(d) of the Federal Clean Water Act (1972) requires that waterbodies which exceed water quality criteria, thereby failing to fully protect beneficial uses, be identified and placed on the 303(d) list. Stream monitoring has indicated that some water temperatures in the Malheur River Basin exceed the State of Oregon temperature criteria. **Table 9-2** lists the temperature impaired waterbodies in the Malheur River Basin on the 2004/2006 integrated 303(d) list. **Figure 9-1** shows their location in the basin. **Table 9-3** lists the total stream miles impaired.

Data collected on the Malheur and North Fork Malheur Rivers downstream of the dams shows river temperatures exceed the 20^{o}C redband use biological criterion (See **Figure 9-2** to **Figure 9-6**). To address these impairments and future ones, the TMDL management measures apply to all perennial and intermittent waterbodies within the Malheur River Basin. Specifically, this TMDL includes waterbodies in Oregon within the Middle Snake-Payette Subbasin (Hydrologic Unit Code [HUC] 17050115), Lower Malheur Subbasin (HUC 17050117), Bully Subbasin (HUC 17050118), Willow Subbasin (HUC 17050119), and Upper Malheur Subbasin (HUC 17050116).

Table 9-2. Waterbodies in the Malheur River Basin impaired for temperature

Subasin	Waterbody	River Mile	Criterion	List Date	Record ID
Crosses Subbasins	Malheur River	126.8 to 162.3	Rearing	1998	2190
Crosses Subbasins	Malheur River	162.3 to 185.9	Rearing	1998	2191
Lower Malheur	Alder Creek	0 to 4.1	Rearing	1998	2465
Lower Malheur	Cottonwood Creek	0 to 35.3	Rearing	1998	2464
Lower Malheur	Pole Creek	0 to 6.3	Rearing	1998	2231
Upper Malheur	Bear Creek	0 to 14.7	Rearing	1998	2193
Upper Malheur	Big Creek	0 to 6.1	Bull Trout	1998	2194
Upper Malheur	Crane Creek	0 to 1.1	Bull Trout	1998	2201
Upper Malheur	Dry Creek	0 to 8.3	Rearing	1998	2444
Upper Malheur	Elk Creek	0 to 1	Bull Trout	1998	2204
Upper Malheur	Lake Creek	0 to 11.9	Bull Trout	1998	2206
Upper Malheur	Little Crane Creek	0 to 9.3	Bull Trout	1998	2202
Upper Malheur	Little Malheur River	0 to 28.5	Rearing	1998	2208
Upper Malheur	North Fork Malheur River	20.8 to 43.1	Bull Trout	1998	2211
Upper Malheur	North Fork Malheur River	43.1 to 59.3	Rearing	1998	2210
Upper Malheur	Pine Creek	0 to 24.7	Rearing	1998	2217
Upper Malheur	Stinkingwater Creek	0 to 27.8	Rearing	1998	2220
Upper Malheur	Summit Creek	0 to 14.2	Rearing	1998	2222
Upper Malheur	Bluebucket Creek	0 to 12.1	Redband	2004	12604
Upper Malheur	Warm Springs Creek	0 to 9	Redband	2004	12589
Willow	Basin Creek	0 to 8.8	Redband	2004	12566

Table 9-3. Number of temperature TMDLs and total miles impaired in the Malheur River Basin

Criterion	Number of TMDLs	Impaired River Miles (Current[1])	Impaired River Miles (303d)
Bull Trout Spawning and Juvenile Rearing	6	70.0	45.6
Core Cold Water Habitat		14.2	
Salmonid Rearing	12		245.3
Redband or Lahontan Cutthroat Trout	3	239.3	12.1
Total	21	323.5	320.8

[1] The temperature standards for certain uses and waterbodies changed since the original listing. The "current" column refers to the number of impaired river miles for each criterion under 2010 water quality standards. The "303d" column refers to the number of river miles impaired for each criterion at the time of the listing.

Figure 9-1. Streams impaired for temperature on the 2004/2006 integrated 303(d) list

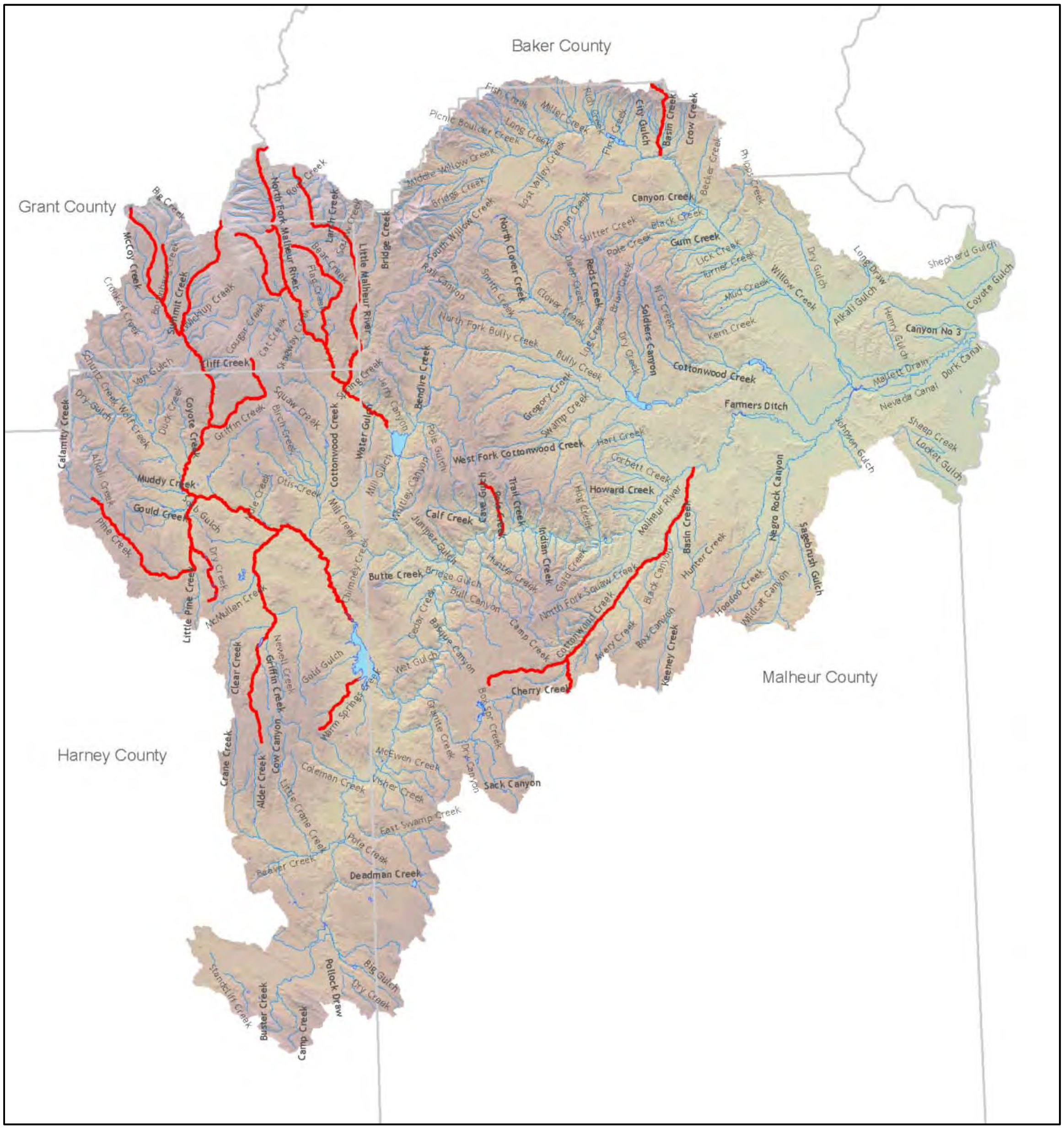


Figure 9-2. River temperatures on the Malheur River downstream of Warm Springs Dam at gage station. Data source: DEQ LASAR #33229.

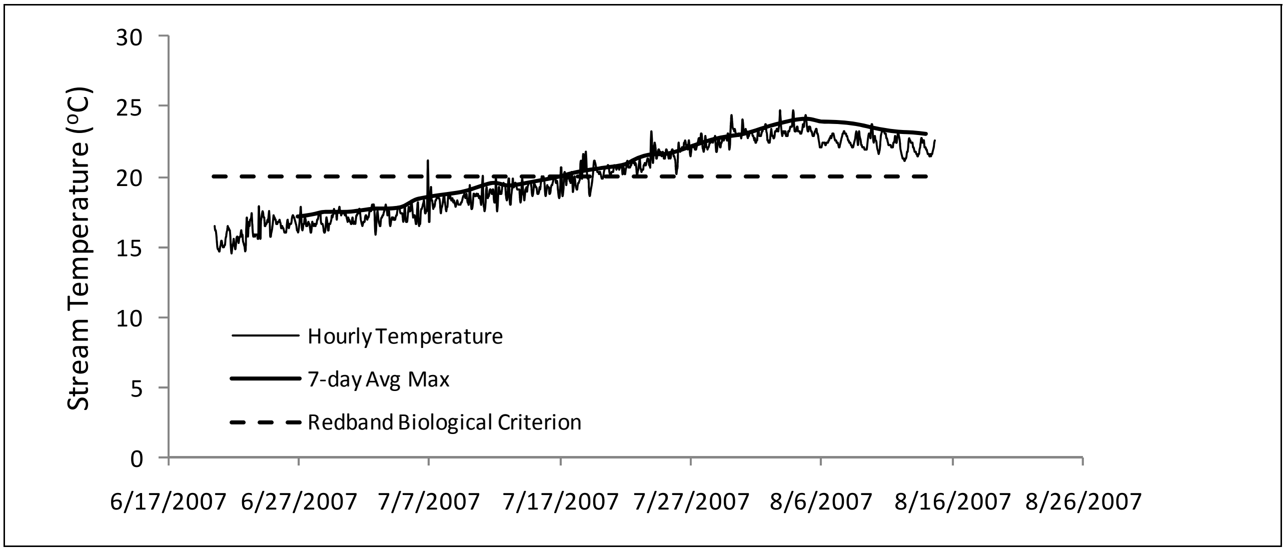


Figure 9-3. River temperatures on the Malheur River at Juntura. Data source: DEQ LASAR #33177.

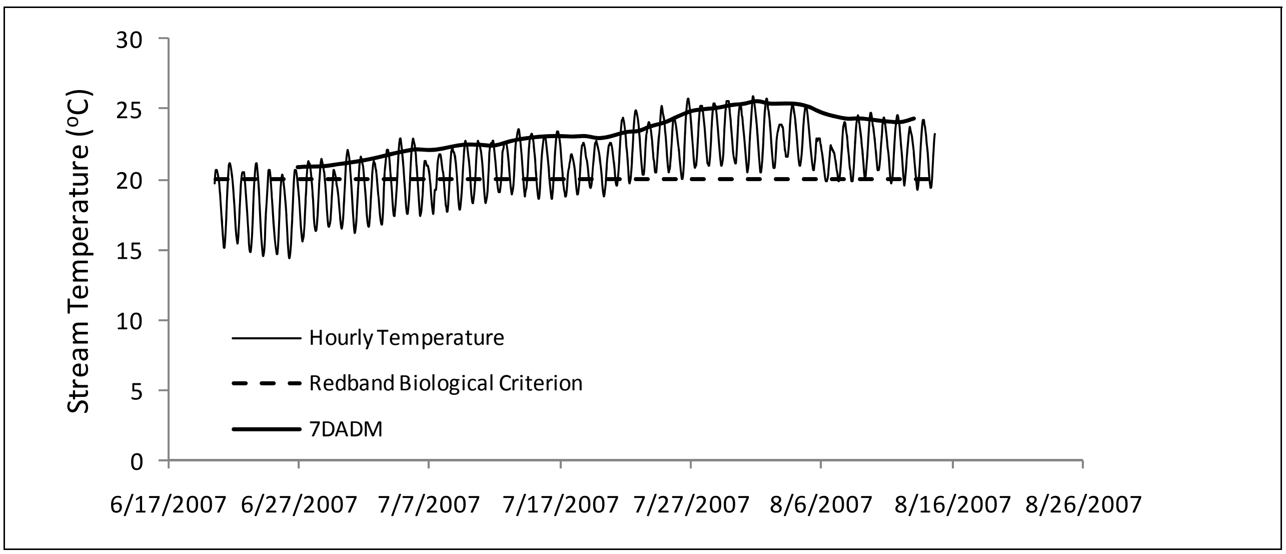


Figure 9-4. River temperatures on the Malheur River at Jones Ranch. Data source: DEQ LASAR #33176.

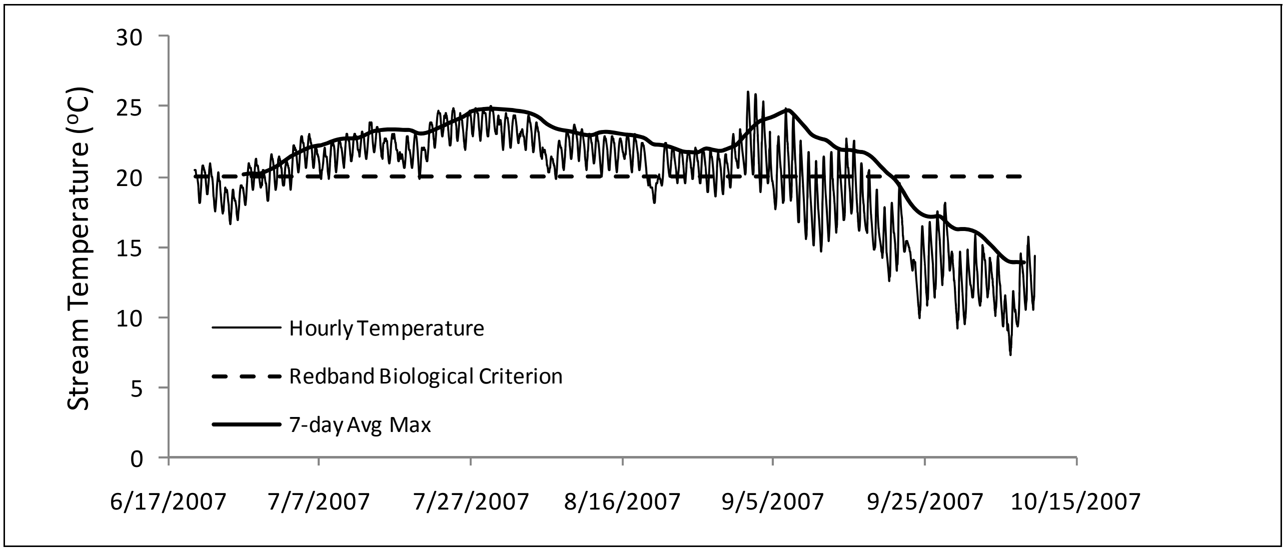


Figure 9-5. River temperatures on the Malheur River at Namorf. Data source: DEQ LASAR #33175.

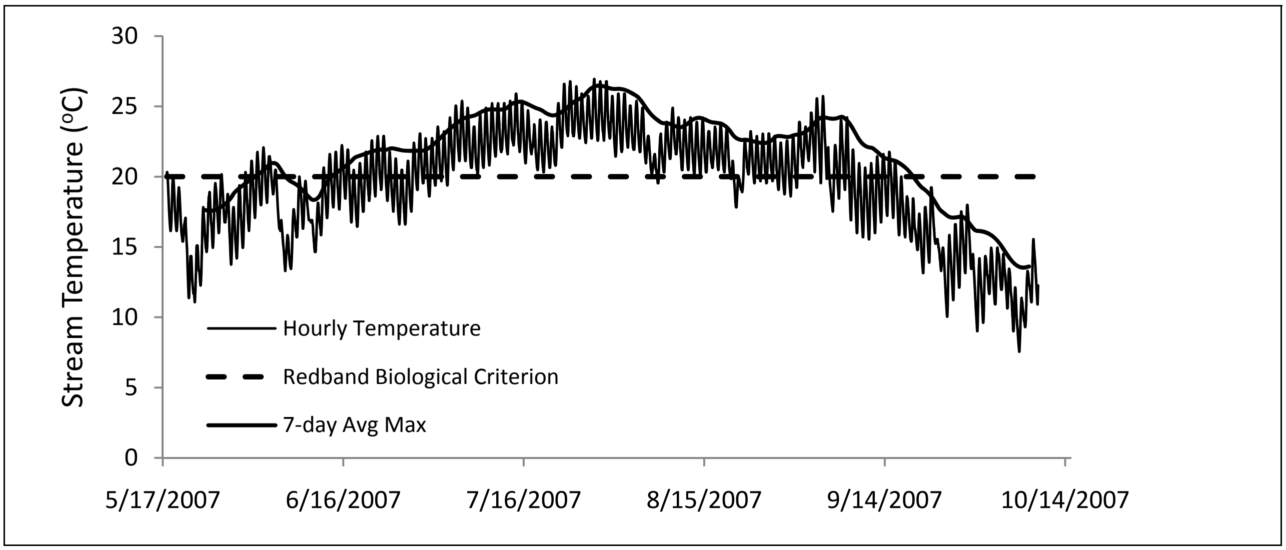
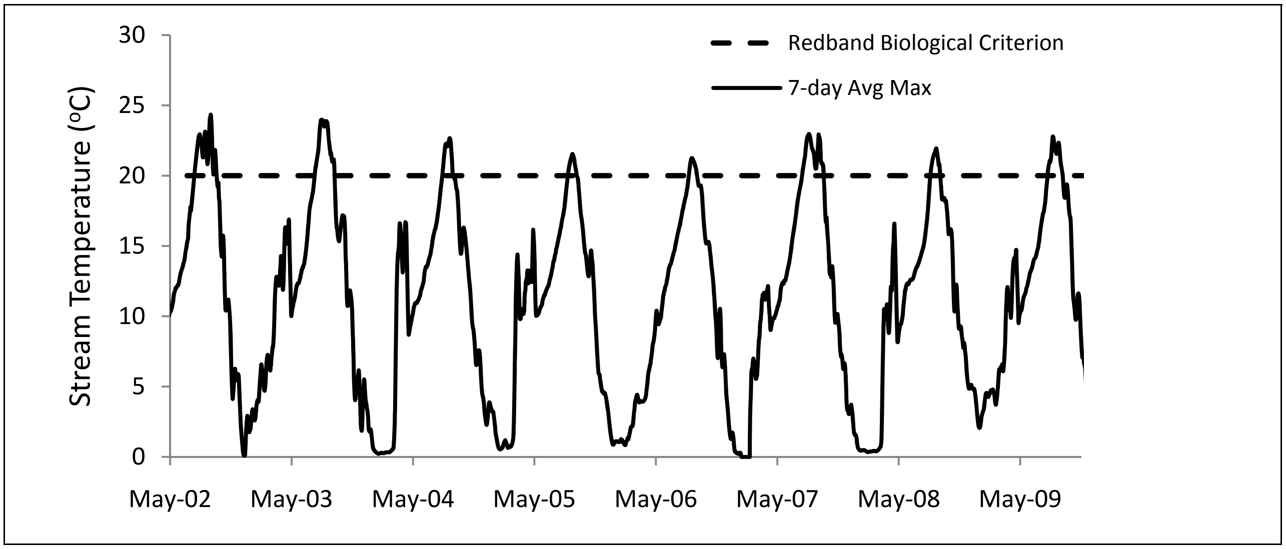


Figure 9-6. River temperatures on the North Fork Malheur River below Beulah Reservoir. Data source: BOR.



9.3 POLLUTANT IDENTIFICATION

OAR 340-042-0040(4)(b)

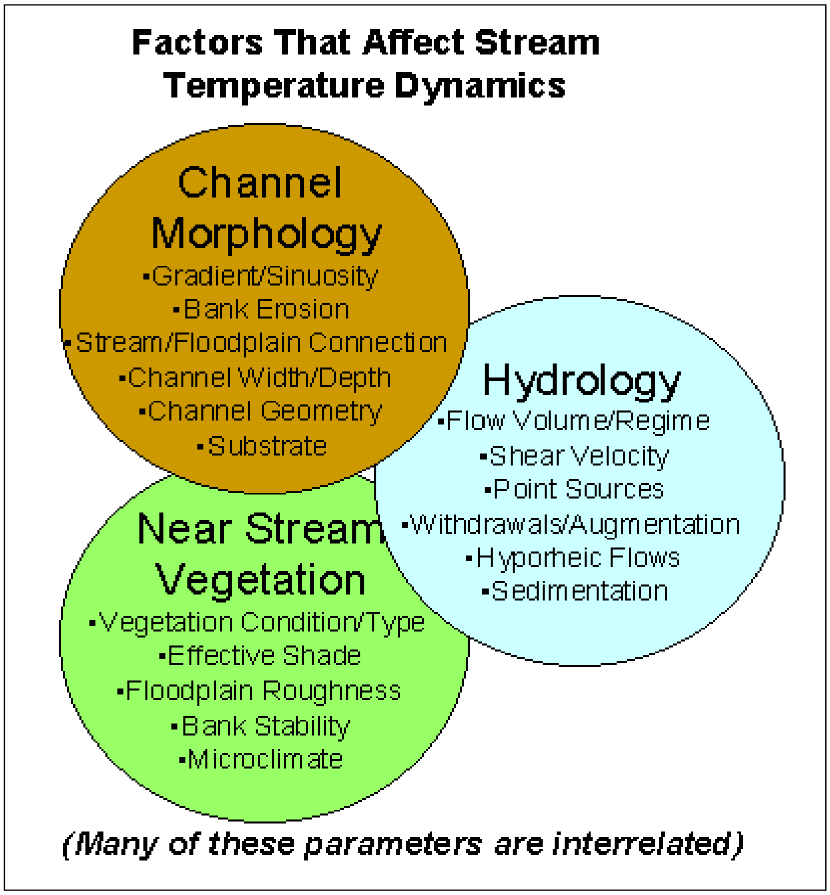
This element identifies the pollutant causing the impairment of water quality addressed in this TMDL.

Temperature is the water quality parameter of concern. In particular, temperature increases caused by human activities (or anthropogenic sources), is the pollutant of concern in this TMDL. Specifically, water temperature change is an expression of heat energy flux to a waterbody:

$$\Delta Temperature \propto \frac{\Delta Heat \quad Energy}{Volume}$$

Stream temperature is influenced by natural factors such as climate, geomorphology, hydrology, and vegetation (**Figure 9-7**). Human or anthropogenic heat sources may include discharges of heated water to surface waters, increases in sunlight reaching the water's surface due to the removal of streamside vegetation and reductions in stream shading, changes to stream channel form, reductions in natural stream flows, and the reduction of cold water inputs from groundwater. The pollutant targeted in this TMDL is heat from human caused increases in solar radiation loading to the stream network.

Figure 9-7. Factors affecting stream temperature



9.4 WATER QUALITY STANDARDS AND BENEFICIAL USE IDENTIFICATION

OAR 340-042-0040(4)(c), OAR 340-41-442, CWA §303(d)(1)

This element identifies the beneficial uses in the basin and relevant water quality standards, including specific basin standards. The beneficial use that is most sensitive to impairment by the pollutant is specified.

The Oregon Environmental Quality Commission (OEQC) has adopted numeric and narrative water quality standards to protect designated *beneficial use*s in the Malheur River Basin (OAR 340–041–0201, Table 201A, November 2003), and antidegradation policies to protect overall water quality (OAR 340-041-0004). The water quality criteria have been set at a level to protect the most sensitive beneficial uses (**Table 9-5**) and seasonal criteria may be applied for uses that do not occur year-round. The beneficial uses affected by excessive temperatures include Fish and Aquatic Life, and Fishing (ODEQ 2006a). Cold-water aquatic life such as Bull Trout and Redband Trout are the most temperature sensitive *beneficial uses* occurring in the Malheur River Basin (ODEQ 1995). Biologically-based numeric criteria were developed that are specific to salmonid life stages such as spawning and rearing. Criteria were also developed for critical habitat areas that serve as the core areas for salmonid protection or restoration efforts. **Figure 9-8** shows the spatial extent of fish use designations and the related biologically-based numeric criteria. Not all streams shown in **Figure 9-8** may flow year round or contain the designated fish use all year or every year. The standards do apply to these streams to ensure beneficial uses are protected from cumulative effects in downstream waters. The complete Oregon temperature rule (OAR 340-041-0028) can be accessed at http://www.deq.state.or.us/regulations/rules.htm.

Salmonid Stream Temperature Requirements

Stream temperatures above 12.0°C (53.6°F) are considered sub-lethal and can be stressful for cold water fish species, such as Bull Trout.

If stream temperatures become too hot, salmonids die almost instantaneously due to denaturing of critical enzyme systems in their bodies (Hogan 1970). The ultimate *instantaneous lethal limit* occurs in high temperature ranges above 90°F (> 32°C). Such warm temperature extremes may never occur in the Malheur River subbasins. More common and widespread, however, is the occurrence of temperatures in the range of 70°F - 77°F (21°C - 25°C). These temperatures, termed *incipient lethal limit*, cause death of cold water fish species during exposure times lasting a few hours to one day. The exact temperature at which a cold water fish succumbs to such a thermal stress depends on the temperature that the fish is acclimated to, and on life-stage. This cause of mortality results from the breakdown of physiological regulation of vital processes such as respiration and circulation (Heath and Hughes 1973).

The most common and widespread cause of thermally induced fish mortality is attributed to interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior, increased exposure to pathogens (viruses, bacteria and fungus), decreased food supply (impaired macroinvertebrate populations) and increased competition from warm water tolerant species. This mode of thermally induced mortality, termed indirect or *sub-lethal*, is more delayed, and occurs weeks to months after the onset of elevated temperatures of 64°F - 74°F (18°C - 23°C). **Table 9-4** summarizes the modes of thermally induced fish mortality.

Most streams in the Malheur River Basin are classified as Redband Trout habitat with a seven-day-average maximum temperature standard of 20 degrees Celsius (68.0 degrees Fahrenheit). Portions of the upper Middle Fork Malheur are designated as core cold water habitat with a seven-day-average maximum temperature standard of 16 degrees Celsius (60.8 degrees Fahrenheit), and headwater portions of the Middle Fork Malheur, North Fork Malheur, and their tributaries are classified as Bull Trout Spawning and Rearing habitat with a seven-day-average maximum temperature standard of 12 degrees Celsius (53.6 degrees Fahrenheit). The lower 67 miles of the Malheur River, the section of Bully Creek below Bully Reservoir, and Willow Creek below Malheur Reservoir are classified as Cool Water Species Habitat. Waters that support cool water species may not be warmed more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the ambient condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life.

Table 9-4. Modes of thermally induced cold water fish mortality

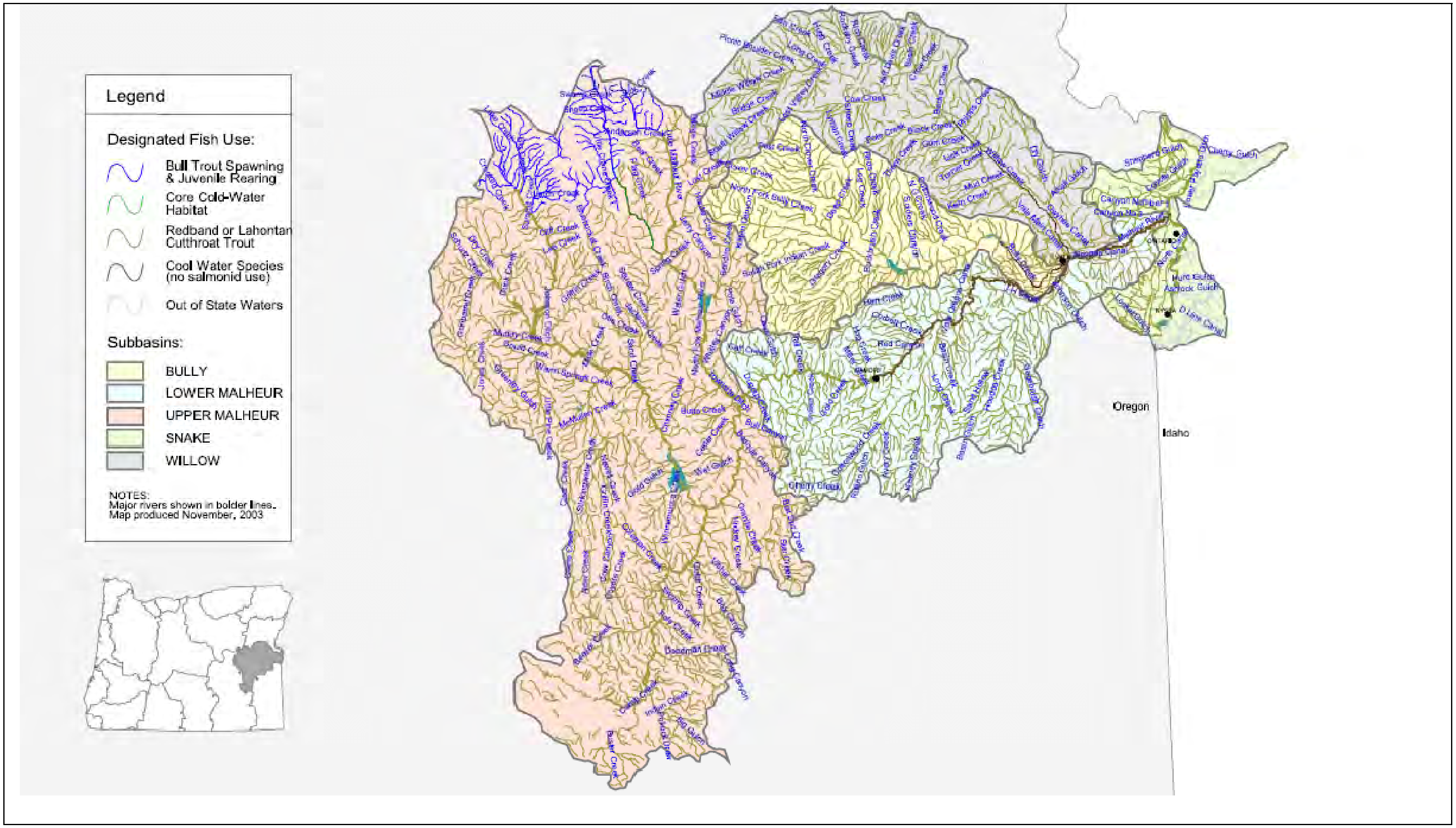
Modes of Thermally Induced Fish Mortality[1]	Temperature Range	Time to Death
Instantaneous Lethal Limit – Denaturing of bodily enzyme systems	> 90°F (> 32°C)	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	70°F - 77°F (21°C - 25°C)	Hours to Days
Sub-Lethal Limit – Conditions that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supply, and increased competition from warm water tolerant species	64°F - 74°F (18°C - 23°C)	Weeks to Months

[1]Brett, 1952; Hokanson et al, 1977; Bell, 1986.

Table 9-5. Beneficial uses in the Malheur River Basin

Beneficial Uses	Malheur River Basin Waterbodies	Temperature Sensitive Beneficial Use
Public Domestic Water Supply[1]	X	
Private Domestic Water Supply[1]	X	
Industrial Water Supply	X	
Irrigation	X	
Livestock Watering	X	
Fish & Aquatic Life[2]	X	X
Wildlife & Hunting	X	
Fishing	X	
Boating	X	
Water Contact Recreation	X	
Aesthetic Quality	X	
Hydro Power		
Commercial Navigation & Transportation		
[1] With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.		
[2] See **Figure 201A** in OAR 340-041-160 or **Figure 9-8** for fish use designations		

Figure 9-8. Fish use designations in the Malheur River Basin (Adapted from figure 201A in OAR340-041-160)



9.4.1 Natural Conditions Criteria

Refer to OAR 340-041-0028(8). Oregon water quality standards include provisions for periods and locations where biologically-based numeric criteria may not be achieved. If biologically-based numeric criteria are not achievable when waters are in their natural condition, stream temperatures achieved under the natural conditions shall be deemed to be the applicable temperature criteria for that water body. In other words, a stream that does not meet biologically-based numeric temperature criteria, but is free from anthropogenic influence, is considered to be at its natural thermal potential. In these situations the natural thermal potential temperatures supersede the biological numeric criteria and are considered the applicable numeric criteria.

9.4.2 Biological Criteria

Refer to OAR 340-041-0028(4). Unless superseded by the natural conditions criteria or by site specific criteria approved by EPA, the temperature criteria in the Malheur Basin and Middle Snake-Payette Subbasin is as follows:

Subsection (b) The seven day average daily maximum stream temperature may not exceed 16.0°C during times and at locations of salmon and trout rearing and migration designated as core cold water habitat. This criterion applies on the North Fork of the Malheur River upstream of the Little Malheur River and downstream of Crane Creek.

Subsection (f) The seven day average daily maximum stream temperature may not exceed 12.0°C during times and at locations of Bull Trout spawning and juvenile rearing uses. This criterion applies in the Upper Malheur Subbasin, primarily on the Malheur National Forest in the following streams: On the North Fork Malheur River and all upstream tributaries upstream of Camp Creek. On the Little Fork of the Malheur River and all upstream tributaries upstream of Camp Creek. On Summit Creek, Camp Creek, Big Creek, Lake Creek, Bosonberg Creek, and all upstream tributaries.

Subsection (e) The seven day average daily maximum stream temperature may not exceed 20.0°C during times and at locations of Redband Trout use. This criterion apples in all streams in the Malheur Basin and Middle Snake-Payette Subbasin except for those areas mentioned in the previous two paragraphs and where the cool water species criterion apply (**Section 9.4.3**)

9.4.3 Cool Water Species

Refer to OAR 340-041-0028(9). No increase in temperature that would impair cool water species during times and locations where cool water species uses occur. The Cool Water Species criterion applies in the Malheur River downstream of Namorf and on Willow Creek (Willow Subbasin) downstream of Black Creek.

9.4.4 Human Use Allowance

Refer to OAR 340-041-0028(12)(b). Oregon water quality standards also have provisions for human use when temperatures exceed applicable numeric criteria. The human use allowance limits cumulative anthropogenic heating of surface waters to no more than 0.3°C (0.5°F) above the applicable biological or natural conditions criteria at the point of maximum impact.

9.4.5 Protecting Cold Water

Refer to OAR 340-041-0028(11). Protection of cold water temperatures requires that streams with maximum summer temperatures less than applicable numeric criteria shall not be warmed by more than 0.3°C above ambient temperatures. This applies to all sources to ensure downstream temperatures comply with the applicable temperature criteria, in waterbodies where threatened or endangered species are present, or where ESA critical habitat has been designated, The U.S. FWS has designated critical habitat for bull trout in the Upper Malheur subbasin.

Subsection (b) of the rule limits the warming of salmon and steelhead spawning waters from point source discharges to 0.5°C above the 60 day average maximum temperature when the rolling average is between 10 to 12.8°C. The allowable increase is 1°C when the 60 day rolling average maximum temperature is less than 10°C unless analysis demonstrates that a greater increase will not significantly impact the use. This provision applies to any future point sources.

9.4.6 Antidegradation

Refer to OAR 340-041-0004. Among the antidegradation policies included in Oregon's water quality standards are provisions to prevent the unnecessary degradation of high quality water and to ensure full protection of all existing beneficial uses. At a minimum, uses are considered attainable wherever feasible or wherever attained historically. Antidegradation policies generally apply when water temperatures are less than the numeric criteria and offer provisions that allow for some degradation in water quality provided that such degradation does not prevent attainment of standards.

Water quality standards for temperature including the antidegradation and mixing zone policies are included in available online at ODEQ at http://www.deq.state.or.us/wq/wqrules/wqrules.htm. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *1992-1994 Water Quality Standards Review Final Issue Papers* (ODEQ, 1995) and in *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (USEPA, 2003).

9.5 SEASONAL VARIATION & CRITICAL CONDITION

OAR 340-042-0040(4)(j), CWA §303(d)(1)

This element accounts for seasonal variation and critical conditions in stream flow, sensitive beneficial uses, pollutant loading and water quality parameters.

Peak temperatures typically occur in mid-July through mid-August. In waters where Redband or Lahontan Cutthroat Trout use occur, the period of exceedances of the water quality standard is generally late May through September based on existing data (see **Figure 9-9** and **Figure 9-10**). In waters where Bull Trout spawning and juvenile rearing uses occur, multiple data sites (
Figure 9-11) indicate the longest period of exceedances of the water quality standard is from May through early October. We have highlighted time periods when the seasonal variation from year to year will likely not exceed the biological water quality standard. These periods are used to establish when the TMDL management measures apply for reduction of anthropogenic warming.

Figure 9-9. Seven day average daily maximum river temperatures on the Malheur River near Drewsey (2000-2008). Data source: USBR.

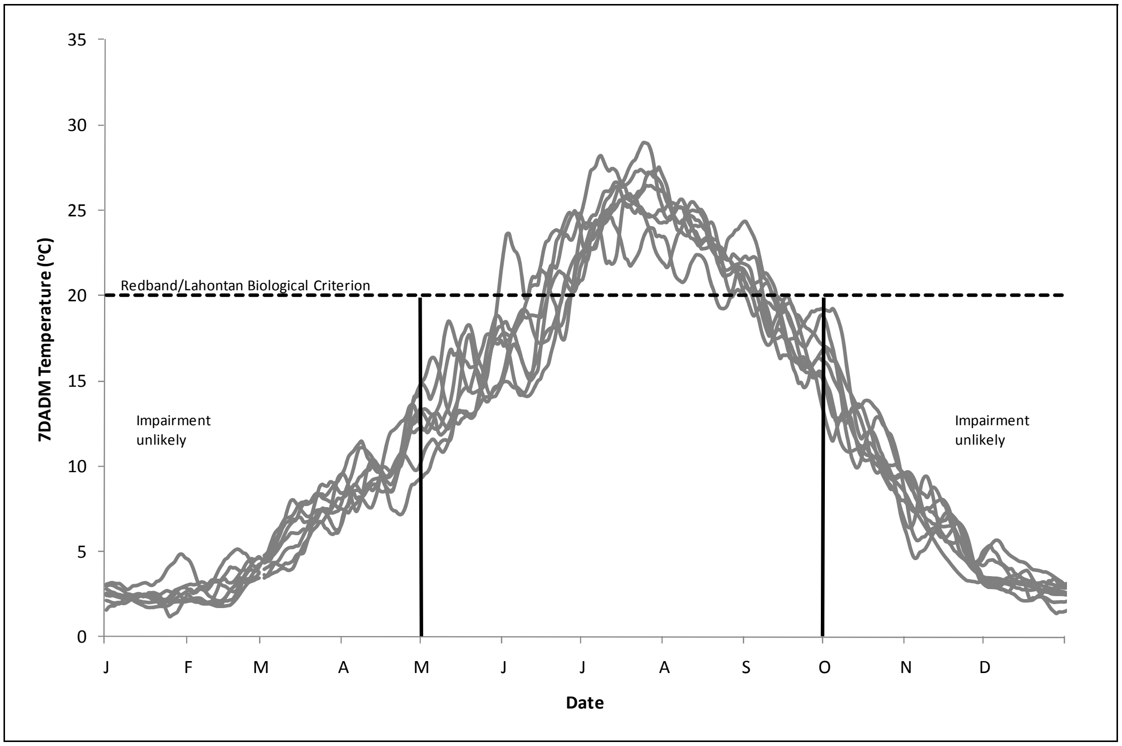


Figure 9-10. Seven day average daily maximum river temperatures on the North Fork Malheur River upstream of Beulah Reservoir (1998-2008). Data source: USBR.

