Public Comment Draft: December 2006

BEAR CREEK WATERSHED TMDL
Section 3: BACTERIA
Section 4: SEDIMENTATION
Section 5: REVIEW OF 1992 TMDL

HUC # 1710030801


Photo Credits: RVCOG 2003

Raccoons may be a potential source of
bacteria in the Bear Creek Watershed


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Hosler Dam and Reeder Reservoir in the
Ashland Creek Watershed

December 2006
Prepared by
Oregon Department of Environmental Quality

DEQ
State of Oregon
Department of Environmental Quality

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Statement of Purpose

This Total Daily Maximum Load (TMDL) document has been prepared to meet the requirements of Section 303(d) of the 1972 Federal Clean Water Act.

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SECTION 3

BEAR CREEK WATERSHED BACTERIA TMDL

Summary of Bacteria TMDL Development and Approach

Why Is Bacterial Contamination Important?

Fecal coliform bacteria, of which E. coli is a subset, are found in the feces of humans and other warm blooded animals. These bacteria can enter waterways through wildlife, livestock waste, failing residential septic systems, wastewater treatment plant malfunctions, rural residential runoff, and urban runoff.

Fecal coliform bacteria by themselves are not pathogenic. Pathogenic organisms include bacteria, viruses, and parasites that cause diseases and illnesses. Fecal coliform bacteria naturally occur in the human digestive tract and aid in the digestion of food. In infected individuals, pathogenic organisms are found along with fecal coliform bacteria.

If fecal counts are high in a river, there is a greater chance that pathogenic organisms are also present. A person swimming or in contact with waters with high counts of fecal bacteria has a greater chance of getting sick from disease causing organisms or pathogens.

Applying Oregon's Water Quality Standard to Bacteria (OAR 340-041-0009).

A change was made in 1996 from monitoring fecal coliform to monitoring E. coli because E. coli is correlated more closely with human disease. Fecal coliform bacteria are still used in the standard as the indicator for protection of human health in assessing water quality in commercial and recreational shellfish harvesting areas.

The current recreational contact standard as stated in (OAR 340-041-0009) is expressed as a 30-day log mean of 126 E. coli organisms per 100 ml, based on a minimum of five samples, with no single sample exceeding 406 E. coli organisms per 100 ml. A water body is considered water quality limited if more than 10% of the samples exceed 406 organisms per 100 ml or the 30-day log mean is greater than 126 organisms per 100 ml.

Scope

All lands (394 square miles) with streams that drain to Bear Creek (HUC 1710030801) are included in this bacteria TMDL. All land uses are included in this TMDL: lands managed by the State of Oregon, the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), Irrigation Districts, private forestlands, agricultural lands, rural residences, urban areas and others.

Bacterial TMDL Overview

In order to use the best data available, the Bear Creek Bacteria TMDL uses a combination of E. coli and Fecal Coliform data to determine loading capacity and percent reduction targets for the watershed. Fecal bacteria loading in the watershed appears to be dominated by nonpoint sources (98.4%). Nonpoint source pollution comes from diffuse sources such as agricultural and urban runoff as opposed to point source pollution which is discharged by individual facilities through a pipe into a waterbody. Non-domestic animals (wildlife) are also nonpoint sources of bacteria; however, human controlled sources can be managed to reduce fecal bacteria loading. A stream flow based loading capacity has been developed for Bear Creek and percent reduction targets are determined for each of 5 stream flow ranges. Percent reduction targets are also developed for primary Bear Creek tributaries. Point source waste load allocations have been developed based on the applicable water quality standard (126 and 406 E. coli organisms per 100 ml for water contact recreation). An explicit margin of safety is applied to percent reduction targets.

For the bacteria standard there is an average concentration target and an extreme concentration target. TMDL targets are based on meeting the average concentration targets. Average concentration represent chronic risk, it is a more stable indicator of fecal contamination which can be addressed through available analytical methods. The management practices that control fecal bacteria to achieve the average concentration target will also control loading associated with the peak concentrations. If during future monitoring it is shown that peak concentrations are consistently exceeding the extreme concentration limit, additional monitoring will be required to ensure compliance with the average target for nonpoint source discharges. In addition the Bear Creek DMAs may be asked to modify their management plans to address these peak loads.

Table 1. Bacterial TMDL Component Summary

Waterbodies **OAR 340-042-0040(4)(a)**	Streams providing recreational contact as defined in OAR 340-041-0027(1), Table 271 within the Bear Creek Watershed (5th field HUC 1710030801)
Pollutant Identification **OAR 340-042-0040(4)(b)**	Human pathogens associated with fecal contamination.
Beneficial Uses **OAR 340–041–0027(1)** **Table 271A**	The most sensitive beneficial use in the Bear Creek Watershed is water contact recreation.
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0009(4)** **OAR 340-041-0009(1)(a)** **CWA §303(d)(1)**	*E. coli* is used as an indicator of human pathogens for water recreational contact. (A) A 30-day log mean of 126 *E. coli* organisms per 100 milliliters, based on a minimum of five samples; (B) No single sample may exceed 406 *E. coli* organisms per 100 milliliters.
Existing Sources **OAR 340-042-0040(4)(f)** **CWA §303(d)(1)**	Fecal bacteria sources may include wildlife, livestock waste, failing residential septic systems, wastewater treatment plant malfunctions, rural residential runoff, and urban runoff.
Seasonal Variation **OAR 340-041-0040(4)(j)** **CWA §303(d)(1)**	Seasonal variation is addressed using load duration curves because they incorporate all observed flows which are seasonally dependent. Allocations apply year round and are based on stream flow.
TMDL Loading Capacity **CWA §303(d)(1)**	The loading capacity was determined using load duration curves which account for the range of observed flows and the applicable water quality standard (126 *E. coli* organisms per 100 ml for water contact recreation).
Allocations **OAR 340-042-0040(4)(e)** **OAR 340-042-0040(4)(g)** **OAR 340-042-0040(4)(h)** **40 CFR 130.2(f)** **40 CFR 130.2(g)** **40 CFR 130.2(h)**	*Loading Capacity:* The loading capacity is expressed as a loading rate that will achieve the water quality criteria (126 or 406 *E. coli* organisms per 100 ml) under all flow conditions, thereby protecting beneficial uses. *Waste Load Allocations (Point Sources)*: The waste load allocation for the City of Ashland's NPDES permitted waste water treatment facility (WWTF) is expressed as the numeric criterion (126 or 406 *E. coli* organisms/100 ml) multiplied by the applicable flow. Municipal stormwater waste loads (NPDES Phase II communities) were given a bacterial percent reduction target based on potentially impacted surface waters. *Load Allocations (Nonpoint Sources)*: A flow based load in Bear Creek is allocated to nonpoint sources. Percent reduction targets are provided for Bear Creek and for primary tributary streams. *Excess Load*: The difference between the actual pollutant load and the loading capacity of a waterbody.
Surrogate Measures **OAR 340-041-0040(5)(b)** **40 CFR 130.2(i)**	Where appropriate, percent reduction in bacterial loading was used as a surrogate measure for loading.
Margins of Safety **OAR 340-042-0040(4)(i)** **CWA §303(d)(1)**	An explicate (numeric) margin of safety was used where appropriate to establish percent reduction targets.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Incorporated into the margin of safety.
Water Quality Standard Attainment Analysis **CWA §303(d)(1)**	Load duration curves were used to establish bacterial loads in Bear Creek at all observed flows. The implementation of flow-based reductions will result in water quality standard attainment.
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 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.

INTRODUCTION

Surface water bodies in the Bear Creek Watershed are water quality limited due to fecal bacteria affecting water contact recreation. Fecal bacteria sources may include wildlife, livestock waste, failing residential septic systems, wastewater treatment plant malfunctions, rural residential runoff and urban runoff. The TMDL includes descriptions of the watershed, the pollutants responsible for impairments, standards being applied, sources of the pollutants, a description of data collected, loading capacity and allocations of loads for various direct loads on a watershed scale, and a margin of safety (Table 1).

Watershed Description

The Bear Creek Watershed Bacteria TMDL applies all perennial and intermittent fish bearing streams within the Bear Creek Watershed. The 252,800 acre (395 square mile) Bear Creek Watershed is located entirely within Jackson County, in southwestern Oregon on the northeastern flank of the Siskiyou Mountains (more detailed information is located in Section 1). The watershed is an important part of the diverse 3,300,000 acre (5,156 square miles) Rogue River Basin. This is one of the most biologically, botanically, and geologically diverse areas in the country. It is steep and rugged, ranging in elevation from 1160 feet to 7533 feet above sea level.

Jackson County has a population of over 181,000 most of who reside within the Bear Creek valley in the population centers of Ashland (19,522), Talent (5,589), Phoenix (4,060), Medford (63,154), Central Point (12,493), and Jacksonville (2235) *(US Census Bureau, Census 2000)*. These urban/non-resource zoned areas cluster predominantly along the valley bottoms along Bear Creek itself and up the valleys created by tributary streams and cover approximately 18.9 percent (47,900 ac) of the land in the watershed. Approximately 24.3 percent (61,700 acres) of the watershed is publicly owned and managed by the US Forest Service, Bureau of Land Management or other public agency. These public lands are located primarily along headwaters of streams in timbered mountainous terrain. These lands are managed for multiple use including water quality, timber production, livestock management, wildlife and recreation.

Sensitive Beneficial Use Identification

The beneficial uses present in the Bear Creek Watershed affected by elevated bacteria levels are primary water contact recreation (e.g., swimming). The criteria for "recreational contact in water" apply to all waters in the watershed. Beneficial uses in the Bear Creek Watershed are defined in the Oregon Administrative Rules (Oregon Administrative Rules OAR 340–041–0271, Table 271A, November 2003), and are shown in Table 2 below. The beneficial use affected by elevated bacteria levels is water contact recreation (DEQ, 2005).

Table 2. Bacteria impacted beneficial uses in the Bear Creek Watershed

Beneficial Use	*Bear Creek Mainstem*	*Bear Creek Tributaries*	*Beneficial Use*	*Bear Creek Mainstem*	*Bear Creek Tributaries*
Public Domestic Water Supply[1]	**	✓	Commercial Navigation & Trans.		
Private Domestic Water Supply[1]	✓	✓	Fish and Aquatic Life[2]	✓	✓
Industrial Water Supply	✓	✓	Wildlife and Hunting	✓	✓
Irrigation	✓	✓	Fishing	✓	✓
Livestock Watering	✓	✓	Water Contact Recreation	✓	✓
Boating	✓	✓	Hydro Power		✓
Aesthetic Quality	✓	✓			

**Note: Designation for this use is currently under study

1. With adequate pre-treament (filtration and disinfection) and natural quality to meet drinking water standards
2. See Figures 271A and 271B for fish use designations for this watershed.

Deviation from Water Quality Standards and 303(d) listings

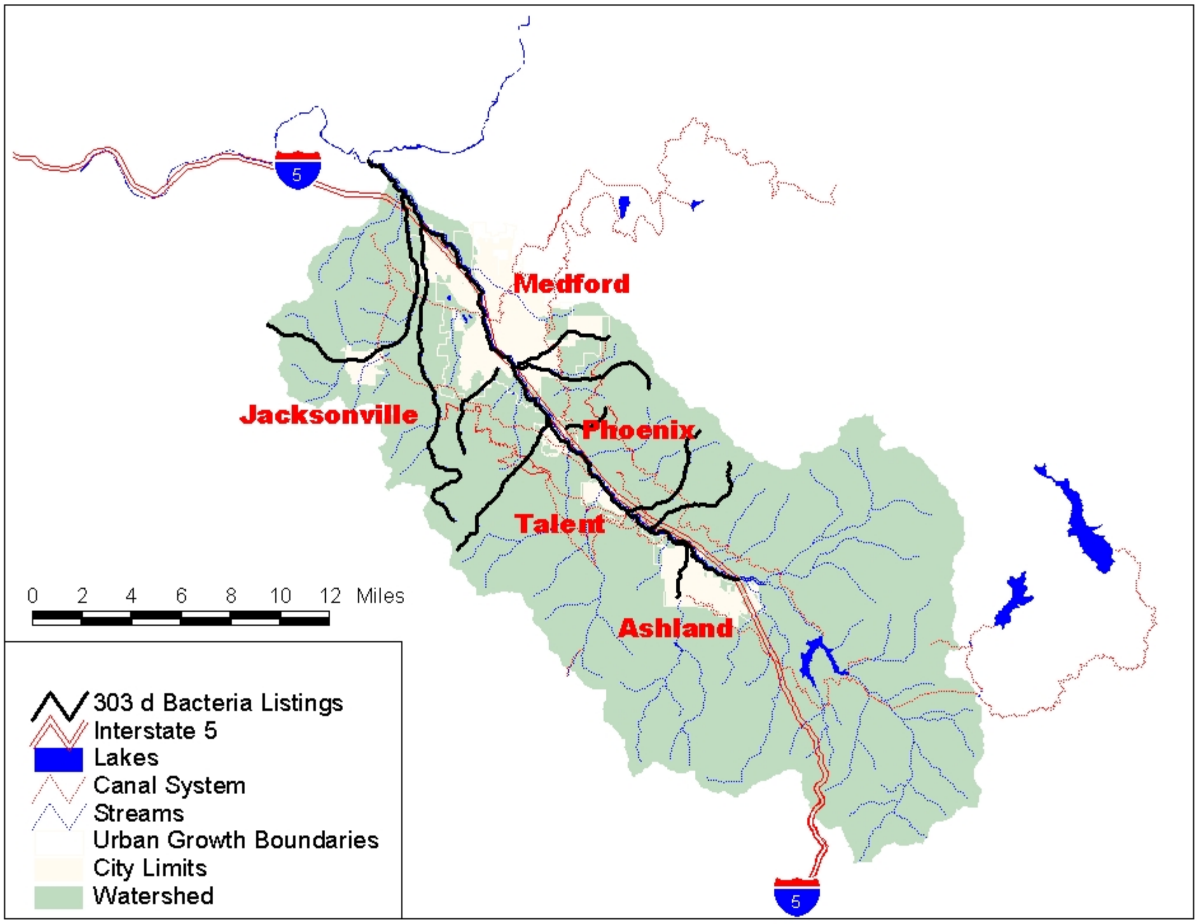
The Bear Creek Watershed includes waterbodies in which concentrations of fecal bacteria have been measured greater than the water quality standard. DEQ is required by the federal Clean Water Act to maintain a list of stream segments that do not meet water quality standards. This list is called the 303(d) List because it is required by Section 303(d) of the Clean Water Act. Table 3 below lists the Bear Creek Watershed streams on the 2004/2006 303(d) list for bacteria, and Map 1 shows their location in the Bear Creek Watershed.

Table 3. 2004/2006 303(d) bacteria listed Waterbodies in the Bear Creek Watershed

Waterbody Name	River Mile	Parameter	Season**
Ashland Creek	0 to 2.8	Fecal Coliform	Fall/Winter/Spring
Ashland Creek	0 to 2.8	Fecal Coliform	Summer
Bear Creek	0 to 26.3	Fecal Coliform	Summer
Bear Creek	0 to 26.3	Fecal Coliform	Fall/Winter/Spring
Bear Creek	0 to 26.3	*E. coli*	Summer
Bear Creek	0 to 26.3	*E. coli*	Fall/Winter/Spring
Butler Creek	0 to 5.2	Fecal Coliform	Fall/Winter/Spring
Coleman Creek	0 to 6.9	Fecal Coliform	Year Around
Crooked Creek	0 to 4.3	Fecal Coliform	Summer
Crooked Creek	0 to 4.3	Fecal Coliform	Fall/Winter/Spring
Griffin Creek	0 to 14.4	Fecal Coliform	Summer
Griffin Creek	0 to 14.4	Fecal Coliform	Fall/Winter/Spring
Jackson Creek	0 to 12.6	Fecal Coliform	Year Around
Larson Creek	0 to 6.7	Fecal Coliform	Year Around
Lazy Creek	0 to 4.5	Fecal Coliform	Year Around
Meyer Creek	0 to 5.3	Fecal Coliform	Summer
Meyer Creek	0 to 5.3	Fecal Coliform	Fall/Winter/Spring
Payne Creek	0 to 2.1	Fecal Coliform	Year Around
Total number of miles listed for summer fecal coliform (n=5)			29.6
Total miles listed fecal coliform fall/winter/spring (n=6)			58.3
Total number of miles listed fecal coliform year round (n=5)			32.8
Total number of miles listed for summer *E. coli* (n=1)			26.3
Total miles listed *E. coli* fall/winter/spring (n=1)			26.3

** Water quality limitations are separated into two seasons: summer (June 1 through September 30) and fall-winter-spring (October 1 through May 31).

Map 1. 2004/2006 Bear Creek Bacteria Listed Streams



Water Quality Standard Identification

Until 1996 DEQ assessed bacterial contamination using fecal coliform bacteria, since then *E. coli* has been used. Bacterial criteria for the waters of the Bear Creek Watershed are contained in the Oregon Administrative Rules (OAR 340-041-0009).

In order to use the best, most robust data sets available, the Bear Creek Bacteria TMDL uses a combination of fecal coliform and *E. coli* data. *E. coli* data is used to set the Load and Waste Load Allocations, while percent reduction targets where determined using Fecal Coliform data. Percent reduction targets provide a realistic measure of how much improvement is needed to meet the standard.

The change from fecal coliform to *E. coli* in 1996 was made in part because *E. coli* has a more direct connection to sources that also carry pathogens harmful to humans and is correlated more closely with human disease (Fecal coliform bacteria are still used in the standard as the indicator for protection of human health in assessing water quality in commercial and recreational shellfish harvesting areas).

The current recreational contact standard is a 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples, with no single sample exceeding 406 *E. coli* organisms per 100 ml. A water body is considered water quality limited if more than 10% of the samples exceed 406 organisms per 100 ml or the 30-day log mean is greater than 126 organisms per 100 ml(Table 4). The standard is based on 1986 USEPA recommendations that correlate a geometric mean concentration of 126 organisms per 100 ml of *E. coli* per 100 milliliters (mL) of water with a gastrointestinal illness rate of about 8 individuals per 1,000 swimmers.

In both the *E. coli* and the fecal coliform standard that preceded it, there is an average concentration target and an extreme concentration target. TMDL targets are based on achieving the average concentration targets. Average concentrations represent chronic risk. It is a more stable indicator of fecal contamination which can be addressed through available analytical methods. The management practices that control fecal bacteria to achieve the average concentration target will also control most loading associated with the peak concentrations. If during future monitoring it is shown that peak concentrations are consistently exceeding the extreme concentration target, additional monitoring will be required to ensure compliance with the average target for nonpoint source discharges. In addition Bear Creek DMAs will be asked to modify their management plans to address these peak loads.

Table 4. Water quality standards for bacteria in the Rogue Basin

Beneficial Use	Standard and Description
Freshwaters and Estuarine Waters Other than Shellfish Growing Waters (Water Contact Recreation)	(A) A 30-day log mean of 126 *E. coli* organisms per 100 milliliters, based on a minimum of five samples; (B) No single sample may exceed 406 *E. coli* organisms per 100 milliliters.
Freshwaters and Estuarine Waters (Water Contact Recreation) prior to 1996:	(A) A 30-day log mean of 200 fecal coliform organisms per 100 milliliters, based on a minimum of five samples; (B) No more than 10% of samples greater than 400 fecal coliform organisms per 100 milliliters.

Bacterial Die-off

Fecal coliforms, of which *E. coli* is a subset, are found in the intestines of warm blooded animals. This environment provides warm constant temperatures and nutrients which are conducive to bacterial growth. Once excreted from an animal host, however, these organisms encounter limited nutrient availability, osmotic stress, large variations in temperature and pH, and predation (Winfield and Groisman, 2003). However, bottom sediment can serve as a reservoir for fecal indicator bacteria, complicating the link between sources and bacteria concentrations in the water column.

Once excreted from their host, fecal bacteria typically have a limited ability to survive in the water column (EPA 2001). Death rates can be influenced by temperature, salinity, predation and sunlight. However, it is usually considered sufficient to approximate the die-off rate with an exponential decay which is dependent on concentration and temperature. Low survival rates of *E. coli* in waterbodies have been well documented with an approximate half life of 1 day (Winfield and Groisman 2003). Anecdotal evidence suggests that coliform exposed to polluted waters may survive for long periods of time and reproduce. The fate of *E. coli* in sediment, though, is not clear and has been the topic of many studies.

Bacterial Re-suspension

Fecal indicator bacteria can adhere to suspended particles in water which then settle causing an accumulation of bacteria in the bottom sediment (Davies et al., 1995). Numerous studies have found fecal indicator bacteria at greater concentrations in the sediment than in the overlying water in rivers, estuaries and beaches (Stephenson and Rychert, 1982, Struck 1988, Obiri-Danso and Jones, 1999, Byappanahalli, et al. 2003, Whitman and Nevers, 2003). Concentrations in the sediment can range from 10 to 100 times greater than in the overlying water. Re-suspension of bottom sediment has been shown to increase fecal indicator bacteria concentrations in the water column. (Sherer et.al., 1988, and Le Fever and Lewis, 2003).

The higher concentrations of fecal indicator bacteria in sediment are attributed to much slower die-off rates when compared to overlying water (Gerba and MeLeod, 1976, LaLiberte and Grimes, 1982, Burton et. al., 1986, Sherer et. al., 1992, Davies et. al. 1995,). Davies et al. (1995) found that the usual exponential decay model is not appropriate for fecal coliforms in sediment. Particle size distribution, nutrients and predation were hypothesized to influence survival rates; however, no quantitative correlation of survival rates with environmental factors was presented.