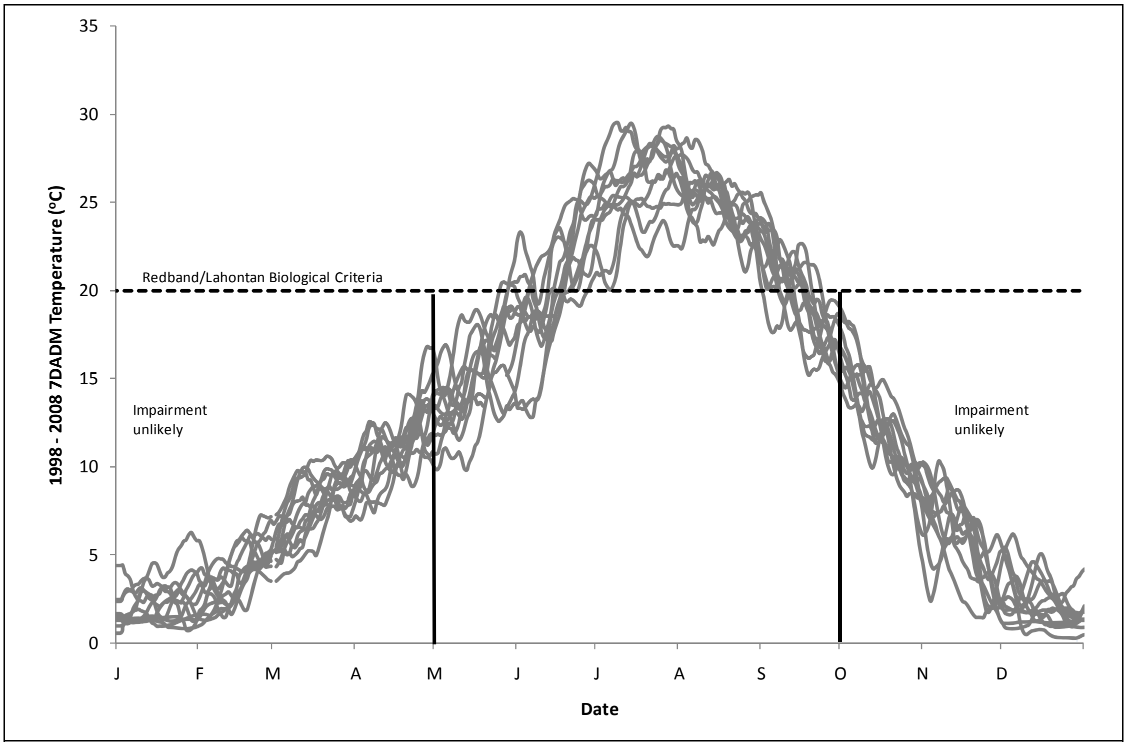


Figure 9-11. Seven day average daily maximum river temperatures on Big and Lake Creeks – Bull Trout spawning and juvenile rearing uses. Various years. Data source: Burns-Paiute Tribe.

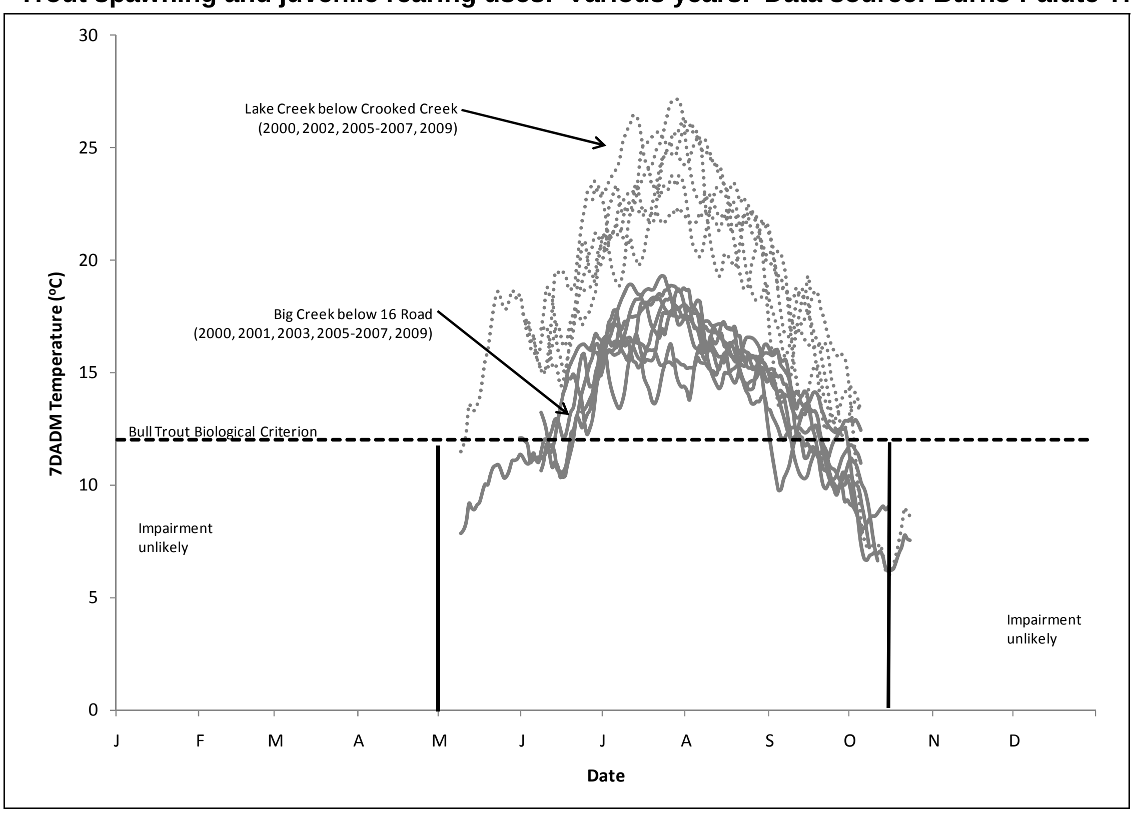


Figure 9-12 through **Figure 9-14** shows the seasonal variation in stream flow for locations with long term flow data. Monthly and seasonal critical low river flows are shown in **Table 9-6**. Low flows represent the log-Pearson Type III 7Q10 low flow metric. The 7Q10 is the lowest stream flow observed for seven consecutive days that would be expected to occur once in ten years. 7Q10s were calculated with DFLOW 3.1 (USEPA 2006).

Table 9-6. 7Q10 critical low flows (cfs) at various locations.

Period	Malheur River Near Drewsey	Malheur River below Warm Spring Reservoir	North Fork Malheur River above Beulah Reservoir
May 1 - Sept 30	0	0	29
Yearly	0	0	25
January	36	0	31
February	48	0	34
March	74	0	52
April	94	0	104
May	37	29	96
June	10	61	47
July	2	57	33
August	1	7	29
September	1	0	31
October	6	0	35
November	30	0	37
December	30	0	29
Data Source	USBR	USGS	USBR
Data Period	1927-2008	1909-2008	1914, 1936-2008

Figure 9-12. Monthly flow statistics (1927–2008) at Malheur River near Drewsey (upstream from Warm Spring Reservoir). Data Source: USBR.

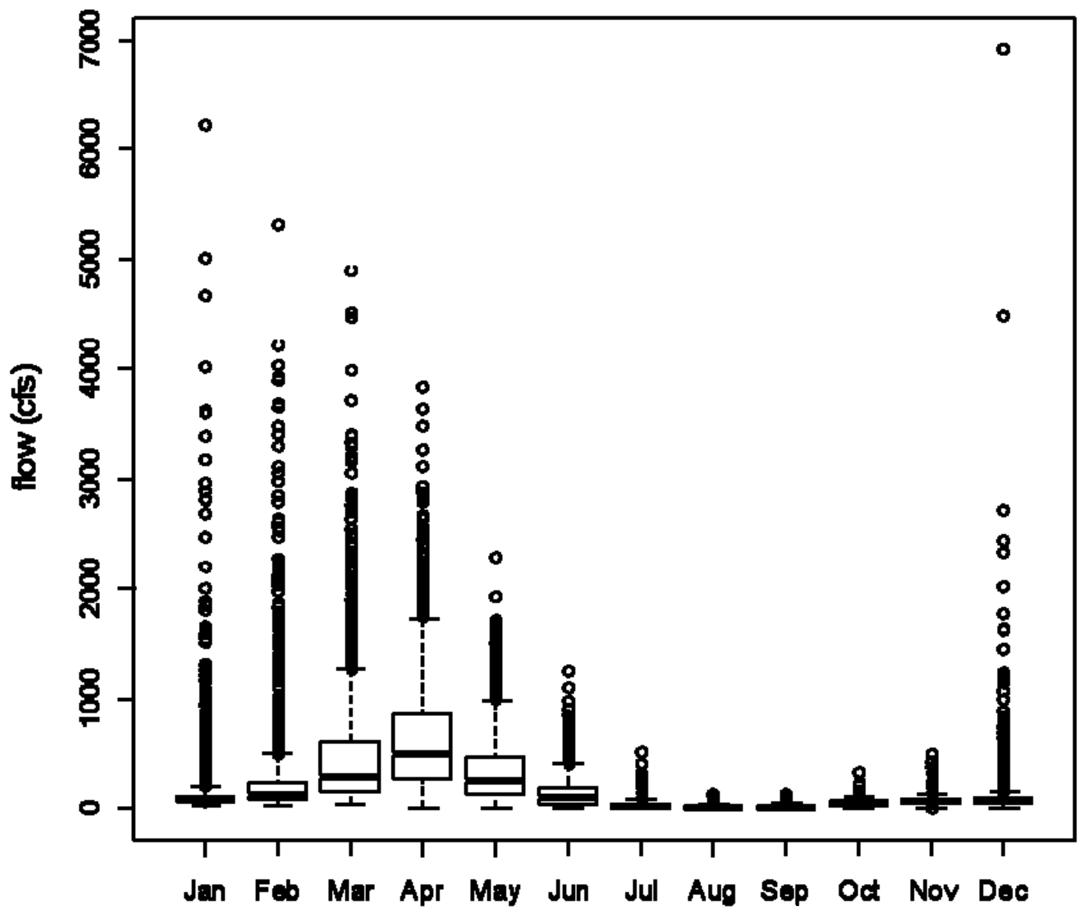


Figure 9-13. Monthly flow statistics (1920–2008) at Malheur River near Riverside below Warm Spring Reservoir. Data Source: USBR/USGS.

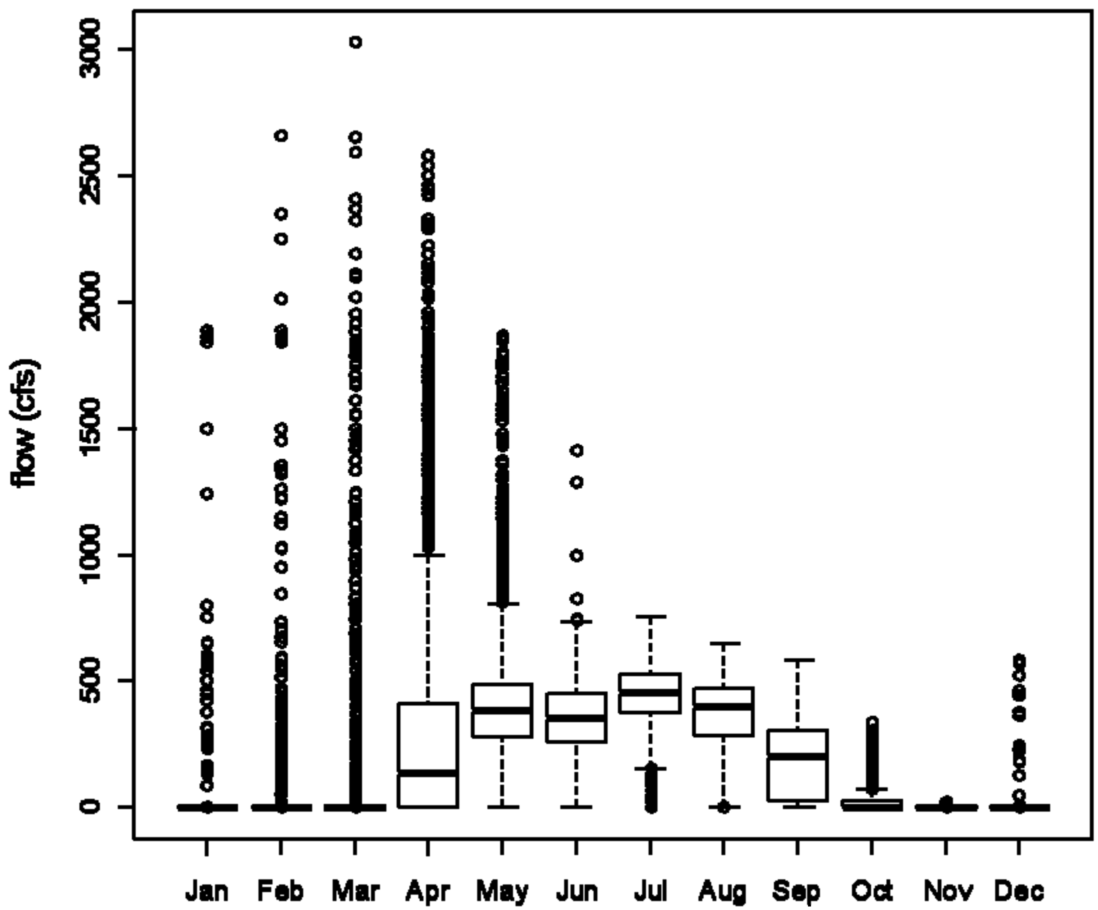
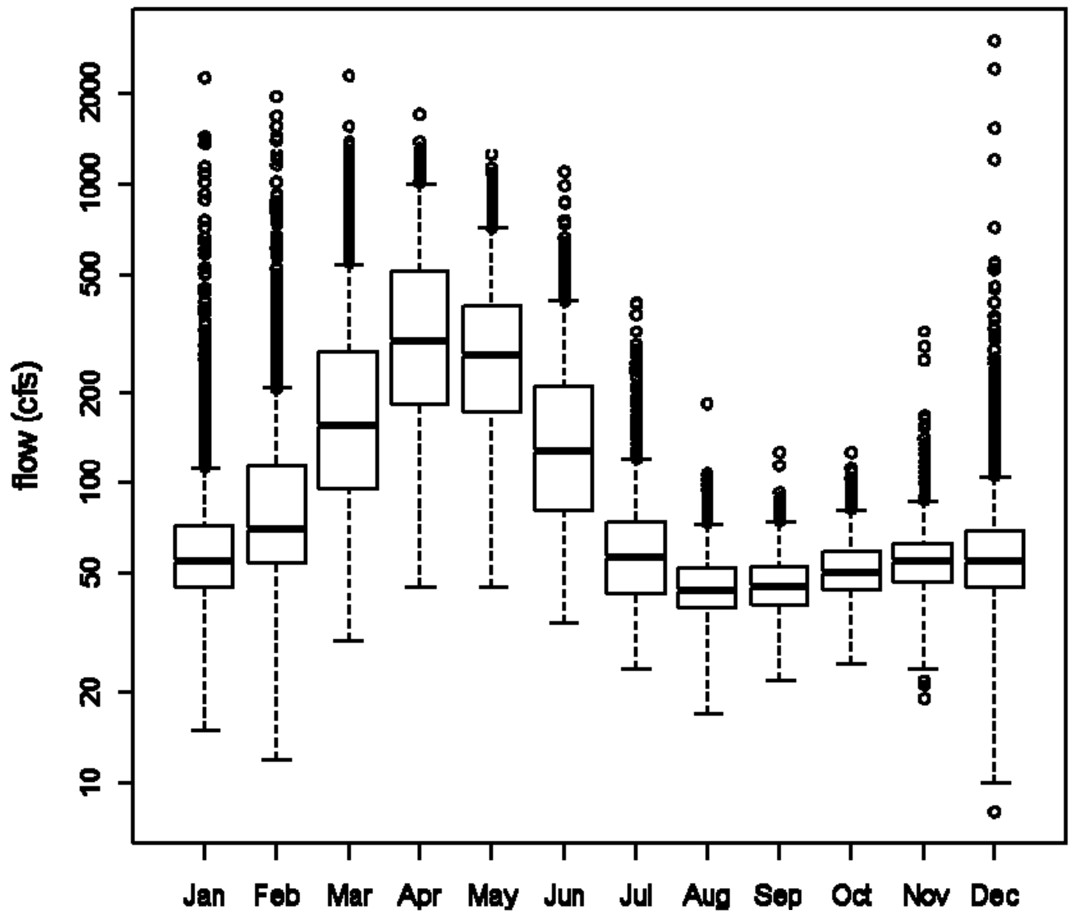


Figure 9-14. Monthly flow statistics (1936–2008) on a log scale at North Fork Malheur above Beulah Reservoir. Data Source: USBR.



9.6 SOURCES OF TEMPERATURE INCREASES

OAR 340-042-0040(4)(f), CWA §303(d)(1)

This element identifies the pollutant sources and estimates, to the extent existing data allow, the amount of actual pollutant loading from these sources.

Natural Background Sources

Natural or background inputs of solar radiation are by far the largest heat source in the Malheur River Basin. Streams in Oregon are generally warmest in summer when solar radiation inputs are greatest and stream flows are low. The amount of solar energy that actually reaches the surface of a stream is determined by many factors including the position of the sun in the sky, cloud cover, local topography, stream aspect, stream width, and streamside vegetation. Streams generally warm in a downstream direction as they become wider and streamside vegetation is less effective at shading the surface of the water. In addition, the cooling influences of ground water inflow and the impact of smaller tributaries have less of an impact downstream as a stream becomes larger. Greater reach volumes are associated with a reduction in stream sensitivity to natural and human sources of heat.

In the absence of human disturbance, many low elevation streams were likely warmer at times than is optimal for salmonids which may not have occupied these waters during the peak heat of the summer period. Channel complexity, deep pools, cool water inflows, and hyporheic exchange are thought to provide local but important thermal refuges in these inhospitable environments during the warmest months of the year.

Natural disturbance events are essential elements for healthy and productive salmonid streams. Flood, fire, windstorms, and other natural disturbance processes contribute to the complexity of the riverine environment. These disturbances often affect streamside vegetation and the riparian tree canopy, potentially decreasing stream shade for decades. However, such disturbances are viewed as beneficial processes. In a functional riparian community, one with most of the structural components and ecological processes in place, riparian canopy and shade will recover with time and the salmon, trout and other native species will benefit from the large wood and habitat complexity these disturbance processes provide. For the purposes of this plan, these disturbance processes are considered natural and are part of the natural background heat load.

Point Sources

Currently, there are three general and two individual NPDES permitted point sources in the Malheur River Basin. All three general permits are for storm water discharges. The two individual permits are irrigation districts permitted for herbicide application. In this temperature TMDL, irrigation districts are considered non-point sources because the primary source of temperature pollutant loading within the irrigation system is related primarily to agricultural return flows and agricultural storm water. The Oregon Revised Statues does not consider these sources point sources**.** ORS 468B.005(4) defines a point source as the following:

> *"Point source" means any discernible, confined and discrete conveyance, including but not limited to a pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft, from which pollutants are or may be discharged. "Point source" does not include agricultural storm water discharges and return flows from irrigated agriculture.*

Irrigation districts are considered point sources for application of herbicides because it is discharged from a hose (see *Headwaters Inc. Vs Talent Irrigation District*).

The three active general permits do not discharge into temperature impaired streams and likely will not exceed the waste load allocation reserved for point sources.

Non-Point Sources

The term "Nonpoint Sources" refers to “any source of pollution other than a point source” (ORS 468B.005(3) and applies to a diffuse or unconfined source of pollution where wastes can either enter into or be conveyed by the movement of water to waters of the state (OAR 340-41-0002 (40). For the purposes of this temperature TMDL, nonpoint sources are *past or present human activities that contribute to warmer surface waters than that which would occur naturally either through increased heat load or decreased assimilative capacity that do not require a NPDES permit for temperature.* Historically, human activities have contributed to altered stream morphology, hydrology and decreased the amount of riparian vegetation in the basin. The basin includes urban, agricultural, and forested lands. Additionally, dams and multiple points of diversion have altered stream flow levels. Low flows decrease the thermal assimilative capacity of streams. Pollutant (solar radiation) loading causes larger temperature increases in stream segments where flows are reduced by human uses.

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are generally outside of human control, riparian condition, channel morphology and hydrology are affected by human activities. For the Malheur River Basin Temperature TMDL five nonpoint source categories are discussed below:

1. Riparian vegetation disturbance/removal
2. Channel modifications and widening
3. Hydromodification: Dams, Diversions, and Irrigation Districts
4. Hydromodification: Water Rights
5. Other Anthropogenic sources

1. Riparian vegetation disturbance/removal

The removal or disturbance of riparian vegetation reduces the amount of shading and increases the amount of solar radiation reaching the stream surface. Direct solar radiation is typically the largest contribution of heat in a stream thermal budget (Brown 1969; Johnson 2004). An increase in solar radiation will likely increase stream temperatures. Furthermore, vegetation even beyond the distance necessary to shade a stream can influence the micro-climate, providing cooler daytime temperatures and moderating night time cool temperatures (Anderson et al 2007; Chen et al. 1999). Riparian vegetation also plays an important role in shaping channel morphology, resisting erosive high flows, and maintaining floodplain roughness. The overgrazing of domestic livestock (legacy and current impacts, see **Figure 9-15**) and historical vegetation removal in agricultural areas appears to be the largest sources of riparian vegetation removal in the Malheur River Basin.

Figure 9-15. Overgrazing on the Malheur River has contributed to loss of vegetation, unstable banks, and channel widening.

2. Channel Modifications and Widening

Human activities that have altered channel form generally fall into one of three categories: direct modification, increased sediment load, and removal of riparian vegetation. Direct modification includes changes to channel form associated with road building, flood control, gravel extraction, or channel realignment. Increased sediment loading can result from some agricultural practices, overgrazing, logging, and mining activities which can result in increased runoff, landslides, debris torrents and other mass wasting events. Lastly, removal of riparian vegetation can lead to bank instability and increased erosion. In the Malheur River Basin, waterbodies within wide valleys with low gradients are likely to be more degraded due to channel modifications than waterbodies in steep and narrow canyons. Channel modifications can impact water temperatures in the following ways:

Sediment filled pools
In California, a Mattole River study observed that thermally stratified pools often contained sediments decreasing the depth of thermal refugia, therefore decreasing the volume and frequency of the pools, decreasing assimilative capacity for thermal loading in a reach (California Regional Water Board 2002).

Less storage base flow
Many land use activities that disturb riparian vegetation and associated flood plain areas affect the connectivity between river and groundwater sources (ODEQ 2000). Wetlands, floodplain gravels, or other natural features that act as a temporary water storage slowly release water during dry periods, increasing base flow. Reduced summertime saturated riparian soils reduce

the overall watershed ability to capture and slowly release stored water. Reductions in stream flow slow the movement of water and generally increase the amount of time the water is exposed to solar radiation (ODEQ 2007). There are some thermal benefits gained from connecting the cooler, spring-fed pools and off-channel areas to the main channel (ODEQ 2007).

Decreased hyporheic and groundwater exchange
Groundwater inflow and hyporheic exchange can have a cooling effect on summertime stream temperatures (Bilby 1984, Loheide and Gorelick 2006) . Subsurface water is insulated from surface heating processes and is often cooler than daytime surface river temperatures. Channel straitening, wetlands infill, stream channel revetments, and loss of riparian vegetation all contribute to decreased hyporheic and groundwater exchange. Excess fine sediment can also decrease permeability and porosity in the hyporheic zone, greatly reducing hyporheic flow, and resulting in less cool water inputs (Rehg et al. 2005).

Wider shallower streams
Human activities (such as logging and overgrazing of domestic livestock) can cause wider, shallower streams (increased width to depth ratios) which increases surface area exposed to solar radiation and ambient air temperatures. Wider channels will have less effective shade than narrower channels with the same amount of riparian vegetation, thereby allowing more direct solar radiation to reach the stream surface. Narrower channel widths may also increase sinuosity and channel complexity.

Riparian vegetation disturbances
Increased geomorphological changes such as mass wasting events change the physical channel, and further disturb riparian vegetation reducing stream surface shading.

3. Hydromodification: Dams, Diversions, and Irrigation Districts

There are multiple irrigation districts operating within the Malheur River Basin. Below are some activities that could lead to warm stream temperatures:

- Diversion dams are used to divert water from a stream to an irrigation ditch or canal. Diversion dams affect stream temperature by dewatering the downstream reach of the river. Reductions in stream flow in a natural channel slow the movement of water and generally increase the amount of time the water is exposed to solar radiation. Stream temperatures downstream of diversion dams can be substantially warmer than those can above.

- Canals and other unpiped water conveyance systems generally are open ditches. These ditches are usually unshaded and increase the surface area of water exposed to solar radiation. Where canal waters are allowed to mix with natural stream flows, such as at diversion dams and at places where natural stream channels are used to convey irrigation water to downstream users, stream temperatures can increase. In addition, irrigation return flows will runoff fields or pastures after irrigation. These excess waters may end up in a stream or the irrigation ditch to be used by the next water right holder. Often in the Malheur River Basin, irrigation water infiltrates into the ground and may return as groundwater.

- Operational spills are places in the irrigation delivery system where excess unused irrigation water in the canals is discharged back into a downslope canal, a lateral stream, or a natural stream channel without being delivered to or used on an individual field. These waters may be picked up by the next water right holder. Then when the water is returned, it can increase stream temperatures.

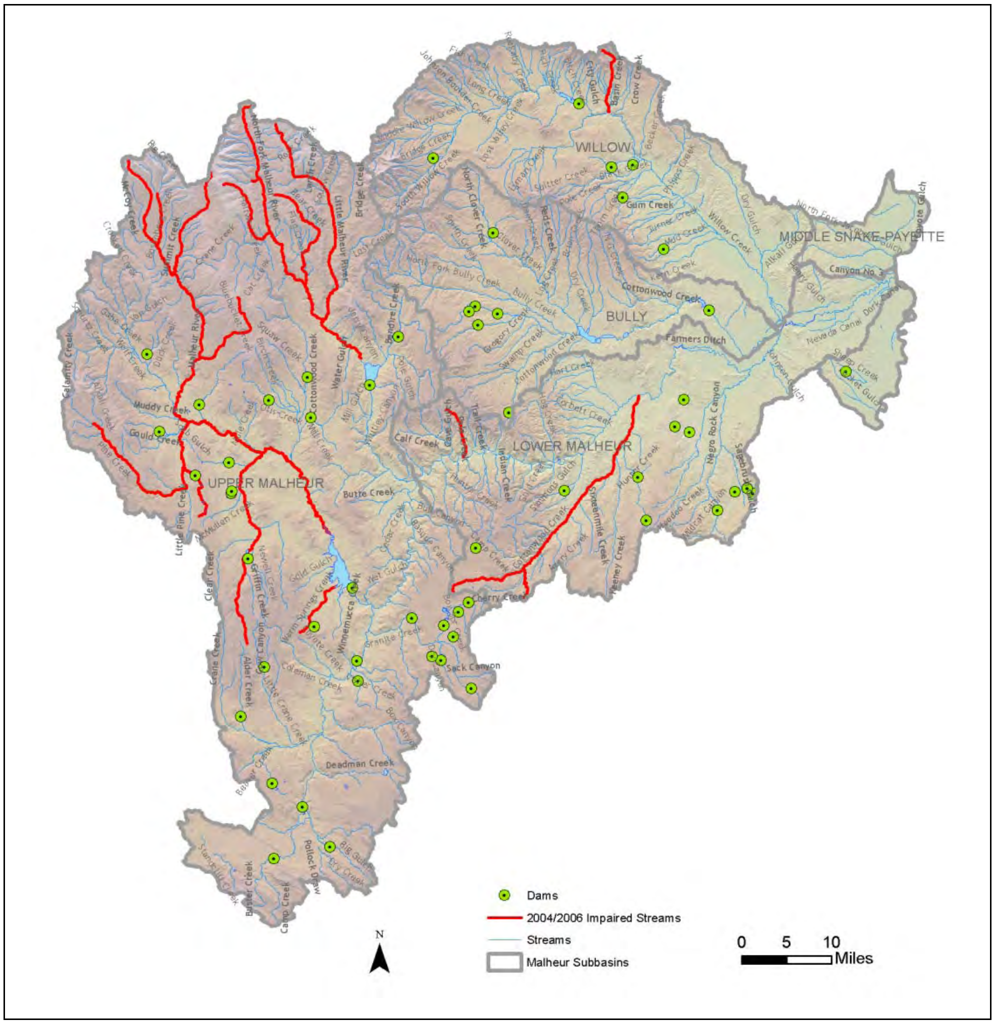
There are 55 dams (**Table 9-7)** identified by Oregon Water Resources Department (OWRD) (Falk and Hormon 1998) which are greater than 10-feet high and storage greater than or equal to 9.2 acre-feet in the Malheur River Basin (**Figure 9-16**). Thirteen of those dams are on or upstream of temperature impaired waterbodies on the 2004/2006 303(d) list. There may be other dams not identified in this list that fall within the scope of this TMDL.

Table 9-7. List of known dams in the Malheur River Basin.

Dam Name	Stream	State ID	Lat.	Long.	On /upstream of 303d stream
Agency Valley Res	N. Fk. Malheur River	R-671	43.9117	-118.1567	
Albertson's Res.	Feedlot Runoff	R-6092	43.9067	-117.0950	
Alder Creek	Alder Creek	R-5844	43.3833	-118.4633	
Altnow Res.	Warm Spring Creek (not 303d impaired Warms Spring Creek)	8-257	43.8617	-118.2900	X
Becker Res	North Fork. Indian Creek	R-502	44.0200	-117.8667	
Beede North	Unnamed	R-384	43.7467	-118.4700	X
Beede South	Unnamed	R-384	43.7433	-118.4717	X
Beer's Res.	Unnamed	R-322	43.4650	-118.0167	
Big Twin Reservoir	Sand Hollow Creek, Trib. to	R-7273	43.8183	-117.4486	
Blaylock Res. 3	(off stream)	R-10617	43.4672	-118.2033	
Box Springs Res.	Box Springs Creek	R-509	43.5417	-117.9750	
Brown, A. E. Res	Dry Creek	R-635	43.1700	-118.2733	
Bully Creek Res	Bully Creek & Malheur River	R-4456	44.0133	-117.3950	
Chapman Upper	Granite Creek, Trib to	R-929	43.4717	-118.0367	
Cob Creek	Visher & Cob Creeks	R-2863	43.4350	-118.2017	
Cottonwood (Drewsey)	Cottonwood Creek	R-4699	43.9267	-118.2950	X
Deadman Res	Deadman Creek	R-8391	43.2739	-118.3975	
Dickson Res.	High Horn Creek	R-931	44.2733	-118.0000	
Easterday Res.	Granite Creek	R-913	43.5200	-118.0083	
Griffin Creek Dam	Griffin Creek	R-1312	43.8867	-118.5383	X
Hunter Creek Res.	Cottonwood Creek, Trib. to	R-7424	43.7492	-117.5672	X
Hunter Res.	Little Crane Creek	R-5065	43.4617	-118.4083	
Jag Spring Reservoir	Sand Hollow Creek, Trib. to	R-7278	43.8286	-117.4811	
Jones Res	Duck Creek	R-1178	43.9700	-118.6517	X
Lockett Res	Gum Creek	R-130	44.2000	-117.5789	
Mahon's Res	Camp Cr. & S. Fork. Malheur R.	8-283	43.1533	-118.3983	
Miller Res.	Gould Creek	R-878	43.8450	-118.6283	X
Mills' No.1 Res.	Sagebrush Gulch & Sagebrush Spring	R-551	43.7167	-117.3133	
Mills' No.3 Res.	Sagebrush Gulch, Trib. to	R-541	43.7200	-117.3533	
Mills' Res. No.2	Sagebrush Gulch & Sagebrush Spring	R-551	43.7250	-117.3250	
Morrison Res	Malheur River, Trib. to	R-5339	44.1150	-117.4917	
Murphy Dam	Bendire Creek	R-1005	43.9883	-118.0900	
N. Fk. Indian Cr. Res	N. Fork. Indian Creek	R-1004	44.0333	-117.9167	
Opie Flat Res.	Warm Springs Creek, Trib. to	R-9655	43.5244	-118.2958	X
Pole Creek	Pole & Blacks Creek	R-1364	44.2517	-117.5533	
Quicksand	Long Creek	R-5177	43.6783	-117.5517	
Rabbit		R-5207	43.8717	-117.4589	
Rye Field Res.	Nergo Rock Creek, Trib. to	R-7425	43.6903	-117.3931	

Sexton Res.	Dry Creek	R-307	43.5017	-117.9878	
Shumway Res.	Unnamed	R-425	43.5567	-117.9517	
Sitz Res.	Warmspring Creek. (not 303d impaired Warms Spring Creek)	R-539	43.7933	-118.4750	X
South Cottonwood Res.	Unnamed	R-7922	43.8606	-117.8486	
South Fork Res	S. Fork. Malheur River.	R-5438	43.2350	-118.3317	
Squaw Creek Res.	S. Fork Squaw Creek	R-5149	43.7317	-117.7317	
Stallard Dam	Otis Creek	R-964	43.8917	-118.3833	X
Star Creek	Star Creek	R-1253	43.4183	-117.9517	
Star Mountain	North Fork Granite Creek	R-6769	43.5333	-118.0783	
Stinking Water Creek	Stinking Water Creek	R-5601	43.6367	-118.4383	X
Vanderveer Dam	Dry Creek	R-106	43.7733	-118.5500	X
Vaughn Res	S. Fork. Indian Creek	R-2076	44.0033	-117.9117	
Warmsprings Res.	Middle Fork Malheur River	R-457	43.5850	-118.2083	
Wheaton Creek Res	Wheaton Creek	R-1642	44.1500	-117.8717	
Wildhorse Basin Res.	Malheur River, Trib. to	R-3410	43.6433	-117.9317	
Willow Creek 3	Willow Creek	9-219	44.3533	-117.6700	
	Road Canyon	3-292	44.2500	-117.6008	

Figure 9-16. Locations of dams greater than 10-feet in height and storage greater than or equal to 9.2-acre-feet of water behind.



Dams and reservoirs may contribute to stream warming in the following ways:

<u>Increased riverine surface area</u>
The reservoir water behind the dam increases the surface area of water exposed to solar radiation and may delay the movement of water through the river system. Throughout the summer months reservoirs store solar radiation as heat in the warm surface waters pooled behind the dam. These reservoirs may become thermally stratified in late summer. Accumulated heat is discharged with the stored water from each reservoir into downstream river reaches during annual draw down, which occurs in early summer and continues into late fall. Deep stratified reservoirs can also release cooler water during some periods in the summer.

<u>Daily diel change</u>
Dams can also dampen the daily diel temperature pattern contributing to downstream temperature increases. This is caused by the warmer daily minimum temperatures contributing to increased daily maximum temperatures 12 hours travel time downstream (ODEQ 2006; Khangaonkar and Yang 2008).

Data presented in **Figure 9-17** and **Figure 9-18** show warmer daily minimum downstream temperatures immediately downstream of the dam compared to upstream temperatures. The daily maximum temperatures downstream of Warm Springs Dam are of particular concern because they are equal to or warmer than both the upstream temperatures and the biological criterion (**Figure 9-18**).

Figure 9-17. Daily maximum and minimum temperatures up and downstream of Agency Valley Dam and Beulah Reservoir (North Fork Malheur River) in 2005.

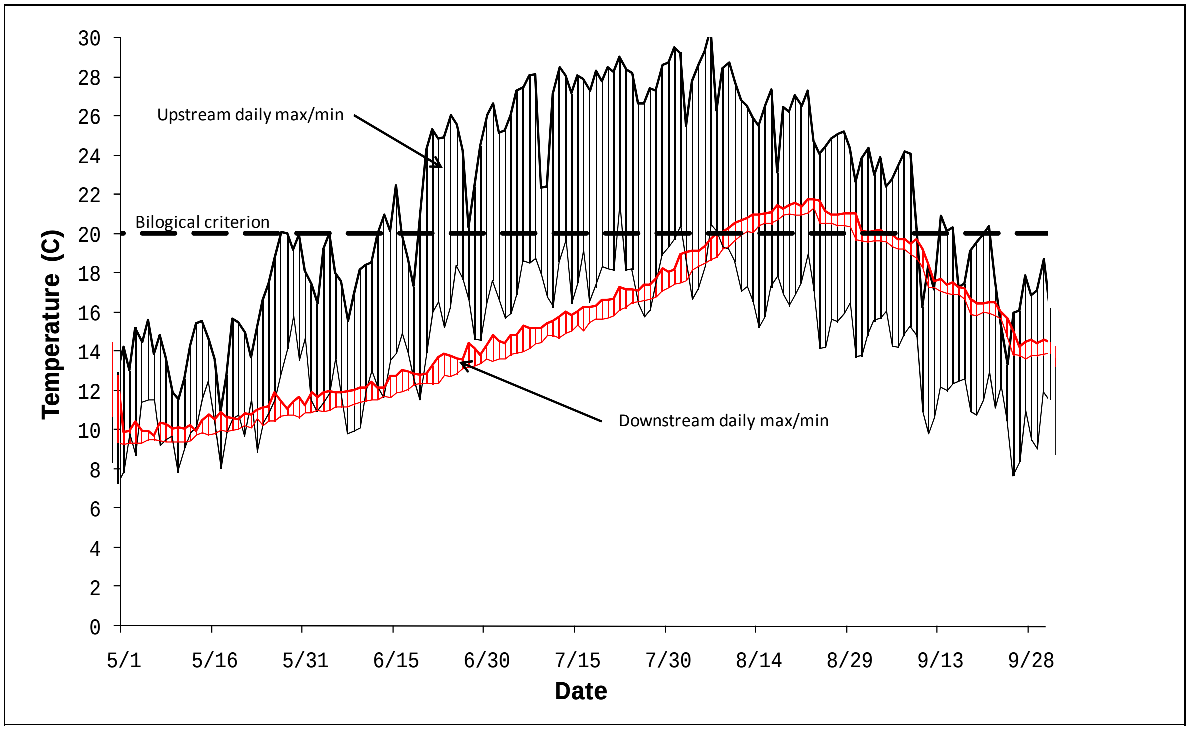
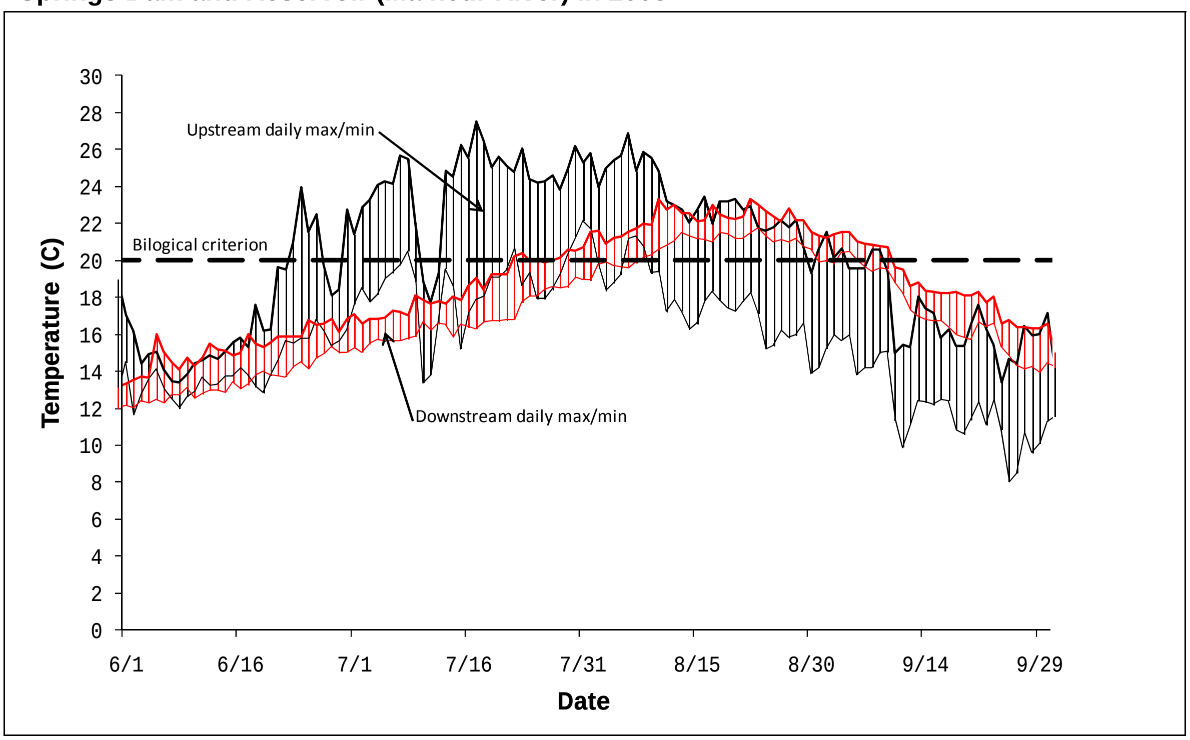


Figure 9-18. Daily maximum and minimum temperatures up and downstream of Warm Springs Dam and Reservoir (Malheur River) in 2005.



Comparing up and downstream rolling seven day average of daily average stream temperatures (7DADA) is a way to screen for this diel effect because the 7DADA captures changes to both the daily maximum and minimum. At Beulah Reservoir, the downstream 7DADA temperatures were warmer than the upstream 7DADA 29% of the time for the period of available data (2002-2009). At Warm Springs Reservoir, the downstream 7DADA stream temperatures were warmer than the upstream 7DADA stream temperatures 32% of the time for the period of available data (2005-2009). At both reservoirs more than 50% of the downstream 7DADA temperatures in August and September were warmer than upstream 7DADA temperatures (see **Figure 9-19**). All calculations were made only when the upstream rolling seven day average daily maximum (7DADM) temperatures exceeded the 20 °C biological criterion. Similar upstream/downstream comparisons were made using the 7DADM temperatures (see **Figure 9-20**).

Figure 9-19. Monthly boxplot distribution of the daily difference between 7DADA stream temperatures (downstream dam minus upstream dam) when upstream 7DADM temperatures >= 20 °C).

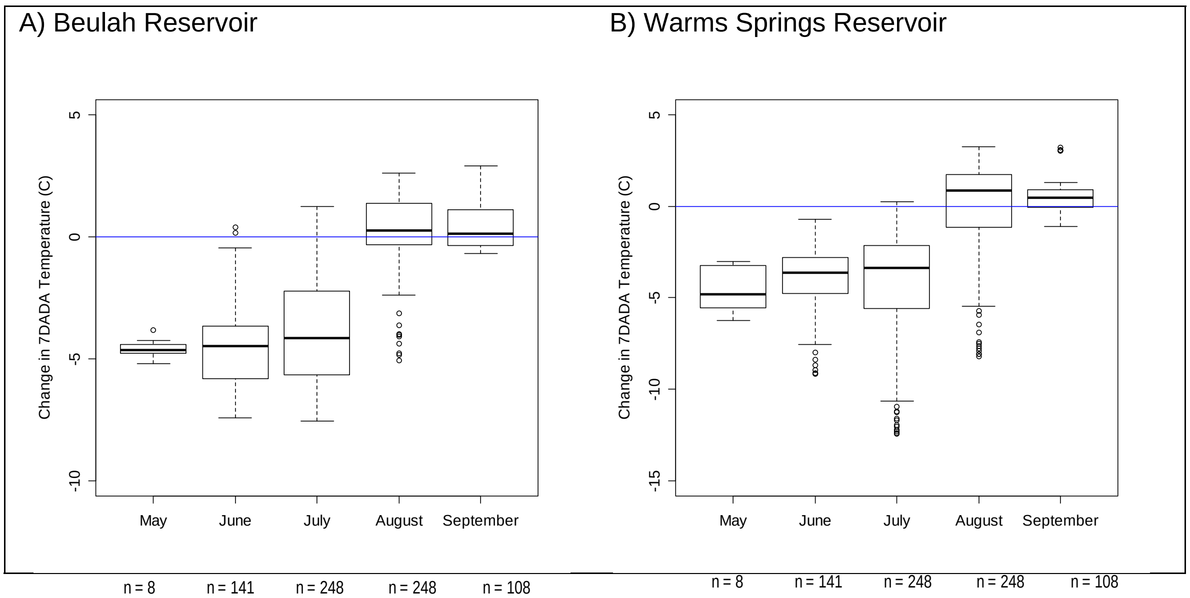
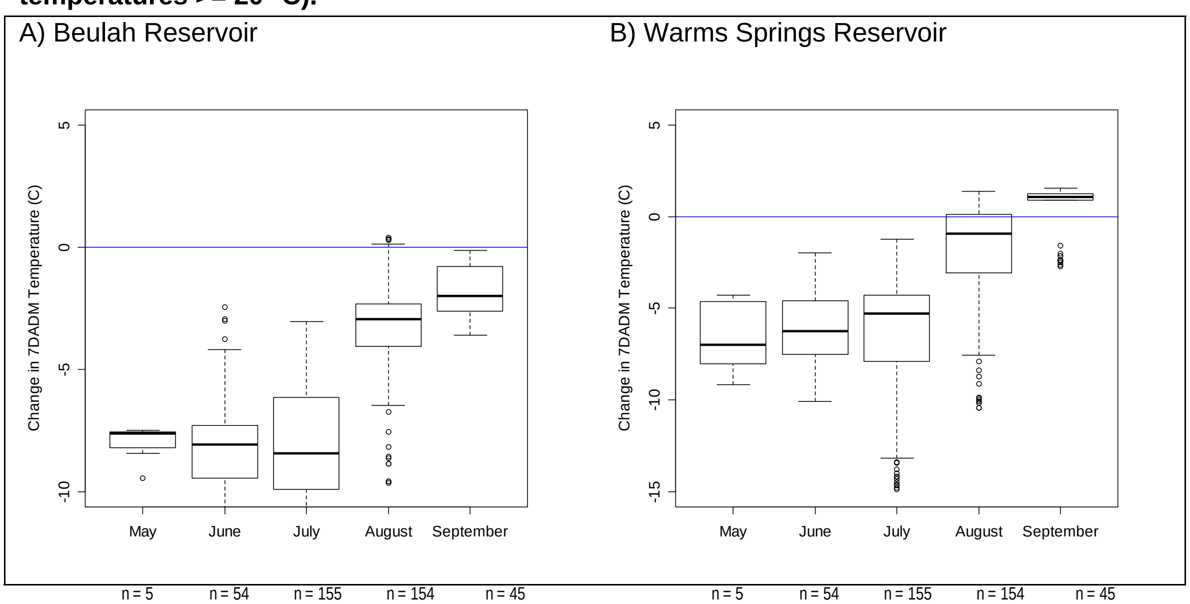


Figure 9-20. Monthly boxplot distribution of daily difference between 7DADM stream temperatures (downstream dam minus upstream dam) when upstream 7DADM temperatures >= 20 °C).



Flow reductions

Another source of stream temperature increase is caused by extreme reductions in flow when the reservoirs are storing water during the non-irrigation season (roughly October to May). The downstream flow is severely reduced decreasing assimilative capacity and contributing to downstream temperature increases. This is of particular concern during in May. **Figure 9-21** shows how this kind of operation at Warm Springs Reservoir dramatically increases stream temperature downstream of the dam. In May of 2005 and 2006, the downstream flow was reduced which resulted in a dramatic increase in seven day maximum temperatures. In 2005, the increase nearly exceeded the 20°C temperature standard and likely contributed to additional warming downstream.

Vegetation change from modified flood magnitude and frequency

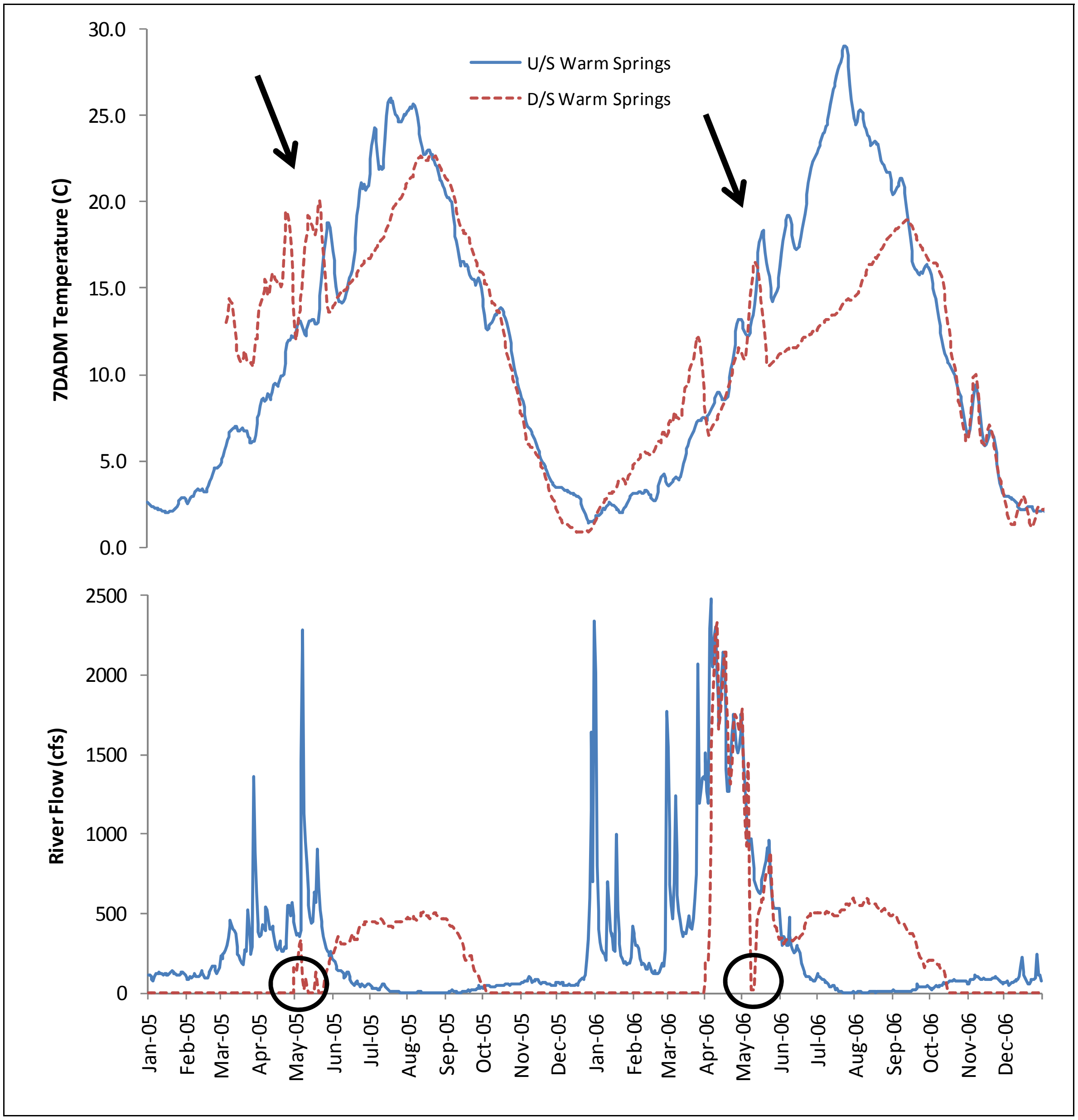
Dams and diversions alter the natural hydrograph (flow pattern) and typically reduce the frequency and magnitude of flood flows thereby reducing the extent of floodplain inundation and potentially lowering the water table (Naimen et al 2005). These changes interrupt the natural hydrochory of woody vegetation (Rood and Mahoney 1995, Andersson et al 2000, Merritt and Cooper 2000, Beauchamp and Stromberg 2007). Hydrochory is the process of dispersal of reproductive propagules (seeds or branch fragments) by water (Nilsson and Berggren 2000).

In arid regions, woody vegetation such as willows and cottonwoods rely on periodic flooding to transport branches and seeds to new locations. Dams reduce the amount of propaguls transported downstream. The altered hydrograph affects the narrow window and specific conditions needed for successful colonization during those peirods. Flooding exposes new bank material, moistens the soil and stabilizes water tables – a process needed for rooting of branch fragments and seed germination (Lisle 1989; Hughes 1990; Stromberg et al 1991). This process is further described in the USDA Plant Guide for coyote willow (Stevens et al 2005):

> *For natural seed revegetation, coyote willow requires moist soil from spring over-bank flows or capillary wetting of the soil surface for establishment. A number of studies have related components of the reproductive cycle of Salix species to floodplain site conditions produced by streamflow and associated fluvial processes. In particular, components of the annual pattern of streamflow, or annual hydrograph, are associated with specific stages of Salix seedling emergence and growth. These include the following: 1) flood flows that precede Salix seed dispersal produce suitable germination sites; 2) flow recessions following a peak expose germination sites and promote seedling root elongation; and 3) base flows supply soil moisture to meet summer and winter seedling water demand (Shafroth et al. 1998; Mahoney et al. 1998). The combination of root growth and capillary fringe defines the successful recruitment band for seedling establishment, which is usually from about 0.6 to 2 m in elevation above the late summer stream stage (Mahoney et al. 1998). The rate of stream stage decline is also critical for seedling survival and should not exceed 2.5 cm per day.*

As described previously, dam management at Warm Springs and Beulah Reservoirs dramatically reduce the downstream frequency and magnitude of flood flows that would typically occur during the winter and spring months. Documentation of similar changes at other systems have demonstrated the distribution of riparian vegetation has been altered and often reduced (Rood and Mahoney 1995, Merritt and Cooper 2000, Beauchamp and Stromberg 2007) contributing to the invasion of upland species laterally over the floodplain. These types of conditions are observable in many areas along the Malheur River. Changes in flow management may be necessary for riparian restoration (Richter and Richter 2000, Rood and Mahoney 2000, Rood et al 2003, Rood et al 2005.

Figure 9-21. 7DADM temperatures and daily average stream flows up and downstream of Warm Springs Reservoir (Malheur River) Jan 2005 – Dec 2006.



4. Hydromodification: Water Rights

The influence of river flow is generally inversely related to the daily maximum stream temperature with higher flows moderating the diel swing of temperatures holding everything else unchanged. Diversion of water generally decreases the ability of a stream to assimilate heat load and result in warmer stream temperatures.

The location and relative rate of permitted points of diversion for temperature impaired streams in the Malheur River Basin was mapped in **Figure 9-22**. **Figure 9-23** shows the cumulative withdrawal rate moving downstream on temperature impaired streams. Withdrawal rates are not adjusted for priority date or senior and junior water rights. While this may be a factor on certain occasions the charts are intended to give an overview of the potential withdrawal rates for each stream. Withdrawal rates reducing flow from tributaries are not included in the cumulative totals.

Figure 9-22. Points of diversion on temperature impaired streams.

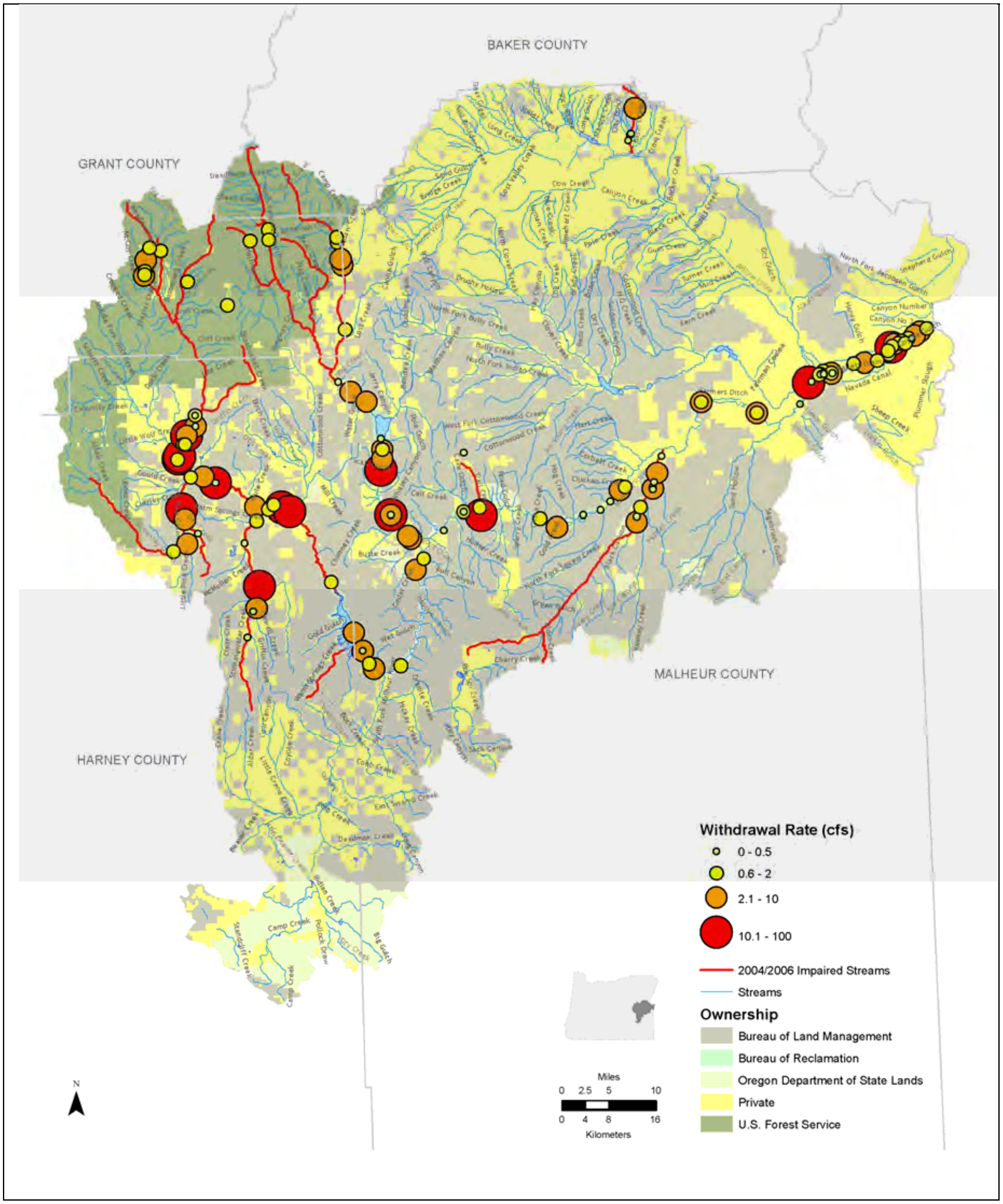


Figure 9-23. Permitted cumulative water withdrawals in temperature impaired streams.

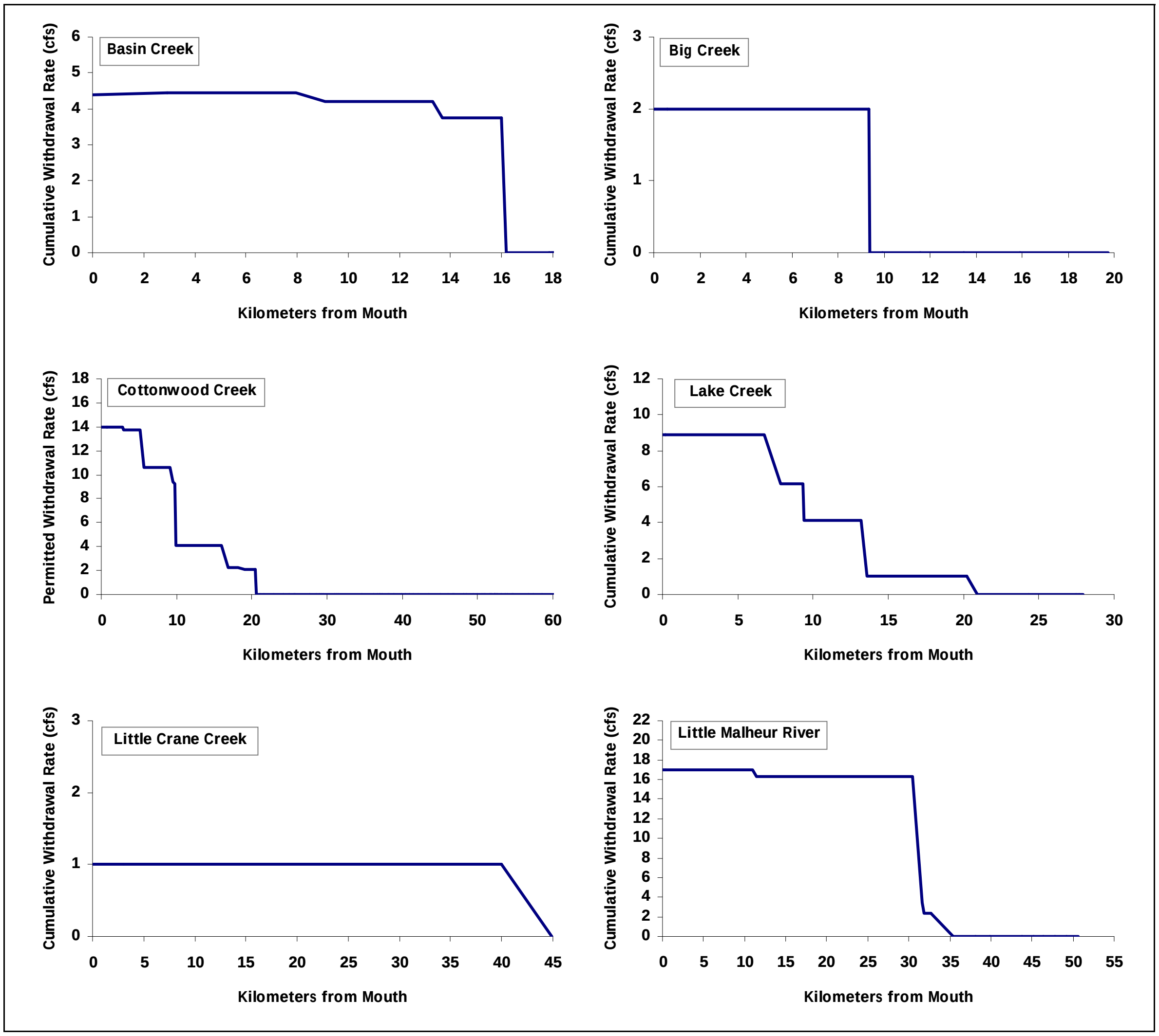
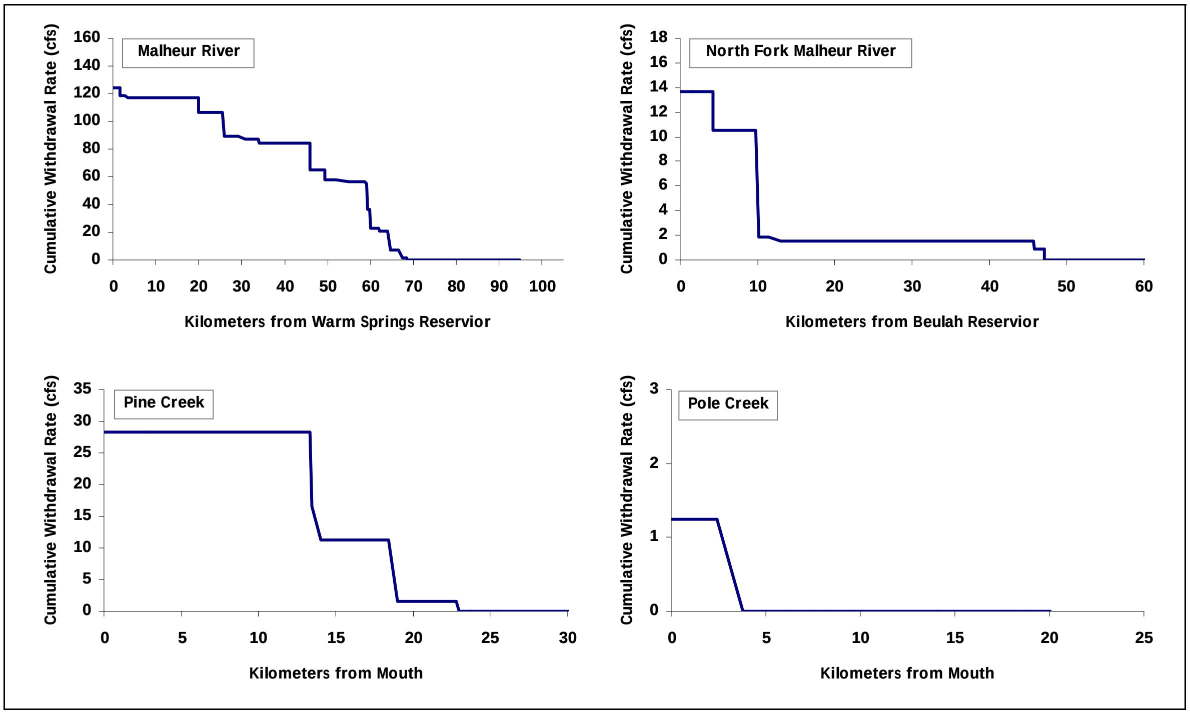


Figure 9-23 (cont.). Permitted cumulative water withdrawals in temperature impaired streams.



5. Other Anthropogenic Sources

Starting in the 1880's, Western Juniper *(Juniperus occidentalis)* began to spread rapidly on eastern Oregon's rangelands (Azuma et al 2005). The expansion has been attributed to, fire suppression, overgrazing of domestic livestock, and climatic shifts. From Azuma et al 2005:

> *"…overgrazing has reduced the amount of fuel available to carry fire, and fire suppression has reduced the occurrence of fires that would have killed smaller juniper in sparsely populated stands. This coupled with a warmer, wetter climate conducive to seedling establishment has created favorable conditions for juniper to establish and expand its range."*

Western Juniper expansion (**Figure 9-24**) has contributed to a loss of herbaceous plant communities, increased soil erosion, and reduced water infiltration/soil moisture which impact springs and groundwater sources that provide localized flows to streams (Deboot 2008; Huang et al 2006, OWEB 2007). Reduced local cold water refugia and warmer stream temperatures are a result of these changes.

Figure 9-24. Juniper invasion of an Aspen stand.

9.7 LOADING CAPACITY AND ALLOCATION APPROACH

> **OAR 340-042-0040(4)(d)**
>
> *This element specifies the amount of a pollutant or pollutants that a water body can assimilate and still meet water quality standards. The TMDL will set a level to ensure that the loading capacity is not exceeded.*

EPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*." (40 CFR §130.2(f)). It provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. Loading capacity can be quantified and allocated as the sum of natural background heat load and allowable heat loads from nonpoint source and point source sectors. Portions of the loading capacity may also be reserved to accommodate future growth and as an explicit margin of safety. The established loading capacity must ensure that water quality standards are met regardless of seasonal variation and foreseeable increases in pollutant loads from point or nonpoint source activities.

The loading capacity is the sum of background, allowable nonpoint source heat, allowable point source heat, heat included in a margin of safety, and heat held as a reserve capacity (**Equation 1**).

Equation 1. Loading Capacity

$$\text{TMDL} = \text{Loading Capacity} = H_B + H_{NPS\ LA} + H_{WLA} + H_{MOS} + H_{RC}$$

where:

H_B	Background (H_B)
$H_{NPS\ LA}$	Nonpoint Source Load Allocations
H_{WLA}	Waste Load Allocations
H_{MOS}	Margin of Safety
H_{RC}	Reserve Capacity

Background loading capacity (**Section 9.8**) is expressed as a solar load in Gigacalories/day (Gcal/day); however, in order for the TMDL to be more meaningful to the public and guide implementation efforts, allocations have also been expressed in terms of the establishment of site potential vegetation and the percent effective shade it produces.

> *Nonpoint source effective shade targets represent site potential vegetative conditions. This is especially useful for nonpoint source activities that affect streamside vegetation and shade levels. Shade targets and vegetation conditions identify TMDL objectives more clearly to land managers than change in stream temperature or energy units such as Gigacalories/day.*

Heat available for human use is based on an allowable 0.3°C temperature increase at the point of maximum impact above the applicable temperature standard. The applicable temperature standard may be either the biologically-based numeric criteria or the natural conditions criteria.

The human use allowance and background heat load has been divided between point sources, nonpoint sources, reserve capacity, and margin of safety. The distribution of the total heat load is described in **Table 9-8**.

Table 9-8. Allocation approach and distribution of the human use allowance

Source	Allocation
Non Point Source: Agriculture/Forestry	No Increase - Site Potential Vegetation – all waterbodies
Non Point Source: Irrigation Districts	0.1°C – all waterbodies
Non-Point Source: Reservoirs/Dams	No increase above background – all waterbodies
Non Point Source: Transportation/Urban	0.1°C where noted – all waterbodies
Point Source	0.05 °C – all waterbodies
Reserve Capacity	0.025 °C – all waterbodies
Margin of Safety	0.025 °C – all waterbodies

9.8 EXCESS LOAD

OAR 340-042-0040(4)(e)

This element evaluates the difference between current pollutant load in a waterbody and the loading capacity.

Solar radiation has the largest influence on stream temperature therefore solar radiation was used to evaluate the difference between the current pollutant load and the loading capacity. The loading capacity for the Malheur River Basin is defined as the amount of solar radiation received at site potential vegetation conditions (site potential vegetation is defined in **Section 9.10.1**). Solar radiation received on portions of the Malheur River and North Fork Malheur River were modeled using the mathematical model Heat Source Version 8.0.2. Heat Source simulates open channel hydraulics, flow routing, heat transfer, effective shade, and stream temperatures (Boyd and Kasper, 2003). See **Appendix B** for more information on the modeling analysis.

Table 9-9 and **Table 9-10** shows the solar excess load by land ownership on the two modeled streams. The percent reduction refers to the percent of solar load that must be reduced to meet water quality standards. **Figure 9-25 and Figure 9-26** show the distribution of the total solar load including the amount from natural background (aka the solar loading capacity) and the excess solar load (portions from anthropogenic activities broken down by ownership). Solar load is calculated using **Equation 2**.

Equation 2. $$\boldsymbol{Solar\ Load = A \times \Phi solar \times 0.00002064}$$

where,

$$Solar\ Load = Solar\ load\ receved\ at\ the\ stream\ surface\left(\frac{Gigacalories}{day}\right)$$
$$A = Wetted\ surface\ area\ of\ the\ stream\ (m^2) = length\ (m) \times width\ (m)$$
$$\Phi solar\ = Total\ daily\ solar\ radiation\ flux\ received\ at\ the\ stream\ surface\ \left(\frac{W}{m^2}\right)$$
$$0.00002064\ = \frac{W}{m^2} \times\ m^2 \times \left(W\ or\ \frac{J}{second}\right) \times \frac{86400\ seconds}{1\ day} \times \frac{1\ cal}{4.1868\ J} \times \frac{1\ Gigacalories}{1000000000\ calories}$$

Table 9-9. Excess solar load on the modeled portion of the Malheur River.

Ownership	Current Solar Load (Gcal/day)	Solar Loading Capacity (Gcal/day)	Excess Solar Load (Gcal/day)	Percent Reduction
BLM	509.2	379.9	129.4	25%
ODSL	1198.8	1083.0	115.8	10%
Private	3796.4	3089.2	707.2	19%
USFS	750.5	484.6	265.9	35%
All (Total)	6254.9	5036.6	1218.3	19%

Table 9-10. Excess solar load on the modeled portion of the North Fork Malheur River.

Ownership	Current Solar Load (Gcal/day)	Solar Loading Capacity (Gcal/day)	Excess Solar Load (Gcal/day)	Percent Reduction
BLM	440.9	363.4	77.5	18%
BOR	23.8	22.7	1.1	5%
Private	1262.4	1052.3	210.1	17%
USFS	1138.1	698.0	440.2	39%
All (Total)	2865.3	2136.4	728.9	25%

Figure 9-25. Distribution of the total load as loading capacity (background) and excess load by ownership on the Malheur River.

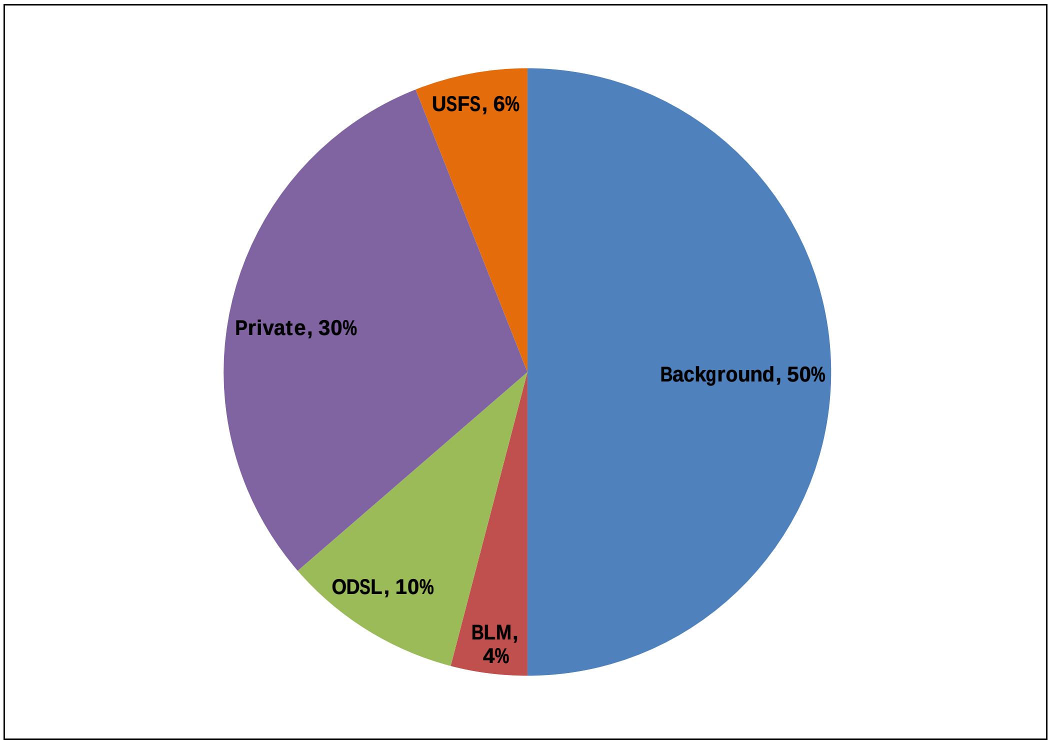
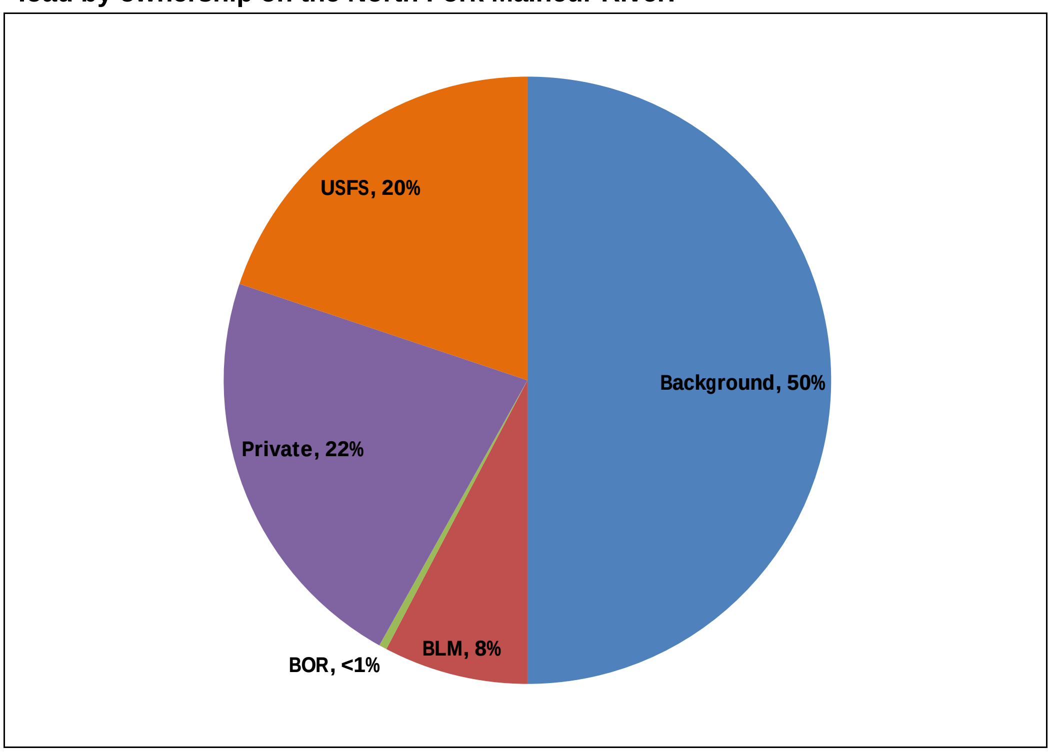


Figure 9-26. Distribution of the total load as loading capacity (background) and excess load by ownership on the North Fork Malheur River.