Two recent field studies have indicated the possibility that fecal indicator bacteria can form a stable, dividing population in sediment in a temperate environment (Whitman R.L and M.B. Nevers, 2003 and Byappanahalli, et al. 2003). Whitman and Nevers (2003) concluded that "more research into the environmental requirements and potential for in situ growth is necessary before *E. coli* multiplication in temperate environments can be confirmed, but this study provides initial data supporting that hypothesis."

Pollutant Identification

The pollutant of concern is fecal-related microorganisms. Fecal coliform and *E. coli* bacteria (a subset of fecal coliform bacteria) have been measured in water bodies within the Bear Creek Watershed. These bacteria are produced in the guts of warm-blooded vertebrate animals, and indicate that human pathogens may be present.

EXISTING POLLUTION SOURCES – CWA §303(D)(1)

Natural background Sources

Natural background sources of fecal bacteria include those sources associated with wildlife. This includes animals such as deer, rats, raccoons, ducks, geese and others that live or graze near or in surface waters. For the purposes of this plan these bacterial sources are considered natural and are part of the natural background of bacteria in the Bear Creek Watershed.

Point Sources

Oregon Revised Statute (ORS 468B.050) requires that no person shall discharge waste into waters of the state or operate a waste disposal system without obtaining a permit. The following is a discussion of all permitted point sources in the Bear Creek Watershed with the potential to discharge bacteria to waters of the state.

NPDES WWTF

The City of Ashland owns and operates a secondary wastewater treatment facility that discharges treated effluent into Ashland Creek about 1600 feet upstream of its confluence with Bear Creek. It is the one facility in the Bear Creek Watershed that treats domestic sewage with discharge to surface waters. The plant's discharge of domestic waste water is regulated under DEQ NPDES[1] permit 101609. The NPDES permit for the facility was last renewed on May 27, 2004. The NPDES permit for this facility requires that the effluent not exceed 126 *E. coli* organisms per 100 ml based on a monthly geometric mean and no single sample shall exceed 406 *E. coli* organisms per 100 ml prior to discharge, with no allowance for mixing. In addition, by rule, overflows of untreated sewage are prohibited in the summer months except during the 1-in-10 year 24 hour storm and in the winter months, the plant is expected to convey and treat all sewage up to the 1-in-5 year 24 hour storm.

NPDES Landfill

Valley View Landfill Inc. operates in the watershed under a DEQ issued NPDES permit. The permit allows the discharge of treated leachate into Jeffery Creek, a Bear Creek tributary from December 1 through April 30th. There is no allowed discharge May 1 – November 30. *E. coli* limits are not to exceed the monthly average of 126 *E. coli* organisms per 100 ml or a daily maximum of 406 *E. coli* organisms per 100 ml. Monitoring has confirmed that the landfill is not exceeding its permit limits and is therefore not a significant source of fecal bacteria.

Onsite Systems

Failing and/or poorly situated on-site sewage systems can produce significant loads of *E. coli*. An on-site system may not be visibly failing but located too close to streams to properly treat sewage. If failing or poorly situated on-site systems were the dominant source of bacteria loading, bacteria concentrations would likely remain constant in the winter between rainfall events when soil is saturated due to constant loading. This is not the pattern observed in Bear Creek. Thus, while there may be some contribution from failing on-site sewage systems, this does not appear to be the dominant source of bacteria in Bear Creek. There are regulatory programs in place at DEQ to insure on-site systems do not cause or contribute to water quality violations. In the Bear Creek watershed the on-site program is managed by Jackson County.

Stormwater NPDES Permits

Rural residential, commercial, industrial, and urban zoning together compose approximately 12.5% of the Bear Creek Watershed (OSSC, 1998). Storm water discharges from storm drains in urbanized areas are considered point source discharges and are a concern because of the potential for high pollutant concentrations. Concentrated development in urbanized areas substantially increase impervious surfaces, such as city streets, driveways, parking lots, and sidewalks, on which pollutants from concentrated human activities settle and remain until a storm event washes them into nearby storm drains. Common pollutants include pesticides, fertilizers, oils, heavy metals, salt, litter and other debris, and sediment. Another concern is the possible illicit connections of sanitary sewers, which can result in fecal coliform bacteria entering the storm sewer system. Storm water runoff picks up and transports these and other harmful pollutants untreated into waters of the state. When left uncontrolled, these discharges can result in fish kills, the destruction of spawning and wildlife habitats, a loss in aesthetic value, and contamination of drinking water supplies and recreational waterways that can threaten public health (USEPA website: http://www.epa.gov/nps/).

Stormwater discharges are considered point sources, which under certain circumstances require an NPDES permit. The federal NPDES permit regulations were issued in two phases. Phase I was established in 1990. It required NPDES permit coverage for large or medium municipalities that had populations of 100,000 or more as well as certain types of industrial facilities and construction sites disturbing 5 or more acres. The NPDES Phase II program extends permit coverage to construction sites disturbing 1 or more acres and smaller (< 100,000 pop.) communities and public entities that own or operate municipal separate storm sewer systems (MS4). In the Bear Creek Valley the jurisdictions of Ashland, Talent, Phoenix, Medford, Central Point, Jacksonville and Jackson County meet the qualifications to fall under the NPDES Phase II program. DEQ determined that the City of Jacksonville met the criteria for a waiver from Phase II permit requirements.

Confined Animal Feeding Operations

Confined Animal Feeding Operations (CAFO) are generally defined as the concentrated confined feeding or holding of animals in buildings, pens or lots where the surface is prepared to support animals in wet weather or where there are wastewater treatment facilities for livestock(e.g., manure lagoons). CAFO wastes include but are not limited to manure, silage pit drainage, wash down waters, contaminated runoff, milk wastewater, and bulk tank wastewater. The CAFO permit program began in the early 1980s to prevent CAFO wastes from contaminating groundwater and surface water. There are 5 permitted CAFOs operating in the Bear Creek Watershed: Vogel and Medina dairies, Dogs for the Death, Rogue River Ranch, Siskiyou Crest Goats. All CAFOs operate under general NPDES permits issued and managed by the Oregon Department of Agriculture and are managed to ensure no discharge of fecal bacteria under normal conditions. Discharge is allowed under conditions of an extreme rainfall event, defined in the permit as greater than the 25-year, 24-hour rainfall. The general permit also stipulates that during such a discharge effluent cannot cause or contribute to a violation of state water quality standards.

Nonpoint Sources

Nonpoint source pollution comes from diffuse sources as opposed to point source pollution which is discharged by an individual facility. Potential nonpoint fecal bacteria sources include wildlife, livestock waste, failing residential septic systems, pets, and illegal discharges. Fecal bacteria can be deposited directly into a water body or transported into water bodies by runoff or subsurface flow. The sources of the fecal bacteria are not obvious. Many of these sources overlap in space and time; for instance, a rural residential area may have failing septic tanks, livestock, pets, and wildlife. The following is a discussion of potential bacteria sources by land use.

Forest Managed Lands

Approximately 46% of the Bear Creek Watershed is classified as forested (OSSC, 1998). Bacterial contamination in forested areas can result from a variety of sources including dispersed and developed recreation, wild and domestic animal populations, and human settlements (MacDonald et al, 1991). Bacterial TMDL studies in the Willamette and North Coast Basins have indicated that background levels coming from forested areas are well below standards.

Agricultural Lands

Approximately 35% of the Bear Creek Watershed is zoned exclusive farm use (OSSC, 1998). Bacteria from livestock waste can be transported to the stream during rainfall/runoff events and bacteria in livestock waste can be directly deposited to streams while livestock are watering. Septic systems, pets, and wildlife are also commonly associated with agricultural land. Differing management practices and landscape properties control the delivery of fecal bacteria to water bodies.

Irrigation Districts

There are three large irrigation districts operating within the Bear Creek watershed. While district operations themselves are not a source of fecal bacteria, the canals can play a major role in transporting bacterial contamination across the valley. The 3 districts, Talent Irrigation District (TID), Medford Irrigation District (MID), and Rogue River Valley Irrigation District (RRVID), combined operate over 250 miles of canals, 7 storage dams, and 20 diversion dams in the Bear Creek Watershed (USBOR, 2002).

CURRENT CONDITIONS

Bacteria Source Tracking

Bacterial Source Tracking (BST) methods are potentially powerful tools that are increasingly being utilized to identify the animal source of bacteria in surface waters. The central premise of BST is that bacteria exhibit some degree of host specificity – that is, bacteria from different host organisms (livestock, humans, wildlife, etc.) can be differentiated and used to identify the sources of bacterial pollution in surface waters (Harwood 2002, Samadpour 2002). BST techniques fall into two broad categories, molecular and non-molecular. Non-molecular techniques such as Antibiotic Resistance Analysis (ARA) and Carbon Utilization Profile (CUP) use non-genetic characteristics to differentiate the sources of fecal bacteria, while molecular techniques, which are commonly referred to as “DNA fingerprinting”, are based on the unique genetic makeup of different strains of fecal bacteria (EPA 2002).

In 2004 and 2005 the Rogue Valley Council of Governments undertook a BST pilot study in the Bear Creek watershed (RVCOG, 2005). Water samples were collected in the summer/fall of 2004 and again in the winter/spring of 2005 from a total of six streams. The purpose of the pilot study was 1) to determine whether bacteria found in local streams is from human or animal sources and 2) to evaluate different BST methodology for future use within the Rogue Valley.

This study was divided into two sampling phases. Phase I, was conducted in the summer/fall of 2004 and utilized DNA Fingerprinting, (Ribotyping), to identify human vs. animal contamination. Three creeks were sampled: Ashland Creek, Baby Bear Creek, and Griffin Creek. The results were uncertain because 19 of the 50 isolates were found to be indeterminate, meaning they could not be matched to known human or animal sources. Of the isolates that could be identified, the study confirmed animal contamination in all three creeks, but no human isolates were positively identified. Changes were made to selected creeks and methodology in the second phase based on the DNA Fingerprinting results, TMDL *E. coli* results, winter flows, and discussion with officials.

Phase II, conducted in the winter/spring of 2005 assessed the effectiveness of Human Enterococcus ID and Human Bacteroidetes ID in identifying human contamination. Three creeks were sampled; Butler Creek, Payne Creek, and Larson Creek. Again the results were uncertain because of a high number of indeterminate isolates. The study confirmed high counts of enterococcus were present within all three creeks, human contamination was not confirmed within any of the identified samples.

Study Highlights

- Three methods of bacterial source tracking were analyzed: DNA Fingerprinting, Human Enterococcus ID, and Human Bacteroidetes ID.
- DNA Fingerprinting identified animal contamination in Ashland, Baby Bear, and Griffin Creek. No human contamination was detected but a high number of samples (19 samples) were found to be indeterminate.
- Indeterminate samples could not be matched to known human or animal source.
- Due to the high number of indeterminate samples and the lack of identifying human contamination, Human Bacteroidetes ID and Human Enterococcus ID were assessed.
- Human contamination was not identified in Butler, Payne, or Larson Creek. However high levels of enterococci and *E. coli* were present.
- Additional analysis conducted by the lab suggested that a regrowth issue in secondary environments may occur within local waterways. Additional sampling would be needed to evaluate whether the regrowth condition exists.

Photo 1. Raccoon Footprints in a Local Creek

From RVCOG, 2005

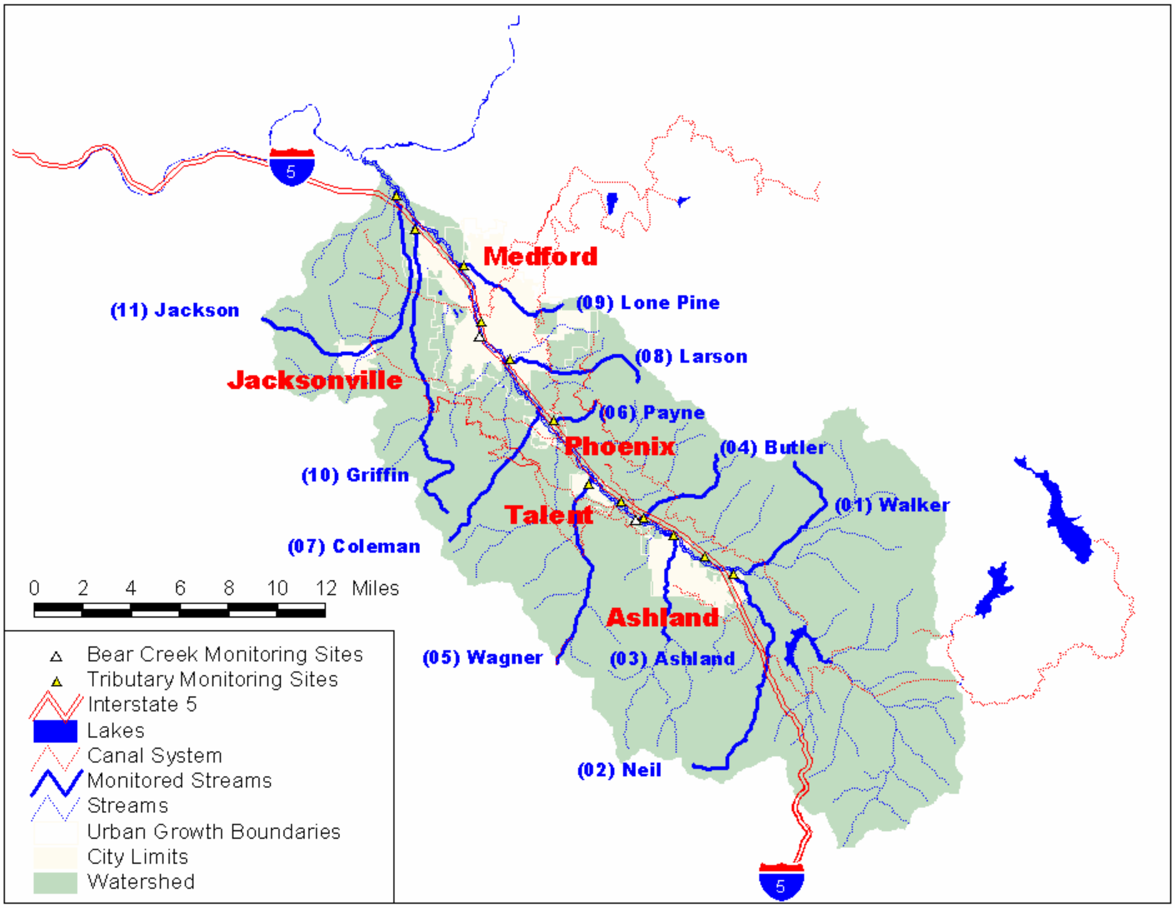
Bear Creek Bacteria Analysis

Presented below is a summary of the results of the analysis of bacteria samples taken by the Oregon Department of Environmental Quality, the US Bureau of Reclamation and the Rogue Valley Council of Governments. Full results are shown in Appendix B.

Note that all data for this analysis was for fecal coliform bacteria. The 11 tributary sites on Bear Creek were sampled and flow determined on a monthly basis during the non-irrigation season (Nov-Mar) and bi-monthly during the irrigation season (Apr-Oct) between February of 1995 and October of 1998. All tributaries were sampled at or near the mouth (Map 2).

For the Bear Creek mainstem there is an extensive fecal bacteria record going back to 1967. For this TMDL, fecal coliform data used for analysis dated from June,1990 through October, 2001 at the Medford gage (river mile 11, USGS #14357500) and at the Ashland Gage (river mile 22.9, USGS #14354200).

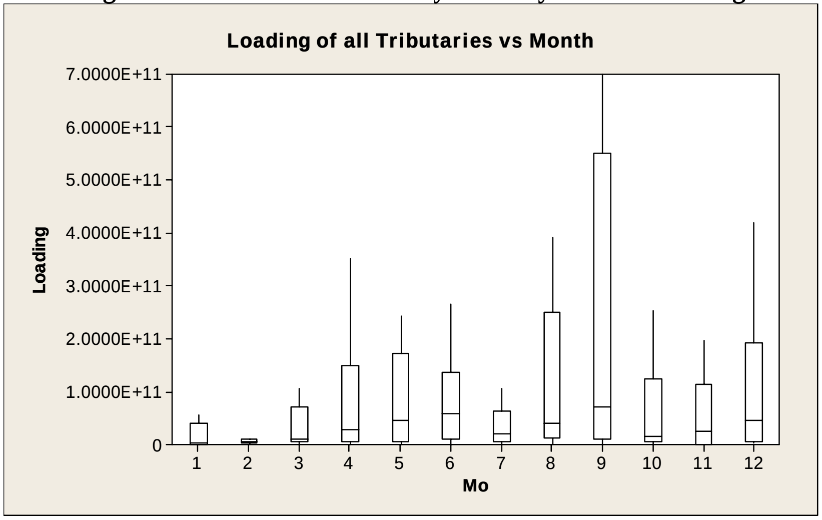
Map 2. Fecal Coliform Sampling Sites



Tributary Data
The behavior of typical nonpoint source bacterial pollution follows certain well-established patterns. Fecal material accumulates on ground surfaces within the watershed and is carried into streams and rivers during rainfall events. With the dry summers of the Rogue Valley, this produces a pattern of low bacterial numbers in the summer, high values in the rainy season with the highest values during the first fall freshets. This pattern is common in watersheds west of Oregon's Cascade Mountains (Tillamook TMDL, DEQ, 2001; North Coast Subbasins TMDL, DEQ, 2003). However bacteria loads coming out of tributary system of Bear Creek exhibit quite a different behavior (Figure 1). The highest numbers occur in summer months of August and September which are also the driest months. Bacteria loads during the high-level rainfall months of December through March are much lower by comparison. A slight spike occurs in April - May, but these levels are still much lower than levels during the height of summer dry conditions.

The flows in Bear Creek and tributaries are greatly influenced by irrigation water. The irrigation season in the Bear Creek Valley is legally defined as April 1 through October 31 (30 cfs is also allocated for frost control February 15 and April 1). The irrigation districts move water around the valley through a complex system of over 250 miles of canals. Irrigation water has the potential to pick up bacterial contamination as excess water runs over fields, animal pastures, along roadside ditches or as it detours through urban stormwater pipes and culverts before it finds its way back to a tributary or the Bear Creek mainstem. This whole process might happen several times as the water gets diverted and used again farther downstream.

Figure 1. Bear Creek Tributary Monthly Bacteria loading



** Loading is expressed as fecal coliform bacteria colony forming units (CFU) per day

Table 5 shows the percent exceedance of the fecal coliform bacterial standard for two points on Bear Creek; the Medford Gage (River Mile 11) and the Ashland gage (River Mile 22.9) for the period June 1990, through October 2001. The analysis was broken into two time periods: a dry season (July – October) and a wet season (December – May). The shoulder months of November and June are left out of the table analysis. Both the Medford and Ashland gage sites have roughly twice the number of violations of the fecal coliform standard during the dry season (July - October) than they do during the wet season (December-May). The dry season is the time of year when the majority of flows in Bear Creek are controlled by irrigation water delivery and return flows. The analysis in the table also indicates that the Medford site, being further down in the watershed, exceeds the state standard about twice as often as the Ashland site in both the wet and dry seasons.

Table 5. Percent Exceedance of Standard – Dry Season and Wet Season

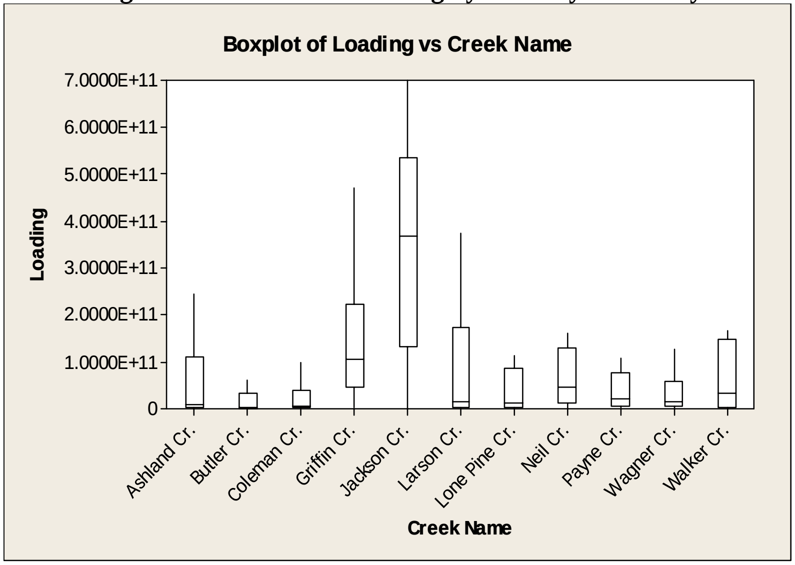
Gage Location	Dry Season (July-October)	Wet Season (Dec – May)
	Percent Exceedance of Standard[1]	Percent Exceedance of Standard[1]
ASHLAND	35.7	18.5
MEDFORD	70.5	28.4

[1] Note that exceedances are based on 200 CFU/100 mL of fecal coliform bacteria

Tributaries – Spatial Variation

The tributary systems exhibit marked differences in their contribution of bacteria (Figure 2). Bacteria loading in Jackson Creek is higher than other tributaries. The 25th percentile values are above the 75th percentile values of every other system, except for Griffin and Larson Creeks. Fecal material is highly soluble, as water moves down the valley, it picks up and carries whatever bacteria it finds along with it. Jackson Creek conveys irrigation return water and operational spills from the Medford Irrigation District and experiences relatively high flows throughout the summer.