9.9 WASTE LOAD ALLOCATIONS

OAR 340-042-0040(4)(g), 40 CFR 130.2(g)

This element determines the portions of the receiving water's loading capacity that are allocated to existing point sources of pollution, including all point source discharges regulated under the federal Water Pollution Control Act Section 402 (33 USC Section 1342).

There are two individual NPDES permitted sources and three general NPDES permitted point sources discharging to waterbodies in the Malheur River Basin. These sources are listed in **Table 9-11.**

The two individual NPDES permitted sources are irrigation districts. These NPDES permits address the application of herbicide to control weed growth within the irrigation system. In this temperature TMDL, irrigation districts are considered non-point sources because the primary source of pollutant loading within the irrigation system is related primarily to agricultural return flows and agricultural storm water. The Oregon Revised Statues ORS 468B.005(4) does not consider these sources point sources**.** Any temperature related impacts are addressed in the load allocation **Section 9.10**.

Table 9-11. Active NPDES point sources in the Malheur River Basin.

Common Name	Permit Type	WQ File Nbr.	Permit Nbr.	Latitude	Longitude	Stream Name	River Mile
SEUBERT EXCAVATORS	GEN12A	107742	13691	44.0677	-117.0125	Canyon Number 1	2.2
AIKEN ELEMENTARY SCHOOL	GEN12C	117867	23501	44.0288	-116.9844	Unknown	0.44
ONTARIO TO QUARTZ 138 KV TRANSMISSION LINE MAINTENANCE	GEN12C	118548	24184	44.3359	-117.2499	Unknown	2.1
OWYHEE IRRIGATION DISTRICT	NPDES-IW-B15	111849	102606	43.8767	-116.9932	Malheur River	19.55
VALE OREGON IRRIGATION DISTRICT	NPDES-IW-B15	111848	102605	43.9816	-117.2446	Willow Creek	4.36

The three general NPDES permitted point sources do not discharge to temperature impaired waterbodies and their impacts have not been evaluated due to lack of data. The conditions stipulated within general NPDES permits likely means that these sources have a de-minimis temperature impact. All waterbodies in the Malheur River Basin, however, have been allocated 0.05°C of the human use allowance for use by NPDES permitted point sources as a measure of caution. The waste load allocation applies between May 1st and Sept 30th where Redband Trout use occurs and between May 1st and October 31st where core cold water habitat or bull trout spawning and juvenile rearing use occurs. These time periods correspond to the period when stream temperature most often exceeds or might exceed the applicable temperature standard based on available data (see **Section 9.3)**.

New point sources may be allocated a portion of the 0.05 °C human use allowance. If the point source allocation is not sufficient, new sources will need to apply to the Department for use of a portion of the reserve capacity for additional capacity.

If a point source is allocated a portion of the point source human use allowance or reserve capacity, thermal load limits can be calculated using **Equation 3.** Note that the limit shall be calculated using the monthly or yearly 7Q10 unless continuous river flow data is available and the source will operate under a variable thermal load limit.

Equation 3.

ETL = $(\Delta T) \times (Q_R + Q_E) \times (C_F)$

where:
ETL = Excess Thermal Load limit (kilocalories/day)
ΔT = portion of the HUA or reserve capacity allocated to the new source (^{o}C)
Q_R = monthly 7Q10 river flow rate (cfs) or current river flow rate if using a variable ETL
Q_E = effluent flow rate (cfs)
C_F = conversion factor = 2,446,665 (kcal seconds/ ^{o}C ft^3 day)

Compliance with the excess thermal load limit could be calculated using **Equation 4**.

Equation 4.

AETL = $\left(\frac{Q_E}{Q_R + Q_E}\right) \times (T_E - T_R) \times (Q_R + Q_E) \times (C_F)$

where:
AETL = Actual Excess Thermal Load (kilocalories/day)
T_E = effluent temperature (^{o}C)
T_R = applicable temperature criteria (^{o}C) w/o a NTP, use the biological criteria
Q_R = current river flow rate upstream (cfs)
Q_E = effluent flow rate (cfs)
C_F = conversion factor = 2,446,665 (kcal seconds/ ^{o}C ft^3 day)

9.10 LOAD ALLOCATIONS

OAR 340-042-0040(4)(h), 40 CFR 130.2(h)

This element determines the portion of the receiving water's loading capacity that is allocated to existing nonpoint sources of pollution or to background sources. Load allocations are best estimate of loading, and may range from reasonably accurate estimates to gross allotments depending on the availability of data and appropriate techniques for predicting loading. Whenever reasonably feasible, natural background and anthropogenic nonpoint source loads will be distinguished from each other.

Irrigation Districts

Irrigation districts within the scope of this TMDL are allocated (0.1^{o}C) of the human use allowance. Because of the complexity and size of the irrigation system, it was not possible to quantify the heat impact of each district's irrigation withdrawals, delivery, and return flows. Irrigation districts should work with ODEQ, ODA and other agencies to implement BMPs or other water conservation management strategies that will meet this allocation.

Dams and Reservoirs

In order to ensure dam or reservoir operations within the scope of this TMDL do not warm stream temperatures anywhere downstream during the period of impairment, dam and reservoir operations are allocated an instream temperature target that equates to no additional temperature increase above natural seven day average daily average background temperatures between May 1st and Sept 30th.where redband trout use occurs and between May 1st and October 31st where core cold water habitat or bull trout spawning and juvenile rearing use occurs. During the rest of the year this allocation does not apply because stream temperatures meet the water quality standard (see **Section 9.3)** and the Malheur River is not likely to exceed the Snake TMDL load allocation (see **Section 9.11**). Natural background temperatures may be established from temperatures upstream of the dam. If data or analysis show water temperatures do not exceed the applicable temperature standard anywhere downstream (within the scope of this TMDL), a dam may warm a stream above the seven day average daily averge temperatures.

In addition, DMAs managing dams shall address these flow management issues in their implementation plans:

1. Management of flows to minimize or eliminate the dewatering of downstream reaches that may cause an exceedance to the load allocation.

2. Controlled floods for restoration. Controlled floods or alternative flow management may be necessary to promote regeneration and continued survival of site potential vegetation (particularly for willows and cottonwoods). DMAs shall evaluate managed flood flow scenarios and coordinate with restoration efforts to ensure dam operations do not contribute to the loss of existing or restored site potential vegetation.

Agriculture, Forestry, Urban, and Transportation

Section 9.8 describes the solar load reductions in the modeled portions of the Malheur and North Fork Malheur Rivers needed to meet the water quality temperature standards. Because load reductions are of limited value in guiding land management activities, this TMDL will target the establishment of site potential vegetation (**Section 9.10.1**) and the corresponding effective shade (**Sections 9.10.2** and **9.10.3**) as the *surrogate measure* to meet the load reductions for agriculture, grazing, forest, or urban nonpoint source activities in the riparian area. EPA regulations (40 CFR 130.2(i)) provide the use of "*other appropriate measures*" (or surrogate measures) for use in TMDLs to solve water quality problems.

The non-point source human use allowance of (0.1^{o}C) may be used to address transportation uses, utility crossings, or locations where *currently existing* buildings or other existing structures may not allow the establishment of site potential vegetation.

Where these uses do not occur, the establishment or maintence of site potential vegetation and the corresponding effective shade shall be the surrogate measure used to demonstrate compliance with the natural conditions criteria, Protecting water quality, and (Section 9.4.1)this TMDL.

Land managers will find it is fairly straight forward to document the establishment of site potential vegetation and then measure the effective shade it produces as it matures over time. Effective shade is measured at the stream surface using a relatively inexpensive instrument called a Solar Pathfinder™ shown in **Figure 9-27**.

Figure 9-27. Solar Pathfinder™

The term 'shade' has been used in several contexts, including its components such as shade angle or shade density. In this TMDL, effective shade is defined as the percent reduction of potential daily solar radiation delivered to the water surface. The role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the background loading capacity. Site potential vegetation corresponds to no anthropogenic increase above natural background temperatures.

9.10.1 Site Potential Vegetation

Site potential vegetation refers to the vegetation that can grow and reproduce on a riparian site given the natural plant biology, site elevation, soil characteristics, local climate, channel morphology, hydrology, and natural disturbance regime. Site potential vegetation has the following qualities:

- Vegetation is native to the Malheur River Basin;
- Vegetation is allowed to grow at its natural growth rate to reach maturity;
- Vegetation height and density is at or near the potential expected for the given plant community and site conditions;
- Vegetation buffer is sufficiently wide to maximize solar attenuation (Note: Buffer widths required to meet the site potential effective shade target will vary given potential vegetation type, topography, stream width, and aspect.),
- Vegetation buffer width accommodates natural channel migrations.

Riparian vegetation types can vary dramatically throughout the Malheur River Basin. A single stream such as the Malheur River can flow through wide high altitude floodplains with dense woody vegetation near its headwaters (**Figure 9-28),** mature coniferous forest in steep canyons (**Figure 9-29**), and floodplains of intermixed riparian woody shrub and herbaceous grasses with dry scrubland hills and terraces. Because such diversity exists, Level IV Ecoregions (Thoresen et al 2003) are used to delineate the zones for different types of site potential vegetation. Level IV Ecoregions are appropriate zones to characterize vegetation because they encompass similar geologies, physiography, vegetation, climate, soils, land use, wildlife distributions, and hydrology.

Site potential vegetation for specific ecoregions is described in **Appendix B**. The tables were developed using information from the cited literature as well as knowledge from local experts at the U.S. Forest Service and Bureau of Land Management. They are presented as a guide for site potential vegetation types that could be present in a given ecoregion. Land managers should use the information in the TMDL and referenced documentation as a resource but defer to site-specific conditions when establishing site potential vegetation at the plot level.

Figure 9-28. Looking downstream on Big Creek in the 11o Cold Basin ecoregion (Logan Valley).'

Figure 9-29. Looking downstream on the Malheur River near mouth of Bluebucket Creek in the 11i Continental Zone Foothills ecoregion.'

Figure 9-30. Looking upstream on the Malheur River at Van-Drewsey Road in the 80f Owyhee Uplands and Canyons ecoregion.'

9.10.2 Site Specific Effective Shade

Site specific effective shade surrogates were developed to help translate the nonpoint source heat load allocations. **Figure 9-31 and Figure 9-32** show the simulated percent effective shade estimates on modeled streams by river kilometer upstream of Warm Springs and Beulah reservoirs. The “Current Condition” effective shade (simulation 1 - dashed in red) is generally less than the “Site Potential” effective shade (in blue) at the stream surface under site potential vegetation conditions (simulation 4). The “Natural Disturbance Range” indicates the shade levels that could potentially occur in the event of natural disturbances. The lower end of that range (in black) represents that amount of shade that the stream would receive if topography were the only shade-producing feature (i.e., no vegetation – simulation 7). **Appendix B** contains detailed descriptions of the methodology used to develop the temperature TMDL and site potential vegetation conditions.

Figure 9-31. Malheur River half kilometer moving average effective shade.

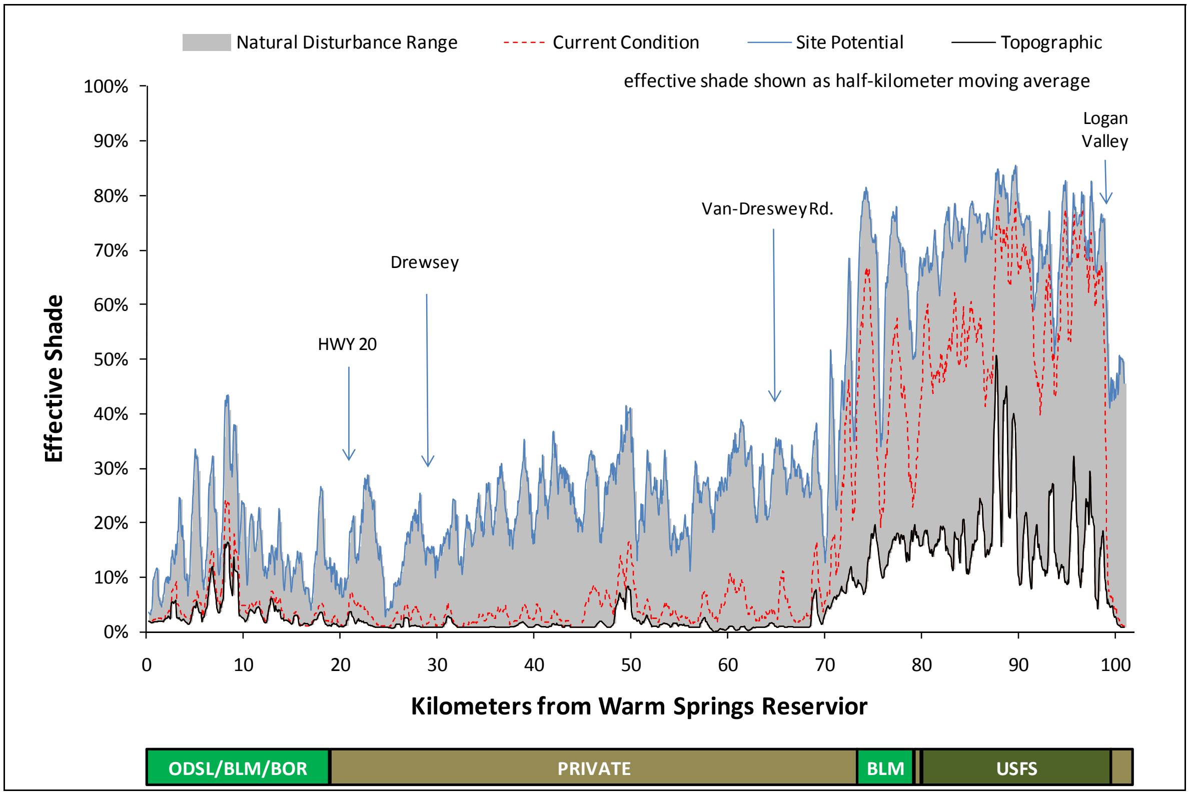
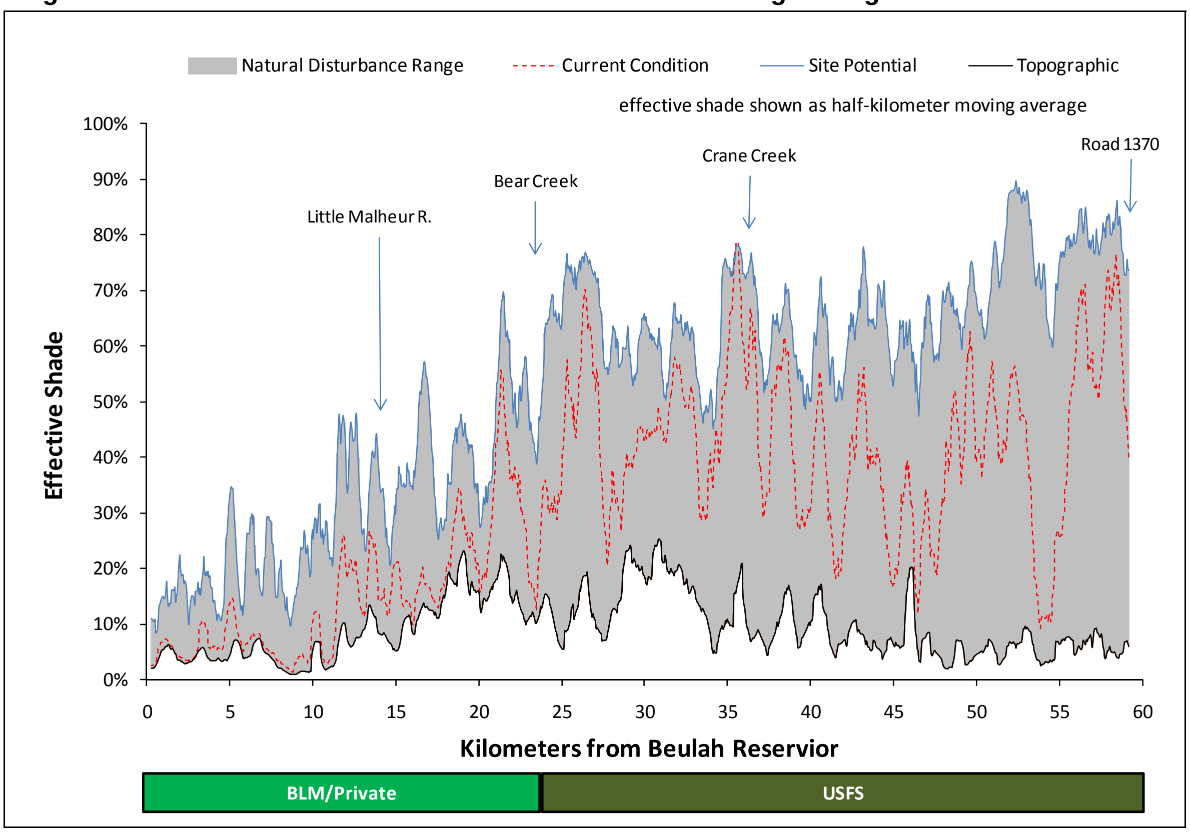


Figure 9-32. North Fork Malheur River half kilometer moving average effective shade.



Caution should be used when interpreting the charts in **Figure 9-31 and Figure 9-32**. It is unlikely any single location will be at the stated site potential effective shade all the time. **Figure 9-31 and Figure 9-32** represent a single snapshot in time. As time passes, the effective shade values may fluctuate from site to site in response to natural disturbances or sucsession of vegetation communities. For land managers to track restoration progress under a dynamic system, we have presented the same effective shade values as a cumulative frequency distribution by major landowner type (see **Figure 9-33** through **Figure 9-37**). The cumulative frequency distribution has the advantage of accommodating a dynamic system as long as the overall distribution of effective shade is within a similar distribution. For assessment and monitoring, land managers could measure effective shaded using a random sample study design and compare the results to the frequency distributions. The black lines around the site potential line represent the potential human error in measuring effective shade in the field compared to model results. As restoration occurs and monitoring is conducted, the field measurements should fall within the error range. The error value is based on the 10% root mean square error (RMSE) calculated by comparing DEQ field measured effective shade to model values. See **Appendix B** for more information on effective shade measurement error.

Figure 9-33. Cumulative frequency distributions of modeled effective shade on BLM ownership.

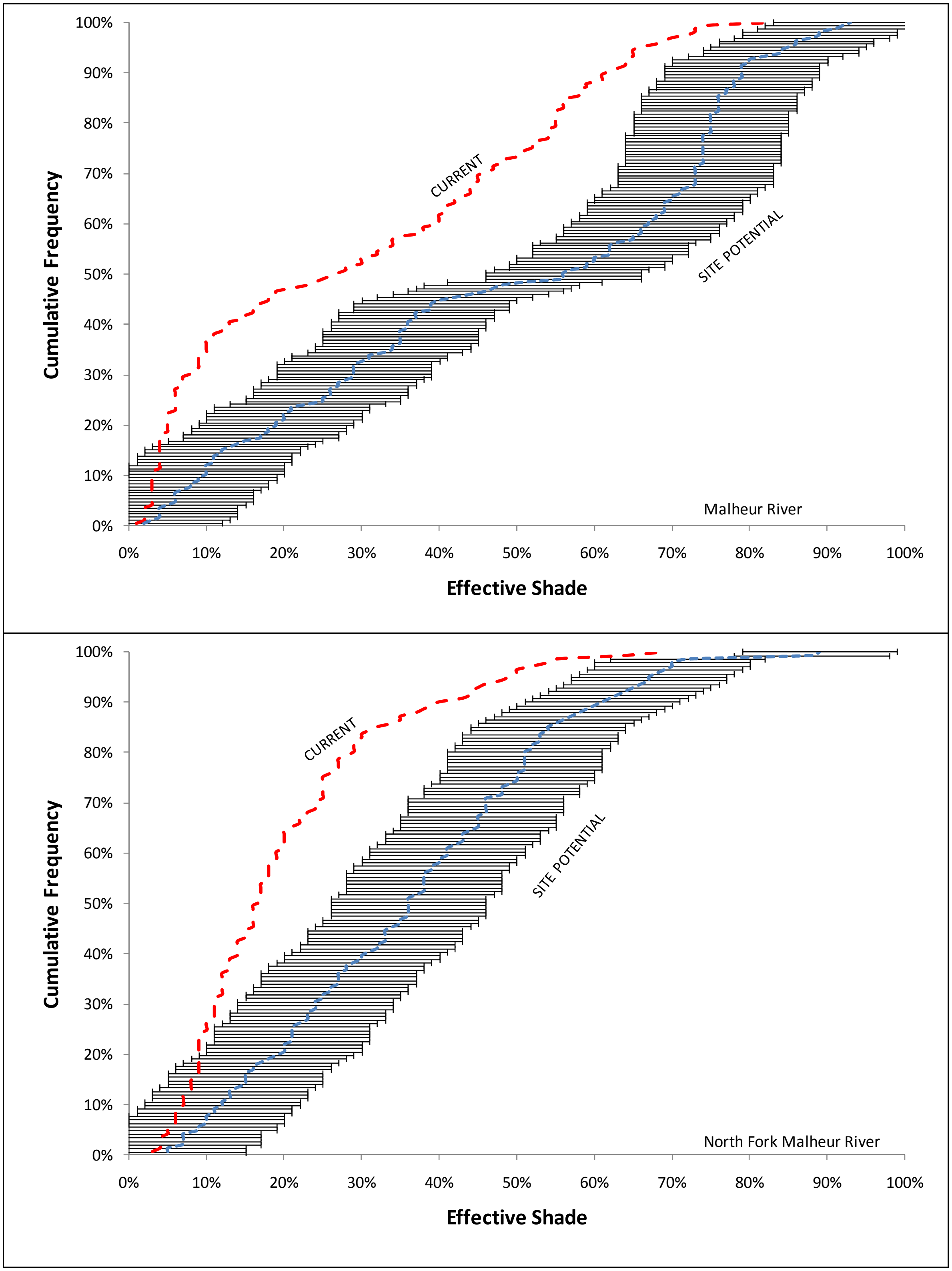


Figure 9-34. Cumulative frequency distribution of modeled effective shade on BOR ownership.

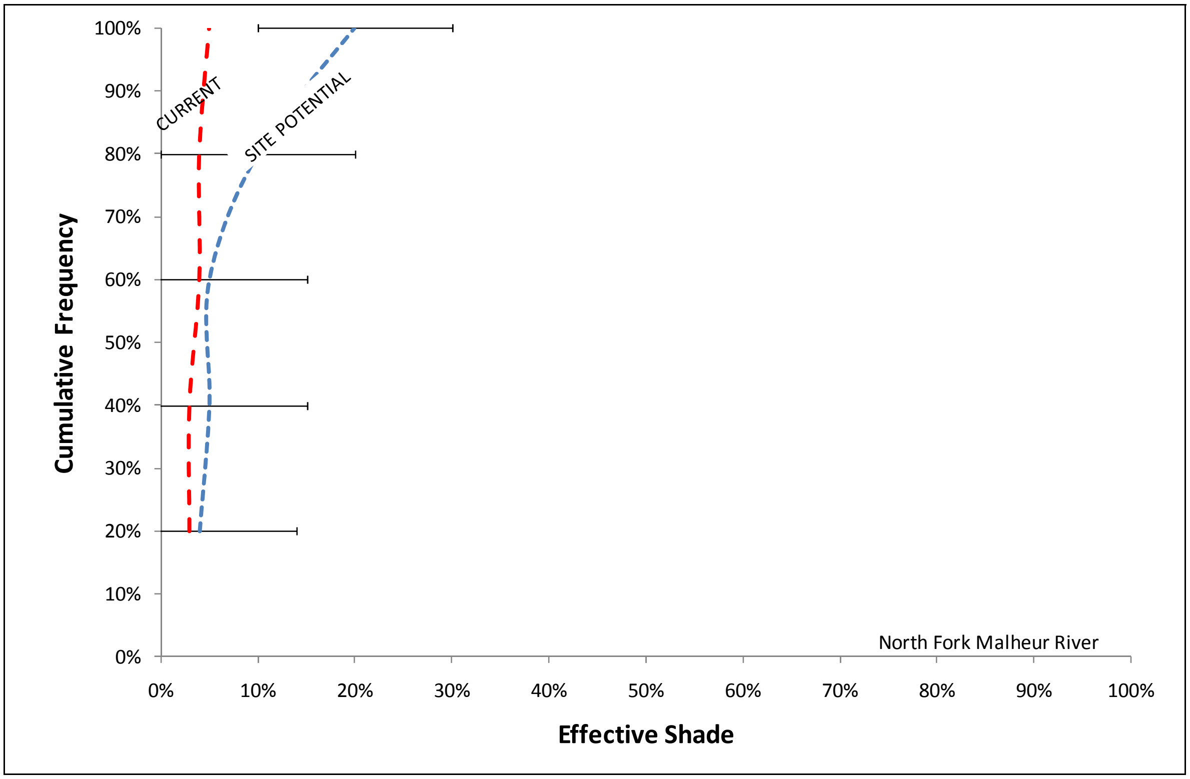


Figure 9-35. Cumulative frequency distribution of modeled effective shade on OSDL ownership

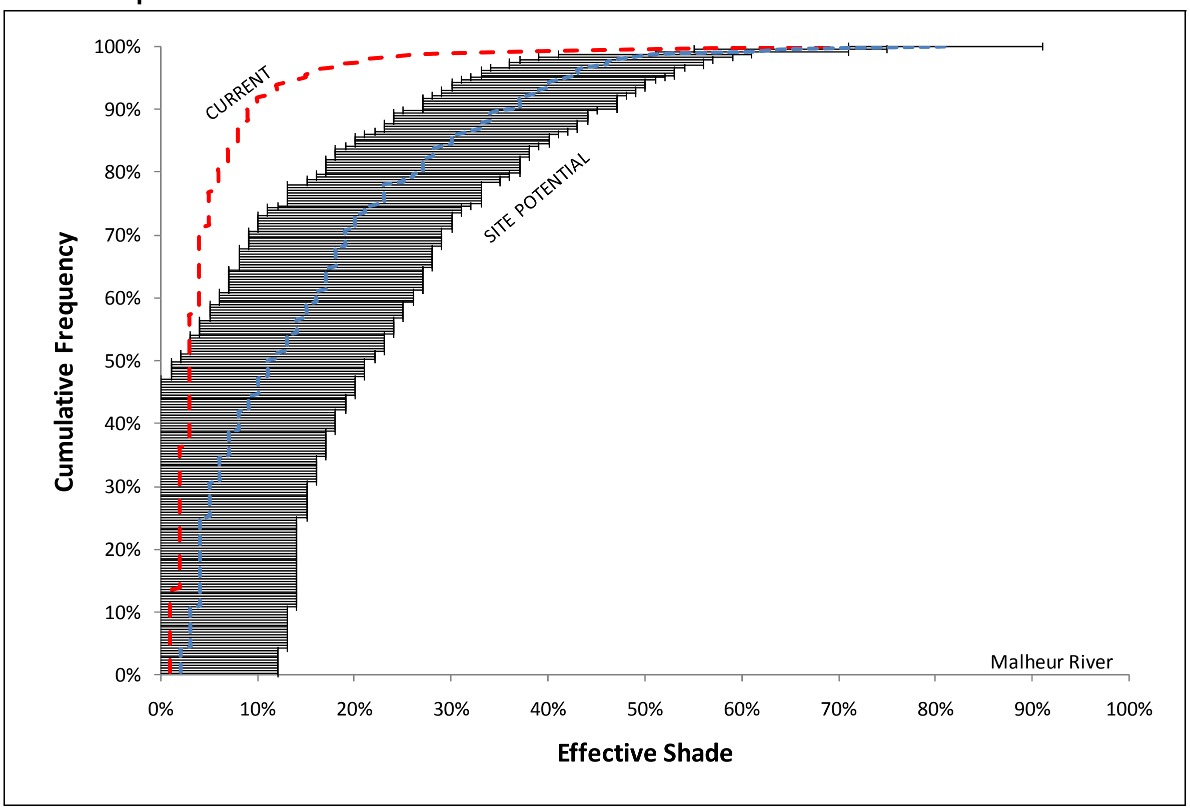


Figure 9-36. Cumulative frequency distributions of modeled effective shade on private ownership

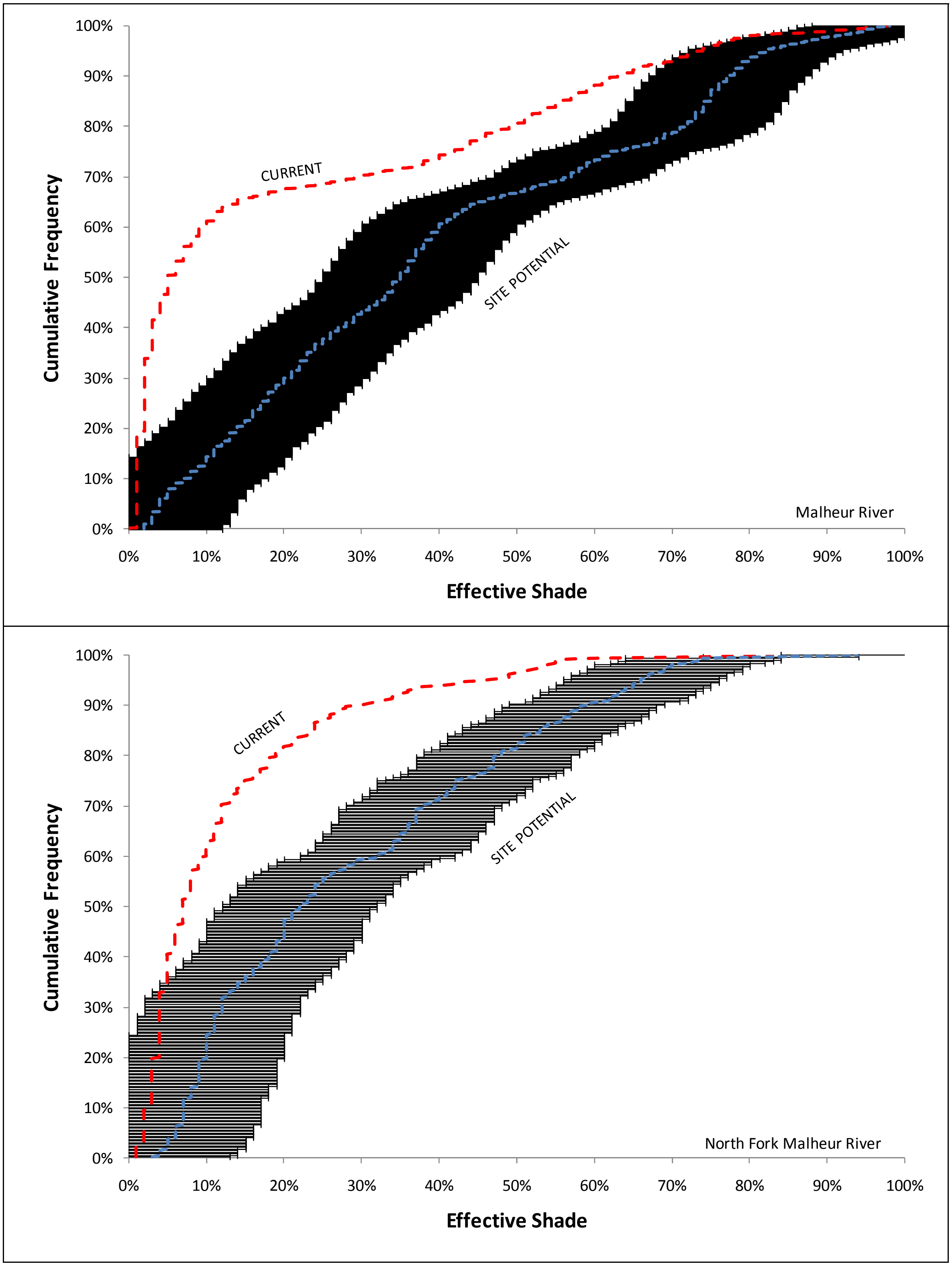
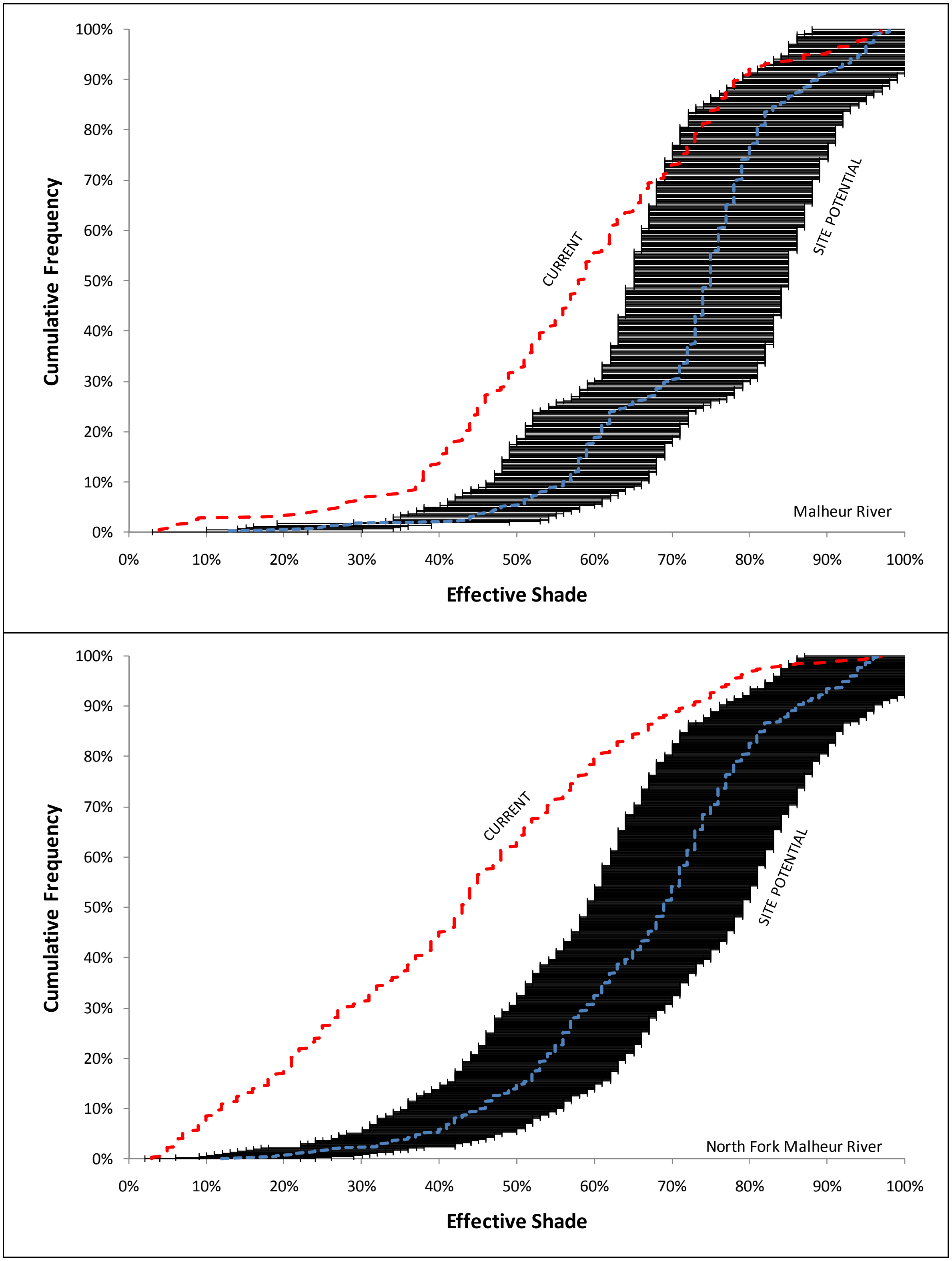


Figure 9-37. Cumulative frequency distributions of modeled effective shade on USFS ownership



9.10.3 Ecoregion Based Effective Shade Curves

Effective shade curves are general heat load allocations applicable to any stream that was not specifically simulated. The heat load and effective shade surrogates are identified by region and channel width for different types of site potential vegetation. Effective shade curves represent the *maximum* possible effective shade for a given vegetation type. Natural disturbance was not included in the effective shade curve calculations. The values presented within the effective shade curves represent the effective shade that would be attained if the vegetation were at its stated potential height and density. See **Appendix B** for methodology to determine site potential vegetation.

Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other factors may prevent effective shade from reaching the values presented in the effective shade curves. The goal of the Malheur River Basin Temperature TMDL is to minimize anthropogenic impacts on effective shade. Natural vegetation conditions or natural disturbances (non-anthropogenic) that result in effective shade below the maximum potential will not be considered out of compliance with the TMDL. This TMDL recognizes that complex vegetation communities and unpredictable natural disturbances may result in effective shade well below the levels presented in the effective shade curves.

Ecoregion-specific effective shade curves were derived for different vegetation types as a function of channel width and apply to all perennial and intermittent streams in the Malheur River Basin. The effective shade curves account for latitude, critical summertime period (July/August), and stream aspect.

Site-specific effective shade simulations (i.e., Heat Source modeling) supersede the effective shade curves (see previous section). **Figure 9-38** displays the locations of each EPA Level IV ecoregion. The shade targets for each ecoregion and vegetation type are presented in **Figure 9-39.**

Figure 9-38. Level IV ecoregions in the Malheur River Basin.

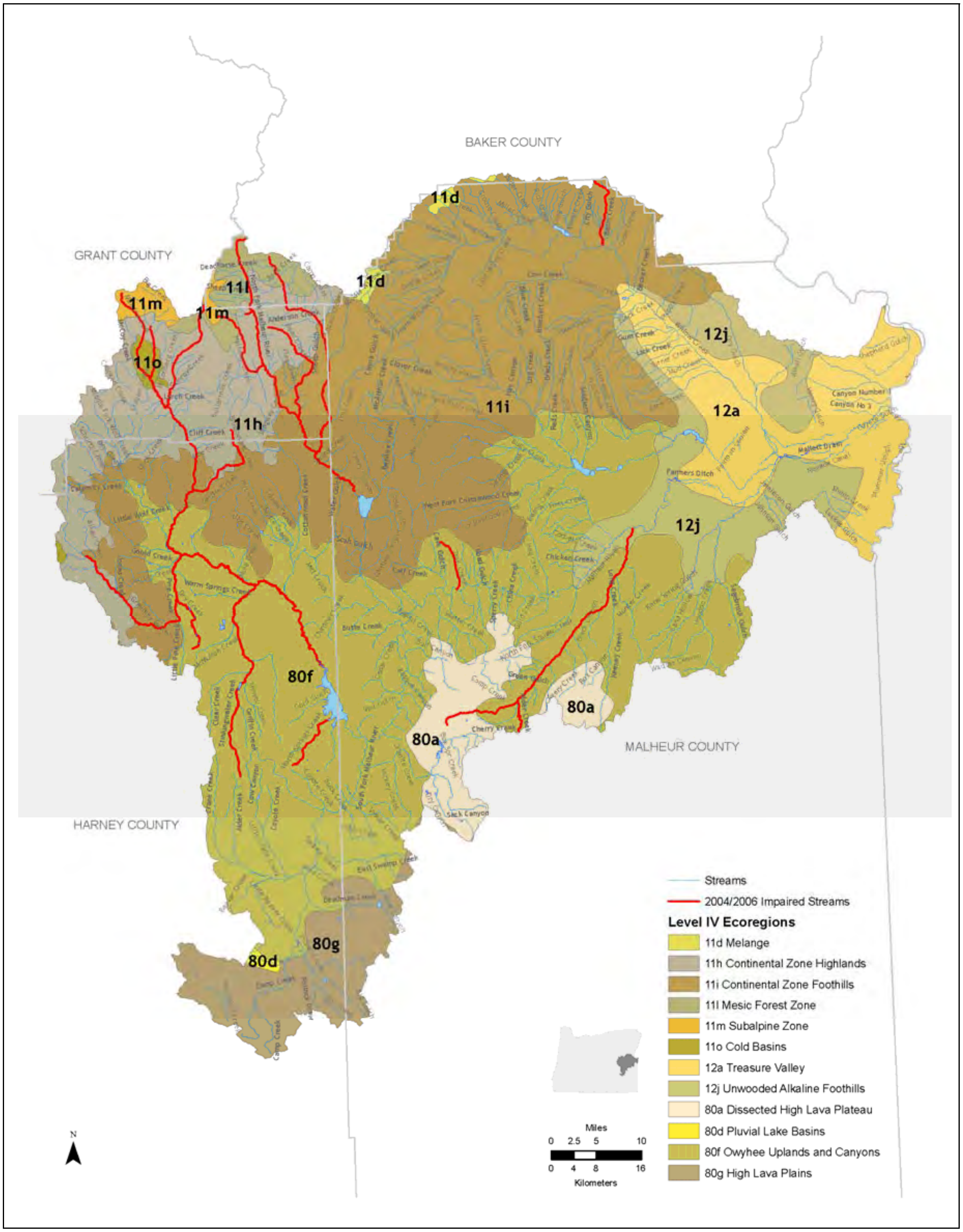
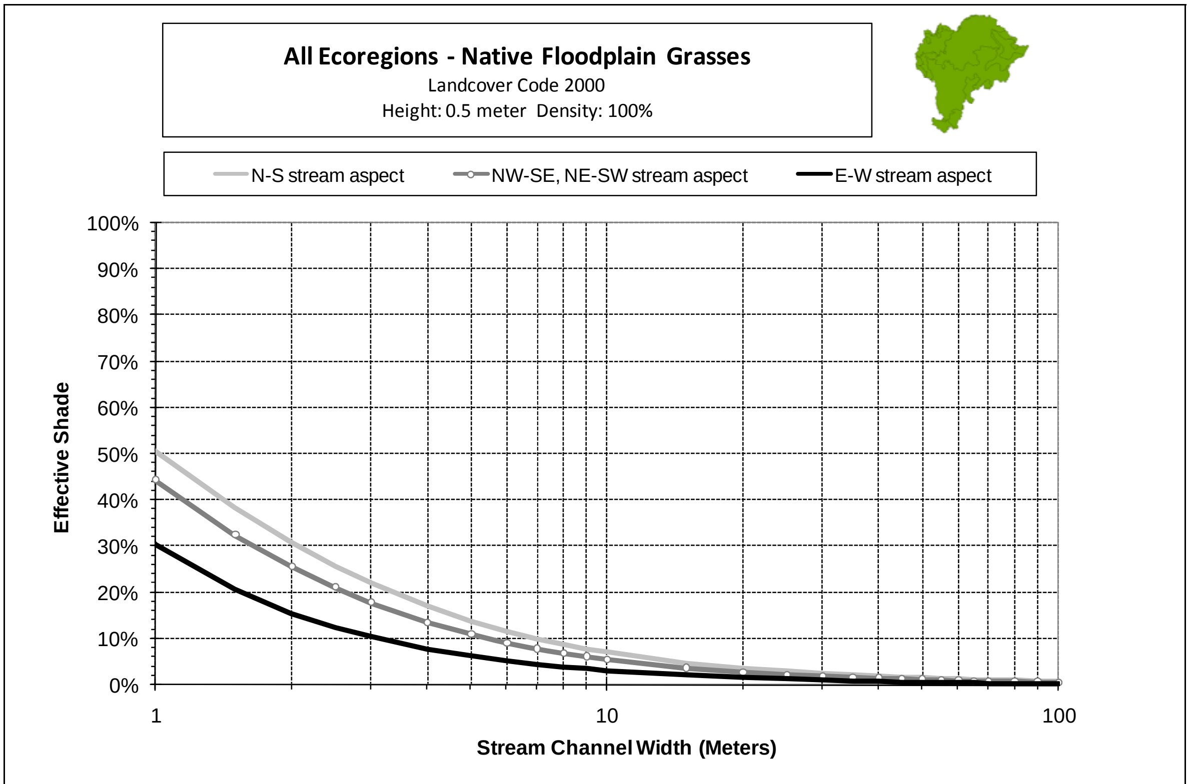


Figure 9-39. Ecoregion effective shade curves



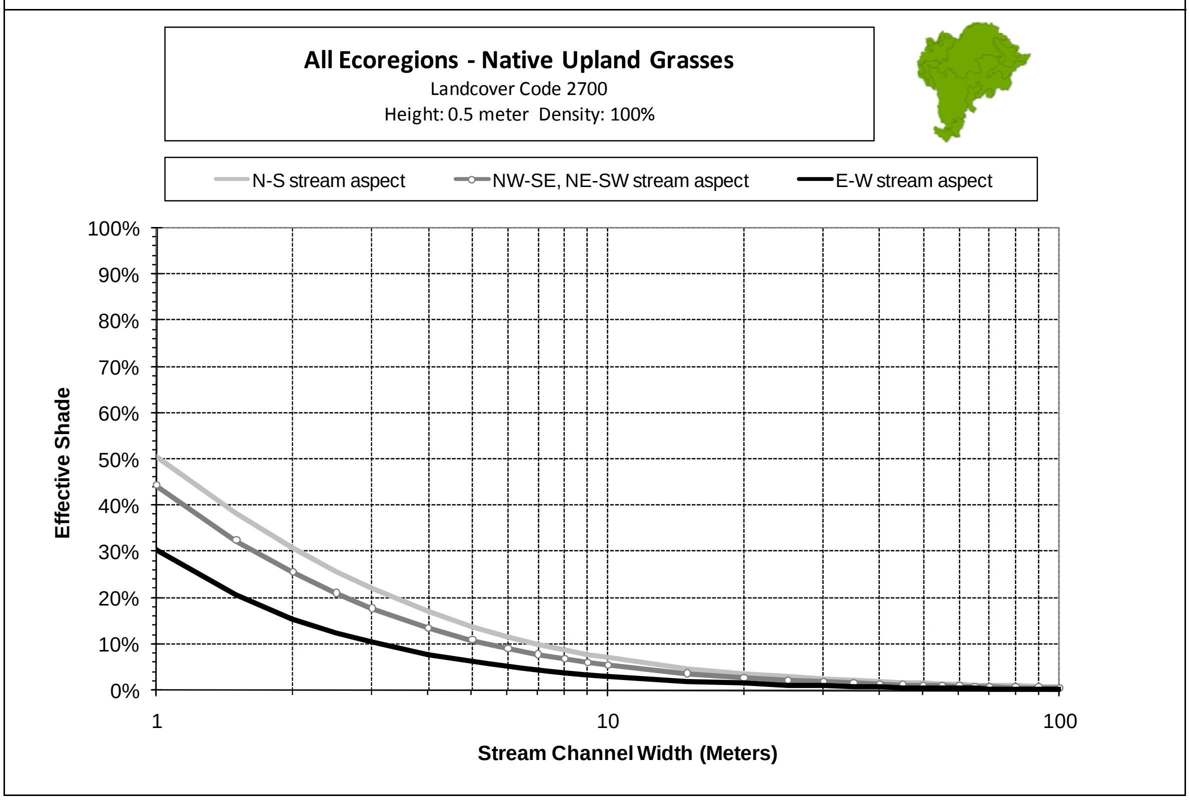
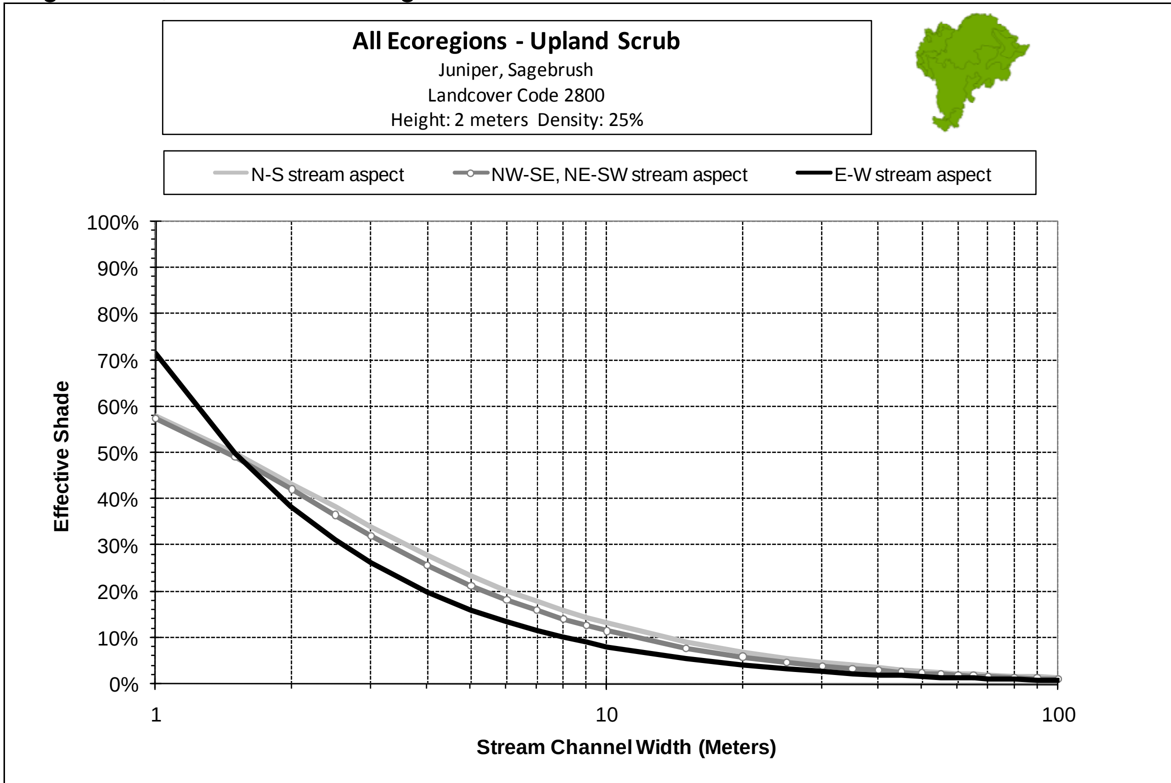


Figure 9-39, continued. Ecoregion effective shade curves.



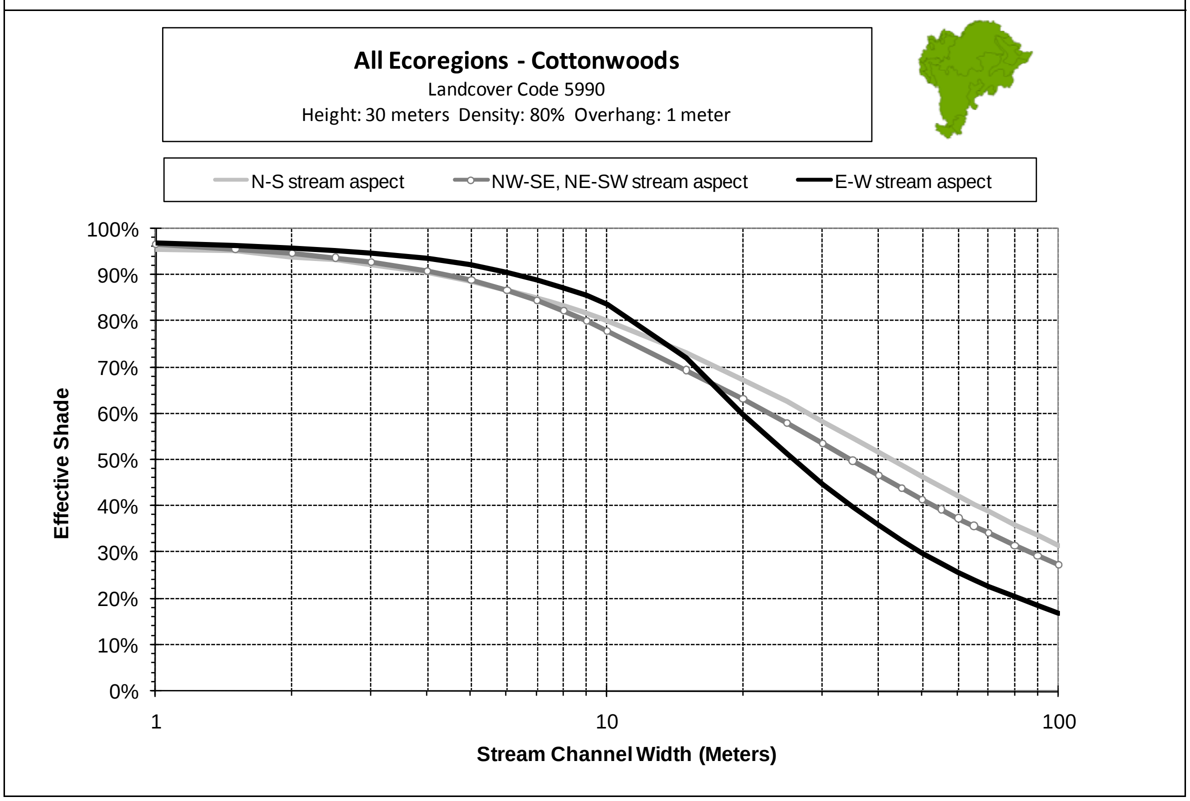
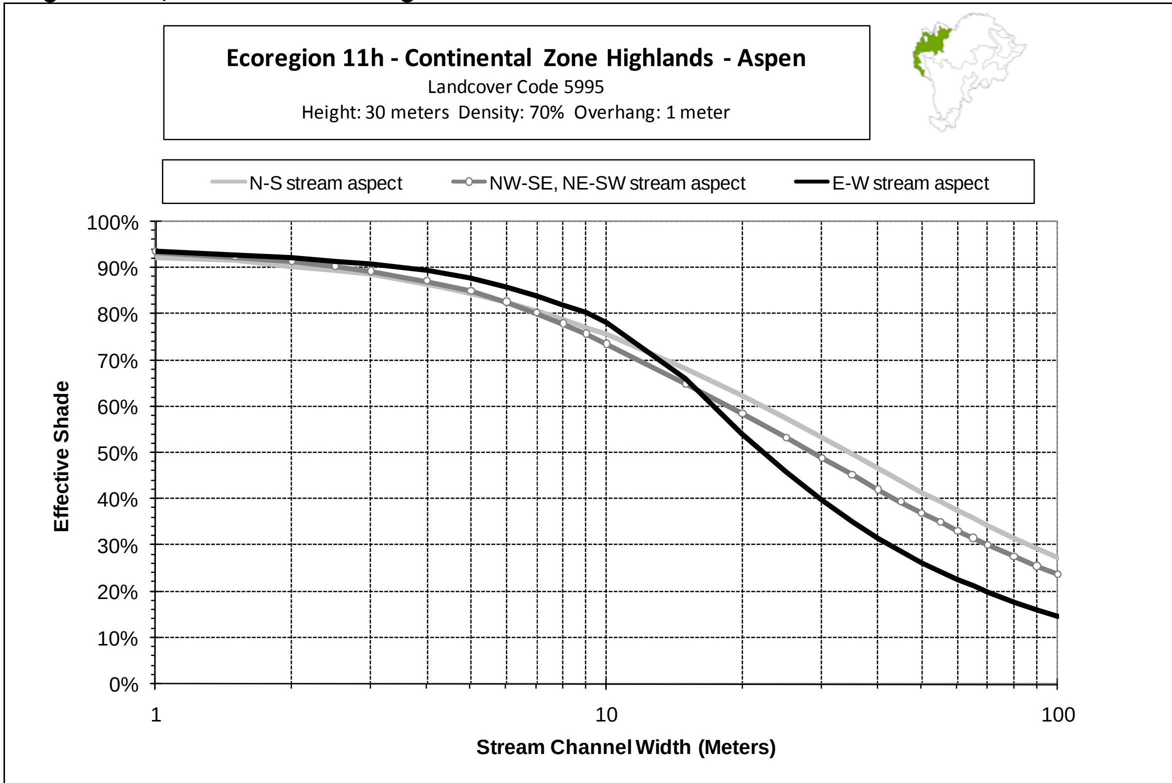


Figure 9-39, continued. Ecoregion effective shade curves.



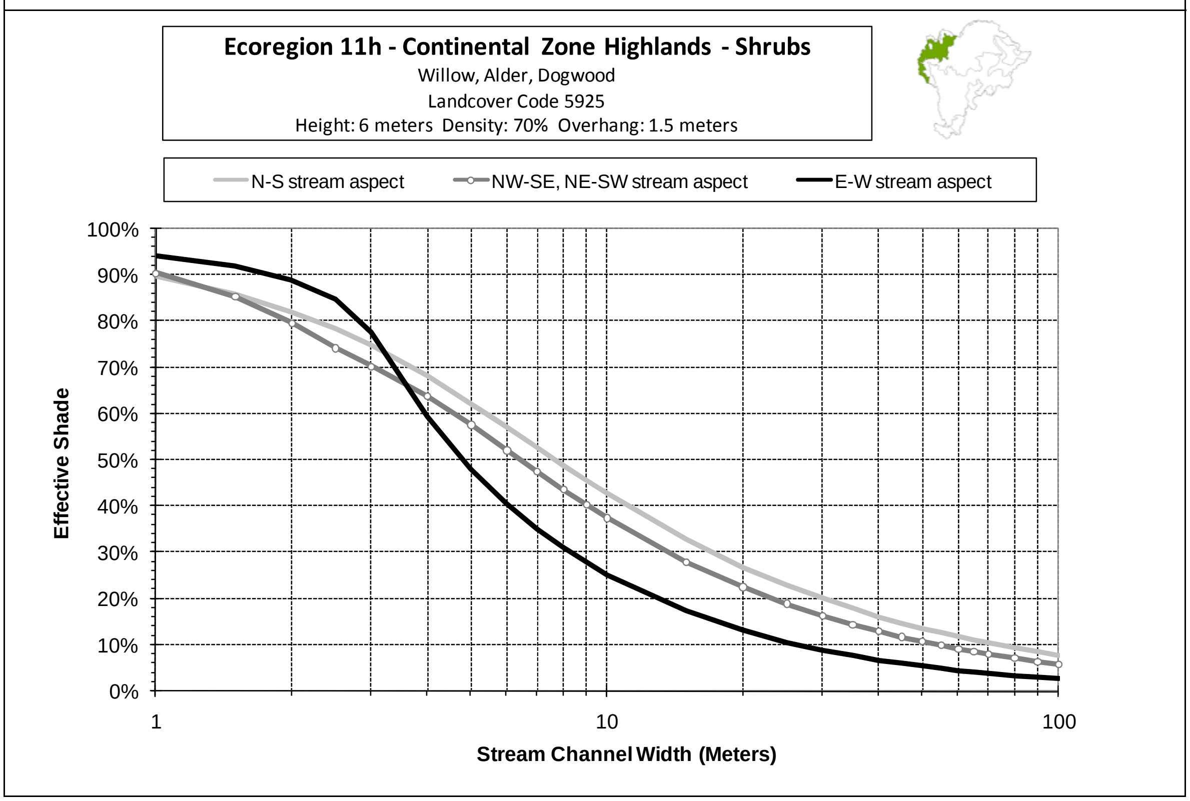
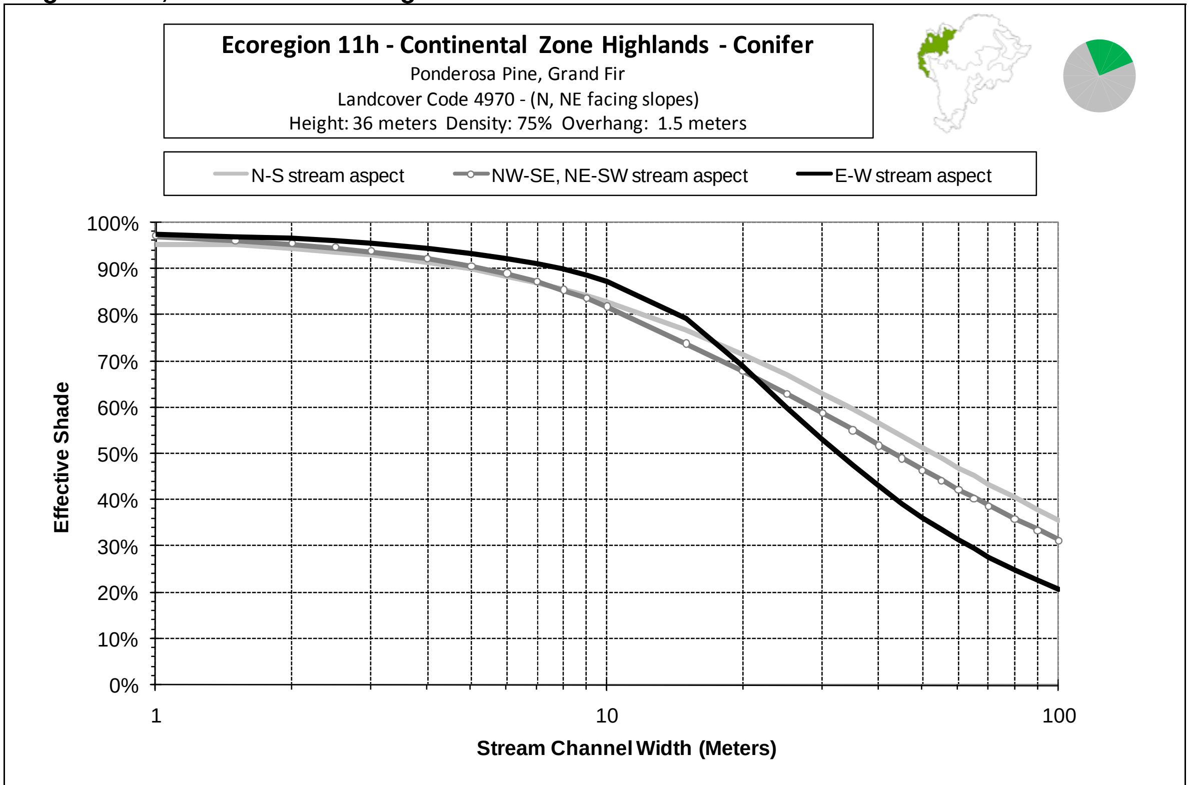


Figure 9-39, continued. Ecoregion effective shade curves.



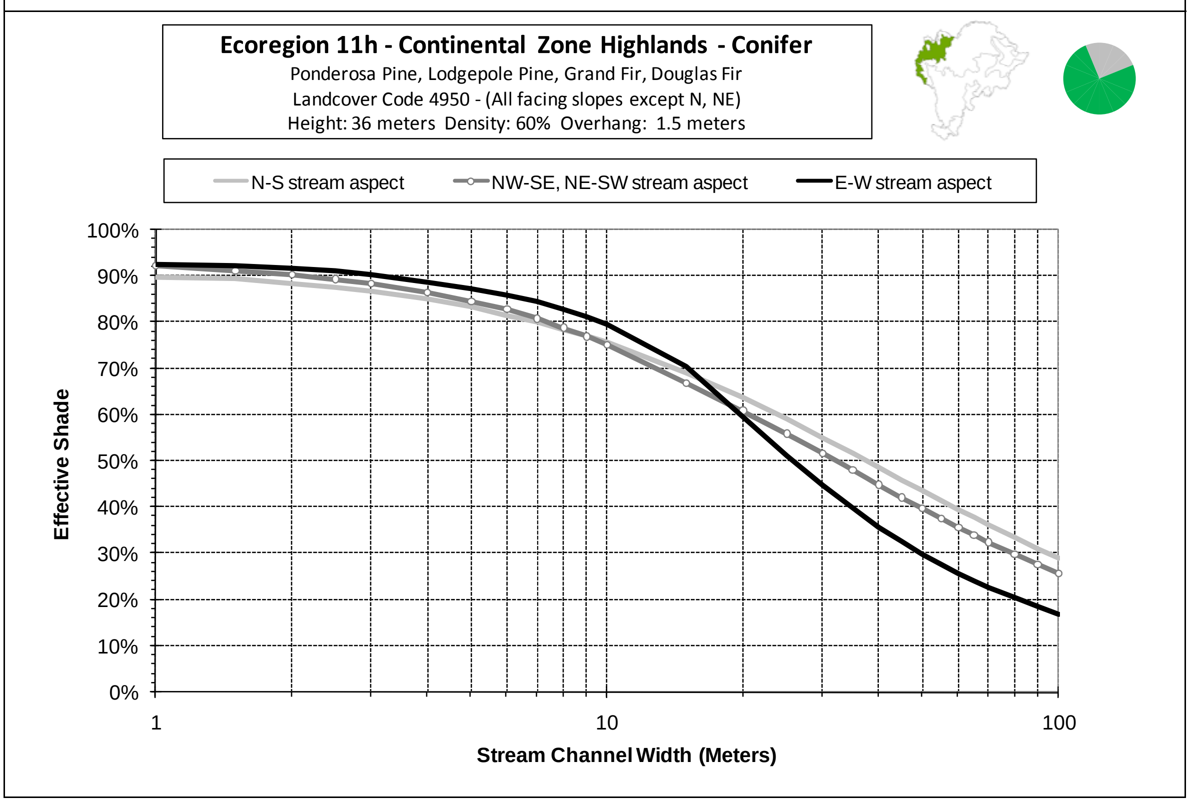
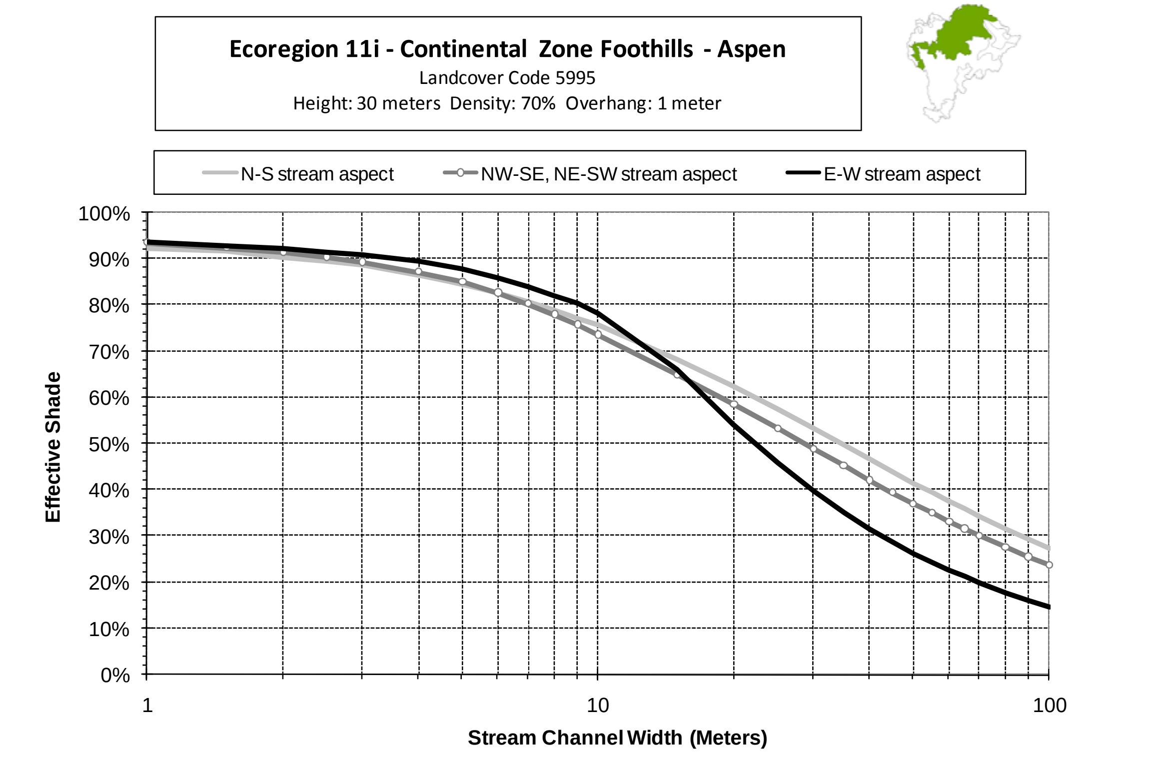


Figure 9-39, continued. Ecoregion effective shade curves.



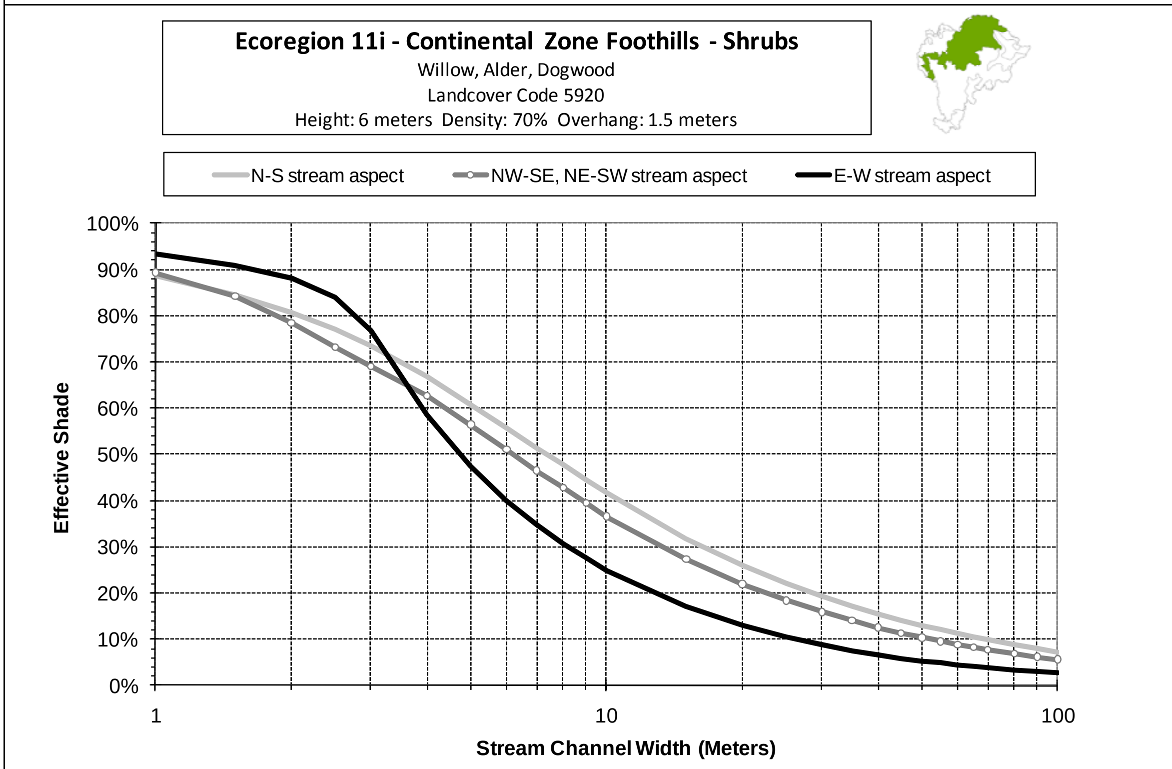
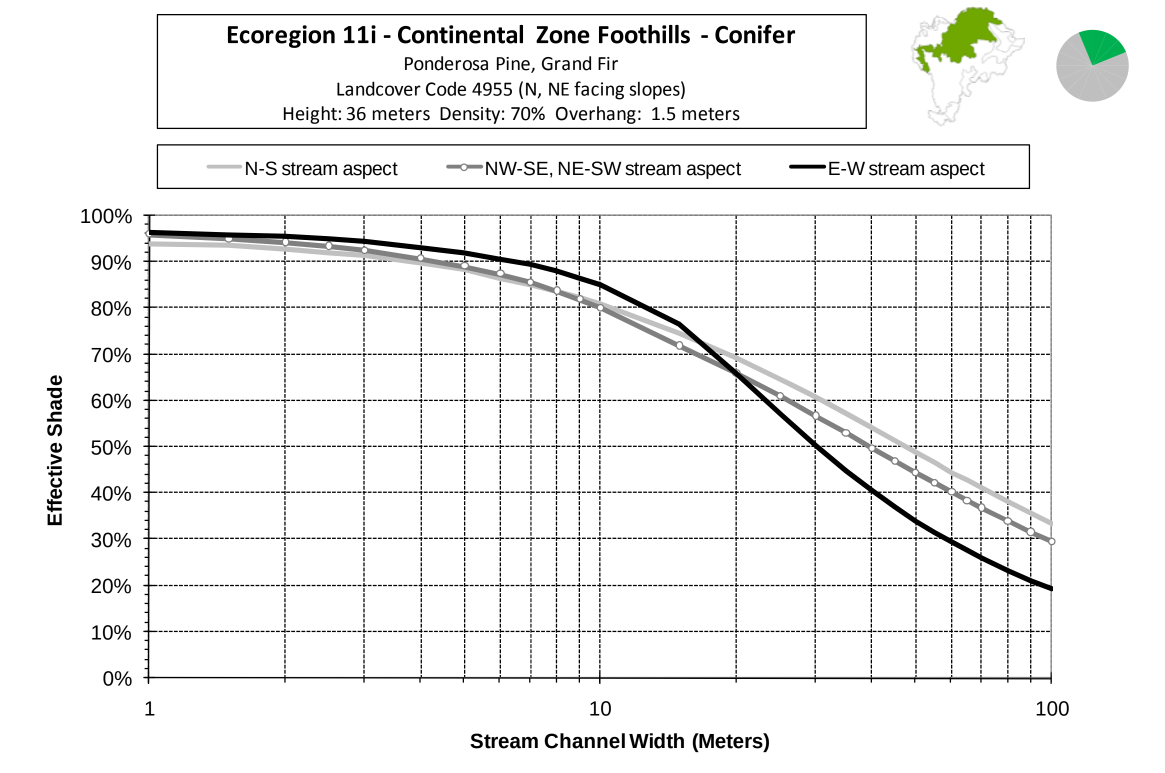


Figure 9-39, continued. Ecoregion effective shade curves.



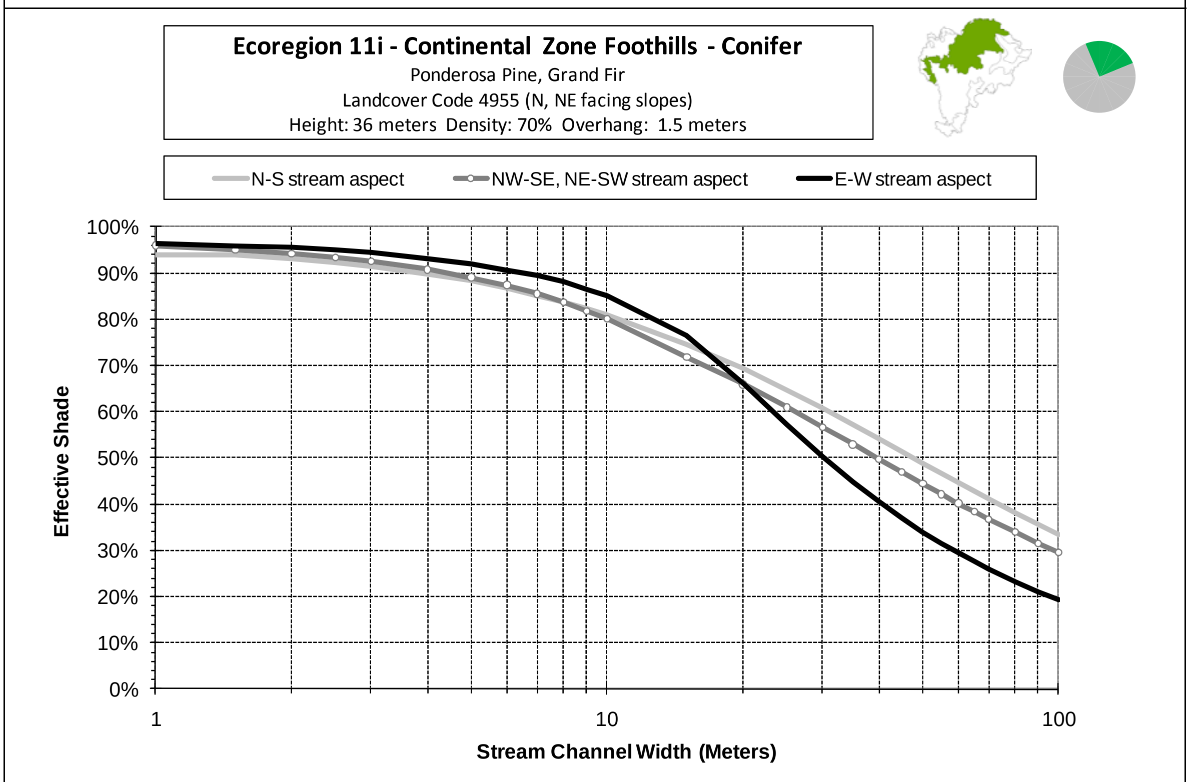
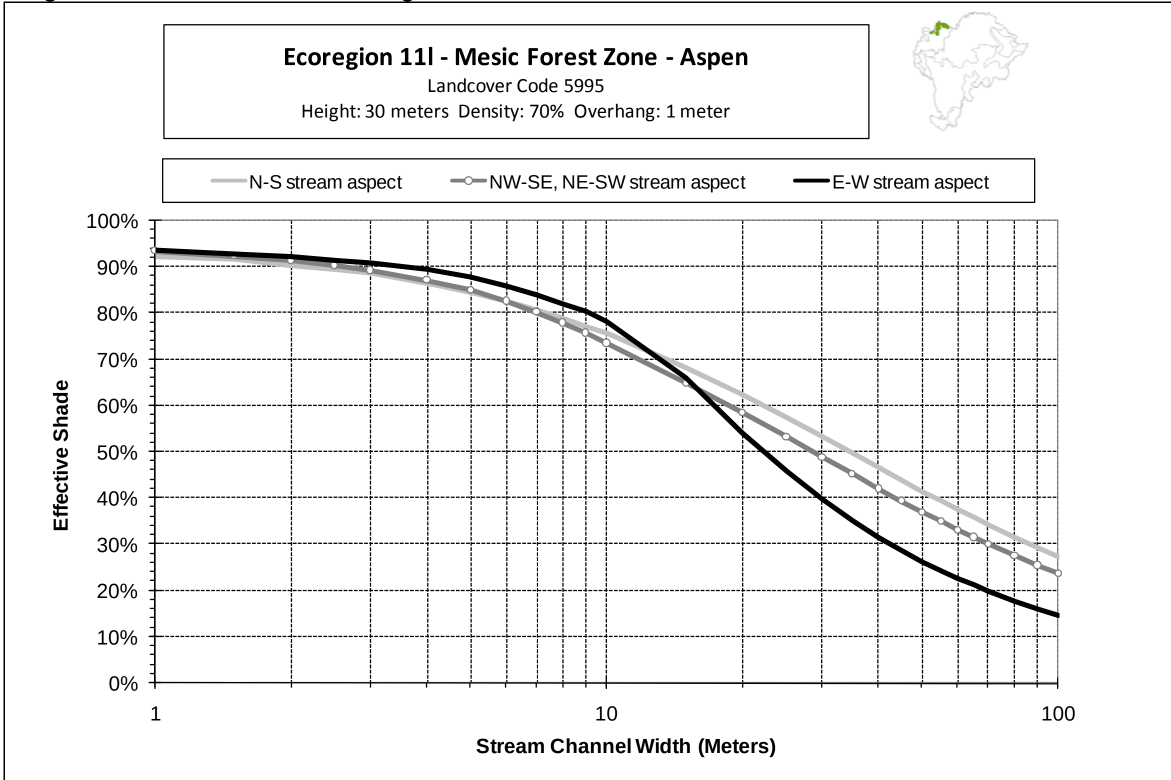


Figure 9-39, continued. Ecoregion effective shade curves.



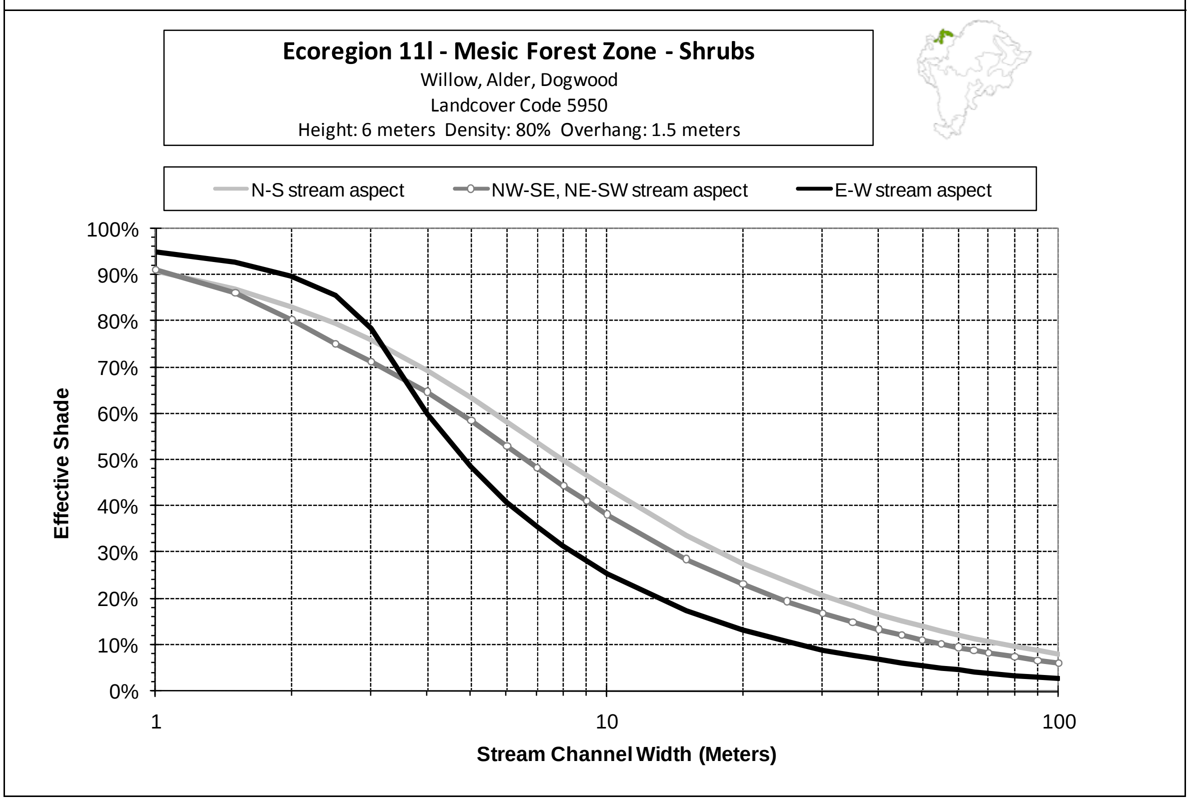
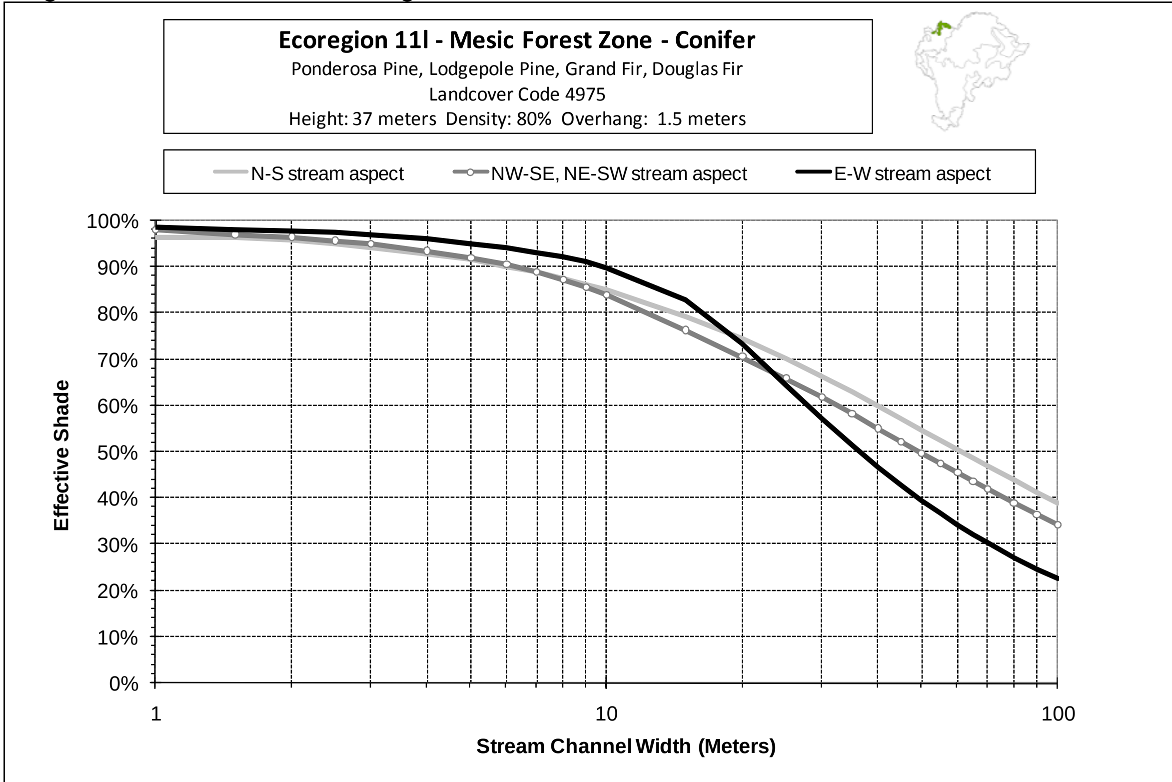


Figure 9-39, continued. Ecoregion effective shade curves.



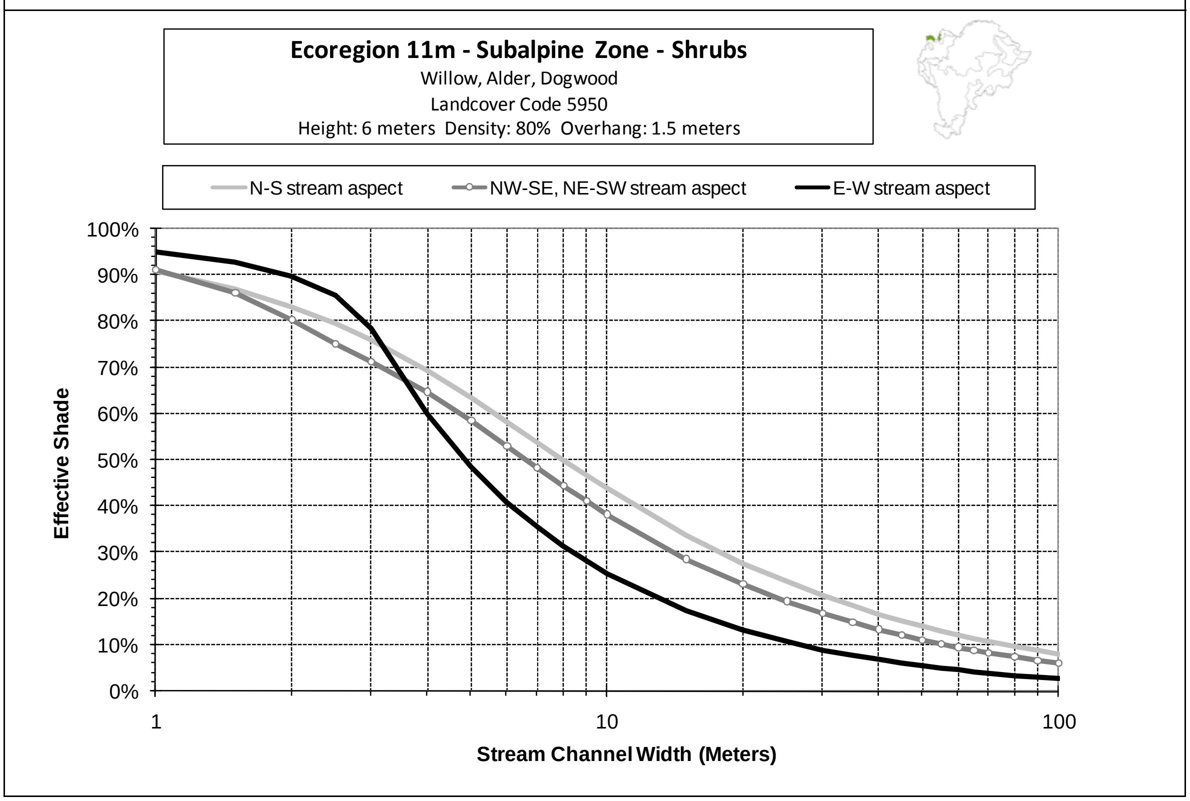
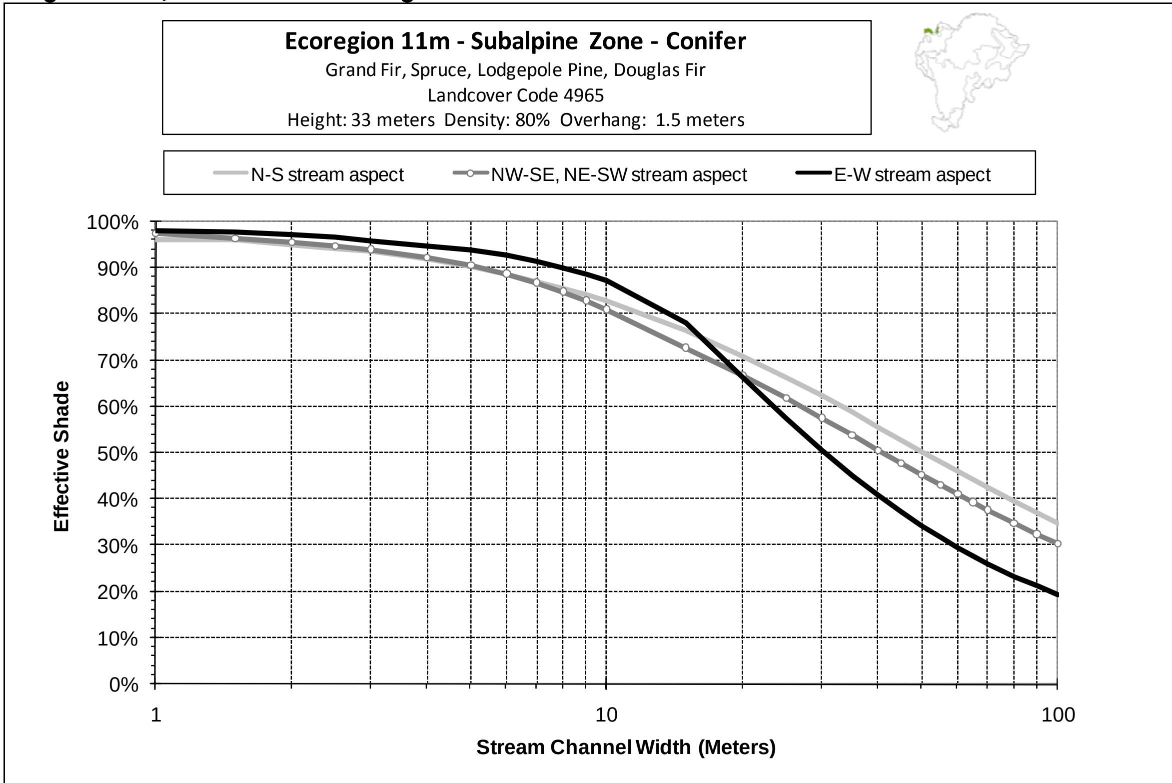


Figure 9-39, continued. Ecoregion effective shade curves.



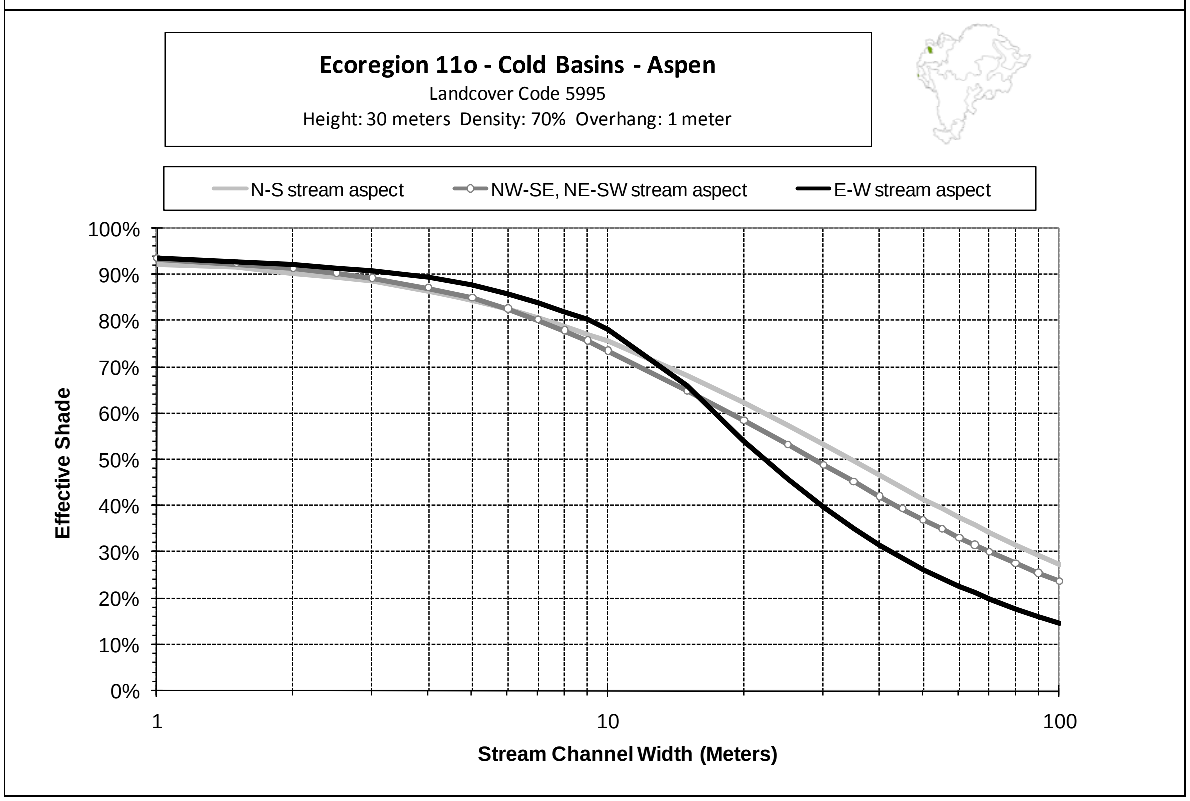
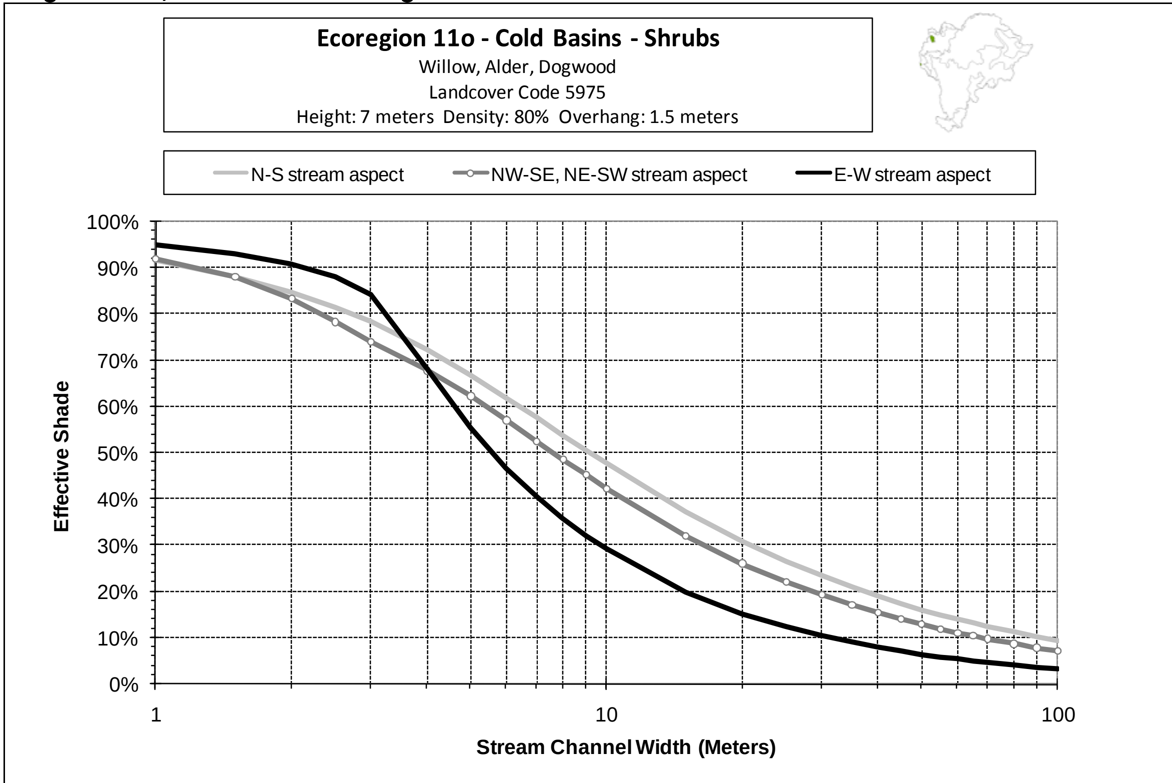


Figure 9-39, continued. Ecoregion effective shade curves.



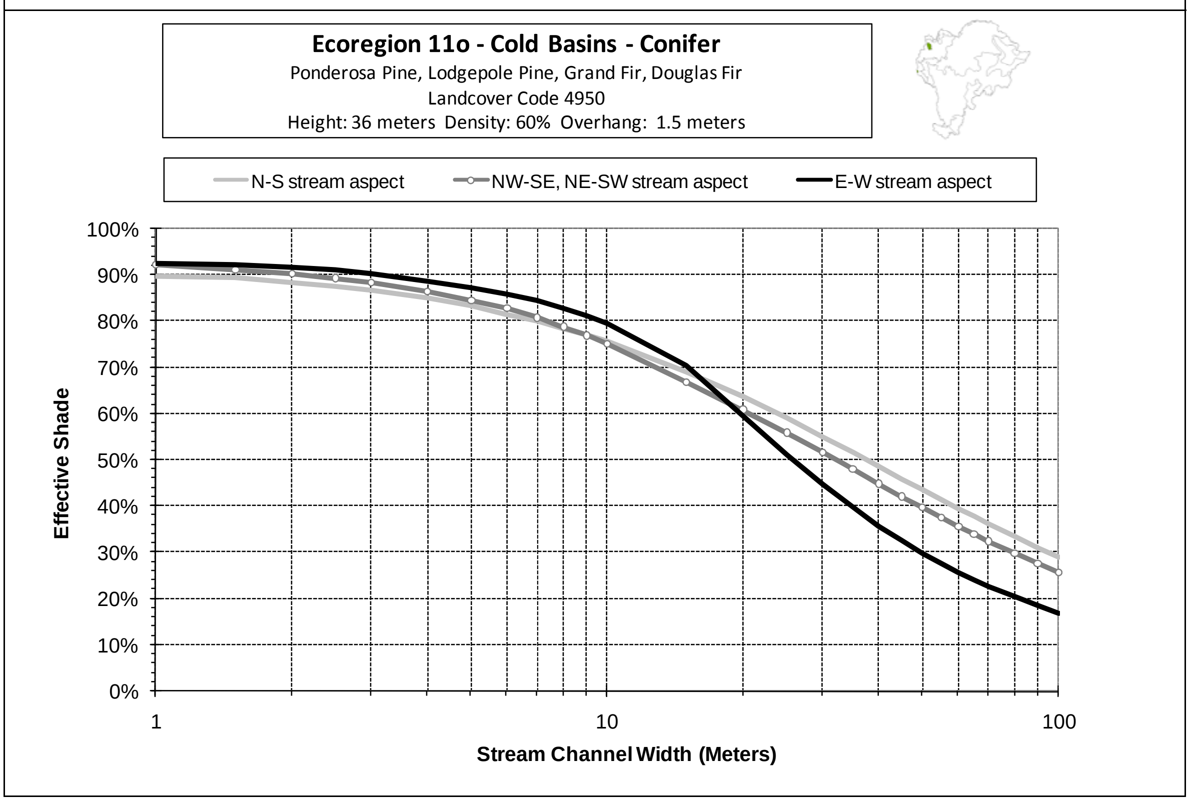
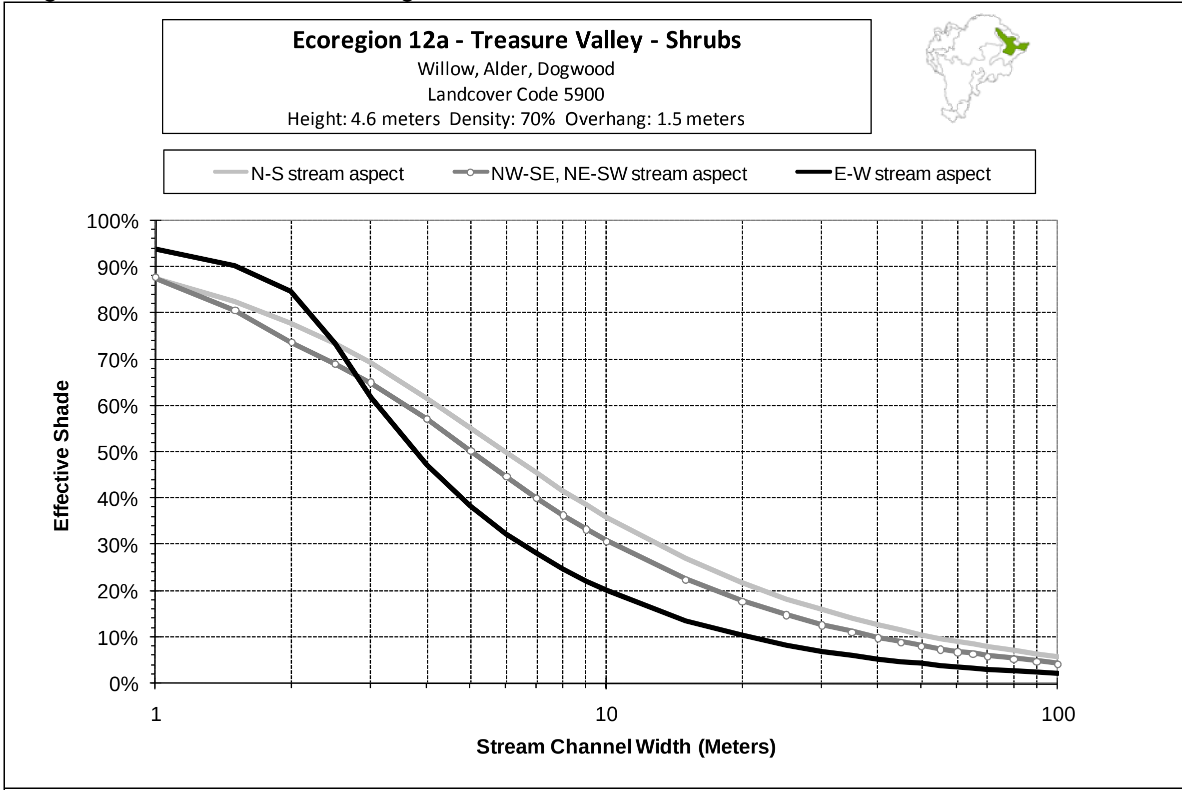


Figure 9-39, continued. Ecoregion effective shade curves.



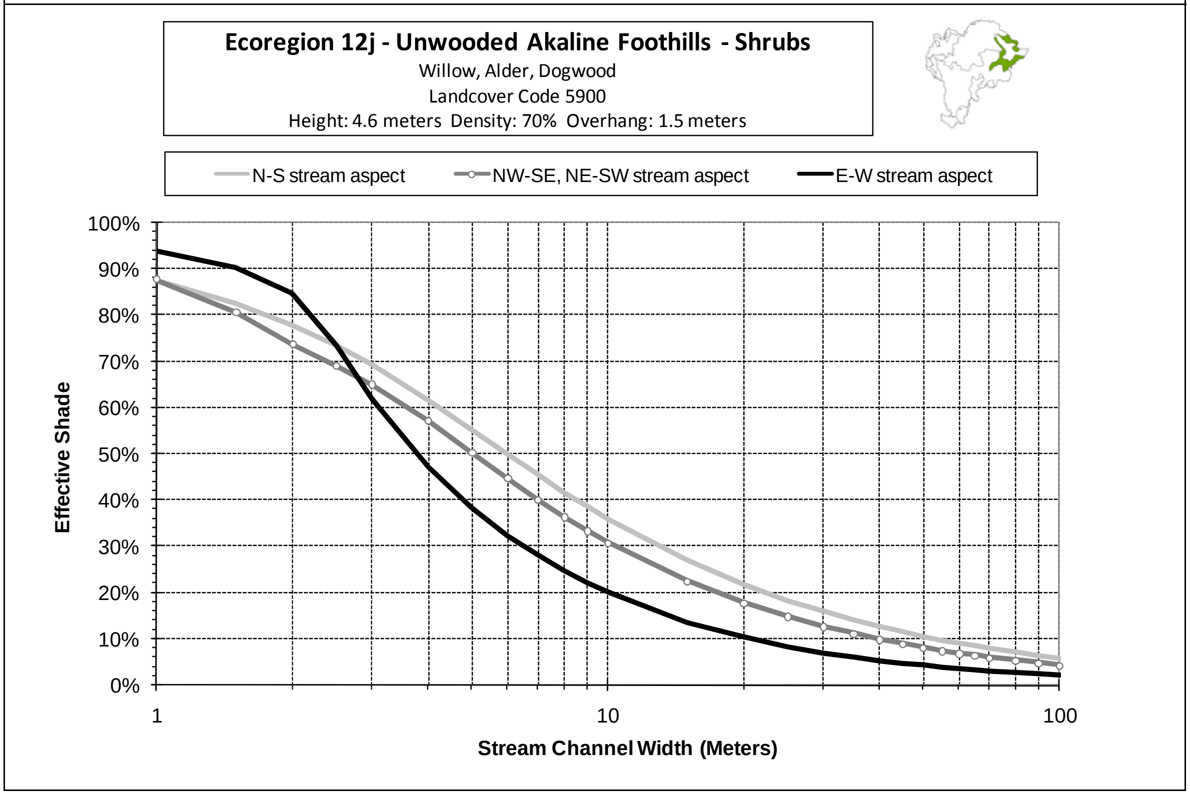
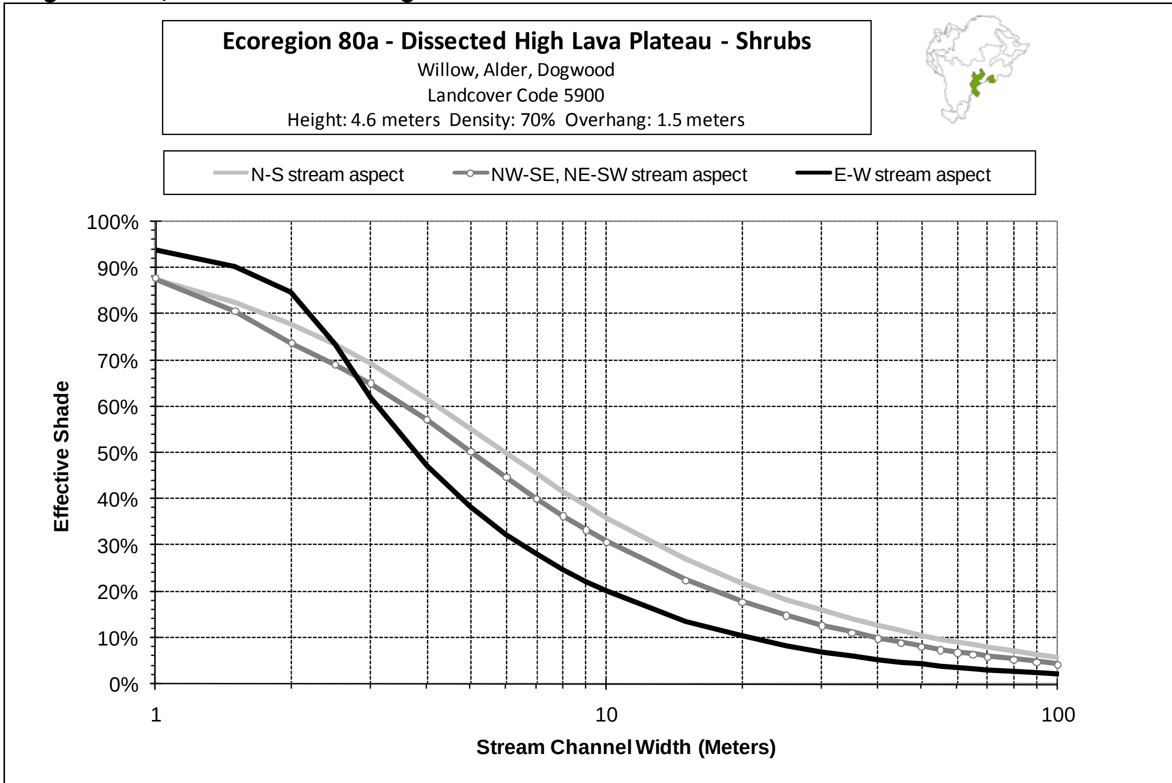


Figure 9-39, continued. Ecoregion effective shade curves.



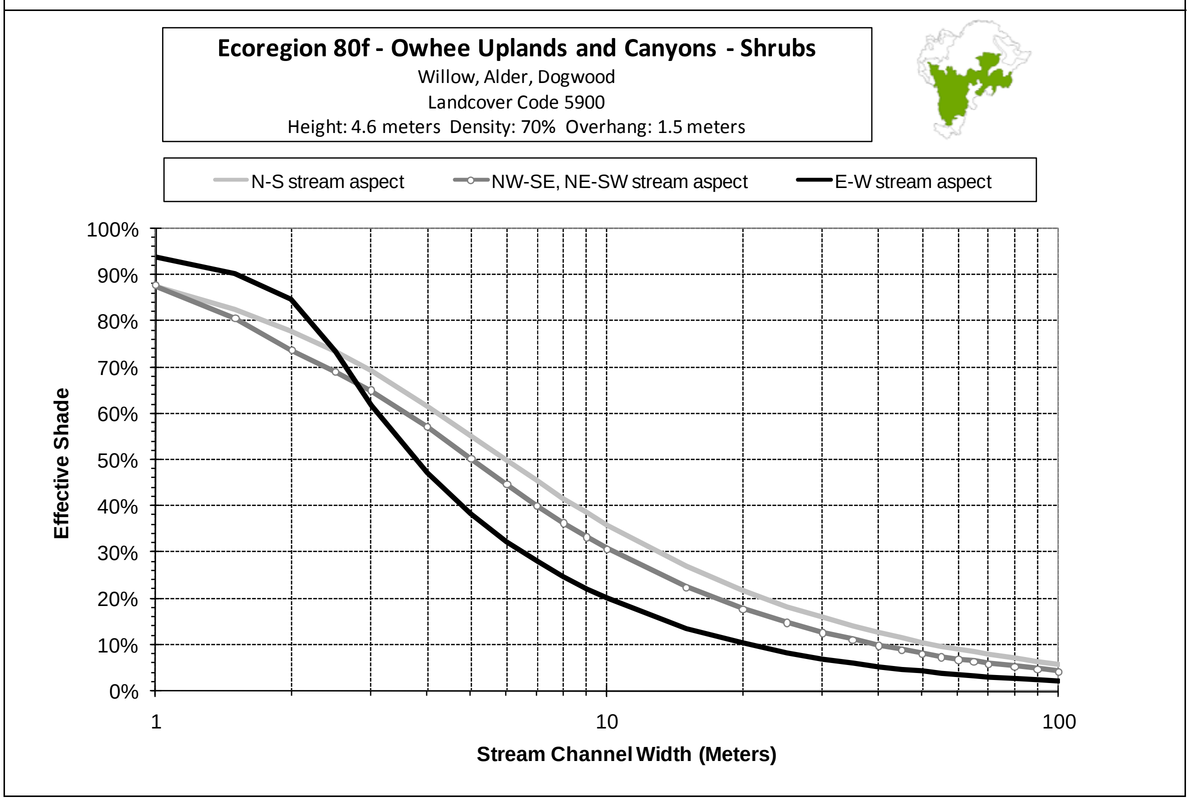
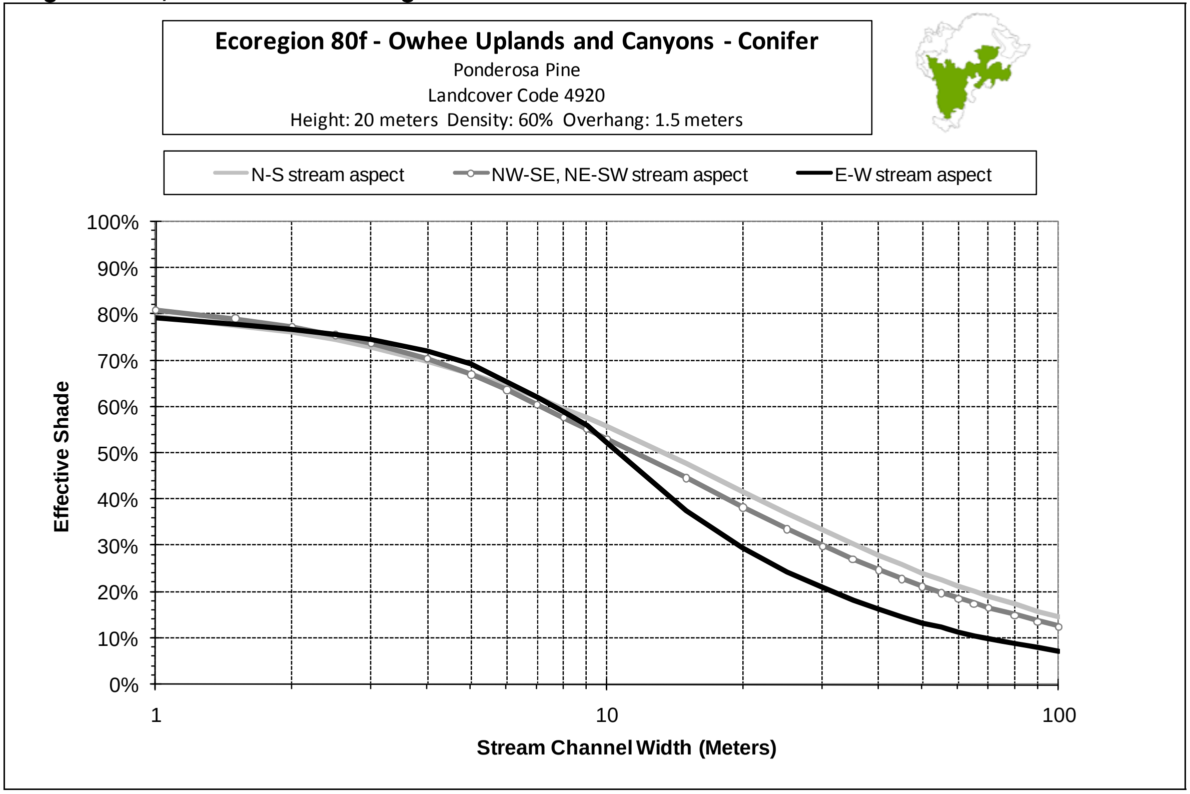


Figure 9-39, continued. Ecoregion effective shade curves.