Figure 2. Bear Creek Loading by Primary Tributary

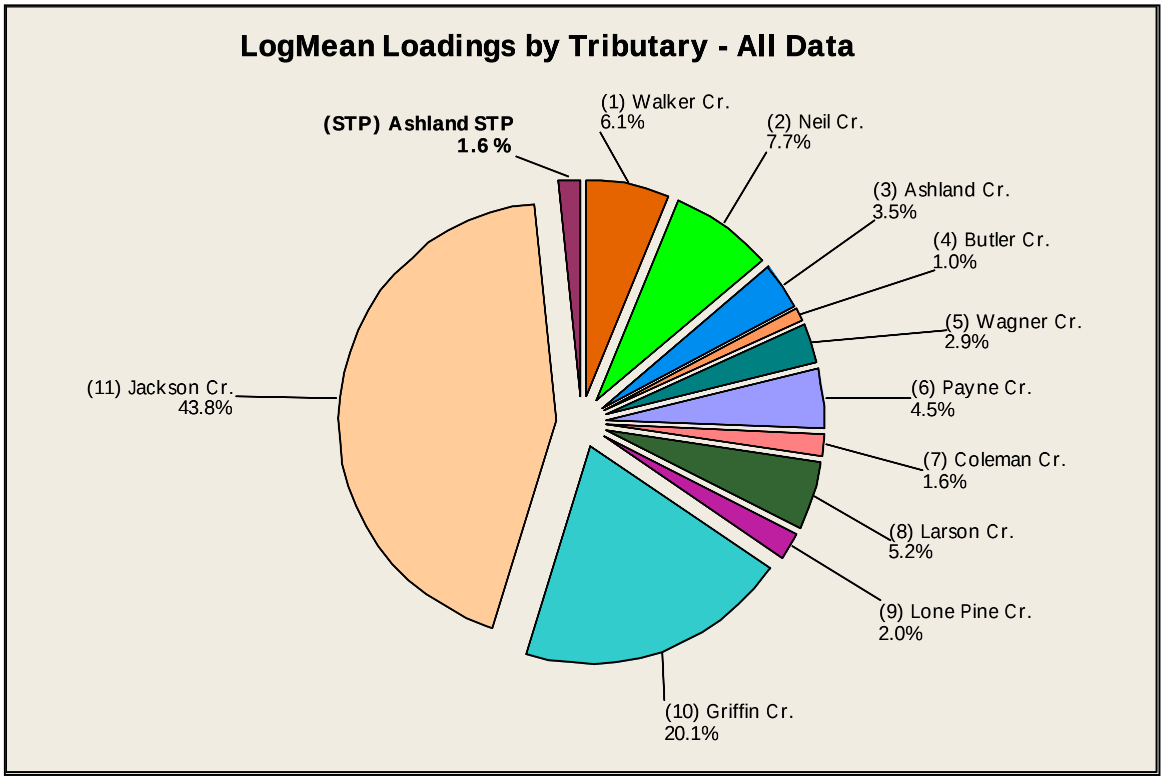


** Loading is expressed as fecal coliform bacteria colony forming units (CFU) per day

Point verses Nonpoint Sources – relative contributions

Figure 3 compares the relative loadings of fecal coliform (CFU/day) from NPDES point sources and from monitored tributaries within the Bear Creek Watershed. Loading from the Ashland waste water treatment facility (WWTF) was determined from the discharge monitoring reports for the period of February 1995 through October 1998 (Note: the Ashland WWTF is in compliance with its NPDES permit for bacteria). Bacterial loads coming from the plant used in that analysis were overestimated by using the monthly median flow times the maximum bacterial concentration for that month. This conservative approach constitutes an implicit margin of safety since a review of records indicates that the average monthly bacteria concentrations are many times less than the monthly maximum. In addition, monthly averages are well below the bacterial standard for fecal coliform. Even with the margin of safety employed, the Ashland WWTF accounts for approximately 1.6% of the bacterial load coming into Bear Creek. By far the greatest load to Bear Creek is from nonpoint sources accounting the remaining 98.4% of the load. The largest nonpoint source contributors are Jackson Creek at 43.8%, and Griffin Creek at 20.1% of the load.

Figure 3. Relative Contributions of Point and Nonpoint Sources of Bacteria to Bear Creek (1995-1998)



The Ashland WWTF discharge achieves the bacteria criteria as specified in its NPDES permit, no additional improvements are required. The vast majority of bacterial loading in the watershed is due to nonpoint sources (98.4%). Nonpoint sources will be addressed through the development and implementation of TMDL implementation plans by all designated management agencies with land management authority in the watershed.

CRITICAL PERIOD - SEASONAL VARIATION – CWA §303(D)(1)

Section 303(d)(1) requires a TMDL to be "established at a level necessary to implement the applicable water quality standard with seasonal variations." The critical period for the Bear Creek bacteria TMDL is that period of time when bacterial concentrations exceed the states standard for contact recreation. Based on the 2004/2006 303(d) list there are 5 waterways listed for exceeding summer fecal standards (29.6 miles) (June 1 through September 30), 6 waterways exceeding the winter/fall/spring standard (58.3 miles) (October 1 through May 31), and 5 waterways found to exceed the standard year round (32.8 miles) (Table 3).

This TMDL analysis examines fecal bacteria year-round in the Bear Creek Watershed.

TMDL - LOADING CAPACITIES 40 CFR 130.2(F)

Loading Capacity: This element specifies the amount of a fecal bacteria expressed as *E. coli* organisms per day that Bear Creek can receive and still meet water quality standards.

EPA's current regulation defines loading capacity as "*the greatest amount of loading that a waterbody 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 for Bear Creek was determined at the Medford gage (RM 11.0) by multiplying the standard (126 *E. coli* org./100 ml and 406 *E. coli* org./100 ml) by the flow and converting the units into organisms per day (Figure 4). The Medford gage site was chosen because of a robust flow data set (period of record 2006-1917) and because its downstream location accounts for bacteria loading from a majority of the watershed. The range of observed flows was separated into five categories based on flow percentiles: high (<10%), high-middle (10-40%), mid-range (40-60%), low middle (60-90%), and low (>90%). A generalized loading capacity for each of the five flow ranges was calculated based on meeting the *E. coli* standard (Table 6). In the figure the black line represents loading based on 126 *E. coli* organisms per day, and the gray line represents the loading based on 406 *E. coli* organisms per day at the flow percentile given for the Medford gage.

Figure 4. E. coli Loading Capacity for Bear Creek at the Medford Gage.

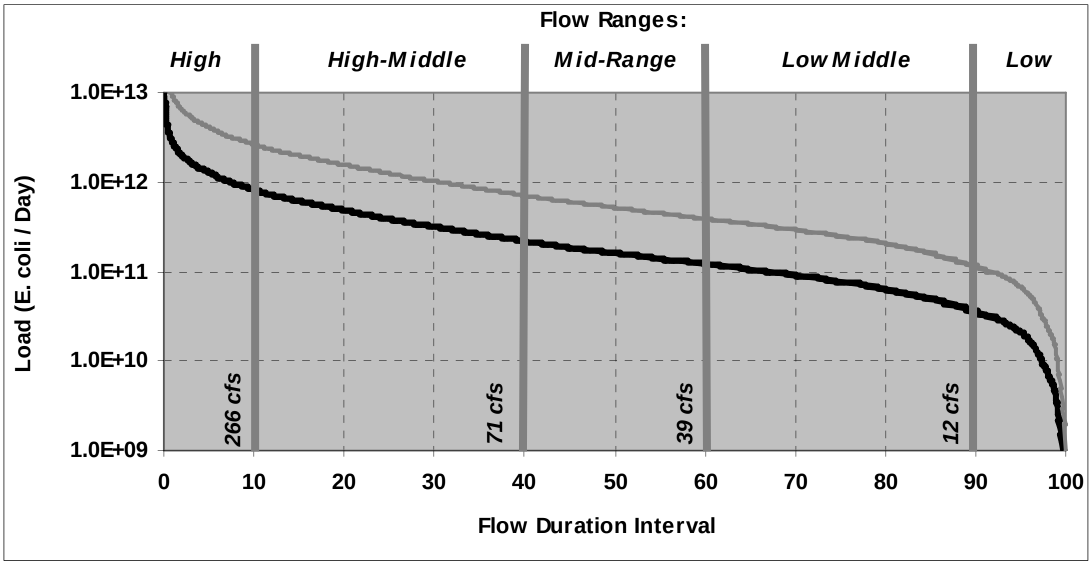


Table 6. E. Coli Loading Capacity for Bear Creek at Medford

Flow in Bear Creek at Medford gage (RM 11)	**High Flow (Above 266 cfs)**	**High Medium (71 to 266 cfs)**	**Mid-Range (39 to 71 cfs)**	**Low Medium (12 to 39 cfs)**	**Low Flow (Below 12 cfs)**
	E. coli Organisms per Day				
Loading Capacity (based on 126 *E. coli* organisms per 100 ml criteria)	Greater than $8.2\text{x}10^{11}$	$2.19\text{x}10^{11}$ to $8.2\text{x}10^{11}$	$1.2\text{x}10^{11}$ to $2.19\text{x}10^{11}$	$3.7\text{x}10^{10}$ to $1.2\text{x}10^{11}$	Less than $3.7\text{x}10^{10}$
Loading Capacity (based on 406 *E. coli* organisms per 100 ml criteria)	Greater than $2.6\text{x}10^{12}$	$7.1\text{x}10^{11}$ to $2.6\ \text{x}10^{12}$	$3.9\text{x}10^{11}$ to $7.1\text{x}10^{11}$	$1.2\text{x}10^{11}$ to $3.9\text{x}10^{11}$	Less than $1.2\text{x}10^{11}$

TMDL - LOAD ALLOCATIONS AND WASTE LOAD ALLOCATIONS 40 CFR 130.2(G) AND 40 CFR 130.2(H)

This element divides the bacterial loading capacity between individual point and nonpoint sources and sets the load reduction targets and margins of safety that when reached will result in achieving the TMDL loading capacity.

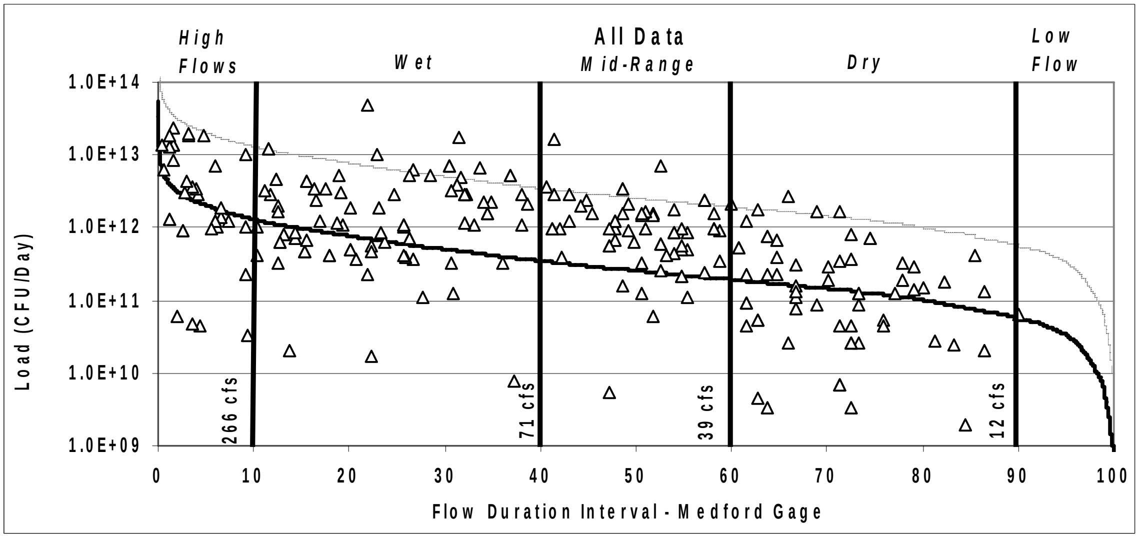
Flow-based loading capacity and allocations were determined using a load duration curve (Figure 5). This method segregates data by flow creating a graphical display of the range of data and the determination critical periods for water quality. See Appendix B for a technical explanation of load duration curves.

Fecal Coliform data from June 1990 through October 2001 collected in Bear Creek at the Medford gage (River Mile 11) was used in the creation of the curve. Percent reduction targets were determined for each data point by comparing the actual measured loads to load at that flow if concentrations were meeting the standard (fecal coliform standard 200 org./100 ml). This analysis was performed for each data point and an average percent reduction target determined within each of the 5 flow ranges. The generalized flow ranges and recurrence intervals were: high (<10%), high-middle (10-40%), mid-range (40-60%), low middle (60-90%), and low (>90%) (Figure 5).

In other bacterial TMDLs (Willamette, DEQ 2006; North Coast Basins, DEQ 2003; Umpqua, DEQ 2006) load duration curves are used make flow-based source assessments. The assumptions made in these systems are that high fecal counts during low flow periods (60-90% flow, called dry weather) indicate that point sources are the primary impact to the systems. High fecal counts during high flow periods (10-40% flow, called wet weather) are indicative of nonpoint source inputs from across the landscape. These relationships do not apply to the Bear Creek watershed where the primary determinant of flow in the creeks is irrigation water delivery and return, especially during the summer. In Bear Creek, some of the highest creek flows occur during the summer dry period when irrigation demands are the highest.

In Table 7, load and waste load allocations are presented as well as percent reduction targets needed to reach the standard. It is important to note that although fecal coliform data is used to determine the percent reduction targets, actual TMDL allocations are all based on *E. coli* numbers. This was done in order to use the best, most robust data sets available. Percent reduction targets in fecal coliform directly translate to *E. coli* percent reductions and provide a realistic measure of how much improvement is needed to meet the standard. In the sections that follow individual load and waste load allocations are discussed.

Figure 5. Bear Creek at Medford Load Duration Curves



Note: Dark line represents fecal coliform loading capacity of 200 CFU/100 ml. The dotted line represents 400 CFU/100ml.

Table 7. Bear Creek at Medford: Load Allocations and Percent Reduction Targets (Fecal Coliform)

	Range of Bear Creek Flow				
Allocations	**High Flow** (Above 266 cfs)	**High Medium** (71 to 256 cfs)	**Mid-Range** (39 to 70 cfs)	**Low Medium** (12 to 38 cfs)	**Low Flow** (Below 12 cfs)
Allowable Loading Capacity (Fecal Coliform Standard)	$8.51x10^{13}$	$5.56x10^{13}$	$1.41x10^{13}$	$7.82x10^{12}$	$5.38x10^{10}$
Current Load (Fecal Coliform Org./day)	$2.15x10^{13}$	$2.62x10^{13}$	$9.17x10^{13}$	$2.26x10^{13}$	$6.46x10^{10}$
Percent Reduction (Fecal Coliform) [1]	60.5%	78.8%	84.6%	65.4%	20.0%

[1] An explicate 10% margin of safety was incorporated into these TMDL percent reduction targets since human contact recreation has the potential to occur under most flow conditions.

For the Bear Creek tributaries, percent reduction targets were calculated based on the difference between fecal coliform loading and loadings that meet the 200 CFU/100 ml for each sample taken. The percent reduction calculations are based on tributary data collected between February 1995 and October 1998 (Note: all percent reduction targets are based on fecal coliform samples (Table 8).

Table 8. Percent Reduction Surrogate Targets for Primary Tributaries (fecal coliform)

Tributary Name	**% Reduction Target**[1, 2]
Walker (n=35)	61
Neil (n=47)	55
Ashland (n=41)	38
Butler (n=29)	69
Wagner (n=27)	41
Payne (n=48)	79
Coleman (n=31)	47
Larson (n=44)	64
Lone Pine (n=24)	73
Griffin (n=35)	69
Jackson (n=45)	73

[1]percent reduction surrogate targets based on Fecal Coliform Loads (CFU/Day).
[2]An explicate 10% margin of safety was incorporated into this TMDL, since human contact recreation has the potential to occur under most flow conditions.

Note that in this TMDL, the distinction between sources, such as wildlife, livestock, failing septic systems, urban runoff, and agricultural runoff, was not possible because of the complex movement of water around the watershed as well as the complexity of spatially overlapping sources. Therefore the percent reduction targets shown in Table 8 generally apply to all land uses within the specific tributary watershed.

PERMITTED POINT SOURCES OAR 340-042-0040(4)(G), 40 CFR 130.2(G)

This element explains the waste load allocations for all point source discharges regulated under the NPDES permit process.

Oregon Revised Statute (ORS 468B.050) requires that no person shall discharge waste into waters of the state or operate a waste disposal system without obtaining a permit. The following is a discussion of all permitted point sources in the Bear Creek Watershed with the potential to discharge bacteria to waters of the state and their associated waste load allocations (WLA). NPDES permits may be revised when renewed to insure that all permittees are operating in accordance with this Bacteria TMDL.

Ashland WWTF

Agency with oversight: DEQ
The City of Ashland's WWTF discharge is regulated under DEQ NPDES[1] permit 101609 (last renewed on May 27, 2004). When operating in compliance with the requirements of the NPDES permit, the Ashland waste water treatment does not cause or contribute to bacteria water quality standard violations in the Bear Creek Watershed. A review of Discharge Monitoring Reports (DMRs) indicates that the WWTF meets its permit requirements and therefore does not cause or contribute to violations of the bacteria water quality standard. The waste load allocation (WLA) for the Ashland WWTF is that the final effluent meets the water quality criteria for bacteria.

The permits prohibits discharge of untreated sewage except during certain storm events. Raw sewage discharges are prohibited to waters of the state from November 1- May 21, except during a storm event greater than a 1 in 5 year, 24 hour duration storm and from May 22-October 31, except during a storm event greater than the 1 in 10 year, 24 hour duration storm event.

The NPDES permit for the Ashland WWTF uses a concentration target for *E. coli* rather than a load. For the purposes of this TMDL, a waste load allocation is derived using the maximum permitted daily flow for a facility (average dry weather peak capacity of 2.3 MGD) and the *E. coli* bacteria standard (Table 9). In meeting the NPDES permit requirements for bacteria, the Ashland wastewater treatment plant discharges effluent that is at or below the bacteria standard. This is considered compliance with the bacteria TMDL.

Table 9. Waste Load Allocation for the Ashland WWTF

Facility Name	Receiving Stream	River Mile	Maximum Permit Flow (MGD)	Waste Load Allocation (*E. coli* organisms per 100 ml)	Maximum Waste Load (*E. coli* organisms per 100 ml)
Ashland WWTF	Ashland Creek	0.25	2.3 MGD	126	1.10×10^{10}
Ashland WWTF	Ashland Creek	0.25	2.3 MGD	406	3.5×10^{10}

NPDES Landfill

Agency with oversight: DEQ

Valley View Landfill Inc. operates in the watershed under a DEQ issued NPDES permit. The permit allows the discharge of treated leachate into Jeffery Creek, a Bear Creek tributary from December 1 through April 30th. There is no allowed discharge May 1 – November 30. Monitoring has confirmed that the landfill is not exceeding its permit limits and is therefore not a significant source of fecal bacteria. The Waste Load Allocation that applies to the Valley View Landfill is 126 *E.coli* organisms per 100 ml expressed as a monthly average.

Onsite Systems

Agency with oversight: DEQ

Management Agency: Jackson County

Failing and/or poorly situated on-site sewage systems can produce significant loads of *E. coli*. There are regulatory programs in place at DEQ to insure on-site systems do not cause or contribute to water quality violations. In Bear Creek the on-site program is managed by Jackson County. On-site systems are designed to produce a zero loads. The waste load allocation for all on-site systems is zero *E. coli* organisms per 100 ml.

Stormwater NPDES Permits

Agency with oversight: DEQ

The Waste Load Allocation that applies to each NPDES Phase II community is expressed as a percent reduction in *E. coli* bacteria. Percent reductions in bacteria are shown in Table 7 for Bear Creek and in Table 8 for the monitored tributaries and applies to those streams within an NPDES Phase II community's jurisdiction. It is important to note that fecal coliform data is used to determine the percent reduction targets in Tables 7 and 8. It is assumed that measures taken to meet the percent reduction targets for fecal coliform will meet the E coli standard as well.

There are currently 6 NPDES Phase II communities in the Bear Creek Watershed: Ashland, Talent, Phoenix, Medford, Central Point and Jackson County. As a Phase II community, all stormwater discharges are managed as point sources under an NPDES permit. At the time of this writing all 6 of the Phase II communities have applied for stormwater permits. DEQ expects to issue these permits in the near future. Permit regulations (40CFR 122.34) requires permittees at a minimum to develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the community to the maximum extent practicable.

The stormwater management program must include these six minimum control measures:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

In addition, DEQ may propose specific TMDL-related requirements in the NPDES Phase II MS4 permits. Specifically, if an approved TMDL establishes a waste load allocation for municipal stormwater, the permitted MS4 would be required to do the following: (a) revise their stormwater management plans, if necessary, to ensure that best management practices are designed to reduce the TMDL pollutant(s) to the maximum extent practicable; (b) establish a total pollutant load reduction target (or "benchmark") that can be achieved within a 5-year permit term, as well as performance measures for specific BMPs designed to meet the benchmark; (c) at the end of the permit term, evaluate the progress toward meeting the numeric benchmark, and if it hasn't been met, propose additional changes to the stormwater management plan to achieve greater reductions during the next 5-year permit term. These requirements are still tentative, as DEQ needs to propose the Phase II permits for public comment prior to issuance.

Confined Animal Feeding Operations

Management Agency: Oregon Department of Agriculture

Each permitted Confined Animal Feeding Operation (CAFO) receives a routine inspection from their area Livestock Water Quality Inspector once a year, on average. During this inspection, the operator and inspector discuss the operation, and the inspector views the entire operation to assure compliance with permit terms and water quality rules and laws. In the event a violation is found, the inspector works with the operator to develop a solution to the problem and a schedule to complete the corrective actions.

CAFOs are managed in the State of Oregon to ensure no discharge of fecal bacteria under normal conditions. Discharge is allowed under conditions of an extreme rainfall event, defined in the permit as greater than the 25-year, 24-hour rainfall. The general permit also stipulates that during such a discharge effluent cannot cause or contribute to a violation of state water quality standards. Because the TMDL does not address extreme rainfall event (i.e. the 25-year, 24-hour rainfall), the CAFOs in the Bear Creek Watershed are each allocated zero load.