9.10.4 Load Allocation Compliance Measures

DEQ will evaluate compliance with the load allocations based on the following factors:

1. Implementation Plans and Actions: DMAs will submit implementation plans to DEQ, as required by the WQMP, and implement those plans and any riparian area management rules, polices, or guidance. TMDL compliance on public lands will be partly determined by the implementation of BLM and USFS guidance and rules, particularly regarding riparian vegetation and grazing management. Compliance on private agricultural and rural lands will be evaluated based on compliance with the ODA Malheur River Basin Agricultural Water Quality Management Area Plan.

2. Riparian Area Management: DMAs will manage or eliminate human disturbance from land management activities such as road building, urban development, forest harvest, forest management, farming, and grazing such that riparian vegetation can passively restore and meet the effective shade surrogates according to the qualities described in Section 9.10.1. This will be demonstrated through the implementation of BMPs and administrative rules, ordinances, and/or riparian protection policies by each DMA.

3. Improving Trends: In areas which do not meet the current effective shade surrogates, DMAs with an improving trend in riparian vegetation growth, effective shade, channel morphology, large wood abundance, or floodplain connectivity will be considered in compliance with the TMDL. The Department recognizes that even with effective management, some sites will pose short term challenges for passive restoration. These challenges may include locations with a severely down cut channel or a water table that is no longer near the plant root zone. In these instances, the department will rely primarily

on riparian area management and implementation plans and actions. If improving trends are compromised by natural disturbance factors such as flooding, ice jam scouring, and wild fires, DMAs will still be in compliance with the TMDL.

Compliance with the TMDL and implementation plans on public lands will be evaluated on a 5-year cycle. Compliance on private agricultural and rural lands will be evaluated based on compliance with the ODA Malheur River Basin Agricultural Water Quality Management Area Plan, and will be reviewed on a two year cycle coincident with the biannual updates of that plan.

9.11 SNAKE RIVER TMDL LOAD ALLOCATION

The Snake River – Hells Canyon TMDL (ODEQ/IDEQ 2003) gave load allocations to all tributaries of the Snake River. The load allocation to the Malheur River, (from Table 4.0.17 on page 466 in the Snake River – Hell Canyon TMDL) is as follows:

> *"Total anthropogenic loading less than 0.14 ^{o}C at RM 409 during that period of time that the site potential of the mainstem Snake River is above 17.8 ^{o}C due to natural or non-quantifiable temperature sources"*.

The TMDL did not provide a method to calculate site potential temperatures or define a period when site potential temperatures in the Snake River are above 17.8 ^{o}C. To determine this occurrence, current 7DADM temperatures from an Idaho Power Company gage at Snake River mile 345.6 was used to establish a conservative estimate of the applicable time period when the allocation applies. Between 2004 and 2008, the 7DADM Snake River temperatures downstream of the Malheur River were warmer than 17.8 ^{o}C approximately May 1st through October 15th (see **Figure 9-40**). When Snake River temperatures are above 17.8 ^{o}C, the Malheur River at BOR's 36th Street Bridge gage in Ontario was warmer than the Snake River most often in May and part of June (see **Figure 9-41**).

Figure 9-40. 7DADM temperatures in the Snake and Malheur Rivers (2004-2008).

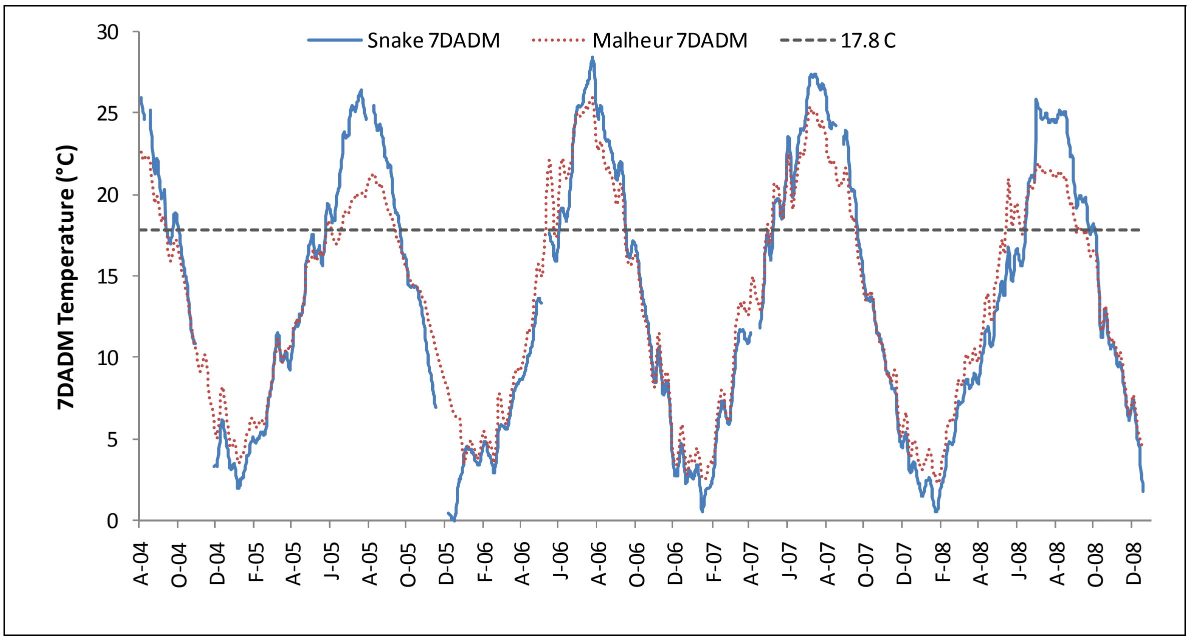


Figure 9-41. Degrees Celsius the Malheur River is warmer than the Snake River (2004-2008).

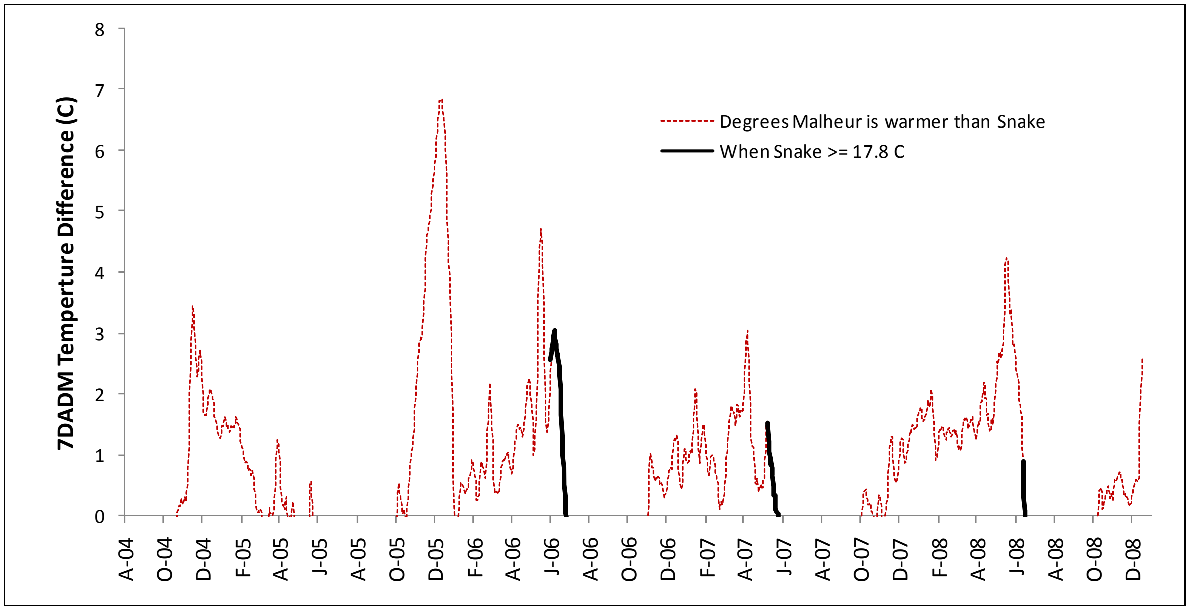
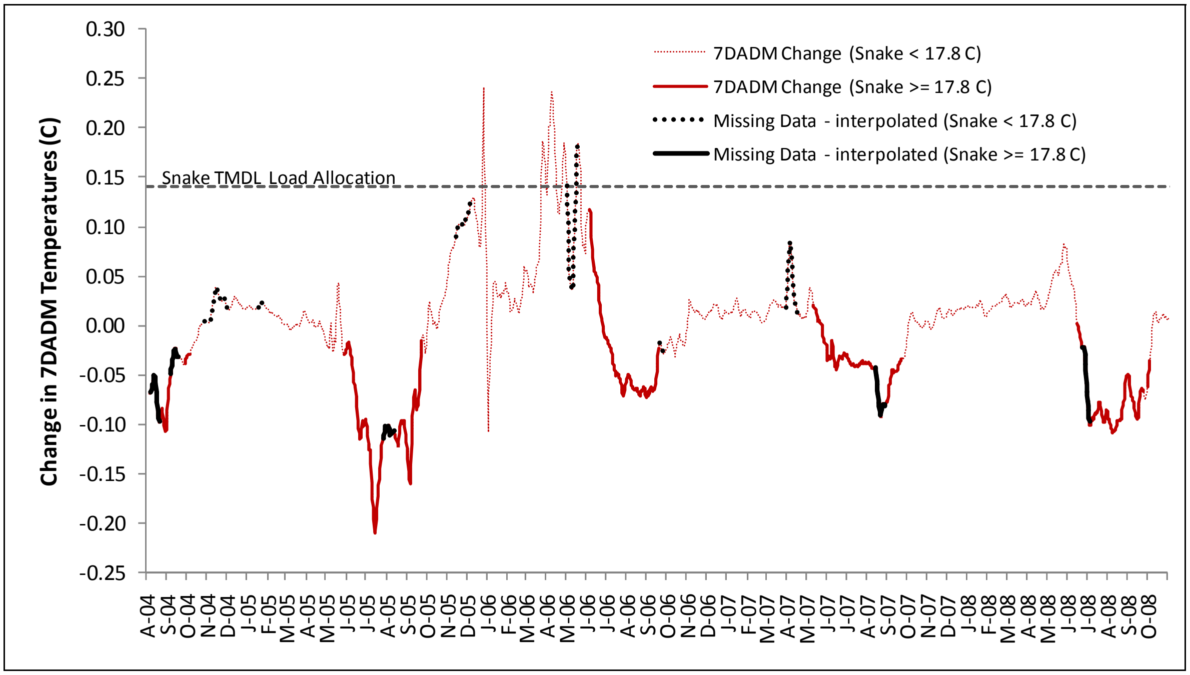


Figure 9-42 shows the estimated change in Snake River 7DADM temperatures caused by the Malheur River between 2004 and 2008. This estimate includes both natural and current anthropogenic sources. The temperature change was calculated with a mass balance equation using available flow and temperature data. Any missing data points were interpolated.

Including both natural and current anthropogenic sources, the Malheur River did not exceed the Snake River load allocation of 0.14 ^{o}C during the period of available data. In May of 2006 the load allocation was almost exceeded because of high stream flows in the Malheur River and warm Malheur River temperatures in mid May (see **Figure 9-40)**.

Figure 9-42. Estimated 7DADM change in the Snake River from current anthropogenic and naturally derived Malheur River warming sources.



Compliance with the Load Allocation

With the data available it is not possible to estimate the Malheur River's current anthropogenic heating to the Snake River. It is possible, however, using conservative assumptions to estimate the anthropogenic heating to the Snake River based on the heat load allocated under the Malheur Basin TMDL. The Malheur Basin TMDL provides heat load allocations to basin anthropogenic sources through the allocation of the human use allowance (**Section 9.7**). To ensure that these heat load allocations do not exceed the 0.14 ^{o}C allocation in the Snake River, mass balance equations (**Equation 5**, **Equation 6** and **Equation 7)** were used to calculate the TMDL allowable anthropogenic heat loads. The Snake River temperature was assumed to be at 17.8 ^{o}C and the current Malheur River temperatures were assumed to be the "natural" condition. These are not realistic temperatures but they provide a rigorous evaluation threshold for the Malheur TMDL allocations. If the Malheur allocations can meet this threshold they are sufficient to always meet the Snake River allocations under normal river conditions.

Equation 5

$$\Delta \boldsymbol{Tmalheur} = \frac{\boldsymbol{Qsnake}}{\boldsymbol{Qsnake} + \boldsymbol{Qmalheur}} \times (\boldsymbol{Tmalheur} - \boldsymbol{Tsnake})$$

Equation 6

$$\Delta \boldsymbol{Thua} = \frac{\boldsymbol{Qsnake}}{\boldsymbol{Qsnake} + \boldsymbol{Qmalheur}} \times (\boldsymbol{Tmalheur} + \boldsymbol{HUA} - \boldsymbol{Tsnake})$$

Equation 7

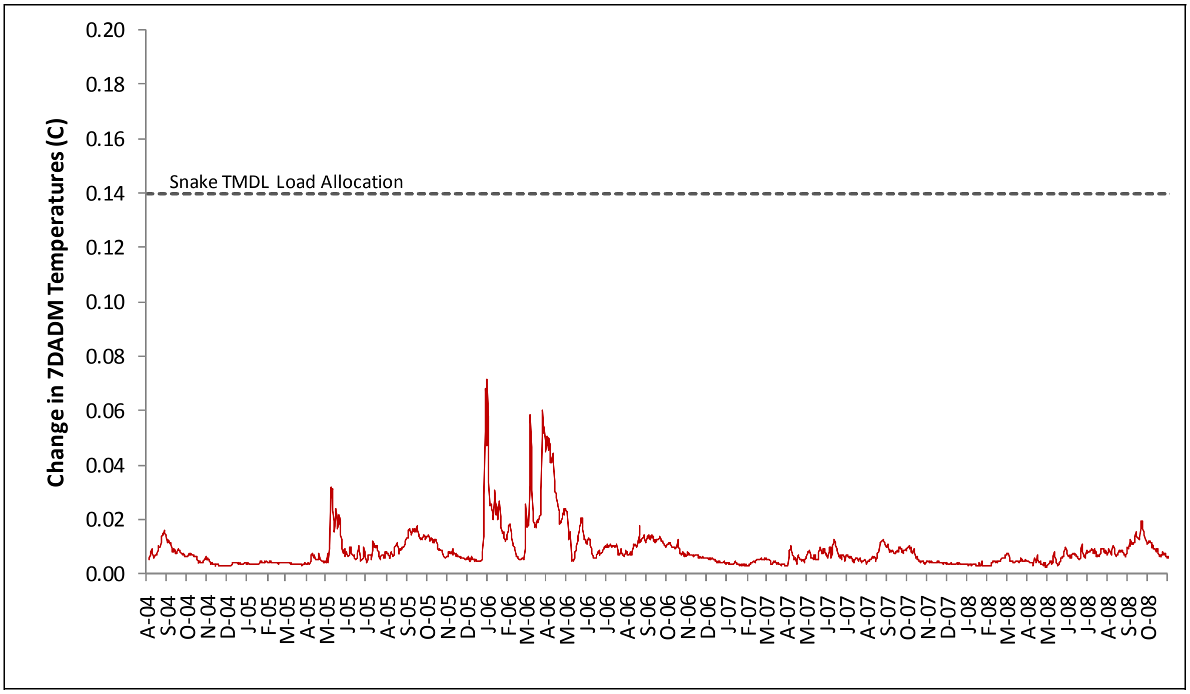
$$\Delta Tanthro = \Delta Thua - \Delta Tmalheur$$

Where.

$\Delta Tmalheur =$	Change in Snake River 7-day average daily maximum temperatures caused by the Malheur River.
$\Delta Thua =$	Change in Snake River 7-day average daily maximum temperatures caused by the Malheur River plus the 0.3 °C TMDL allocated human use allowance.
$\Delta Tanthro =$	Change in Snake River 7-day average daily maximum temperatures caused by the heat load allocated to Malheur River Basin sources.
$Tmalheur =$	Malheur River current 7-day average daily maximum temperatures at 36th Street bridge in Ontario (BOR MALO gage).
$Tsnake =$	Applicable temperature standard in the Snake River. For this analysis we used current 7-day average daily maximum temperatures at Idaho Power Company's gage at Snake River mile 345.6, or 17.8 °C when 7DADM temperatures were greater than 17.8 °C.
$HUA =$	The 0.3°C human use allowance allocated to anthropogenic sources.
$Qmalheur =$	Daily average Malheur River flow at 36th Street Bridge in Ontario (BOR MALO gage).
$Qsnake =$	Daily average Snake River flow at Nyssa gage upstream of the Malheur River.

Figure 9-43 shows the results of the mass balance equations and demonstrates that the anthropogenic heat load allocations in the Malheur Basin TMDL do not exceed the Snake River – Hells Canyon TMDL allocation and will be sufficient under even extremely high flow conditions such as those observed in 2006.

Figure 9-43. Conservative estimate of 7DADM temperature change in the Snake River from Malheur Basin TMDL allocated anthropogenic sources (2004-2008).



9.12 RESERVE CAPACITY

> OAR 340-042-0040(4)(k)
>
> *This element is an allocation for increases in pollutant loads for future growth and new and expanded sources. The TMDL may allocate no reserve capacity and explain that decision.*

There is an explicit allocation for reserve capacity throughout the Malheur River Basin set aside for future growth of new, expanded, or unidentified sources. The portion of human use allowance set aside for reserve capacity is equal to 0.025°C. With the exception of dams and reservoirs, reserve capacity is available for use by either nonpoint or point sources to accommodate future growth as well as to provide an allocation to any existing source that may not have been identified during the development of this TMDL.

9.13 MARGIN OF SAFETY

> OAR 340-042-0040(4)(i), CWA §303(d)(1)
>
> *This element accounts for uncertainty related to the TMDL and, where feasible, quantifies uncertainties associated with estimating pollutant loads, modeling water quality and monitoring water quality*

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS) to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. An MOS is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (i.e., derivation of numeric targets, modeling assumptions, or effectiveness of proposed management actions).

The MOS may be implicit, as in conservative assumptions used in calculating the loading capacity, Waste Load Allocation, and Load Allocations. The MOS may also be explicitly stated as an added, separate quantity in the TMDL calculation. In any case, assumptions should be stated and the basis behind the MOS documented. The MOS is not meant to compensate for a failure to consider known sources. **Table 9-12.** Approaches for Incorporating a Margin of Safety into a TMDL presents six approaches for incorporating a MOS into TMDLs.

Table 9-12. Approaches for Incorporating a Margin of Safety into a TMDL

Type of Margin of Safety	*Available Approaches*
Explicit	1. Set numeric targets at more conservative levels than analytical results indicate. 2. Add a safety factor to pollutant loading estimates. 3. Do not allocate a portion of available loading capacity; reserve for MOS.
Implicit	1. Conservative assumptions in derivation of numeric targets. 2. Conservative assumptions when developing numeric model applications. 3. Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

In the Malheur River Basin TMDL, an *explicit* margin of safety is left unallocated to account for uncertainty and limitations in this analysis. The MOS is equal to 0.025°C of the human use allowance. The source of uncertainty and the limitations in this analysis are as follows.

- The scale of this effort is large with obvious challenges in capturing spatial variability in stream and landscape data. Available field data for vegetation and channel morphology is limited. Derived data sets are limited to aerial photo resolution and human error.

- Land use patterns vary through the basin from heavily impacted areas to areas with little human impacts. It is difficult to find large areas without some level of either current or past human impacts. Some types of site potential vegetation heights, densities, and appropriate distribution were difficult to validate.

- Cumulative temperature impacts were not calculated for this analysis because meeting the water quality standard and achieving the load reductions required in this TMDL (establishment of site potential vegetation effective shade) are not dependent on this information. If, in the future, point sources become a source of heat, lack of this information may be a limitation and a source of uncertainty in establishing wasteload allocations and permit limits.

- Other than the Bureau of Reclamation dams, data was not available for an assessment of dams, reservoirs, and irrigation withdrawals and return flows.

- Natural channel morphology was not factored into the calculation of the site specific effective shade allocations due to lack of channel dimension data..

The following items affect model uncertainty:

- Riparian vegetation was mapped from aerial photographs and placed within general height categories. For example, trees identified as “Large Conifers” were assigned a single height in all locations, when in reality, “Large Conifer” heights may range in heights. It is not possible to assign actual heights to each tree mapped using aerial photographs. Site potential vegetation used similar general categories. Using these general height categories as a model input are one source of modeling imprecision.

- Riparian vegetation densities were estimated based on aerial photograph analysis. General categories such as “high”, “medium”, and “low” density were used to delineate vegetation stands. Potential vegetation used similar general category density values for each ecoregion and vegetation type. In the real world, vegetation densities are variable and this variability is not accounted for in the simulations.

- The actual position of the sun within the sky can only be calculated with an uncertainty of 10-15%. The sun’s position is important when determining a stream’s effective shade. Solar position is another source of modeling imprecision.

- Heat Source assumes that the wetted stream is flowing directly down the center of the active channel, and effective shade calculations are based upon that assumption. In reality, a stream migrates all over the active channel. This is another source of modeling imprecision.

- Increased channel complexity and more coarse woody debris are not accounted for in the site potential vegetation simulations. Including these factors may result in additional effective shade.

- Heat Source breaks the stream into 50-meter segments. The inputs (vegetation, channel morphology, etc.) are averaged for each 50-meter segment, which means that the simulation may not account for some of the real world variability. For example, isolated pools or riffles within a 50 meter reach will not be included as unique features.

- Stream and surface elevations were sampled and calculated from 10-meter digital elevation models (DEMs). DEMs have a certain level of imprecision associated with them and may be a source of uncertainty in the simulation results.

In this TMDL process, there are a number of necessary decisions which are based on information with a certain amount of uncertainty: determination of impairment, model calibration acceptance, model scenario acceptance, and allocations. For each of these four decision points, the uncertainty is handled differently.

The determination of impairment is based on a comparison of data with the water quality standard. The comparison of data with a numeric standard is relatively straight forward, however comparison of data to a ‘natural conditions’ based standard has more uncertainty because ‘natural condition’ cannot be observed and is based on estimates. ODEQ accounts for this uncertainty by trying to minimize the likelihood of a Type II error (where the actual condition is impaired but analysis shows the system is not impaired).

The determination that a model is representing a system (i.e. acceptance of a calibrated model) is based on comparison of model results with observed data, using statistics and graphical comparison. The uncertainty related to allocations of site potential vegetation and the resulting effective shade is accounted for in the Margin of Safety allocation.

While these assumptions outline potential areas of weakness in the analysis methodology, the Oregon Department of Environmental Quality has undertaken a comprehensive approach an areas of limitations should be the focus for future studies.

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MALHEUR RIVER BASIN TMDL

WATER QUALITY MANAGEMENT PLAN (WQMP)

Final
September 2010

State of Oregon
Department of Environmental Quality

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Figures

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1.0 BACKGROUND

A Total Maximum Daily Load (TMDL) defines the amount of a pollutant that can be present in a water body while meeting water quality standards. A Water Quality Management Plan (WQMP) is developed by DEQ as a broad strategy for implementing TMDL allocations. TMDLs, WQMPs and associated planning work together to protect designated beneficial uses, such as aquatic life, drinking water supplies, and water contact recreation.

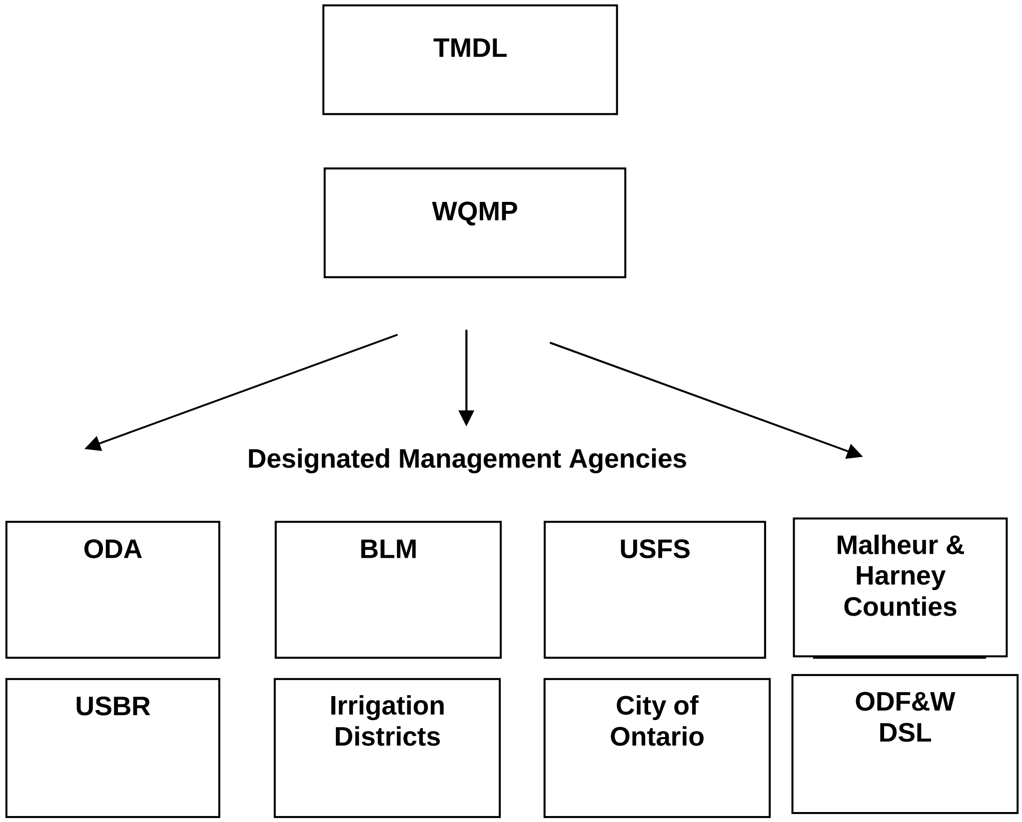
In December of 2002, the State of Oregon's Environmental Quality Commission (EQC) adopted a rule commonly referred to as the "TMDL rule" (OAR 340-042). The TMDL rule defines DEQ's responsibilities for developing, issuing, and implementing TMDLs as required by the federal Clean Water Act (CWA). The WQMP is one of the twelve TMDL elements called for in the TMDL rule. Oregon Administrative Rule 340-042-0040-(4)(l) states the following:

Water quality management plan (WQMP). This element provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific Implementation Plans.

2.0 INTRODUCTION

This WQMP lays out strategies for implementing the Malheur River Basin TMDLs documented in the TMDL documents. As indicated below, two scales of planning are addressed. The WQMP itself serves as a multi-sector framework plan for the entire Subbasin. It describes and references various plans and programs that are specific to a given land use or management sector. The sector-specific plans, or *TMDL Implementation Plans*, comprise a second tier of planning prepared by the local land use or water quality authority. This organizational process is represented schematically in **Figure 2.1**

Figure 2.1. TMDL/WQMP/Implementation Plan Schematic. Agency abbreviations are for: Oregon Department of Agriculture, US Bureau of Land Management, US Forest Service and US Bureau of Reclamation, and Oregon Department of Fish and Wildlife.



This WQMP addresses the entire Malheur River Basin as well as the Middle Snake-Payette subbasin. The TMDL Implementation Plans, when complete, are expected to fully describe the efforts of Designated Management Agencies (DMAs) to achieve their applicable TMDL allocations. Because the DMAs will require some time to fully develop these Implementation Plans once the TMDLs are finalized, the first iterations of the Implementation Plans are not expected to completely describe management efforts.

This WQMP establishes timelines to develop Implementation Plans. DEQ and the DMAs will work collaboratively to assure that the WQMP and TMDL Implementation Plans collectively address the elements described below under “TMDL Water Quality Management & Implementation Plan Guidance”. In short, this document is a starting point and foundation for the WQMP elements being developed by DEQ and the DMAs.

DEQ recognizes that the relationship between management actions and pollutant load reductions is often not precisely quantifiable. An ***adaptive management*** approach is encouraged, including interim objectives and feedback through monitoring. This is addressed in **Section 1.2: Implementation and Adaptive Management** of the TMDL document.

3.0 WATER QUALITY MANAGEMENT PLAN ELEMENTS

The TMDL rule of OAR 340-042 lists the required elements of a WQMP. This WQMP is intended to fulfill the requirement of the rule. These elements, identified below, serve as the outline for this WQMP.

A. Condition assessment and problem description
B. Goals and objectives
C. Proposed management strategies
D. Timeline for implementing management strategies
E. Relationship of management strategies to attainment of water quality standards
F. Timeline for attainment of water quality standards
G. Identification of responsible participants or DMAs
H. Identification of sector-specific Implementation Plans
I. Schedule for preparation and submission of Implementation Plans
J. Reasonable assurance
K. Monitoring and evaluation
L. Public involvement
M. Planned efforts to maintain management strategies over time
N. Costs and funding
O. Citation of legal authorities

4.0 TMDL IMPLEMENTATION PLANS

4.1 Expected Components

Some of the elements listed above are sufficiently addressed in the WQMP and others are partly or largely deferred to the DMA programs. The TMDL Implementation Plans need not further elaborate upon **elements E, G, H, I, and O**. The Oregon Administrative Rules in OAR 340-042 clarify DEQ's expectation of TMDL Implementation Plan content, as follows:

> 340-042-0080(2): "The Oregon Department of Forestry will develop and enforce Implementation Plans addressing state and private forestry sources as authorized by ORS 527.610 through 527.992 and according to OAR chapter 629, divisions 600 through 665. The Oregon Department of Agriculture will develop Implementation Plans for agricultural activities and soil erosion and enforce associated rules as authorized by ORS 568.900 through 568.933 and according to OAR chapter 603, divisions 90 and 95."
>
> 340-042-0080(3): "Persons, including DMAs other than the Oregon Department of Forestry or the Oregon Department of Agriculture, identified in a WQMP as responsible for developing and revising sector-specific or source-specific Implementation Plans must:
>
> (a) Prepare an Implementation Plan and submit the plan to DEQ for review and approval according to the schedule specified in the WQMP. The Implementation Plan must:
>
>> (A) Identify the management strategies the DMA or other responsible person will use to achieve load allocations and reduce pollutant loading;
>>
>> (B) Provide a timeline for implementing management strategies and a schedule for completing measurable milestones;
>>
>> (C) Provide for performance monitoring with a plan for periodic review and revision of the Implementation Plan;
>>
>> (D) To the extent required by ORS 197.180 and OAR chapter 340, division 18, provide

evidence of compliance with applicable statewide land use requirements; and

(E) Provide any other analyses or information specified in the WQMP.

(b) Implement and revise the plan as needed.

The following **Sections 4.4, 4.7, 4.10, 4.12, and 4.14** include further discussion regarding TMDL Implementation Plan Content. **Section 4.9** identifies sector specific implementation plans.

General discussion of the expected content of TMDL Implementation Plans can be found in *Guidance for Developing Water Quality Management Plans that will Function as TMDLs for Nonpoint Sources*, DEQ, 1997. Nonpoint source pollution reduction measures are described in *Nonpoint Source Pollution Control Guidebook for Local Government*, DEQ and Oregon Department of Land Conservation and Development, 1994. More recent guidance for urban settings is available on the DEQ website http://www.deq.state.or.us/wq/, including the *Water Quality Model Code and Guide Book*, DEQ and Oregon Department of Land Conservation and Development, 2000. Most Federal and State natural resource agencies publish watershed planning guidance as well.

A final section, **5.0 TMDL-RELATED PROGRAMS, INCENTIVES AND IMPLEMENTATION EFFORTS**, recognizes the importance of related programs and initiative-based efforts in watershed restoration.

4.2 Condition Assessment and Problem Description

As described in Section 2.3 of the Malheur River Basin TMDL document, the Malheur River system is characterized by high levels of nutrients, which trigger algae blooms and depressed oxygen levels that are particularly acute downstream in the Snake River. The lower portion of the river and its tributaries also contain elevated levels of bacteria and the legacy pesticides, dieldrin and DDT. The upper portions of the Malheur River system does not meet water quality standards for temperature. Loss of riparian vegetation, altered channel form, and low flows contribute to these conditions. Pollutant sources are discussed in Section 4.0 of the Malheur River Basin TMDL document.

4.3 Goals and Objectives

The goal of this WQMP is to reduce nonpoint source pollution in the form of nutrient, bacteria, pesticide and solar heating to the Malheur River and its tributaries. This goal will be achieved through the implementation of best management practices in agricultural as well as urban areas, and the implementation of riparian vegetation restoration projects. With regard to riparian vegetation restoration, land managers should use the information in the TMDL and referenced documentation as a resource but defer to site specific conditions when establishing site potential vegetation at the plot level In areas where flow regimes have been artificially modified, instream flow restoration is encouraged.

4.4 Proposed Management Strategies

DEQ recognizes that restoration efforts have been underway in the Malheur River Basin for many years. It is also widely recognized that much more work is needed, and that success depends on a united pro-active approach that involves all stakeholders in the basin. DEQ is reliant upon Designated Management Agencies for programs and projects that will address sources of non-point pollution. The following is a list of conditions that need to be addressed by TMDL implementation plans:

- Healthy riparian vegetation. This condition is the most significant need basin wide.
- Stable and natural stream channels along with increases in sinuosity and functioning floodplains.
- Upland land management that will support the development of natural stream channels.
- Reductions in nutrient loading (particularly phosphorus) throughout the basin.
- Reductions in bacteria loading.
- Reductions in sediment loading which will lead to reductions in bacteria, phosphorus, and toxics (legacy pesticides) loading.

- A less “flashy” hydrograph with a reduction in storm-induced runoff along with increased summer base flows above the major reservoirs, and winter base flows below the major reservoirs. Flow conditions are not directly addressed in the TMDL, but it is recognized that instream flow increases will be needed to achieve water quality standards.

4.5 Timeline for Implementing Management Strategies

Natural resource agencies, local jurisdictions, watershed councils, tribal agencies, and land owners have been actively promoting and implementing water quality improvement projects throughout the basin for many years. This WQMP does not include a timeline for the many on-going and voluntary efforts. Individual TMDL Implementation Plans will address timelines for completing measurable milestones as appropriate. DEQ recognizes that it may take from several years to several decades after full implementation of the TMDL before management practices identified in a TMDL implementation plan become fully effective in reducing and controlling forms of pollution such as heat loads from lack of riparian vegetation.

Attainment of water quality standards is discussed in Section 4.6., Timelines and content for Implementation Plans are addressed in Sections 4.9.

4.6 Relationship of Management Strategies to Attainment of Water Quality Standards

The Temperature TMDL is the natural thermal profile that would be obtained when solar heating is reduced to the level of the load allocations, as accomplished by improving vegetation and channel conditions including reduced width to depth ratios and flood plain connections. Management strategies should be clearly linked to improving channel conditions and increasing shade. Improvement of flow conditions will also be necessary and should be included in management strategies where possible.

The nutrient, dissolved oxygen, bacteria, and toxics TMDLs are strongly linked to reductions in sediment runoff. Management strategies for these pollutants should reductions in sediment loading. Improvement in riparian vegetation conditions would also be beneficial in reducing sediment loading and cycling nutrients.

4.7 Timeline for Attainment of Water Quality Standards

The timeline for attainment will vary substantially across the basin, with some portions of the upper basin at or near the attainment of water quality standards and other portions of the basin severely degraded. DEQ expects that water quality standards will be attained as soon as feasible given technical, political, and economic constraints. DMAs are expected to estimate timelines in their individual implementation plans when feasible.

4.8 Identification of Responsible Participants or Designated Management Agency

Organizations which are responsible for implementing TMDLs are known as Designated Management Agencies (DMAs). DMAs for the Malheur River basin TMDL are identified in **Table 4.1**. A more detailed discussion of each organization’s responsibilities is provided in Section 4.9.