NONPOINT SOURCES: LOAD ALLOCATIONS OAR 340-042-0040(4)(H), 40 CFR 130.2(H)

This element determines the portions of the receiving water's loading capacity that are allocated to existing nonpoint sources of pollution.

Nonpoint Sources

Potential nonpoint fecal bacteria sources include wildlife, livestock waste, failing residential septic systems, pets, and illegal discharges. Fecal bacteria can be deposited directly into a water body or transported into water bodies by runoff or subsurface flow. Many of these sources overlap in space and time; for instance, a rural residential area may have failing septic tanks, livestock, pets, and wildlife. Because management agencies are generally designated by land use the following is a discussion of bacteria sources by land use also naming the management agency with land use authority.

Forest Managed Lands

Management Agency: ODF, BLM, USFS

In forested areas, high levels of fecal bacteria usually will be associated with inadequate waste disposal by recreational users, the presence of livestock or other animals in the stream channel or riparian zone, and poorly maintained septic systems (MacDonald et al, 1991). There is little data locally that indicate the potential input of bacteria from forest areas, usually located in the headwaters of tributaries in the Bear Creek watershed.

Agricultural Lands

Management Agency: Oregon Department of Agriculture

Bacteria from livestock waste can be transported to the stream during rainfall / runoff events, and bacteria in livestock waste can be directly deposited to streams while livestock are watering. Septic systems, pets, and wildlife are also commonly associated with agricultural land. Differing management practices and landscape properties control the delivery of fecal bacteria to water bodies. The Bear Creek Sub-Basin Agricultural Water Quality Management Area Plan was revised in 2004 to include management actions to address sources of fecal bacteria. The purpose of this Area Plan is to identify strategies to reduce water pollution from agricultural lands through a combination of educational programs, suggested land treatments, management activities, and monitoring. The Oregon Department of Agriculture (ODA) has enforcement authority for the prevention and control of water pollution from agricultural activities under administrative rules for Bear Creek and Oregon Administrative Rules (OAR) 603-090-0120 through 603-090-0180.

Irrigation Districts

Management Agency: Talent Irrigation District (TID), Medford Irrigation District (MID), and Rogue River Irrigation District (RRVID)

The distribution of bacteria throughout the Bear Creek Valley as well as the timing of those levels is intimately tied to the movement of irrigation water throughout the valley by the three large irrigation districts: Talent Irrigation District (TID), Medford Irrigation District (MID), and Rogue River Valley Irrigation District (RRVID). It should be emphasized that the irrigation system does not create bacteria, it simply transports it. The monitoring data examined in this TMDL sheds some light on the timing and location of high bacterial levels in the valley. It also indicates that irrigation water movement may be a primary transport mechanism for bacteria. The irrigation districts have an aggressive operations and maintenance improvement plan in place however additional outreach may be beneficial to keeping fecal organisms out of the irrigation system and out of surface waters.

Rural Residential and Urban Lands
Management Agency: Jacksonville
The potential bacteria inputs from the city of Jacksonville are similar in nature to the inputs from the NPDES Phase II communities. The stormwater discharges from these areas, since they are not covered under Phase II permits are considered nonpoint sources from a regulatory standpoint. If additional monitoring indicates that the City of Jacksonville's efforts to address fecal bacteria are not adequate, the city may be required to change its implementation strategies or undertake additional actions.

FUTURE SOURCES

Future permitted sources may discharge effluent containing fecal bacteria at concentrations in compliance with water quality standards (126 *E. coli* / 100 ml as a monthly average, 406 *E. coli* / 100 ml daily maximum).

MARGIN OF SAFETY OAR 340-042-0040(4)(I), CWA §303(D)(1)

This element accounts for the uncertainty related to the TMDL and, where feasible, quantifies uncertainties associated with estimating pollutant loads, modeling water quality and monitoring water quality.

A margin of safety is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A margin of safety is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions) Table 10.

Table 10: 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 margin of safety.
Implicit	4. Conservative assumptions in derivation of numeric targets. 5 Conservative assumptions when developing numeric model applications. 6 Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

Explicit Margin of Safety

An explicit margin of safety results employing a 10% margin of safety for all nonpoint source percent reduction targets. This MOS is justified at all levels in the Bear Creek basin since all flows may occur during the period of time when waterways become more attractive for water contact recreation.

Implicit Margin of Safety

The Ashland WWTF loading and the nonpoint source loadings as calculated are based on the plant operating at average dry weather peak capacity of 2.3 MGD and discharging at a permit maximum of 200 fecal CFU/100ml. This constitutes an implicit margin of safety since a review of records indicates that the plant discharges well below the bacteria standard and currently discharges at less than design capacity.

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BACTERIA REFERENCES

Burton, G.A. Jr., D. Gunnison, and G.R. Lanza, 1987. Survival of Pathogenic Bacteria in Various Freshwater Sediments, Applied and Environmental Microbiology, Vol. 53, No. 4, p. 663-638.

Davies, C.M., J.A.H. Long, M. Donald, and N.J. Ashbolt, 1995. Survival of Fecal Microogranisms in Marine and Freshwater Sediments, Applied and Environmental Microbiology. Vol. 61, p. 1888-1896.

DEQ 2005. Assessment Methodology for Oregon's 2004 Integrated Report on Water Quality Status. ODEQ Water Quality Division. August 12, 2005.

Gerba, C.P. and J.S. MeLeod, 1976, Effect of Sediments on the Survival of *Escherichia coli* in Marine Waters, Applied and Environmental Microbiology, Vol. 32, No. 1, p. 114-120

LaLiberte P. and D.J. Grimes, 1982, Survival of Escherichia coli in Lake Bottom Sediment, Applied and Environmental Microbiology, Vol. 43, No. 3, p. 623-628.

Le Fevre, N.M. and G.D. Lewis 2003, The role of resuspension in enterococci distribution in water at an urban beach, Water Science and Technology, Vol. 47, No. 3, pp 205 – 210.

MacDonald L.H., Smart A.W., Wissmar R.C. 1991. Monitoring Guidelines to Evaluate the Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. USEPS Region 10. EPA 910/9-91-001.

OSSC, 1998. Oregon State Service Center for GIS records, 1998, Zoning for the State of Oregon.

ODA, 2004. Bear Creek Sub-Basin Agricultural Water Quality Management Area Plan 2004 Revisions Developed by the Bear Creek Local Advisory Committee and OREGON DEPARTMENT OF AGRICULTURE with assistance from JACKSON SOIL AND WATER CONSERVATION DISTRICT November 30, 2004

DEQ 2003. North Coast Subbasins: Lower Columbia-Youngs, Lower Columbia-Clatskanie, Necanicum, and Nehalem. August 20, 2003. Available at www.deq.state.or.us

DEQ, 2003. Consolidated Assessment and Listing Methodology for Oregon's 303(d) List of Water Quality Limited Waterbodies and Integrated 305(b) Report. DEQ 811 6th Ave., Portland, Oregon 97204, January 2003.

DEQ 2006. Willamette Basin Total Maximum Daily Load (TMDL) Documents. September 9, 2006. Available at www.deq.state.or.us

DEQ 2006. Umpua Basin TMDL and Water Quality Management Plan. November 01, 2006. Available at www.deq.state.or.us

RVCOG, 2005. Bacterial Source Tracking Pilot Study DNA Fingerprinting, Human Bacteroidetes ID and Human Enterococci ID. Rogue Valley Council of Governments, Natural Resources Department, 155 North First Street, Central Point, Oregon, June 2005

Sherer, B.M., J.R. Miner, J.A. Moore, and J.C. Buckhouse, 1988, Resuspending Organisms from a Rangeland Stream Bottom, Transaction of the American Society of Agricultural Engineers, Vol. 31(4), p. 1217-1222.

Sherer, B.M., J.R. Miner, J.A. Moore, and J.C. Buckhouse, 1992, Indicator Bacterial Survival in Stream Sediments, Journal of Environmental Quality, 21:591-595.

Stephenson G.R. and R.C. Rychert, 1982, Bottom Sediment: a Reservoir of Escherichia Coli in Rangeland Streams, Journal of Range Management, 35(1) p. 119-123.

U.S. Environmental Protection Agency. 2001, Protocol for Developing Pathogen TMDLs, First Edition, EPA 841-R-00-002.

USEPA website: http://www.epa.gov/nps/

Winfield M. D., and E.A. Groisman, 2003, Role of Nonhost Environments in the Lifestyles of Salmonella and Escherichia coli, Applied and Environmental Microbiology. Vol. 69, No. 7, p. 3687-3694.

SECTION 4

REEDER RESERVOIR SEDIMENTATION TMDL

Summary of Sedimentation TMDL Development and Approach

Why Is Sedimentation Important?

The measurable dimensions of a river develop over time to move the amount of water and sediment supplied by surrounding uplands. Human activities or natural events may result in more sediments being delivered than the channel morphology and flow characteristics are capable of moving downstream. An excess of can adversely affect fish and other aquatic organisms by: 1) killing fish directly, 2) reducing growth, or reducing disease resistance; 3) interfering with the development of eggs and larvae; 4) modifying natural movements and migration of salmonids, and 5) reducing the abundance of food organisms (Newcombe and McDonald, 1991).

Applying Oregon's Water Quality Standards to Sedimentation

The state of Oregon has a narrative criteria that applies to sedimentation: "formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed" OAR 340-041-0007(13).
Reeder Reservoir is included on the 2004/2006 303(d) list as sediment impaired. This listing was determined after the a USFS watershed analysis confirmed that excessive sedimentation was requiring period sluicing of the reservoir. (USFS, 1995).

Scope

The Reeder Reservoir sedimentation 303(d) listing applies to all lands within the Ashland Creek Analytical Watershed which drain into Reeder Reservoir including East and West Forks of Ashland Creek and the several small unnamed creeks. All land uses and ownerships are included in this TMDL including the U.S. Forest Service (USFS), and the City of Ashland.

Sedimentation TMDL Overview

The Ashland Creek watershed is composed of granitic soil types subject to debris landslides and surface erosion. Surface erosion, erosion from roads, debris flows/slide, and stream channel erosion are possible sources of sediment into streams and Reeder Reservoir.

Macroinvertebrate data has indicated that the East and West Forks of Ashland Creek above Reeder Reservoir provides habitat in excellent condition. The survey recommends that the sites may serve as reference sites for the region, and more specifically, for granitic watersheds in the area. "What this site, and a handful of others in SW Oregon demonstrates, is that a granitic watershed, where stream channels are naturally storing and transporting high amounts of coarse, granitic sand, can display and maintain very high biotic integrity" (Wisseman 1997).

For purposes of this TMDL, the loading capacity is set at that amount of sediment Reeder Reservoir would receive under natural conditions. No significant delivery of sediment to Reeder Reservoir above that which would occur naturally is permitted.

Long-term monitoring and the adaptive management nature of this TMDL will be used to evaluate this goal over time. It is recommended that in addition to monitoring sedimentation in East and West Forks of Ashland Creek, the Reeder Reservoir catchment basins be monitored to determine trends in sediment delivery and to determine potential sediment sources. Monitoring of stream cobble embeddedness or percent fines (through Wolman pebble count method) and monitoring that continues to incorporate macroinvertebrates as trend indicators for sedimentation in the East and West Forks of Ashland Creek is requested.

Table 1. Sedimentation TMDL Component Summary

Waterbodies **OAR 340-042-0040(4)(a)**	Ashland Creek Analytical Watershed draining into Reeder Reservoir above Hosler Dam on Ashland Creek at River Mile 4.2. (Portion of 5th field HUC 1710030801)
Pollutant Identification **OAR 340-042-0040(4)(b)**	Sedimentation. *Anthropogenic Contribution:* excess inputs of fine sediment and coarse sediments.
Beneficial Uses **OAR 340-042-0040(4)(c)** **OAR 340-041-0007(13)**	Beneficial use affected by sedimentation includes resident fish and aquatic life, salmonid fish spawning and rearing.
Target Criteria Identification **OAR 340-042-0040(4)(c)** **OAR 340-041-0009(1)(a)(A)** **OAR 340-041-0009(1)(a)(B)** **CWA §303(d)(1)**	Applicable Water Quality Standards: Sedimentation OAR 340-041-0007(13) "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed."
Existing Sources **OAR 340-042-0040(4)(f)** **CWA §303(d)(1)**	*Anthropogenic sources of sediment:* • Surface erosion from roads • Road stream crossings
Seasonal Variation **OAR 340-041-0040(4)(j)** **CWA §303(d)(1)**	*Time period of interest:* Year-round. Sediment inputs are dependent on quantity and intensity of precipitation. Winter is the time of maximum sediment input and maximum movement of sediments through the system. Impacts from sediment are yearlong.
TMDL Loading Capacity **CWA §303(d)(1)**	The loading capacity is set at that amount of sediment Reeder Reservoir would receive under natural conditions. No significant delivery of sediment to Reeder Reservoir above that which would occur naturally is permitted.
Allocations **OAR 340-042-0040(4)(e)** **OAR 340-042-0040(4)(g)** **OAR 340-042-0040(4)(h)** **40 CFR 130.2(f)** **40 CFR 130.2(g)** 40 CFR 130.2(h)	The TMDL is divided into allocations to point sources (waste load allocations) and nonpoint sources (load allocations). Allocations apply year round. *Waste Load Allocations (Point Sources)*: There are currently no NPDES-permitted point source discharges of sediment within the Ashland Creek Watershed above Reeder Reservoir. *Load Allocations (Nonpoint Sources)*: The Rogue-Siskiyou National Forest and the City of Ashland are both allocated a load of no significant measurable increased delivery of sediment to Reeder Reservoir over that which would occur naturally.
Surrogate Measures **OAR 340-041-0040(5)(b)** **40 CFR 130.2(i)**	The sediment loading capacity surrogate for all streams draining into Reeder Reservoir is that amount of sediment resulting in <33% cobble embeddedness in East and West Fork of Ashland Creek. The monitoring of percent fines using a modified Wolman pebble count method can be used to ensure that fine sediment inputs are not increasing in the system.
Margins of Safety **OAR 340-042-0040(4)(i)** **CWA §303(d)(1)**	Implicit margins of safety in the form of conservative loading capacity assumptions were used where appropriate.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Incorporated into the margin of safety.
Water Quality Standard Attainment Analysis **CWA §303(d)(1)**	The implementation of BMPs to achieve a natural conditions sediment delivery regime will result in meeting the sedimentation standard.
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 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.

INTRODUCTION

This TMDL Summary seeks to clearly address the elements required by EPA to meet the requirements for Total Maximum Daily Load (TMDL) development for sedimentation for Reeder Reservoir located within the Ashland Creek analytical watershed. These elements are addressed in this TMDL with references to the accompanying Water Quality Management Plan (WQMP). The TMDL and WQMP were prepared by the Oregon Department of Environmental Quality (DEQ) with assistance from state, federal, and local partners (Table 1).

Subwatershed Description and Ownership

The Ashland Creek Analytical Watershed encompasses an area of approximately 18,790 acres in the Bear Creek watershed. This TMDL applies only to East and West Forks of Ashland Creek and the several small unnamed creeks that drain into Reeder Reservoir. East and West Forks comprise a total area of 12698 AC, (20.48 sq miles). East Fork Ashland Creek 5232 AC (8.81 sq miles) and West Fork Ashland Creek 7466 AC (11.67 sq miles) (USFS, 1987). Within this area approximately 160 acres are owned by the City of Ashland, the remainder are Federal Lands managed by the Rogue Siskiyou National Forest (Figure XX). The watershed is located in the Klamath Mountains Physiographic Province and ranges in elevation from 2870ft at Hosler Dam to 7533 feet at the top of Mount Ashland (USFS, 1987).

Sensitive Beneficial Use Identification

The Oregon Environmental Quality Commission (OEQC) has adopted numeric and narrative water quality standards to protect designated *beneficial use*s (Administrative Rules OAR 340–041–0271, Table 271A, November 2003). In practice, water quality standards have been set at a level to protect the most sensitive beneficial uses and seasonal standards may be applied for uses that do not occur year-round. The beneficial uses affected by excessive sedimentation include Fish and Aquatic Life and Fishing (DEQ, 2005) (Table 2).

Table 2. Temperature Sensitive Beneficial Uses (OAR 340-041-0271, Table 271A)

Beneficial Use	***Bear Creek Mainstem***	***Bear Creek Tributaries***	***Beneficial Use***	***Bear Creek Mainstem***	***Bear Creek Tributaries***
Public Domestic Water Supply[1]	**	✓	Commercial Navigation & Trans.		
Private Domestic Water Supply[1]	✓	✓	Fish and Aquatic Life[2]	✓	✓
Industrial Water Supply	✓	✓	Wildlife and Hunting	✓	✓
Irrigation	✓	✓	Fishing	✓	✓
Livestock Watering	✓	✓	Water Contact Recreation	✓	✓
Boating	✓	✓	Hydro Power**		✓
Aesthetic Quality	✓	✓			

**Note: Designation for this use is currently under study

3. With adequate pre-treament (filtration and disinfection) and natural quality to meet drinking water standards
4. See Figures 271A and 271B for fish use designations for this watershed.

Deviation from Water Quality Standards and 303(d) Listings

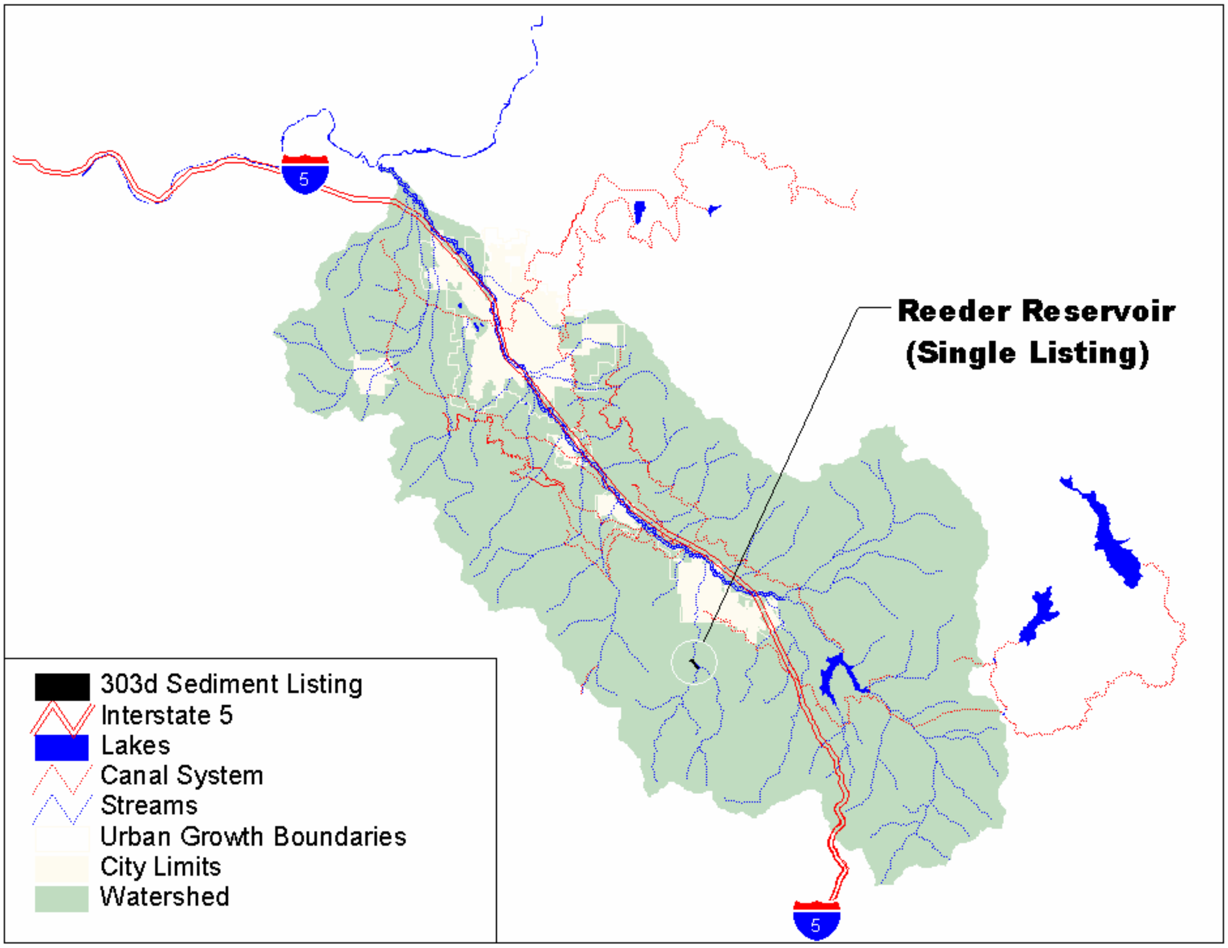
Reeder Reservoir is included on the 2004/2006 303(d) list for sedimentation due to a USFS Watershed Assessment (USFS 1995) that stated “excessive sedimentation requires periodic sluicing of Reeder Reservoir to provide storage for drinking water supply (Table 3, Map 1).

Table 3. 2004/2006 303(d) listed waterbodies for sedimentation.

Stream Segment	**Listed Parameter**	**Applicable Rule**	**River Mile (Ashland Creek)**

Stream Segment	Listed Parameter	Applicable Rule	River Mile (Ashland Creek)
Reeder Reservoir	Sedimentation	*OAR 340-041-0007(13)*	4.9-5.4

Map 1. 303(d) Sedimentation Listed Waterbodies in the Bear Creek Watershed



Water Quality Standard Identification

State of Oregon water quality standards related to sedimentation include:

> <u>*Sedimentation*</u> *OAR 340-041-0007(13)* - “The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed.”

Pollutant Identification

The sediments found in Reeder Reservoir consist of both coarse and fine sediments which can be attributed to surface erosion, debris flows/slides, and stream channel erosion (USFS, 1995). This sediment has negative effects to the streams above and fisheries habitat below the reservoir (USFS, 1995). Fine sediments can adversely affect fish and other aquatic organisms by: 1) killing salmonids, 2) reducing growth, or reducing disease resistance; 3) interfering with the development of eggs and larvae; 4) modifying natural movements and migration of salmonids, and 5) reducing the abundance of food organisms (Newcombe and McDonald, 1991).

Note: This TMDL addresses only depositional sediment. There are currently little data or evidence that the listing should be broadened to address suspended sediments (e.g., turbidity).

Photo 1. Hosler Dam and Reeder Reservoir.

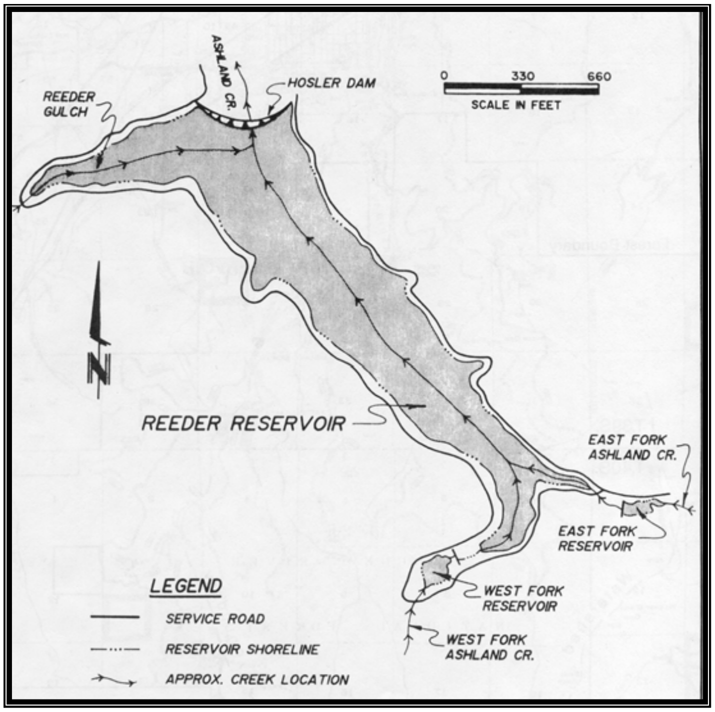
Photo Credits: Fred Stockwell for Ashland Daily Tidings 2005

Historical Influences

The City of Ashland has used the waters of Ashland Creek for domestic water supply, power, and irrigation since the late 1850's. There was some logging in the watershed in the late 1800's utilizing sawmills located at present sites of Lithia Park and Reeder Reservoir. In 1893 President Cleveland proclaimed the Ashland Watershed a Forest Reserve. Wood production was allowed in the reserve with the primary objective being the maintenance of water quantity and quality. The Ashland Reserve was closed to camping in 1906 and closed to grazing in 1907. In 1908 a power plant was constructed in what is now known as upper Lithia Park. The East and West Forks of Ashland Creek were impounded and water was routed by a pipeline for power production. The completion of Hosler Dam in 1928 impounded the waters of Ashland Creek creating Reeder Reservoir with a storage capacity of 850 acre feet (about 280 million gallons)(Photo 1, Map 2).

A Cooperative Agreement between the City of Ashland and the Secretary of Agriculture in 1929 was made for the purpose of conserving and protecting the water supply of the City. A filtration plant was built in 1950 and expanded in 1967. Roads were constructed in 1956 to facilitate harvesting of timber in the late 1950's and early 1960's. Wildfire has historically been a significant threat to the watershed and in 1959 a 4,700 acre fire advanced into the area. The two historic major storms of 1964 and 1974 resulted in the release of significant volumes of material which was trapped behind the dam and later removed from the reservoir. No commercial harvesting has occurred in the watershed since 1965. Some administrative timber sales in the 1980s created shaded fuel breaks for fire control. The Mt Ashland Ski Area was developed and completed in 1964. During the first few years following the development some severe erosion occurred in the clearings for the ski runs and lift areas (USFS, 1995).

Map 2. Reeder Reservoir



Sedimentation History

The sedimentation history of the reservoir is dominated by the storm events in 1948, 1955, 1964, and 1974. The 1974 flood yielded the largest volume of sediment, but the 1964 storm may have produced a similar amount. It is important to note that sound, quantitative data regarding sediment volumes is limited to the period from 1976-1987, and to the 1974 storm event. The rest of the information is qualitative and in some cases based on memory or visual observations (USFS, 1987).

- 1927-1947: No major sediment-producing storms occurred during this time period. Deposition was probably dominated by silt with minor sand delivered from Reeder Gulch and when the east and west fork reservoirs were cleaned.
- 1948: A large storm delivered sediment to the reservoir, and the water was unpalatable for a month. This suggests that a large amount of fine sediment was delivered and remained in suspension, but the amount of coarse sediment is unknown.
- 1949-1954: No large sediment influxes, therefore, mostly silt deposition occurred.
- 1955: Flood flows probably delivered considerable sediment to the reservoir. The water was acceptable for domestic use with filtration. Quantitative data regarding sediment volumes apparently does not exist.
- 1956-1961: No large sediment influxes, therefore, deposition was limited to silt.
- 1962: Several large storms occurred this year. In March a slide occurred in the Weasel Creek Drainage.
- 1963: Silt deposition occurred
- 1964: This was a very large sediment-producing storm that closed down the city plant. Though definitive data has not been found, it appears that this storm was less severe than the 1974 event in terms of sediment delivered to the reservoir.
- 1966-1973: City cleanout information indicates that 230,000 cubic yards of sediment were removed from the reservoir. 70,000 cubic yards were sluiced out of the reservoir in 1973.
- 1974: This was a historically unprecedented (?) depositional event in which approximately 130,000 cubic yards of sediment was delivered to the reservoir as determined by surveyed cross sections. City cleanout information indicates that 198,000 cubic yards were removed from 1974 - 1976.
- 1975: Remobilization of alluvial zone sand and silt allowed by reservoir drawdown. Sluicing also moved sediment toward dam and drain (only about 6,000 cubic yards).

- 1976: Remobilization of alluvial zone sediments caused by reservoir drawdown, and subsequent sluicing of about 70,000 cubic yards of sediment. It is interpreted that this sediment represents the balance of the 1974 storm deposits.
- 1977-1981: Silt deposition. It appears that the reservoir was not drawn down during these years. In 1981, cleanout of the east and west fork reservoirs delivered a small amount of sand to the upper part of the reservoir.
- 1982-1985: Silt deposition. A drawdown occurred some time between 1982 and 1984, allowing mobilization of sands and silts in the alluvial zone.
- 1986-1987: Silt deposition. Drawdown in 1986 and sluicing of about 17,000 cubic yards of material.
- 1996-1997. During December 1996/ January 1997 heavy rains released a significant amount of material as debris landslides throughout the watershed. The East and West Forks Ashland Creek and Reeder Gulch all received between 40,000 and 50,000 cubic yards of material that was removed by trucks immediately after the flood (City of Ashland, Personal Communication 1999)
- 1999: The amount of material within the reservoir appears to be within 12,000 cubic yards and did not warrant bringing in a dredge. (City of Ashland, Personal Communication 1999)
- 2000: Approximately 40,000 cubic yards of material was removed by trucks from the upper end of the reservoir (City of Ashland, Personal Communication 1999).

Historical Grazing Practices

Overgrazing by sheep and cattle during the mid to late 19th century occurred over much of the high Siskiyou Mountains, creating bare soil conditions in most of the high mountain meadows (Laurent 1994, Vance 2000). Between 1870 and 1890, extensive sheep grazing took place in the meadows on both north, and south slopes of Mt. Ashland (Brown 1989). By the turn of the century, drift fences had been installed to prevent cattle from moving into the watershed (Crater/Rogue River National Forest Historical Grazing Records 1915 – 1950). Historical photos taken below and east of the rental shop at Mt Ashland in the 1960s, before the ski area was developed, show the effects of overgrazing on meadows. These photos show sparse soil cover and well-established rill and gully systems. With the loss of vegetative cover and the high soil disturbance by sheep trampling, it is believed that the topsoil has eroded away during summer thunderstorms (Vance 2000). Reestablishment of vegetation has been slow to occur because of poor soil conditions, harsh climate, and gopher activity. A century after this disturbance ended, many impacted areas still have not recovered (USFS, 2004).

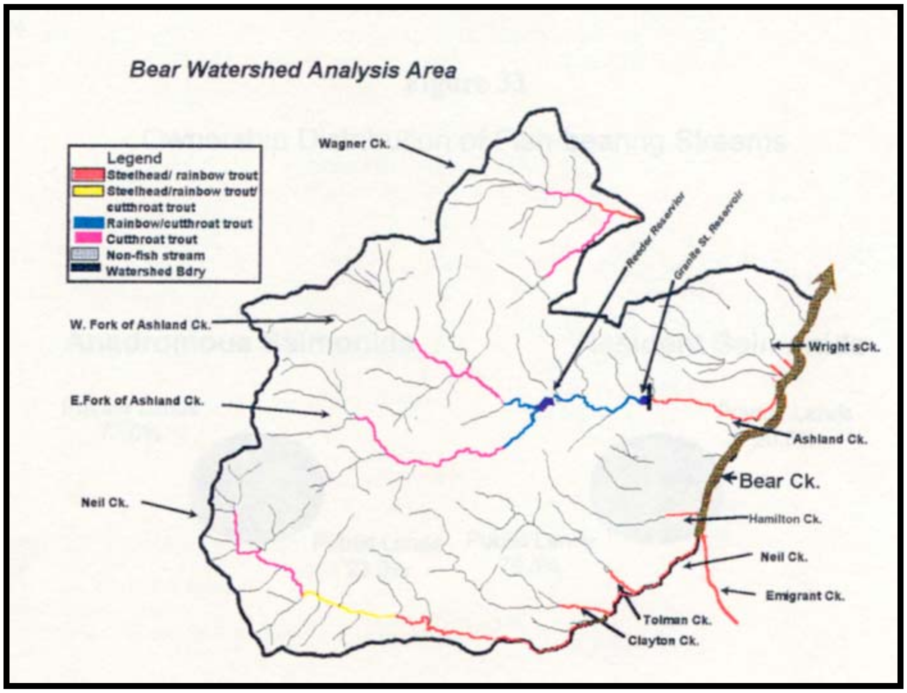
The meadows in upper Ashland watershed have undoubtedly once experienced these extreme grazing pressures, but have had more time to recover due to the near total exclusion of cattle grazing over the past one hundred years. Annual erosion rates in meadows where vegetative cover is still low (<75% cover) could be as high as 100 times the natural rates of erosion occurring under a forested environment (USFS, 2004).

CURRENT CONDITIONS

Fish Usage

Ashland Creek contains a diversity of fish and aquatic life. Steelhead spawn in the lower reaches of Ashland Creek up to the Granite Street Reservoir (River Mile 3)(USFS, 2004). Rainbow trout and cutthroat have been observed in both East and West forks of Ashland Creek in approximately the first mile of habitat. The rainbow are presumably remnant populations of past steelhead runs before Hosler Dam was constructed in 1928. East and West Forks of Ashland Creek have healthy populations of resident cutthroat trout. In both of these streams hybridization between rainbow and cutthroat has been observed (USFS, 1995). Coho salmon have historically spawned and reared in the tributaries and mainstem of Bear Creek including the lower 3 miles of Ashland Creek (Map 3).

Map 3. Fish Usage in Ashland Watershed



There are no fish species present that are proposed or listed under the Endangered Species Act (ESA) above the Granite Street Reservoir including East Fork, West Fork, and the mainstem of Ashland Creek. However, this area was deemed as potential and/or historic coho habitat, Southern Oregon Northern California (SONC) coho salmon critical habitat and coho essential fish habitat. Due to the municipal water developments, Granite Street Reservoir and Reeder Reservoir and associated impoundments, it is unlikely that coho will re-occupy this habitat (USFS, 2004). Federal Endangered Species Act (ESA) status of these fish species is as follows: Southern Oregon Northern California (SONC) coho salmon - listed as Threatened by the National Marine Fisheries Service (NMFS), May 1997. Critical habitat designated by National Marine Fisheries Service (NMFS) in May 1999.

Macroinvertebrates

The US Forest Service and BLM contracted macroinvertebrate surveys in West and East Forks of Ashland Creek during 1995. Bob Wisseman, contractor, states "The East and West Forks of Ashland Creek above Reeder Reservoir can serve as reference sites for the region, and more specifically, for granitic watersheds in the area. These can also be classified as old-growth control sites, although there has been some logging and road building activity in the watershed in the past." Mr. Wisseman states that the habitat is in excellent condition: "What this site, and a handful of others in SW Oregon demonstrates, is that a granitic watershed, where stream channels are naturally storing and transporting high amounts of coarse, granitic sand, can display and maintain very high biotic integrity" (Wisseman 1997).

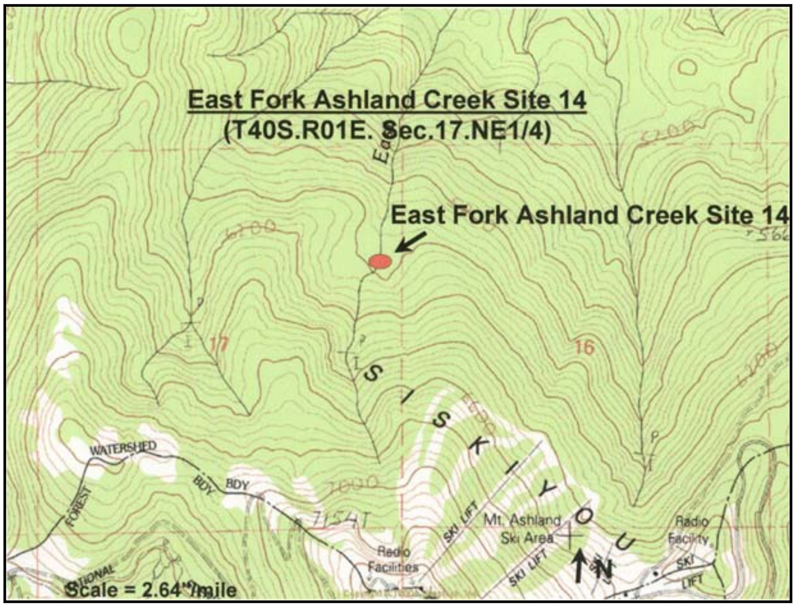
A 1999 survey by Wisseman showed similar results at the same sites. Mr. Wisseman stated in his 1999 report that the site surveyed on East Fork (T40S, R01E, Sec17 NE1/4 – headwaters of East Fork of Ashland Creek) had very high index scores (>90 percent) for all three aquatic insect habitat types (erosional, margin, and detritus). "This is not often encountered. This, combined with the high proportion of rare and small stream associated taxa, identify this stream as a unique resource. It was noted that there are many rare taxa present at this site that may eventually become candidates for sensitive taxa. The *Salmoperla* record is only the second known collecting locale for Oregon. This is a rare stonefly that has a good chance of being listed as Sensitive in the future. The caddisflies *Homophylax, Eocosmoecus frontalis* and *Palaeagapetus* are rare and may eventually become sensitive taxa" (Wisseman 2000).

Two sampling sites were setup on East Fork Ashland Creek: 0.5 miles upstream from Forest Road 2060 and 500 feet up the East Fork of Ashland Creek. One sample site was established on West Fork of Ashland Creek T40S, R1E, Sec 7, approximately 400 feet upstream from Forest Road 2060.

Additional Macroinvertebrate trending information was conducted by Schroeder, 2000. Schroeder visited a site on Upper East Fork of Ashland Creek in 1998, 1999, 2000 (Map 4). Summary results state:

- Except for lower scores reported in 1998, scores were high to very high during the sample period (1998-2000).
- Scores for the erosional and detritus habitats were improved by an increased richness of total taxa and abundance of positive indicators in these habitats. Scores in the margin habitat declined due to decreased richness of total taxa, most notably positive indicators.
- Taxa richness was generally moderate to high indicating adequate substrate complexity and or coarse particulate organic matter (CPOM) retention.
- Class O taxa were abundant indicating summer temperatures are not limiting.
- Although the percentage of collector taxa declined during the sample period, a moderate percentage of collector taxa in all habitats suggests excessive FPOM (fine sediment) inputs.

Map 4. Upper East Fork Ashland Creek Macroinvertebrate Monitoring Site (Schroeder, 2000).



POTENTIAL SOURCES

Roads

Road density, use, design, and location can be important in affecting the extent and magnitude of road-related sediment impacts (Reiter *et. al*., 1995). King and Tennyson (1984) observed altered hydrology when roads constituted more than 4% of the drainage area. This correlates to approximately four miles of road per square mile of area (4 mi/mi^2). Current road density in the East and West Forks of Ashland Creek is 1.90 mi/mi^2 (USFS, 2004). Other studies evaluating storm response to road construction indicate sediment effects begin when over 15% of the area is road surface. Results are extremely variable because the effects of roads are not well defined and are difficult to detect, especially as the size of floods increases (Grant, Megahan, and Thomas, 1999).

USFS roads

Historically the Forest Service roads within the Ashland Creek watershed have contributed to the sediment deposits in Reeder Reservoir. However, the time during which these roads produced the most sediment was during the first two or three years after they were constructed. Construction of roads began in 1956 for timber removal, most logging occurred in the late 50's and 60's. No roads have been constructed in the watershed since that time. The majority of cut and fill slopes have been stabilized by vegetation.

The distance of most roads from transporting channels minimizes the sediment contribution from roads into Reeder Reservoir. However, it is not known how much sediment originating from roads does, in fact, enter stream channels. Additional long-term field data will be required before any quantitative information can be developed regarding Forest Service roads as a source of sediment in the reservoir (USFS, 1987).

In addition to road density, consideration must also be given to where roads are located on the hill slope (upper , middle or lower third), the number of stream crossings, and the miles of road within the transient snow zone. These additional parameters are important hydrologically because roads function in two specific ways; 1) as surface flowpaths able to channel appreciable volumes of runoff and, 2) as an integrated component of the stream network (Wemple, 1994).

The total current road miles within the East and West Fork Ashland Creek watershed is 17.5. Fifteen miles of the 17.5 miles correspond to Road 2060. Road 2060 is located primarily midslope and has eight stream crossings. Over 50% of the road miles are located within the transient snow zone, the elevation band from 3,500-5,000 feet, where rain-on-snow-events are most likely to occur (Table 4).

Table 4. Roads Density in the Ashland Creek Analytical Watershed*

Ashland Creek Drainage	Current System Road Density* Miles/square mile	Average Watershed Slope (percent)
East Fork	2.1	12.8
West Fork	1.7	12.4

* Classified Roads only (USFS, 1999).

City Roads (Reeder Reservoir Access Roads)

The City of Ashland maintains the approximately 2.2 miles of natural surface roads surrounding Reeder Reservoir. A USFS survey concluded that cutslopes on the road surrounding the reservoir often exposes the more erodable mafic materials (dark, iron rich minerals) a source of potential sediment sloughing onto the road (USFS, 1987). Backslopes of the roads are mostly raw and unvegetated on the northeast banks (i.e., those facing the southwest). Those on the southwest banks have more protective vegetation due to their northerly exposure and higher moisture content (USFS, 1987).

Many raw areas below berms indicate that road surface material has spilled or been forced over the outside edge of the berms over time. In some locations stumps and logs have been buried within berm (which weakens their structure). Berms are not vegetated with grasses, shrubs and trees which stabilize soils. In the past during sluicing projects decomposed granite has been hauled in, placed on the road and graded thereby contributing additional material to the raw berms (1986 sluicing). Wave action has washed away soil below berms and there is evidence of movement of water on the bank edges due to wind or lowering of water levels. These areas are stabilized by roots and vigorous vegetation if present. As roots die or the area is exposed or disturbed, slopes tend to fail into the reservoir.

In some areas slide and slough waste material has been hauled and dumped on the inside edge of the roads. These sites may be the primary contributor to sediments into the reservoir from the service roads (USFS 1987). Water discharge points occur in many locations along roads. These are found in low vertical curves in the basically flat road. Erosion is occurring in the walls of the reservoir immediately below these discharge points since these areas are not rocked to disperse energy nor do they have protective downspouts to carry water to an appropriate water level.