DMAs are defined as “federal, state or local government agency that has legal authority over a sector source contributing pollutants, and identified as such by the DEQ in a TMDL” (OAR 340-042). Table 4.1 describes the geographic and/or land use areas of responsibility for DMAs for the TMDL.

Table 4.1. Designated Management Agencies

Designated Management Agency	Area of Jurisdiction	Expected Form of Planning in Response to TMDL
Oregon Dept. of Agriculture	Agricultural and associated rural residential land use in the Malheur River Basin and Middle Snake-Payette Subbasin.	Malheur River Basin Agricultural Water Quality Management Area Plan (AgWQMAP), updated as needed to address the TMDL.
Oregon Dept. of Fish and Wildlife	Lands located along Malheur River above and below Warm Springs Reservoir	TMDL implementation plan which addresses grazing management on lands managed by ODF&W.
Oregon Department of State Lands	Removal Fill Program for wetlands and waterways in basin. Management of DSL grazing lands.	TMDL implementation plan addressing Removal Fill Program issues relating to riparian condition in the basin. Participation in ODA AgWQMAP updates regarding DSL grazing lands.
US Forest Service	Malheur National Forest	USFS Water Quality Restoration Plan
US Bureau of Land Management	Portions of Vale and Burns Districts within Malheur River Basin.	BLM Water Quality Restoration Plan
US Bureau of Reclamation	Lands in vicinity of Bully, Beulah, and Warm Springs Dams and other irrigation facilities in basin. Operation of reservoirs.	TMDL implementation plan which includes a nutrient management plan for reservoir lands, and a temperature management plan for reservoirs.
Malheur County Harney County	County roads along Malheur River Basin streams, land use planning. On-site septic system program (Malheur County only).	DEQ expects that there will be consideration given to vegetation and channel recovery during road/bridge and other development and planning projects. TMDL implementation plans are not required as long as the counties agree to support the goals of the TMDL, and the Malheur River Basin AgWQMAP.
City of Ontario	City limits.	DEQ expects that there will be consideration given to vegetation and channel recovery during road/bridge and other development and planning projects. A TMDL implementation plan is not required as long as the City agrees to support the goals of the TMDL and the Malheur River Basin AgWQMAP where applicable.
Irrigation Districts: Vale Oregon Warm Springs Owyhee Old Owyhee	Irrigation canals, ditches and other structures maintained by the districts.	DEQ expects irrigation districts to work to control erosion, sediment transport and temperature increases within their systems and to participate in water quality improvement projects. TMDL implementation plans are not required as long as the districts agree to support implementation of the Malheur River Basin AgWQMAP.

4.9 Identification of Existing Sector-Specific Implementation Plans

Several organizations utilize existing programs as TMDL Implementation Plans. This is typically documented in a memorandum of understanding or agreement with DEQ. The following planning efforts provide for TMDL implementation in the Malheur River Basin and Middle Snake-Payette Subbasin and describe the general form of the anticipated response to the TMDL. DEQ expects that they will be updated as needed to layout all feasible steps toward meeting the TMDL. Expected elements of TMDL Implementation Plans are listed in **Section 3.0** of this document.

The DEQ TMDL Implementation Plan Guidance document can be found at:
http://www.deq.state.or.us/WQ/TMDLs/docs/impl/07wq004tmdlimplplan.pdf

NPDES Permit Program – Point Sources

DEQ is delegated by EPA to administer the National Pollutant Discharge Elimination System (NPDES) permits for surface water discharge. The NPDES permit is a federal permit which is required under the Clean Water Act for discharge of waste into waters of the United States. DEQ is the designated agency for the NPDES permit program, which includes issuing permits and conducting compliance and monitoring. Under a Memorandum of Understanding, ODA and DEQ jointly issue NPDES individual and general permits for the Confined Animal Feeding Operation (CAFO) permit program. ODA assigns the permits and conducts compliance and monitoring under the MOU. The NPDES Program requires the application of controls to ensure that water quality standards are met.

Individual-facility NPDES permits are unique to a discharge facility. General NPDES permits address categories of facilities or aggregate pollutant sources, such as fish hatcheries or storm water. There are currently two individual-facility NPDES permits issued in the Malheur River and Middle Snake-Payette subbasins which discharge to the Malheur River. Both of these permits are related to the discharge of irrigation return water from ditches that are treated with chemicals that control weed growth. There are also several General NPDES permits which discharge to the Malheur River which are related to facilities such as sand and gravel mines, industrial wash water, and storm water from construction sites. None of these sources discharge pollutants related to 303(d) listings for the Malheur River. Discharges to the Snake River from sources in the Malheur Basin and Middle Snake-Payette subbasin were addressed in the Snake River-Hells Canyon TMDL. Any future permits must address the TMDLs as appropriate.

Nonpoint Sources:

Private Agricultural Lands: The Oregon Department of Agriculture is the DMA responsible for regulating agricultural activities on private lands that affect water quality. ODA uses *Agricultural Water Quality Management Area Plans* (AgWQMAP) and associated rules to implement TMDLs throughout the state. The AgWQMP are reviewed biennially.

DEQ and ODA coordinate TMDLs and agricultural planning through a 1998 Memorandum of Agreement (MOA). The MOA states that DEQ will provide load allocations for agricultural nonpoint sources to ODA, which will begin development of an AgWQMP or modification of an existing AgWQMP to address the allocation.

Local Management Agencies (LMA) are funded by ODA to conduct outreach and education, develop individual farm plans for operations in the planning area, work with land owners to implement management practices, and help landowners secure funding for cost-share water quality improvement practices. The Local Management Agencies in the Malheur River Basin are the Malheur County Soil and Water Conservation District (mainly working in the Malheur County portion of the watershed) and the Harney Soil and Water Conservation District (mainly working in the Harney County portion of the watershed). The Malheur and Harney SWCDs work under contract to ODA. The Malheur Watershed Council is also a very active partner, which along with the SWCDs, brings together many state federal and local agencies to work on conservation issues within the Malheur River Basin. The Malheur Watershed Council obtains a majority of its funding from the Oregon Watershed Enhancement Board (OWEB).

Progress reports are developed based on data collected by Local management agencies and ODA report the status of implementation of plans and rules, and are submitted to the Board of Agriculture after the biennial review process. These reports include statistics on numbers of farm plans developed and types of management practices being employed. The reports are available to DEQ for review in assessing implementation progress.

The first Malheur Basin AgWQMAP was completed in March 2001 after completing a two year process including 24 meetings of a local advisory committee. A biennial review was completed in 2005, and another was completed in late 2007.

The area rules are summarized (from the 2007 progress report) as follows:

1. Avoid placing of waste where it is likely to cause pollution.
2. Prevent irrigation return flows from causing excessive, systematic or persistent increases in sediment levels in receiving waters.
3. Avoid causing active streambank erosion beyond natural levels.
4. Allow development of riparian vegetation consistent with site capability to control erosion, filter sediment, moderate solar heating, and allow water infiltration into the soil profile.
5. Manage range and pastures to maintain watershed functionality.

Providing information, education, technical assistance, and grant writing assistance to landowners is the primary strategy for ODA and the Soil and Water Conservation Districts to achieve water quality improvement in the Malheur River Basin. The Malheur County and Harney County SWCDs, acting as the Local Management Agencies, are the lead organizations responsible for implementing this strategy of education and assistance.

DEQ Expectations: DEQ expects that the next biennial review will incorporate measures to ensure achievement of the TMDL load allocations and surrogate measures for the Malheur River Basin and Middle Snake-Payette Subbasin. The biennial review will also include a timeline and milestones for progress toward achievement of the surrogate measures and load allocations, and how progress will be monitored.

<u>State Lands – Oregon Department of Fish and Wildlife, Department of State Lands: The Department of Fish and Wildlife is a DMA for the lands it owns and manages along the Malheur River. The Department of State lands is a DMA pertaining to the Removal Fill program it administers in wetlands and waterways in the Malheur River Basin and Middle Snake-Payette Subbasin.</u>

Oregon Department of Fish and Wildlife (ODF&W): The Oregon Department of Fish and Wildlife is a DMA for state lands located along the Malheur River above and below Warm Springs Reservoir. ODF&W manages grazing on these lands in cooperation with the Vale and Burns District offices of the BLM.

DEQ Expectations: Within 18 months of completion of the temperature TMDL, DEQ expects ODF&W to develop a TMDL implementation plan which will address the percent effective shade goals for all streams on ODF&W managed lands along the Malheur River. It is expected that ODF&W will coordinate with BLM when developing this plan.

Department of State Lands (DSL): DSL manages public-owned lands held in trust and managed for the purpose of generating revenue to the Common School fund primarily by leasing range and agricultural land and portions of navigable waterways for a variety of business activities. DSL uplands classified as agricultural or rangeland use are under the authority of the Agricultural Water Quality Management Act administered by ODA. ODA is the Designated Management Agency for these lands. DSL also administers the State's removal-fill program regulating activities in all wetlands and waterways of the State, with permits required when activities involve more than 50 cubic yards.

DEQ Expectations: Within 18 months of completion of the Malheur River Basin TMDL, DEQ expects a TMDL Implementation Plan or other documentation that demonstrates load allocation implementation related to the removal fill program. All range and agricultural activities on DSL uplands will comply with the Malheur Basin Agricultural Water Quality Management Area Plan, and DSL will be an active participant in plan updates.

Federal Lands – U.S. Forest Service and the Bureau of Land Management and Bureau of Reclamation:
The U.S. Forest Service (USFS), Bureau of Land Management (BLM), and U.S. Bureau of Reclamation (USBR) are DMAs for federal lands in the Malheur River Basin and Middle Snake-Payette Subbasin.

In July 2003, the USFS and BLM signed memorandums of agreement with DEQ defining how water quality rules and regulations regarding TMDLs will be met. The USFS and BLM generally respond to TMDLs by developing and implementing Water Quality Restoration Plans (WQRPs) which will be the equivalent of TMDL implementation plans. Both agencies have developed a protocol for WQRP development (USFS, 1999). The WQRPs are revised as needed in order to implement TMDLs.

Malheur National Forest: The upper portion of the Malheur River, North Fork Malheur River and Little Malheur River and their major tributaries, are located within the Prairie City and Emigrant Creek Districts of the Malheur National Forest. A temperature TMDL has been developed for these streams using percent effective shade as a surrogate for temperature. A WQRP has not yet been developed by the Malheur National Forest.

DEQ Expectations: Within 18 months of completion of the temperature TMDL, DEQ expects the Malheur National Forest to develop the first iteration of a WQRP which will address the percent effective shade goals for all intermittent and perennial streams on USFS managed lands within the Malheur River Basin.

The WQRP shall include the following:

1. A schedule for completion of monitoring activities such as measurement of effective shade, Proper Functioning Condition, greenline, channel morphology or other methods that can demonstrate condition in relation to the TMDL target and if necessary, an upward trend in riparian vegetation to meet the requirements of the TMDL and DEQ TMDL implementation rules and guidance.
2. A schedule for evaluation and implementation of grazing allotment management needs that are related to riparian condition and water quality concerns.
3. Management strategies USFS will use to successfully manage riparian areas to meet the shade surrogates, and the methods for implementing management changes if needed.

Monitoring reports submitted to Oregon DEQ on a 5-year cycle will be used in part to evaluate compliance with the Malheur River Basin TMDL. The first report will be due 5 years from approval date of the WQRP.

Vale District BLM: The lower portions of the North Fork Malheur River and Little Malheur River and a portion of the mainstem of the Malheur River are located within a patchwork of private land and public land managed by the Vale District BLM and the Oregon Department of Fish and Wildlife. A temperature TMDL has been developed for these streams and their tributaries using percent effective shade as a surrogate for temperature. A WQRP has not yet been developed for the BLM lands by the Vale District BLM. TMDL implementation on private lands in this area will be coordinated by the Oregon Department of Agriculture (ODA).

DEQ Expectations: Within 18 months of completion of the temperature TMDL, DEQ expects the Vale District BLM to develop the first iteration of a WQRP which will address the percent effective shade goals for all intermittent and perennial streams within the Malheur River Basin that are located on Vale District BLM managed lands,.

The WQRP shall include the following:

1. A schedule for completion of monitoring activities such as measurement of effective shade, Proper Functioning Condition, greenline, channel morphology or other methods that can demonstrate condition in relation to the TMDL target and if necessary, an upward trend in riparian vegetation to meet the requirements of the TMDL and DEQ TMDL implementation rules and guidance.
2. A schedule for evaluation and implementation of grazing allotment management needs that are related to riparian condition and water quality concerns.
3. Management strategies BLM will use to successfully manage riparian areas to meet the shade surrogates, and the methods for implementing management changes if needed.

Monitoring reports submitted to Oregon DEQ on a 5-year cycle will be used in part to evaluate compliance with the Malheur River Basin TMDL. The first report will be due 5 years from approval date of the WQRP.

Burns District BLM: Portions of the mainstem Malheur River and major tributaries such as Stinking Water Creek, Pine Creek, Wolf Creek, and Blue Bucket Creek are located within private land, and public land managed by the Burns District BLM and the Oregon Department of Fish and Wildlife (ODF&W). A temperature TMDL has been developed for the Malheur River and its tributaries using percent effective shade as a surrogate for temperature. A WQRP for BLM lands was completed by the Burns District BLM in September 2007. The WQRP identifies riparian vegetation as the primary contributing factor affecting nonpoint source pollution in the study area. The primary land management activity believed to have influenced riparian plant communities is livestock and wild horse grazing. Additional factors include alteration of fire frequency, forest health, and the presence and expansion of exotic vegetation and noxious weeds. The WQRP also states that adjustments to timing and duration of livestock grazing, and construction of fences and off channel water developments to control livestock use along riparian areas has aided the restoration of many of the stream systems in the Burns District portion of the Upper Malheur Subbasin. The WQRP provides monitoring data including properly functioning condition assessments and riparian vegetation trends for fish bearing streams within the Burns District portion of the Upper Malheur Subbasin as well as ODF&W lands along the Malheur River between Drewsey and Warm Springs Reservoir. Grazing schedules and exclosure areas are also described. Adaptive management techniques are used to manage grazing based on monitoring information.

DEQ Expectations: Within 18 months of completion of the temperature TMDL, DEQ expects the Burns District BLM to complete the first iteration of a modified WQRP which addresses the percent effective shade goals for all intermittent and perennial streams within the Malheur River Basin that are located on Burns District BLM managed lands.

The modified WQRP shall include the following:

1. A schedule for completion of monitoring activities such as measurement of effective shade, Proper Functioning Condition, greenline, channel morphology or other methods that can demonstrate condition in relation to the TMDL target and if necessary, an upward trend in riparian vegetation to meet the requirements of the TMDL and DEQ TMDL implementation rules and guidance.
2. An updated schedule for evaluation and implementation of grazing allotment management needs that are related to riparian condition and water quality concerns.
3. Management strategies BLM will use to successfully manage riparian areas to meet the shade surrogates, and the methods for implementing management changes if needed.

Monitoring reports submitted to Oregon DEQ on a 5-year cycle will be used in part to evaluate compliance with the Malheur River Basin TMDL. The first report will be due 5 years from approval date of the WQRP.

U.S. Bureau of Reclamation Pacific NW Region: The U.S. Bureau of Reclamation (USBR) manages three major reservoirs in the Malheur River Basin: Bully Creek, Beulah, and Warm Springs. USBR managed lands surround portions of the reservoirs and provide for livestock grazing, wildlife habitat and recreation. The reservoirs affect water quality by acting as sinks for sediment, nutrients and bacteria. They also affect stream temperatures by modifying the daily temperature diel and by storing cooler water at depth in Winter/Spring and releasing it in the Summer, followed by the release of warmer reservoir surface water in the Fall.

DEQ Expectations: DEQ expects USBR to continue to monitor water quality in the reservoirs and the quality and temperature of water entering and leaving the reservoirs, and prepare a TMDL Implementation Plan within 18 months of TMDL completion.

The TMDL implementation plan shall include the following:

1. A description of how nutrient loading from USBR managed lands will be managed to meet TMDL load allocations,
2. A plan for eliminating or mitigating the effects of reservoir nutrient cycling, sediment deposition/discharge, and temperature modification on downstream water quality. Water quality trading may be an opportunity USBR could explore. This plan shall also address how BOR will minimize or eliminate the dewatering of downstream reaches.
3. A schedule for how and when USBR might conduct an analysis or study to determine if modification of historic flood magnitude and frequency contributes to the loss or diminished regeneration of site potential vegetation downstream of the dams. This analysis should be conducted in cooperation with the Burns Paiute Tribe and other downstream private landowners, the Malheur Watershed Council, and land management agencies such as the BLM.

4.10 Schedule for Preparation and Submission of Implementation Plans

In accordance with OAR 340-042-0060, TMDLs are issued as a DEQ order effective on the date signed by the Director. DEQ will notify all DMAs identified in this document along with persons who provided formal comment on the draft TMDL within 20 business days of TMDL issuance. DEQ expects that the USFS, BLM, and USBR will fulfill the planning expectations of Section 4.9 within 18 months of the date of receipt of their notification letter. ODA is expected to review the Malheur Basin AgWQMP on a two year cycle as required by rule, with the next review including measures to address TMDL requirements.

DEQ review and approval of TMDL implementation plans is required by OAR 340-042. DEQ will work closely with DMAs to ensure a successful and timely review and approval process. As required by MOUs with the USFS and BLM, DEQ will provide a letter of approval of a completed Water Quality Restoration Plan (WQRP) within 60 days of receipt with any appropriate requirements for revision.

Review of TMDLs, the WQMP, and Implementation Plans will be done on a 5 year cycle subject to available staff time and agency priorities. Evaluations that trigger revision of implementation plans will include, but not be limited to: DMA recommendations, the periodic evaluation described in Section 4.14, new 303(d) listings, TMDL revision and other BMP effectiveness and water quality trend evaluations.

4.11 Reasonable Assurance

This section of the WQMP is intended to provide reasonable assurance that the WQMP and associated DMA-specific implementation plans, will be implemented and that the TMDL and its allocations will be met.

Federal Lands

The BLM and USFS are DMAs for most of the federal lands in the Malheur River Basin.
As discussed in Section 4.9 and 4.10, both agencies have signed memorandums of agreement with DEQ. These MOAs include agreement to prepare and implement Water Quality Restoration Plans (WQRPs) as implementation plans addressing TMDLs.

The U.S. Bureau of Reclamation (USBR) manages several dams and their associated reservoir lands in the Malheur River Basin. DEQ will work with USBR to establish a schedule for preparation and execution of an implementation plan.

Agricultural Lands

As discussed in Section 4.9, the Oregon Department of Agriculture (ODA) is the DMA responsible for regulating agricultural activities that affect water quality. AgWQMA Plans function as TMDL implementation plans for agricultural activities that affect water quality. As noted in Section 4.9, an AgWQMA Plan has been prepared for the Malheur River Basin. The most recent update of this plan was completed on August 28, 2007.

Voluntary Farm Plans are a key component of the ODA basin planning process. ODA also has the ability to assess civil penalties when operators do not follow their local Agricultural Water Quality Management Area rules. Legal authority is discussed in Sections 4.9 and 4.16.

Irrigation canals, ditches and other structures which are managed by irrigation districts do not fall under the authority of ODA. Water pollution sources, such as erosion of soil from within these structures, are regulated by Oregon DEQ. DEQ expects these irrigation districts to work to control erosion, sediment transport and temperature increases within their canals and ditches and to participate in water quality improvement projects with other stakeholders. TMDL implementation plans are not required for irrigation districts within the Malheur River Basin as long as the districts agree to participate in the implementation of the Malheur River Basin AgWQMAP.

Urban and Rural Lands

Oregon cities and counties have legal authority to regulate land use activities through city and county ordinances and local comprehensive land use plans. The Oregon land use planning system, administered through the Oregon Department of Land Conservation and Development, requires local jurisdictions to address water quality protection through Statewide Planning Goals 5 and 6.

The City of Ontario does not have any storm water point source discharges to the Malheur River. In January 2007, the City prepared an implementation plan which addressed storm water discharges to the Snake River. The plan was written in response to the Snake River-Hell's Canyon TMDL which was completed in 2004.

Storm water mixes with agricultural irrigation drainage water in several open ditches which enter Ontario from surrounding cropland and eventually discharge to the Snake River. The plan outlines monitoring data and includes strategies for reducing the City's portion of the sediment, temperature, and nutrient load to the Snake River. In order to make significant progress toward eliminating water pollution from these drains beyond their own impacts, the City will need to enlist the help and cooperation of local farmers as well as organizations such as the irrigation districts, ODA, Malheur SWCD, and the Malheur Watershed Council. The City's storm water implementation plan outlines plans for annual stakeholder meetings to coordinate efforts and discuss common concerns. It is DEQ's expectation that the City will continue these efforts and report the results to DEQ on an annual basis as part of the implementation of the Snake River-Hell's Canyon TMDL. An implementation plan for the Malheur River Basin TMDL is not required as long as the City of Ontario agrees to support the implementation of the TMDL while conducting activities which have the potential to impact water quality.

As presented in Table 4-1 Malheur and Harney Counties are listed as DMA's, however, TMDL implementation plans are not required at this time, as long as the counties agree to support implementation of the TMDL and the Malheur River and Harney AgWQMAPs . DEQ expects that in the future there will be consideration given to vegetation and channel recovery during road/bridge projects as well as other planning and development projects.

4.12 Monitoring and Evaluation

TMDL monitoring and evaluation consists of three basic components: 1) implementation of plans identified in this document, 2) management practice effectiveness monitoring and, 3) assessment of water quality improvement. DEQ generally expects that DMAs will monitor implementation efforts and that DEQ and various natural resource organizations including DMAs will participate in effectiveness and water quality monitoring.

Monitoring information will be evaluated by DEQ and used to determine the effectiveness of management actions. This evaluation will be conducted on a five-year cycle dependent on agency resources. If progress is judged to be insufficient, the appropriate management agency will receive a request for additional action. This monitoring feedback mechanism is a major component of the “reasonable assurance of implementation” for the Malheur River Basin WQMP.

It is anticipated that monitoring efforts will consist of some of the following types of activities:

- Reports on the numbers, types and locations of projects, BMPs and educational activities completed.
- Water quality monitoring for parameters such as temperature, sediment, nutrients, bacteria and pesticides.
- Monitoring of riparian condition, percent effective shade, channel type, and channel width/depth to assess progress toward achieving system potential targets established in the temperature TMDL.

Ongoing monitoring of water quantity and quality, riparian vegetation, channel shape, and fish populations is being conducted by the Malheur Watershed Council, Malheur Soil and Water Conservation District, Oregon Department of Agriculture, Oregon Department of Environmental Quality, U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, Burns-Paiute Tribe, and Oregon Department of Fish and Wildlife. DEQ recognizes these efforts and encourages and supports them whenever possible.

4.13 Public Involvement

DEQ presented information regarding the Malheur Basin TMDL at approximately 30 meetings with agencies, SWCDs, Tribes, WSC, and the public from late 2005 through 2009. These meetings included six technical discussions in Ontario, Burns and Drewsey, regarding bacteria, pesticides, nutrients and temperature data.

Informal meetings to discuss preliminary draft documents will be held followed by formal meetings and comment period and finalization of documents.

4.14 Planned Efforts to Maintain Management Strategies Over Time

In response to the Malheur River Basin TMDL, each DMA will prepare an Implementation Plan. Every five years each DMA will report implementation efforts and describe changes in water quality based on monitoring data. DEQ will review these reports and recommend changes to individual Implementation Plans if necessary.

4.15 Costs and Funding

The purpose of this element of the WQMP is to demonstrate that there are sufficient current and future funding sources for TMDL implementation. DMAs and other organizations are working in the basin on watershed enhancement projects using a variety of funding sources. Watershed restoration activities can be passive or active. Passive restoration results from removing stresses to the channel, vegetation and floodplain and allowing the river system to naturally recover. Passive restoration can be accomplished through measures such as fencing riparian vegetation or allowing vegetation to grow in areas between farm fields and streams. Restoration can also be accomplished by simply changing management, such as changing the timing of grazing use. Active restoration involves activities such as channel construction, installation of structures to capture sediment or re-direct flow. Active restoration generally costs more than passive restoration.

The cost of restoration activities can range from near zero cost for some forms of passive restoration, to hundreds of thousands of dollars per river mile for active activities such as channel reconstruction. Financial assistance is funded through a mix of cost-share, tax credit, and grant funded incentive programs designed to improve watershed conditions. Some of these programs have specific qualifying factors, priorities and matching requirements. The following is a partial list of programs that are available in the basin:

Program	**Agency/Source**
Oregon Watershed Enhancement Board Grant Program	OWEB
Environmental Quality Incentives Program (EQIP)	USDA-NRCS
Wetland Reserve Program	USDA-NRCS
Conservation Reserve Enhancement Program (CREP)	USDA-NRCS
Stewardship Incentive Program	ODF
Access and Habitat Program	ODF&W
Partners for Wildlife Program	USDI-FSA
Conservation Implementation Grants	ODA
Conserved Water Program	WRD
Nonpoint Source Water Quality Control (EPA 319)	DEQ-EPA
Riparian Protection/Enhancement	COE
State Revolving low interest loans	DEQ-EPA
Bonneville Power Administration	BPA
Nonpoint Source Pollution Reduction Tax Credit	DEQ

Grant funds are available for water quality improvement projects, typically on a competitive basis. Field specialists assist landowners in identifying, designing, and submitting eligible project proposals for these grant funds. Assistance is available through the Malheur Soil and Water Conservation District, the Harney Soil and Water Conservation District, and the Malheur Watershed Council.

4.16 Citation of Legal Authorities

Clean Water Act Section 303(d): Section 303(d) of the 1972 Federal Clean Water Act requires states to develop a list of rivers, streams and lakes that do not meet water quality standards. These water bodies are referred to as “water quality limited”. DEQ updates a list of water quality limited water bodies every two years. The list is commonly referred to as the 303(d) list. Section 303(d) of the Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed for all water bodies on the 303(d) list.

Oregon Revised Statute: The Oregon Department of Environmental Quality is authorized by law to prevent and abate water pollution within the State of Oregon pursuant to ORS 468B.015, which declares that it is the public policy of the state to maintain and protect the quality of waters of the state. The statute ORS 468B.020 (Prevention of pollution) provides that:

1. Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State of Oregon, as set forth in ORS 468B.015.
2. In order to carry out the public policy set forth in ORS 468B.015, the department shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:

a. Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the State; and
b. Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

Oregon Administrative Rules: The following Oregon Administrative Rules provide numeric and narrative criteria (water quality standards, discussed in the TMDL document) for the Malheur River Basin:

Antidegradation – OAR 340-041-0004
Statewide Narrative Criteria – OAR 340-041-0007
Dissolved Oxygen – OAR 340-041-0016
Bacteria – OAR 340-041-0009
Toxics - OAR 340-041-0033
Temperature – OAR 340-041-0028

Agricultural Lands
The Oregon Department of Agriculture (ODA) is the DMA responsible for regulating agricultural activities that affect water quality through the Agricultural Water Quality Management Act of 1993 (ORS 569.000 through 568.933) and Senate Bill 502 (adopted 1995, ORS 561.191).

ORS 569 directs ODA to work with local communities, including farmers, ranchers, and environmental representatives, to develop Agricultural Water Quality Management Area Plans (AgWQMAP) and rules throughout the State. SB502 stipulates that ODA *"shall develop and implement any program or rules that are for the purpose of protecting water quality and that are applicable to areas of the state designated as exclusive farm use zones or other agricultural lands".* The plans are accompanied by regulations in OAR 603-90 and portions of OAR 603-95, which are enforceable by ODA. As discussed in **Section 4.10**, TMDL implementation coordination between ODA and DEQ is guided by an MOA signed in 1998.

Federal Land Managers
As discussed in **Section 4.16**, DEQ maintains Memorandums of Agreement with BLM and the USFS which were originally signed in 2002. The MOAs define processes by which the agencies will work with DEQ to meet State and Federal water quality rules and regulations. The agreements recognize the BLM and the USFS as DMAs for lands they administer in Oregon, and clarifies that WQRPs are the TMDL Implementation Plans for these agencies.

There is no MOA between DEQ and the U.S. Bureau of Reclamation which will guide TMDL implementation. DEQ expects that BOR will comply with the TMDL and Clean Water Act by preparing an implementation plan and performing needed actions to assure progress toward meeting water quality standards.

5.0 TMDL-RELATED PROGRAMS, INCENTIVES, AND IMPLEMENTATION EFFORTS

5.1 Nutrient, Bacteria and Sediment Load Reduction Activities

Various organizations and stakeholders in the Malheur River Basin have been working to address water quality issues related to excess nutrients, sediment, and bacteria for several decades. Best Management Practices for irrigated agriculture have been developed and implemented on a wide scale. In addition, irrigation systems have been improved by installing concrete-lined irrigation ditches, and piped water delivery systems. Wetlands and sediment ponds have been constructed to trap sediment and reduce nutrient and bacteria concentrations. As described in Section 4.0 of the TMDL document, these actions have resulted measurable reductions in sediment and bacteria concentrations. Reductions in nutrient concentrations have been difficult to document, but the work continues.

Examples Best Management Practices for Flood Irrigated Lands are listed below, further information can be found at the OSU Malheur Experiment Station website:
http://www.cropinfo.net/bestpractices/mainpagebmp.html

Irrigation Schedule Optimization
Sediment Basin and Tail Water Recovery (Pump-Back Systems)
Polyacrylamide (PAM)
Mechanical Straw Mulching
Water Conservation Methods
Filter Strips
Gated Pipe
Surge Irrigation
Laser Leveling
Turbulent Fountain Weed Screens
Underground Outlets for Field Tail Water
Nutrient Management
Improved Confined Animal Feeding Operation (CAFO) Practices

Information regarding constructed wetlands in the Malheur River Basin can be found at the Oregon Department of Agriculture website: http://www.oregon.gov/oda/swcd/malheur_wetlands.shtml

Large scale conversions of flood irrigated cropland from flood irrigation to sprinkler, and in some cases drip irrigation, have been occurring in the Malheur River Basin for a number of years. These projects are intended to reduce the amount of water applied to crops and eliminate many of the losses of water from unlined open ditches. Piping of ditches and conversion to sprinkler and other efficient irrigation practices eliminates runoff and greatly reduces soil erosion, reducing sediment loading to streams along with associated bacteria, nutrients, and pesticides. Willow Creek Valley has been the location of the largest projects. Grants from the Oregon Watershed Enhancement Board (OWEB) along with significant matching from landowners, NRCS, Vale Oregon Irrigation District, Malheur Watershed Council, and other partners has made the Willow Creek projects possible. An estimated 28 miles of irrigation lateral ditches have been piped as of mid-2009. These projects will make it possible to convert 6,100 acres from flood to sprinkler irrigation. Vale Oregon Irrigation District (VOID) contains a total of 35,000 acres in the Willow Creek Valley and portions of the Malheur River Valley between Namorf and Vale. Approximately 16,000 acres are estimated to be suitable for piping of irrigation ditches and conversion to gravity powered sprinkler irrigation according to the Malheur Watershed Council.

Warmsprings Irrigation district contains approximately 25,000 acres along the Malheur River between Little Valley and Ontario with most not suitable for conversion to gravity powered sprinkler irrigation due to the lack of a source of irrigation water with sufficient hydraulic head. However, many of these lands are being converted to sprinkler irrigation using electric pumps.

Old Owyhee Irrigation District has additional irrigated lands near Ontario which drain from the end of the Old Owyhee Ditch to the Malheur River near Ontario. The Old Owyhee District lands like most of the Warm Springs District lands are generally not suitable for piping and gravity sprinkler irrigation conversion due to very low head differences between the irrigation ditches and the fields.

Approximately 11,500 acres of irrigated land served by the Owyhee Irrigation District are located within the Malheur River Basin. Most of these lands get their irrigation water from the North Canal and siphon which bring water from the Owyhee Dam to the south. Approximately 4,600 acres of Owyhee Irrigation District irrigated land are located north of the Malheur River between Vale and Ontario. Another 6,900 acres of Owyhee irrigation District land are located south of the Malheur River to the southwest of Ontario. Much of the land served by the Owyhee Irrigation district is suitable for conversion to gravity powered sprinkler systems, and conversion is happening fairly rapidly in some areas. The Owyhee Watershed Council and the Malheur County Soil and Water Conservation District have been very active in the design and implementation of piping projects which are needed for conversion of irrigation systems and the construction of treatment wetlands for irrigation return water. The Owhyhee Irrigation District is and active partner in these projects and has also installed sediment collection ponds on a segment of a major irrigation ditch.

It is likely that at least 36,000 out of a total of 72,000 largely flood irrigated acres (one half) that drain to the Malheur River are suitable for sprinkler or drip irrigation conversion. Conversion to these methods would eliminate virtually all sediment and phosphorus inputs to the Malheur River from the converted lands. Costs for irrigation conversion are high and have been estimated at approximately $1,500/acre. At this rate, full conversion of 36,000 acres would cost approximately $54 million. The remaining irrigated lands would need to rely on other BMPs such as pump back systems, constructed treatment wetlands and other BMPs listed later in this section. Treatment wetland costs have been estimated at approximately $300/acre of land draining to the wetland. Construction of sufficient wetlands to treat drain water from the remaining 36,000 flood-irrigated acres would cost approximately $10.8 million. These BMPs are expected to reduce phosphorus loading from the remaining flood-irrigated lands by approximately 50% over the long term. Based on these assumptions, the phosphorus load to the Malheur River could be reduced by 75% by combining sprinkler conversion and other BMPs such as treatment wetland construction. It is expected that implementation of irrigation conversions and BMPs in the lower Malheur Basin could take decades and cost a total of at least $64.8 million. Approximately $10 million has been spent to date in the Willow Creek Subbasin and significant investments have been made on lands served by the Owyhee and Warmsprings irrigation districts on irrigation lateral ditch piping projects. Additional costs will be needed in the upper basin to reduce the total phosphorus load from sources located above the major reservoirs. Reductions in the upper basin of approximately 10% of the total phosphorus load, would bring the total reduction of phosphorus loading to approximately 85%, which is in the range needed to meet the load reductions needed to meet the Snake River-Hells Canyon TMDL targets for the Malheur River.

It is unlikely that the 81-87% reduction in total phosphorus calculated for the Lower Malheur River can be practically achieved without very significant commitments of resources to BMP implementation throughout the basin over several decades. However, incremental progress toward the goal will likely have significant benefits to water quality for not only phosphorus but also sediment, pesticides, riparian condition, shade and stream habitat. The goal can be reassessed during 5-year review cycles and modified if deemed appropriate.

5.2 Temperature and Flow Related Mitigation Activities

Possible public and private land non-point source temperature TMDL implementation activities might include some of the following actions:

- **Development of alternative forage for livestock displaced by changes in management strategies for riparian recovery and/or fire recovery.** The establishment of grass banks, which serve as reserves of alternate forage can be used as a tool for implementing various rangeland health and riparian restoration projects. Several grass banks have been established in the nearby John Day basin.
- **Development of water reservoirs using reserved water rights.** The Oregon Department of Agriculture holds rights to "Reserved Water" in the Upper Malheur Subbasin. The reserved water consists of 35,000 acre-feet in the Malheur River and tributaries excluding the North Fork and South Fork Malheur Rivers, and 13,200 acre feet in the South Fork Malheur River. Permits for the water use are granted by Oregon Department of Water Resources, and water developments using this reserved water are required to enhance in-stream values such as riparian vegetation and stream habitats. The projects must be reviewed by the Oregon Department of Fish and Wildlife to assess impacts to fish and wildlife, and by the Oregon Department of Environmental Quality to assess possible impacts to water quality. Streamlining of this permit process would be beneficial to these useful projects.
- **Integration of fuel management strategies with riparian vegetation restoration projects.** Disturbance caused by fuels management may cause temporary loss of shade but will ultimately result in more stable and resilient uplands and riparian areas. Fuels management projects should integrate with riparian restoration to reach desired outcomes.
- **In-stream flow restoration related to projects which increase irrigation system efficiency.** Many irrigation efficiency projects have been implemented, particularly in the lower Malheur River Basin. Similar work could be done in the upper Malheur Basin where it would be likely to provide in-stream flow benefits. The Oregon Water Resources Department has a program which requires a portion of saved water from efficiency projects to be retained as in-stream flow. Partnerships with WRD and other entities, such as private conservation groups should be explored.
- **Aquifer storage projects which allow the beneficial release of water in late irrigation season.** Areas in the upper Malheur basin such as Logan Valley, and the vicinity of Juntura and Drewsey, are ideal locations for exploring the possible benefits of aquifer storage with the goal of increasing summer flows and reducing stream temperatures. Aquifer storage projects mimic the effects of historic flood events which seasonally recharged alluvial aquifers in floodplains. Water stored in the flood plain is released throughout the summer, supplementing flows and mitigating heat loads. Increased connection of streams with flood plains and the re-establishment of beaver in suitable areas can be a viable part of aquifer storage projects.

- **Juniper management as a component of watershed restoration.** The issue of the rapid expansion of juniper trees into rangeland was discussed at several outreach meetings with the public. The benefits of juniper thinning to water storage, base stream flow and wildlife habitat has been demonstrated throughout the region. Similar to fuel reduction projects, temporary loss of shade during implementation of juniper management projects will not be considered a violation of the TMDL. Properly planned and implemented juniper management projects should ultimately result in more stable and resilient upland and riparian areas. BLM is actively managing juniper by replicating historic fire regimes and using mechanical methods. Similar practices and additional partnerships between private land owners and public land managers should be used to address juniper issues across the Malheur River Basin.
- **Invasive Species Management.** The widespread effects of invasive plant species were also discussed at outreach meetings with the public. Many riparian and upland areas of the basin are dominated by invasive species such as cheat grass, white top, medusa head, and knap weed, as well as many other species. Invasive species management needs to be incorporated to virtually all watershed restoration projects in the Malheur River Basin.
- **Feral Horse Management.** Impacts to riparian and upland vegetation and degradation of water

quality caused by intensive grazing and trampling of springs and streams by feral horses was discussed with federal land managers and private land owners during TMDL development. Management of feral horses and other wildlife is recognized as a significant aspect of TMDL implementation.