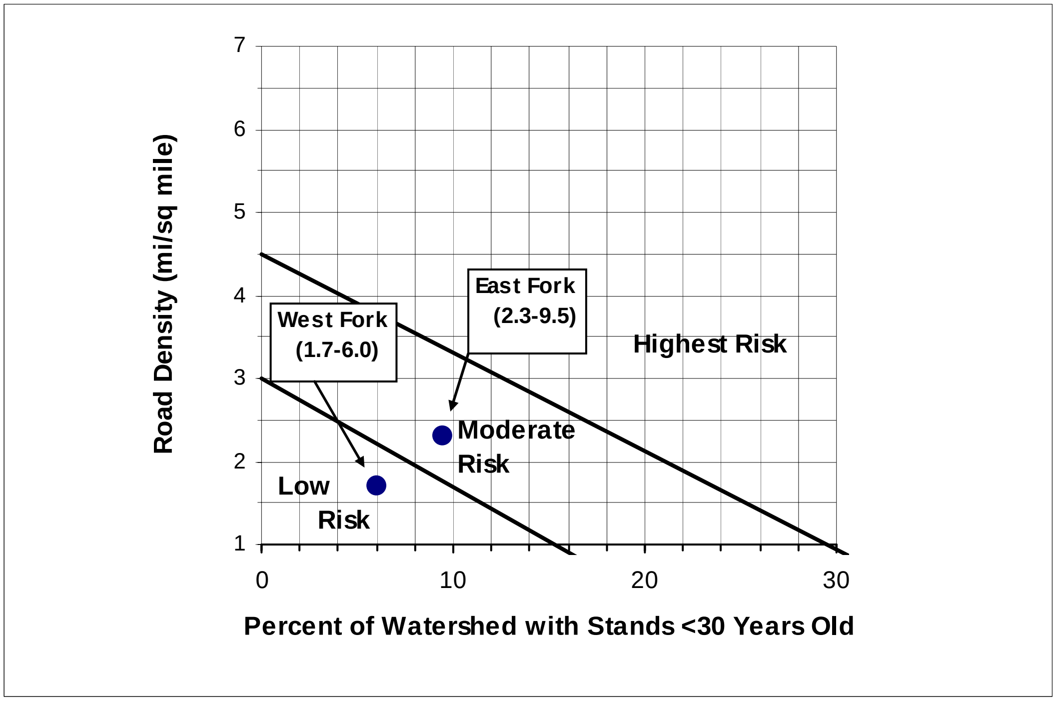
Watershed Condition (Cumulative Effects)

According to the Region 6 USFS methodology for determining risk of cumulative watershed effects (CWE) (USFS, 1993), the probability of experiencing negative effects (i.e. increases in runoff and/or sediment) increases with the amount of watershed that is harvested and roaded. The cited USFS methodology utilizes a Watershed Risk Rating based on three factors: average watershed slope (<30%), road densities, and the percent of watershed with timber stands less than 30 years of age (hyrologically immature vegetation). Road densities and slope are discussed in the section above (Table 4). Hydrologically immature vegetation is defined as stands less than 11 inch diameter breast height (dbh) and stands greater than 11 inch dbh with less than 50% canopy closure (based on "mature habitat" definition, RRNF 1988 Vegetation Update, W.K. Bruckner).

Currently West Fork Ashland Creek has 6.0 % hyrologically immature vegetation and East Fork has 9.5%. Both East and West Forks receive a “GOOD” rating based on the following criteria: "Good" indicates less than 15% of the watershed contains stands less than 11 inch diameter breast height (dbh) and stands greater than II inch dbh with less than 50% canopy closure, 'Fair" would indicate 15%-30% of the watershed contains less than 50% canopy closure, and a "Poor" rating would indicate greater than 30% of the watershed contains less than 50% canopy closure.

Combining data from road densities, and hydrological maturity, the overall East Fork Ashland Creek Watershed Risk Rating is considered “MODERATE”, the West Fork Ashland Creek Risk is considered “LOW” (Figure 1).

Figure 1. Watershed Risk for East and West Forks Ashland Creeks (USFS, 1999)



Stream Crossings

The potential for sediment input to streams is greatest where roads cross drainages. The sediment derives from road surface, ditch line, cut slope, and fill slope erosion, which is routed directly into the stream. The total current road miles within this watershed is 37.4 (East Fork 17.5, West Fork 19.9). There are 31 stream crossings within the watershed (8 East Fork, 23 West Fork) (USFS, 1995) (Table 5).

Within the East Fork 15 miles of the 17.5 miles of roads correspond to Road 2060. Road 2060 creates a large potential for intercepting subsurface flow along road cutbanks and routing it along ditches and through culverts to pre-existing and/or new channels. The road's hill slope position also runs a moderate risk of incising new channels below some culvert outlets. These effects were demonstrated during the January, 1997 storm event. Four culverts failed during the storm (this represents a 50% failure rate for stream crossings on Road 2060) causing overland flow along the roadway, eventually incising new channels (gullies) and/or causing road failure (USFS, 1999).

Table 5. Number of Drainage-Ways Crossed by Roads

Watershed	Stream Class	Number of Drainage-Ways Crossed*
East Fork Ashland Creek	1 2	6 2
West Fork Ashland Creek	1 2	17 6

* Does not include roads managed by the City of Ashland.

Fire

In the event of a large scale wildland fire within the watershed, there would be an increase in the amount of sediment entering Reeder Reservoir (USFS, 2005). Low intensity prescribed fires have been implemented in the Bear Watershed Analysis Area to keep fire risk at reduced levels in the watershed, especially in the area near the

City of Ashland, and to maintain ponderosa pine communities in the Ashland Research Natural Area. Even though soils are highly erosive and susceptible to mass wasting, prescribed fires have been implemented with low intensity, late winter and spring burning prescriptions which leave enough organic matter to keep the soils in place. Even though prescribed fires are of low intensity, there are areas within treatment units which burn with higher intensity (due to areas where fuels are more concentrated) leaving localized areas where soils and slope stability are adversely affected. However, since prescribed fires and hazard reduction reduce the likelihood of large scale stand replacing fires this is an acceptable tradeoff. If a catastrophic fire event occurred in the Analysis Area duff layers and vegetation would be destroyed over a large area leading to a significant increase in soil erosion and landslides. High intensity wildfires can burn with sufficient intensity to destroy tree roots and most the organic material covering the fragile soils (USFS, 1995) resulting in accelerated erosion exceeding the range of variability (USFS, 1999).

Sedimentation

Both East and West Fork Ashland Creek stream substrates are generally embedded with fine and coarse sediment throughout most of the stream system. However, the higher elevation, steeper gradient streams located above road construction and timber harvest activities are likely to resemble historic levels of stream embeddedness. These areas include the East and West Forks of Ashland Creek and Weasel Creek above Forest Road 2060 (USFS, 1995; East and West Forks Ashland Creek USFS, 1999). A Level II report prepared by the Siskiyou Research Group (Siskiyou, 2001) states that the aquatic habitats in West Fork Ashland Creek are diverse and generally of good quality but do appear to suffer from sedimentation and embeddedness. Aquatic habitats in the East Fork contain large amounts of sand as well (from 10-19%, Tioga Resources, 1997). Wolman Pebble Count data from most recent surveys from East and West Forks just above Reeder Reservoir indicate an average of 13% for East Fork (1996 10%, 1997 16%), and 12% (riffle habitat) for West Fork (Siskiyou, 2001). The surveys for percent fines employed a Wolman pebble Count method and included all materials <=2mm diameter. A 1997 survey (Tioga Resources, 1997) found high cobble embeddedness (70% for West Fork, 50% for East Fork) suggestive of excessive transport of fine sediment (Table 6).

Table 6. Substrate Characteristics in East and West Forks Ashland Creeks

Watershed	Substrate Condition	Percent Fines[2] (Just upstream of Reeder Reservoir)
East Fork Ashland Creek	[1]Embedded	13%
West Fork Ashland Creek	[1]Embedded	12%

[1]Embedded refers to >33% embeddedness.

[2] Percent Fines includes all materials <=2mm in size (Silt, Clay, Fine- Medium- Coarse- Very Coarse Sand) as determined by a Wolman Pebble Count procedure.

A target of 20% (maximum) streambed fines in spawning areas (riffles and glides) has been used as an indicator of fine sediment impairment in some areas of Oregon (DEQ Nestucca TMDL, 2002). It is based on documentation that formed the basis for interim guidance for managing federal lands (PACFISH), ODFW habitat benchmarks (Foster et al, 2001), and other studies of sediments in salmonid habitats (Phillips et al, 1975; Hausle and Cobel, 1976; McCuddin, 1977; Bjornn and Reiser, 1991; Rhodes, 1995; Anderson et al,1992; Rhodes et al, 1994). The 20% target is useful for East and West Forks of Ashland Creek below Road 2060. Above Road 2060, the percent fines target is not a useful determinate of the presence of stream fines because in the high gradient system that exists in these areas the sand-sized and finer sediment is largely transported downstream through high shear-stress zones such as riffles and glides, and is either deposited in pools or is carried to the reservoir. Similar conditions have been found in a neighboring watershed. In Applegate Valley just to the west of Ashland, in Beaver Creek, finer granitic sediment is transported downstream due to gradients resulting in low percent fines measurements (USFS – Mike Zan personal communication 2003).

Another useful indicator of excess sediment in the Ashland Creek system is embeddedness. Embeddedness is a measurement of the average proportion of gravel/cobble substrate that is buried, or embedded, by fine sediments. While low percentages of surface fines were found in riffle and glides in East and West Forks of Ashland Creek, sediment embeddedness of spawning and macro-invertebrate habitat (gravels and small to medium cobbles) has been found to be widespread (USFS, 1999, Schroeder, 2000). Biological activity in the gravel/cobble substrate, whether the incubation of salmonid eggs or the early stages of the lifecycle of many macro-invertebrates, depends on the maintenance of inter-gravel flows for the replenishment of nutrients and oxygen, and the removal of metabolic wastes. Unacceptable embeddedness refers to the filling of these inter-gravel, or interstitial spaces to the point where the processes of nutrient and oxygen replenishment and waste removal are disrupted resulting in the suffocation of eggs, the trapping of emergent fry, and the reduction in diversity and numbers of desirable but highly sediment-sensitive taxa, such as caddisflies. Above this condition, however, insect populations decline substantially as habitat spaces become smaller and filled. Studies by Bjorn et al (1974, 1977) concluded that approximately one-third embeddedness (33%) or less is probably the normal condition in proper functioning streams. Current recommendations consider a stream impaired when cobble embeddedness of a particular riffle or glide reaches or exceeds 33% (USFS, 2003 Su Maiyo personal communication, USFS, 1994 Level II Handbook)..

Erosion and Debris Slides

Granitics are widely recognized as one of the most erosive rock types, and natural erosion of the slopes of the watershed occurs continuously. Much of the coarse material is caught and stored in stream channels and in natural basins. A major storm is usually required to move these larger size materials downstream to the reservoir. However, the silt-size materials and organic debris are constantly transported downstream by normal stream flows (USFS, 1987).

Since Hosler Dam was built in 1929 many debris slides have occurred in the watershed. These resulted in sediment eventually being transported into the reservoir. This sediment source was a significant contributor to the sand-and-gravel-size materials deposited in the reservoir during the 1964 and 1974 storms. In non-major storm years the number and size of debris slides have been less. Much of the sediment is held in stream storage, i.e. "stored" behind rocks and other obstructions in streams above the reservoir. For the most part, this trapped sediment remains in storage in stream channels until large storms (of the 1964 and 1974 size) flush it downstream. In 1983 a debris slide occurred above the West Fork of Ashland Creek. This natural slide released approximately 25,000-30,000 cubic yards of material, some of which was deposited into the upper West Fork of Ashland Creek system (USFS, 1987).

Approximately 17,000 cubic yards of sediment was sluiced from the floor of Reeder Reservoir in 1986. This material contained both coarse and fine sediments which can be attributed to surface erosion, debris flows/slides and stream channel erosion. Sampling of these sediments prior to cleanout showed that only 10,000 cubic yards were deposited between 1976 and 1987. Another 11,000 cubic yards of silt was deposited in other areas of the reservoir and was not removed by sluicing in 1987. Thus from 1976-1986 the total amount of sediment delivered to the reservoir was 21,000 cubic yards. This amounts to approximately 0.16 cubic yards per acre per year, however most of these years were of low rainfall or drought (USFS, 1995).

Landslide Hazard Zonation (LHZ) is a technique used by Forest Service geologists to assess slope stability of the terrain in the Ashland Creek area as part of a proposed expansion of the Mt Ashland Ski Area (see Appendix E, and Table III-1, page III-2 of the 1991 FEIS for descriptions of each hazard zone). Following the January 1997 flood event, the Landslide Hazard Zonation mapping was reassessed at lower elevations of the Ashland Creek Watershed, in conjunction with the Ashland Watershed Protection Project. This allowed the Forest Service geologist to compare the initial Hazard Zonation map to where the 1997 landslides and severely eroded areas had actually occurred. A majority of the 1997 failures and erosion proved the prior LHZ mapping to be a confident prediction of where the high-risk terrain was located. Most new landslides occurred in the highest hazard zone (Zone 1), but some also occurred in the lower portions of the second highest hazard zone (Zone 2) (USDA FS 2001c). No new landslides were initiated within the Study Area following the 1997 flood.

Mt Ashland

Mt Ashland Ski Area is a developed ski area on Mt Ashland in the headwaters of Ashland Creek. The area is located within the Rogue River National Forest and it is authorized by the Forest Service under a special use permit. The developed portion of the permitted area occupies 95 acres or less than 1 percent of the Ashland Creek drainage basin. There was a considerable amount of soil and vegetation disturbance when the area was constructed in 1963-1964. During this time, the construction of roads and parking lots accounted for over three quarters of the soil erosion that would have taken place during the 1960s (USFS, 1987). As some access roads were abandoned and permanent roads and parking lots stabilized, the amount of erosion decreased and this accounts for lower rates of soil erosion in the 1970s. In 1988 the parking lot was paved, sediment dams installed and eroding gullies were lined with rock. An increase in overall erosion in the 1990s was due to the ground modification primarily associated with Upper Dream and Upper Avon runs, although there is no evidence of sediment transport to streams and both areas are now revegetated with native grass (USFS, 1995).

At the time of the writing of this document a final Record of Decision (ROD) for the Mt Ashland Ski Expansion has been released (USFS, September 2004). The document details the expansion plans for Mount Ashland and outlines the anticipated increases in sediment delivery as determined by the Water Erosion Prediction Project (WEPP) model. Under worst case scenarios for average year conditions the model predicts the first year increase in sediment delivery over baseline rates to be 5.3 cubic yards of material total delivered to Ashland Creek. The second year sediment yield would decrease to 1.2 cubic yards total (USFS ROD, 2004). These worst case conditions assume that none of the required mitigation measures are in place, conservative growth rates for soil stabilizing vegetation, and all soil disturbances occurring in the same year. The greatest amount of sediment would be produced within the first two years after construction. With mitigation measures in place, sediment rates would decrease, eventually resulting in near background rates (USFS ROD, 2004).

TMDL - LOADING CAPACITIES 40 CFR 130.2(F)

Loading Capacity: *The loading capacity is set as the amount of sediment Reeder Reservoir would receive under natural conditions. No significant increased delivery of sediment to Reeder Reservoir over that which would occur naturally is allowed.*

Monitoring of stream cobble embeddedness or percent fines (through Wolman pebble count method) and monitoring that continues to incorporate macroinvertebrates as trend indicators for sedimentation in the East and West Forks of Ashland Creek is requested.

Numeric Target Identification and Loading Capacity 40 CFR 130.2(f)

The Environmental Protection Agency (EPA) and the State of Oregon do not have numeric water quality standards for sediment. However, excessive fine and coarse sedimentation, such as is occurring in Reeder Reservoir, is addressed through application of state narrative criteria "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed" OAR 340-041-0007(13).

For purposes of this TMDL, the loading capacity is the amount of sediment that Reeder Reservoir would receive under natural conditions. No significant increased delivery of sediment to Reeder Reservoir over that which would occur naturally is allowed.

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. EPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards.*" (40 CFR § 130.2(f)). While load allocations are traditionally expressed as "mass per time", the TMDL regulations also provide for the expression of allocations in "other appropriate measures". Given the data available, it is not possible for sedimentation to be expressed as a load other than to state that it is the amount of sediment that the reservoir would receive under natural conditions. Due to the erosive nature of soils in the Ashland Creek watershed, even under natural conditions significant amounts of sediment would move downslope into East and West Forks of Ashland Creek and the other small drainages that feed Reeder Reservoir. For the purposes of this TMDL, the loading capacity is set as the amount of sediment that Reeder Reservoir would receive under natural conditions. As defined in this TMDL, an increase in sediment load delivered to the reservoir above that which would occur naturally is not permitted.

Surrogate Measures

Although the loading capacity is defined as "the amount of sediment that Reeder Reservoir would receive under natural conditions" it will be difficult to measure and is of limited value in guiding management activities needed to solve the water quality problems of sedimentation. For East and West Forks of Ashland Creek an allocation of a surrogate measures, as provided under EPA regulations (40 CFR 130.2(i)), is appropriate.

The sediment loading capacity surrogate for all streams draining into Reeder Reservoir is that amount of sediment resulting in <33% cobble embeddedness in East and West Fork of Ashland Creek. A <33% embeddedness target has been used in other TMDLs in the region (Applegate, 2003) and has been recommended by USFS Fish Biologists, as an appropriate indicator of fine sediment impairment to salmonids (the most sensitive "resident biological community"). In addition the monitoring of percent fines using a modified Wolman pebble count method can be used to ensure that fine sediment inputs are not increasing in the system.

Long-term monitoring and the adaptive management nature of this TMDL will be used to evaluate this goal over time.

TMDL - LOAD ALLOCATIONS AND WASTE LOAD ALLOCATIONS 40 CFR 130.2(G – H)

This element divides the loading capacity between individual point and nonpoint sources and further defines the load allocation targets and margins of safety that when reached will result in achieving the TMDL loading capacity.

Loading capacity as defined previously can be split into the sum of natural background load and the allowable sediment loads from NPDES point sources and nonpoint sources plus a reserve capacity. Allowable loads are called Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources. In the sections that follow the allocations are explained and surrogate targets, where appropriate, are designated for each source. Allocations are assigned to each designated management agency (DMA) active within the watershed. As per OAR 340-042-0030(2), DMA means "a federal, state or local governmental agency that has legal authority over a sector or source contributing pollutants, and is identified as such by the Department of Environmental Quality in a TMDL".

Note that the TMDL as written does not quantify actual sediment yields for the watershed but rather takes a Best Management Practices (BMP) type approach. It is DEQs expectation that the potential for increased sedimentation will be modeled or estimated before any potential ground disturbing activity occurs and that the review process will be more clearly defined as part of developing Implementation Plans.

NPDES Point Source Waste Load Allocation

A *Waste Load Allocation (WLA*) applies to point sources. It is that portion of the loading capacity that a particular source may provide without causing the water quality criteria to be violated. There are currently no NPDES-permitted point source discharges of sediment within the Ashland Creek Watershed above Reeder Reservoir. There is a potential in the future for construction/development activities associated with Mt Ashland to require NPDES stormwater or construction permits. These permits, NPDES General 1200C, specify the rules and requirements to prevent the discharge of significant amounts of sediment to surface waters.

Non-Point Source Load Allocation

Management Agency: Rogue-River Siskiyou National Forest

The nonpoint source load allocation for the USFS lands in the watershed managed by the Rogue-River Siskiyou National Forest is no significant increase in the amount of sediment delivered to Reeder Reservoir above that which would occur under natural conditions. A Draft Water Quality Management Plan for Reeder Reservoir (USFS, 1999; also attached to this TMDL, Chapter II, Appendix E) has been submitted to DEQ and lists the proposed management measures to address sedimentation. The desired future conditions as stated by the USFS are listed below (Table 7) and recommendations to achieve these conditions are stated in USFS, 1995 and USFS, 1987.

The 1999 Draft WQMP will be reviewed based on the TMDL and the elements of the 2002 Water Quality Memorandum of Understanding between the Oregon Department of Environmental Quality (DEQ) and the U.S. Forest Service (USFS). It may need to be revised if it is determined that the WQRP does not meet the MOA or will not achieve the sedimentation TMDL load allocation.

Table 7. Desired Future Conditions USFS Lands

Desired Future Conditions – USFS managed lands
The sediment regime is more consistent with the historic range of variability
Road prisms, landing, human-caused slides and other sources are no longer sources of erosion. Priority areas are riparian zones of steep tributaries and sensitive (granitic) uplands and unstable slopes.
Soils exist in a non-compacted condition.
Active landslides and severely eroded areas which provide sediments to streams are restored. Streambanks are stable and contribute to a high quality habitat for anadromous and/or resident fisheries.
Landscapes (vegetation) are in a stable condition for maintaining slope and soil stability

Source: USFS, 1995

Management Agency: City of Ashland

The City of Ashland owns and manages approximately 170 acres within the watershed including the access road that surrounds the reservoir. The city is responsible for maintaining those lands and roads to insure that they do not contribute excess sediment loads to Reeder Reservoir to meet the TMDL load allocation of “no significant increased delivery of sediment to Reeder Reservoir over that which would occur naturally is allowed.” Previous studies have indicated that these city managed areas are a source of sediment to the reservoir (USFS, 1987, USFS, 1995). Natural background levels of both organic and inorganic sediments may negatively impact the reservoir as well. As a result of this TMDL, the city of Ashland will be required to develop a Water Quality Implementation Plan for city managed lands as per OAR 340-042-0080(3).

CRITICAL PERIOD - SEASONAL VARIATION – CWA §303(D)(1)

Section 303(d)(1) requires a TMDL to be “established at a level necessary to implement the applicable water quality standard with seasonal variations.” The critical period for the Bear Creek sedimentation TMDL is year-round, that period of time when sedimentation impairs the beneficial uses of Reeder Reservoir and downstream in Ashland Creek.

SEDIMENTATION MARGIN OF SAFETY CWA §303(D)(1)

This element accounts for the uncertainty related to the TMDL and, where feasible, quantifies uncertainties associated with estimating pollutant loads, modeling water quality and monitoring water quality.

A margin of safety is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A margin of safety is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions) Table 8.

Table 8: 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 margin of safety.
Implicit	4. Conservative assumptions in derivation of numeric targets. 5 Conservative assumptions when developing numeric model applications.

	7 Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

Explicit Margin of Safety

No explicit margin of safety has been used in this TMDL.

Implicit Margin of Safety

An implicit margin of safety results from allocating 100% of sedimentation load to natural background sources.

NOTE: The long-term monitoring and the adaptive management nature of this TMDL will be used to ensure that the Sedimentation TMDL will be met.

SEDIMENTATION REFERENCES

DEQ 2005. Assessment Methodology for Oregon's 2004 Integrated Report on Water Quality Status. ODEQ Water Quality Division. August 12, 2005.

Siskiyou Research Group, 2001. West Fork Ashland Creek 2001 Level II Stream Survey Report. Siskiyou Research Group, Post Office Box 2550, Cave Junction, OR 97523.

Tioga Resources, 1997. Bear Creek Watershed, Stream Classification and Water Quality Monitoring within the Rogue River National Forest. Level II sites, West Fork Ashland Creek, East Fork Ashland Creek, Neil Creek. Prepared by Richard K. Nawa, Ecologist. Tioga Resources Inc. Box 149, Roseburg, OR, 97470. March 1997.

USFS, 1987. Origins and Characteristics of Sedimentation in Reeder Reservoir. Rogue River National Forest, 1987.

USFS, 1995. Bear Watershed Analysis. Ashland Ranger District, Rogue River National Forest. Ashland, Oregon, 1995.

USFS. 1997 East Fork Ashland Creek Level II Survey. Ashland Ranger District, Rogue River National Forest, 645 Washington Street. Ashland, OR 97520. August 1997.

USFS, 1999. Draft CWA Section 303(d) Listing (Water Quality Listed Waters) Water Quality Management Plan (WQMP) for Reeder Reservoir. Draft Plan developed by Rogue River National Forest. April, 1999 .

USFS, 2004. DRAFT ENVIRONMENTAL IMPACT STATEMENT. Mt. Ashland Ski Area Expansion. Ashland Ranger District Rogue River National Forest Jackson County, Oregon Scott River Ranger District Klamath National Forest Jackson County, Oregon, August 2004.

USFS, 2004. Record of Decision. Mt. Ashland Ski Area Expansion. Rogue River – Siskiyou national Forest Ashland ranger district. September 2004

USFS, 2005. Draft Environmental Impact Statement. Ashland Forest Resiliency. Ashland Ranger District. Rouge-Siskiyou National Forest. June 2005.

Whiteall, Debra. 1999 (East Fork). Ashland Watershed Protection Project Cumulative Watershed Effects Analysis East Fork Ashland Creek. Rogue River National Forest. April 1999

Whiteall, Debra. 1999 (West Fork). Ashland Watershed Protection Project Cumulative Watershed Effects Analysis West Fork Ashland Creek. Rogue River National Forest. April 1999

Wisseman, R., 1992. Aquatic Biology Associates, Inc. 340 Deer Run Road, Corvallis, Oregon 97330.

Schroeder, P. C., 2002. Benthic Macroinvertebrate Biomonitoring Trend Analysis (1992-2000). Submitted to the Rogue River National Forest, Ashland Ranger District. Peter C. Schroeder, Ph.D., Ashland, Oregon.

SECTION 5

1992 BEAR CREEK TMDLS - REVIEW

Summary of 1992 Bear Creek TMDLs

What are the Existing Bear Creek TMDLs:
In the early1990's DEQ developed TMDLs to address the non-attainment of pH, aquatic weeds and algae and dissolved oxygen (DO) standards in the Bear Creek watershed. These initial TMDLs, among the first in the state of Oregon, were approved by the USEPA on December 12, 1992.

Why are these Standards Important?
DO deficits and pH standards violations occur as a result of conditions conducive to excessive aquatic weeds and algae (especially periphyton) growth. Conditions that violate standards can negatively impact resident aquatic life in the stream and result in the reduction of suitable rearing and spawning habitat for chinook and coho salmon, steelhead and resident rainbow trout.

Applying Oregon's Water Quality Standards
The three current standards that apply to the 1992 Bear Creek TMDLs include: Aquatic Weeds and Algae, OAR 340-041-0007(11); pH OAR 340-041-0021; Dissolved Oxygen Water Quality Standard OAR 340-041-0016.

Scope
All lands (394 square miles) with streams that drain to Bear Creek (HUC 1710030801) are included in the 1992 TMDL for DO, pH, and Aquatic Weeds and Algae. The TMDLs address both point and nonpoint sources within the Bear Creek Watershed. Point sources include those specific NPDES permitted activities identified in the 1992 TMDL. Nonpoint sources apply to all land uses including lands managed by the State of Oregon, the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), Irrigation Districts, private forestlands, agricultural lands, rural residences, urban areas and others.

TMDL Overview
The 1992 Bear Creek TMDLs address the non-attainment of pH, aquatic weeds and algae and dissolved oxygen (DO) standards by establishing instream concentration criteria and load and wasteload allocations for total phosphorus, ammonia nitrogen, and biochemical oxygen demand. The 1992 TMDL targets excessive periphyton growth and the resulting photosynthesis by limiting nutrient inputs into the system. It is important to note that elevated stream temperatures are also significant factor in periphyton growth and that the cooler water temperatures targeted in the 2006 Temperature TMDL will also serve to limit excessive periphyton growth.

Table 1. Existing TMDL Component Summary

Bear Creek Watershed Dissolved Oxygen (DO) , pH, and aquatic weeds and Algae TMDL Components	
Waterbodies **OAR 340-042-0040(4)(a)**	All streams within the Bear Creek Watershed (5th field HUC 1710030801).
Pollutant Identification **OAR 340-042-0040(4)(b)**	Increased algal biomass resulting from inorganic phosphorus loading and increases in stream temperature, channel modifications and near stream vegetation disturbance/removal. Organic solids which settle and cause a sediment oxygen demand.
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing, resident aquatic life, fish passage; 340-041-0320(1), Table 320A)
Target Criteria Identification **DO: 340-041-0016** **PH: 340-041-0021** **Weeds: 340-041-0007(11)** *CWA §303(d)(1)*	**Dissolved Oxygen:** For the summer period, the daily average target is 8.0 mg/L with an absolute minimum of 6.0 mg/L **pH:** The target is no measurable increase over natural conditions or 8.5, whichever is greater. **Aquatic Weeds and Algae**: The development of fungi of other growths having a deleterious effect on stream bottoms, fish or other aquatic life or that are injurious to health, recreation, or industry may not be allowed.
Existing Sources **OAR 340-042-0040(4)(f)** *CWA §303(d)(1)*	Potential sources include waste water treatment plants; runoff from forestry, agricultural, rural residential and urban land uses.
Seasonal Variation **OAR 340-042-0040(4)(j)** *CWA §303(d)(1)*	Excessive periphyton growth, and the resulting photosynthesis, results in elevated pH during the warmer summer months. Therefore, the critical condition for DO and pH is during summer conditions This TMDL addresses the listed parameters year-round.
TMDL Loading Capacity **OAR 340-042-0040(4)(d)&(e)** *CWA §303(d)(1)*	The total maximum daily load (TMDL) is equal to the loading capacity of the water body.
Allocations **OAR 340-042-0040(4)(g)& (h)** *40 CFR 130.2(f), (g) & (h)*	The TMDL is divided into allocations to point sources (wasteload allocations), nonpoint sources (load allocations), and a margin of safety *Waste Wasteload Allocations (Point Sources)*:. Phosphorus: Ashland Waster Water Treatment Facility (WWTF) Ammonia Nitrogen: Ashland WWTF Biochemical Oxygen Demand: Ashland WWTF and Permitted log ponds Nitrogenous plus Carbonaceous Oxygen Demand: Ashland WWTF *Load Allocations (Nonpoint Sources)*: Phosphorus: Emigrant sub-area (Upstream input), Ashland-Talent sub-area, Phoenix-Medford sub-area, Central Point sub-area Biochemical Oxygen Demand: background plus nonpoint sources Nitrogenous plus carbonaceous Oxygen demand: Emigrant sub-area (upstream input) *Other* Phosphorus: Reserve Allocation Nitrogenous plus carbonaceous Oxygen Demand: Reserve Allocation
Margins of Safety *CWA §303(d)(1)* **OAR 340-042-0040(4)(i)**	Implicit through conservative assumptions in analysis.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Explicitly defined reserve allocations for Phosphorus, Nitrogenous plus carbonaceous Oxygen Demand
Water Quality Standard Attainment Analysis *CWA §303(d)(1)*	Future analysis of water quality data demonstrates attainment of pH and dissolved oxygen water quality standards.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with the NPDES[1] permit process for wastewater treatment plants.

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

INTRODUCTION

In 1990, DEQ developed TMDLs to address the non-attainment of pH, aquatic weeds and algae, and dissolved oxygen (DO) standards in the Bear Creek watershed. These initial TMDLs were developed in the form of instream compliance target concentrations, load and waste load allocations for total phosphate as phosphorus, biochemical oxygen demand (BOD5), carbonaceous biochemical oxygen demand (CBOD5) and ammonia nitrogen (Table 1). The Bear Creek TMDLs were approved by the USEPA on December 12, 1992. The purpose of this brief summary is to reaffirm the 1992 TMDL as it was originally developed and as it has been summarized in past Oregon Administrative Rules 340-041-0385 (Figure 1). Past administrative rules formally defined the geographic area impacted by the TMDL as Bear Creek and its tributaries and put into rule the maximum allowable seasonal instream concentrations within the Bear Creek Watershed. The TMDL OARs have since been modified such that Division 041 no longer contains the basin specific language as shown in Figure 1 therefore requiring the inclusion of the 1992 TMDL into the current TMDL. Current OAR language is shown in Figure 2.

Figure 1: TMDL Rules as Part of 1992 Bear Creek TMDL. Division 041

340-041-0385

Special Policies and Guidelines

In order to improve water quality within the Bear Creek subbasin to meet existing water quality standards for dissolved oxygen, and pH, the following special rules for total maximum daily loads, waste load allocations, load allocations, and program plans are established.

(1) After completion of wastewater control facilities and program plans approved by the Commission under this rule and no later than December 31, 1994, unless otherwise modified by program plans no activities shall be allowed and no wastewater shall be discharged to Bear Creek or its tributaries without the authorization of the commission that cause the following parameters to be exceeded in Bear Creek:

(a) Low-Flow Season Approximately May 1 through November 30*:

(A) Ammonia Nitrogen Nitrogen as N (mg/l) --0.25;
(B) Instream Five-Day Biochemical Oxygen (Demand (mg/l)l --3.0;
(C) Instream Five-Day Total Phosphorus as P (mg/l) --0.08.

(b) High Flow Season Approximately December 1 through Apri130*:

(A) Ammonia Nitrogen Nitrogen as N (mg/1) --1.0;
(B) Instream Five-Day Biochemical Oxygen Demand (mg/l)2 --2.5.

[1] As measured at the Valley View Road Sampling Site. For the purposes of waste load allocations, the biochemical oxygen demand is calculated as the ammonia concentration multiplied by 4.35 and added to the measured effluent biochemical oxygen demand.
[2] Median value as measured at the Kirtland Road sampling site.
*Precise dates for complying with this rule may be conditioned on physical conditions, such as flow and temperature, of the receiving stream and shall be specified in individual permits or memorandums of understanding issued by the Department.
(2) The Department shall before September 30, 1990 distribute initial waste load and load allocations to point and nonpoint sources in the basin. These loads are interim and may be redistributed upon conclusion of the approved program plans;
(3) Before October 21, 1989, the City of Ashland shall submit to the Department a program plan and time schedule describing how and when they will modify their sewerage facility to comply with this rule and all other applicable rules regulating waste discharges;
(4) Before May 25, 1991, the industries permitted for log pond discharge, Boise Cascade Corporation, Kogap Manufacturing Company, and Medford Corporation shall submit progress plans to the Department describing how

and when they will modify their operations to comply with this rule and all other applicable rules regulating waste discharge;
(5) Before June 1, 1992, Jackson County and the incorporated cities within the Bear Creek subbasin shall submit to the Department a program plan for controlling urban runoff within their respective jurisdictions to comply with these rules;
(6) Before June 1, 1992, the Departments of Forestry and Agriculture shall submit to the Department program plans for achieving specified load allocations of state and private forest lands and agricultural lands respectively;
(7) Program plans shall be reviewed and approved by the Commission. All proposed final program plans shall be subject to public comment and hearing prior to consideration for approval by the Commission.

Stat. Auth.: ORS 468.710 & ORS 468.735
Stats. Implemented: ORS 468B.030
Hist.: DEQ 17-1989, f. & cert. ef. 7-31-89; DEQ 40-1990, f. & cert. ef. 11-15-90

Figure 2: Current TMDL Rules. Division 041

Basin-Specific Criteria
(Rogue)

340-041-0271
Beneficial Uses to Be Protected in the Rogue Basin
(1) Water quality in the Rogue Basin (see Figure 1) must be managed to protect the designated beneficial uses shown in Table 271A (November 2003).
(2) Designated fish uses to be protected in the Rogue Basin are shown in Figures 271A and 271B (November 2003).
Stat. Auth.: ORS 468.020, 468B.030, 468B.035, 468B.048
Stats. Implemented: ORS 468B.030, 468B.035, 468B.048

Hist.: DEQ 17-2003, f. & cert. ef. 12-9-03

340-041-0274
Approved TMDLs in the Basin:
The following TMDLs have been approved by EPA, and appear on the Department's web site:
Bear Creek -- Ammonia, BOD and Phosphorus -- December 8, 1992
Lobster Creek -- Temperature -- June 13, 2002
Lower Sucker Creek -- Temperature -- May 30, 2002
Upper Sucker Creek -- Temperature -- May 4, 1999

Stat. Auth.: ORS 468.020, 468B.030, 468B.035, 468B.048
Stats. Implemented: ORS 468B.030, 468B.035, 468B.048
Hist.: DEQ 17-2003, f. & cert. ef. 12-9-03

340-041-0275
Water Quality Standards and Policies for this Basin
(1) pH (hydrogen ion concentration). pH values may not fall outside the following ranges:
(a) Marine waters: 7.0-8.5;
(b) Estuarine and fresh waters (except Cascade lakes): 6.5-8.5;
(c) Cascade lakes above 3,000 feet altitude: pH values may not fall outside the range of 6.0 to 8.5.
(2) Total Dissolved Solids. Guide concentrations listed below may not be exceeded unless otherwise specifically authorized by DEQ upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses set forth in OAR 340-04l-0271: 500.0 mg/l.
(3) Minimum Design Criteria for Treatment and Control of Sewage Wastes:
(a) During periods of low stream flows (approximately May 1 to October 31): Treatment resulting in monthly average effluent concentrations not to exceed 10 mg/l of BOD and 10 mg/l of SS or equivalent control;
(b) During the period of high stream flows (approximately November 1 to April 30): A minimum of secondary treatment or equivalent control and unless otherwise specifically authorized by the Department, operation of all waste treatment and control facilities at maximum practicable efficiency and effectiveness so as to minimize waste discharges to public waters.

Stat. Auth.: ORS 468.020, 468B.030, 468B.035, 468B.048
Stats. Implemented: ORS 468B.030, 468B.035, 468B.048
Hist.: DEQ 17-2003, f. & cert. ef. 12-9-03

Beneficial Use Identification

The primary benefit to maintaining adequate dissolved oxygen (DO) concentrations, meeting the pH standard, meeting the ammonia standard, and achieving the aquatic weeds and algae standard is to support a healthy and balanced distribution of aquatic life, and to protect salmonid fish spawning and rearing. The Oregon Environmental Quality Commission (OEQC) has adopted numeric and narrative water quality standards to protect designated *beneficial use*s (Administrative Rules OAR 340–041–0271, Table 271A, November 2003). Beneficial uses sensitive to DO, pH, ammonia, and aquatic weeds and algae are shown shaded in Table 2.

Table 2. DO, pH, ammonia, and Aquatic Weed and Algae Sensitive Beneficial Uses
(Source: OAR 340-041-0271, Table 271A)

Beneficial Use	***Bear Creek Mainstem***	***Bear Creek Tributaries***	***Beneficial Use***	***Bear Creek Mainstem***	***Bear Creek Tributaries***
Public Domestic Water Supply[1]	**	✓	Commercial Navigation & Trans.		
Private Domestic Water Supply[1]	✓	✓	Fish and Aquatic Life[2]	✓	✓
Industrial Water Supply	✓	✓	Wildlife and Hunting	✓	✓
Irrigation	✓	✓	Fishing	✓	✓
Livestock Watering	✓	✓	Water Contact Recreation	✓	✓
Boating	✓	✓	Hydro Power**		✓
Aesthetic Quality	✓	✓			

**Note: Designation for this use is currently under study

5. With adequate pre-treament (filtration and disinfection) and natural quality to meet drinking water standards
6. See Figures 271A and 271B for fish use designations for this watershed.

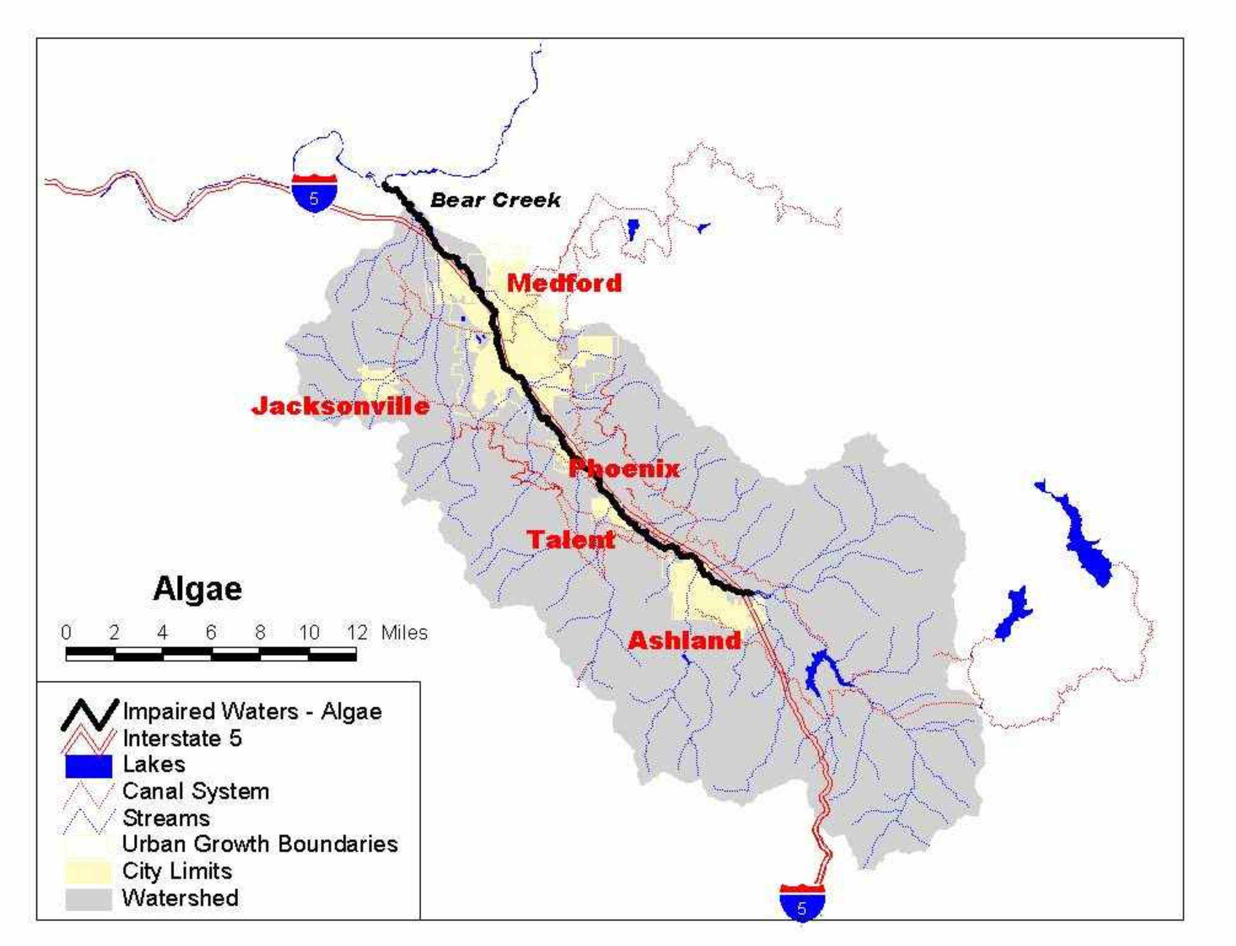
Deviation from Water Quality Standards and 303(d) Listings

Once a watershed has an approved TMDL, waterbodies that were listed as impaired are removed from the state's 303(d) list and are place on the integrated report under the category "TMDL Approved." Table 3 and Maps 1-5 show the location of those streams in the Bear Creek Watershed that are covered in the 1992 TMDL.

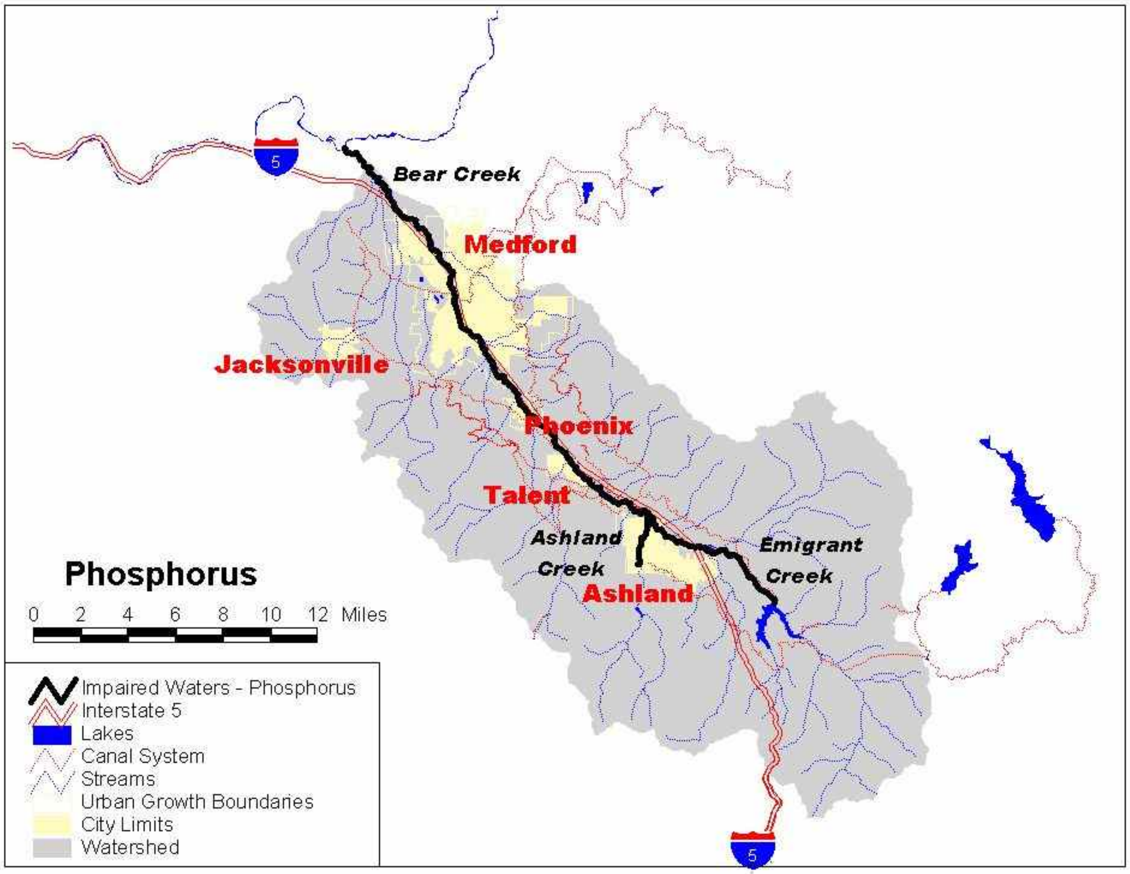
Table 3. Impaired Waterbodies in the Bear Creek Watershed with Approved TMDLs

Waterbody Name	River Mile	Parameter with Approved TMDL	Season
Ashland Creek	0 to 2.8	Ammonia	Spring/Summer/ Fall
Ashland Creek	0 to 2.8	Phosphorus	Spring/Summer/ Fall
Bear Creek	0 to 26.3	Aquatic Weeds & Algae	Undefined
Bear Creek	0 to 26.3	Dissolved Oxygen	October 15- May 15
Bear Creek	0 to 26.3	Phosphorus	Spring/Summer/Fall
Butler Creek	0 to 5.2	Dissolved Oxygen	October 1 – May 31
Butler Creek	0 to 5.2	Dissolved Oxygen	Spring/Summer
Coleman Creek	0 to 6.9	Dissolved Oxygen	October 1 – May 31
Coleman Creek	0 to 6.9	Dissolved Oxygen	Summer
Emigrant Creek	0 to 4.3	Phosphorus	Undefined
Griffin Creek	0 to 14.4	Dissolved Oxygen	Summer
Larson Creek	0 to 6.7	Dissolved Oxygen	October 1 – May 31
Larson Creek	0 to 6.7	pH	Fall/Winter/Spring
Larson Creek	0 to 6.7	pH	Summer
Lazy Creek	0 to 4.5	pH	Fall/Winter/Spring
Neil Creek	0 to 4.8	Dissolved Oxygen	October 1 – May 31
Neil Creek	0 to 4.8	Dissolved Oxygen	Summer
Payne Creek	1 to 2.1	Dissolved Oxygen	October 1 – May 31
Payne Creek	1 to 2.1	Dissolved Oxygen	Summer
Total number of miles with approved ammonia TMDL (n=1)			**2.8**
Total number of miles with approved phosphorus TMDL (n=3)			**33.4**
Total number of miles with approved dissolved oxygen TMDL (n=11)			**83.4**
Total number of miles with approved pH TMDL (n=3)			**17.9**
Total number of miles with approved aquatic weeds and algae TMDL (n=1)			**26.3**

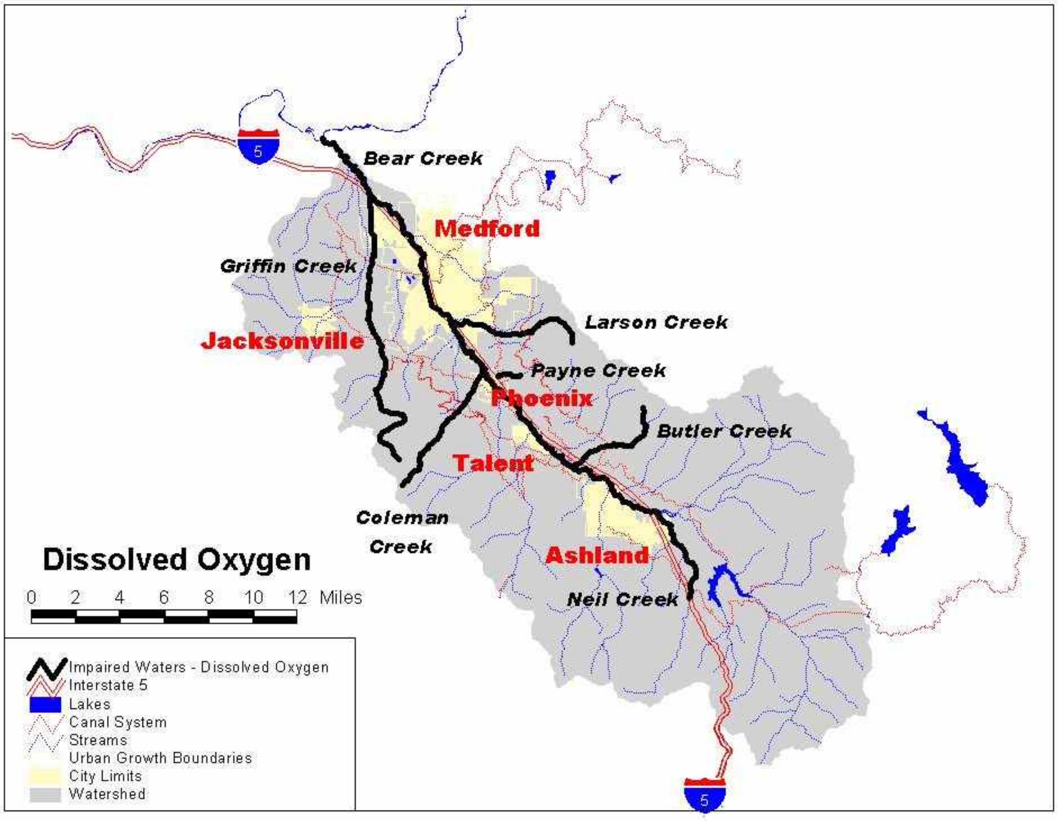
Map 1. Bear Creek - Algae and Aquatic Weeds Impairments



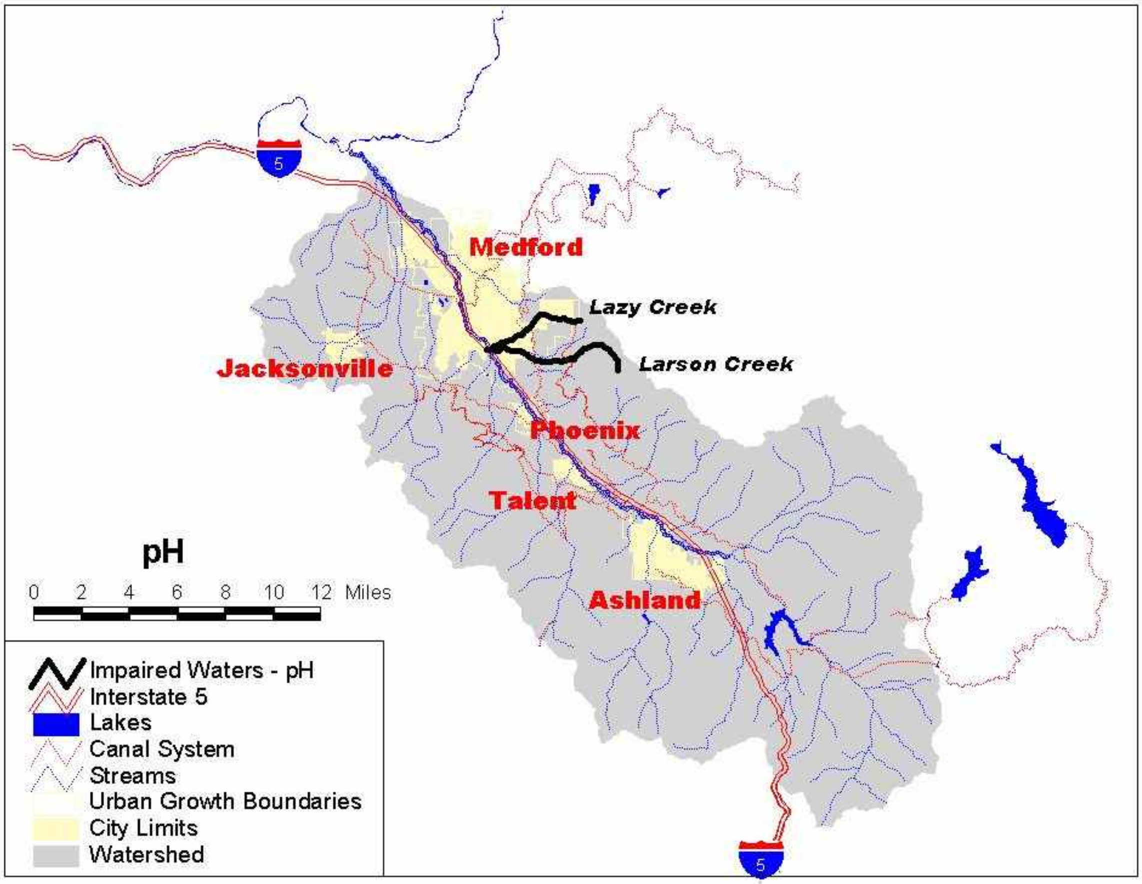
Map 2. Bear Creek – Phosphorus Impairments



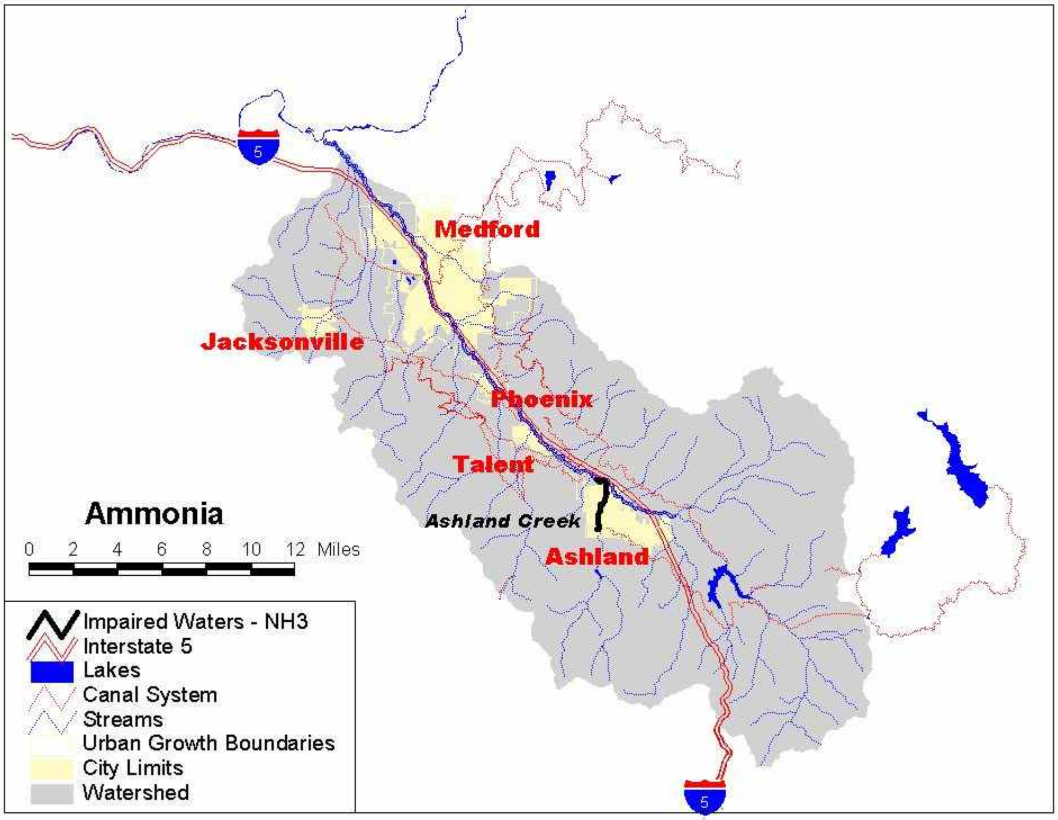
Map 3. Bear Creek – Dissolved Oxygen Impairments



Map 4. Bear Creek – pH Impairments



Map 5. Bear Creek – Ammonia Impairments



WATER QUALITY STANDARD IDENTIFICATION

Dissolved Oxygen Water Quality Standard

Oregon Administrative Rule 340-041-0016 provides as follows, with the provisions applicable to Bear Creek highlighted in bold.

(**1) Dissolved oxygen (DO): No wastes may be discharged and no activities must be conducted that either alone or in combination with other wastes or activities will cause violation of the following standards:** The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply:
(a) **For water bodies identified as active spawning areas in the places and times indicated on the following Tables and Figures set out in OAR 340-041-0101 to OAR 340-041-0340:** Tables 101B, 121B, 180B, 201B and 260B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, **320B**, and 340B, (as well as any active spawning area used by resident trout species), **the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures:**
(A) The dissolved oxygen may not be less than 11.0 mg/l. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/l or greater, then the DO criterion is 9.0 mg/l;
(B) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/l or 9.0 mg/l criteria, dissolved oxygen levels must not be less than 95 percent of saturation;
(C) The spatial median intergravel dissolved oxygen concentration must not fall below 8.0 mg/l.
(b) For water bodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and may not fall below 6.0 mg/l as an absolute minimum (Table 21);
(c) For water bodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/l as a 30-day mean minimum, 5.0 mg/l as a seven-day minimum mean, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(d) For water bodies identified by the Department as providing warm-water aquatic life, the dissolved oxygen may not be less than 5.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 5.5 mg/l as a 30-day mean minimum, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);
(e) For estuarine water, the dissolved oxygen concentrations may not be less than 6.5 mg/l (for coastal water bodies);
(f) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed.

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

OAR 340-041-0004(0(a)(D)(iii) provides: (iii) Effective July 1, 1996, in water bodies designated water-quality limited for dissolved oxygen, when establishing WLAs under a TMDL for water bodies meeting the conditions defined in this rule, the Department may at its discretion provide an allowance for WLAs calculated to result in no measurable reduction of dissolved oxygen (DO). For this purpose, “no measurable reduction” is defined as no more than 0.10 mg/L for a single source and no more than 0.20 mg/L for all anthropogenic activities that influence the water quality limited segment. The allowance applies for surface water DO criteria and for Intergravel dissolved oxygen (IGDO) if a determination is made that the conditions are natural. The allowance for WLAs applies only to surface water 30-day and seven-day means.

pH Water Quality Standard

Oregon Administrative Rule 340-041-0021 provides as follows with the provisions applicable to Bear Creek highlighted in bold.

pH
(1) Unless otherwise specified in OAR 340-041-0101 through 340-041-0350, pH values (Hydrogen ion concentrations) may not fall outside the following ranges:
(a) Marine waters: 7.0-8.5;
(b) Estuarine and fresh waters: 6.5-8.5.
(2) Waters impounded by dams existing on January 1, 1996, which have pHs that exceed the criteria are not in violation of the standard, if the Department determines that the exceedance would not occur without the impoundment and that all practicable measures have been taken to bring the pH in the impounded waters into compliance with the criteria.

Aquatic Weeds and Algae Water Quality Standard

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

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

In the portion of the Bear Creek watershed which has been determined to be impaired for aquatic weeds and algae, the algae are also causing DO and pH impairments. To address the DO and pH impairments large reductions in the growth of algae are necessary. It is likely that these reductions will be sufficient to address the aquatic weeds and algae narrative criteria.

EXISTING SOURCES

Algal Processes Affecting Dissolved Oxygen and pH

Without external influences, DO and pH concentrations would come to equilibrium with the atmosphere based on barometric pressure and water temperature. However, the growth and respiration of attached algae causes daily swings in DO concentrations and pH. During daylight hours the algae grow, and through photosynthesis, oxygen is released into the river. During the night, photosynthesis ceases and algal cells respire causing a reduction in DO. Similarly, inorganic carbon (i.e. carbon dioxide) is consumed during the day during photosynthesis and released at night through respiration. Through the carbonate balance, as inorganic carbon is consumed (during photosynthesis), the concentration of the hydrogen ion decreases which increases the pH.

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

Other Physical and Biological Processes Affecting Dissolved Oxygen

Sediment Oxygen Demand (SOD): Sediments in waterbodies are important to riverine systems. However, too much sediment can increase levels of other potential pollutants. When solids that contain organic matter settle to the bottom of a stream they may decompose anaerobically (with no oxygen present), or aerobically (in the presence of oxygen), depending on conditions. The oxygen consumed in aerobic decomposition of these sediments is called sediment oxygen demand (SOD) and represents a loss of dissolved oxygen for a stream. The SOD can continue to reduce DO for a long period after the pollution discharge ceases (i.e., organic-containing sediment deposited as a result of rain-driven runoff may remain a problem long after the rain event has passed). In contrast, carbonaceous biochemical oxygen demand (CBOD) and nitrification processes are typically short-term. Sources of organic sediments include runoff from farms, rangeland, forest, and urban lands and WWTP upsets.

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

Nitrogenous Biochemical Oxygen Demand (NBOD): When nitrogen in the form of ammonia is introduced to natural waters, the ammonia may “consume” dissolved oxygen as nitrifying bacteria convert the ammonia into nitrite and nitrate. The process of ammonia being transformed into nitrite and nitrate is called nitrification. The consumption of oxygen during this process is called nitrogenous biochemical oxygen demand (NBOD). To what extent this process occurs, and how much oxygen is consumed, is related to several factors, including residence time, water temperature, ammonia concentration in the water, and the presence of nitrifying bacteria. Wastewater treatment plant effluent, animal manure and fertilizers are the primary sources of ammonia.

Stream Temperature: Stream temperature has a significant impact on the dissolved oxygen in a stream in two ways. The first is that with increasing temperatures the amount of oxygen that can remain dissolved in water decreases. The second is that, in general, all of the oxygen consuming processes listed above increase will increase the rate of oxygen consumption as the temperature increases. There are a number of causes of increased stream temperatures in the Bear Creek watershed. Please see the Temperature TMDL (Section 2) for a complete discussion of this topic.

Point Sources

Wastewater Treatment Plants

Bear Creek receives treated effluent from the City of Ashland’s WWTF. Discharge for the plant is regulated under DEQ NPDES[1] permit 101609 (last renewed on May 27, 2004).

Other Point Sources

There currently 146 NPDES permitted discharge sites in the Bear Creek Watershed (ODEQ database 5/15/05). Permits have been issued and renewed to ensure compliance with the 1992 TMDL as appropriate.

Nonpoint Sources

Forestry Sources

Forests can contribute nutrients in several ways. First, sediment association with timber harvesting and related road building can carry nutrients, especially phosphorus, into streams. Second, northwest forests are typically fertilized with urea nitrogen, and this may run off into streams under certain conditions. Where riparian buffers exist, they will help keep stream temperatures cool as well as help to intercept and retain both sediments and nutrients. There are number of natural processes that add nutrients to the river: leaching from the soil, degradation of plant material, and fish returning to spawn from the ocean.

Agricultural Sources

Lands used for agriculture can contribute nutrients in a variety of ways. Soil erosion can carry nutrients with it, particularly phosphorus, and soil particles can increase the sediment oxygen demand (SOD). Animal manure is another potential source of nutrients and particulates. Additionally, fertilizers can run off and contribute nutrients to the stream. Riparian buffers, where they exist, will help to intercept and retain both sediments and nutrients.

Urban Land Runoff

Urbanized land areas, with their high percentages of impervious surfaces and extensive drainage systems, have surface runoff even during relatively small rainfall events. Runoff from landscape irrigation can also carry high levels of nutrients due to fertilizers.

Unregulated (Unpermitted) Upland Sources

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

TMDL - LOADING CAPACITIES 40 CFR 130.2(F)

Loading Capacity: This element specifies the concentration of phosphorus, biochemical oxygen demand, and ammonia nitrogen that Bear Creek can contain and still meet water quality standards.

EPA’s current regulation defines loading capacity as “*the greatest amount of loading that a waterbody 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. The 1992 Bear Creek TMDL established the following instream concentration criteria.

For the low flow period – May 1 through November 15:

- Total phosphate as phosphorus concentration must be less than 0.80mg/l
- Total ammonia as nitrogen concentration must be less than 0.25mg/l
- Total BOD5 concentration must be less that 3.0mg/l

Measured as an absolute instream concentration not to be exceeded during the summer 7Q10 condition at the Valley View Road Bridge, RM 21.2.

For the high flow period – November 16 through April 30:

- Total ammonia as nitrogen concentration must be less than 1.0mg/l
- Total BOD5 concentration must be less that 2.5mg/l

Measured as median instream concentrations not to be exceeded during median winter conditions at the Kirtland Road Bridge, RM 0.9.

TMDL - LOAD ALLOCATIONS AND WASTE LOAD ALLOCATIONS 40 CFR 130.2(G) AND 40 CFR 130.2(H)

This element divides the loading capacity between individual point and nonpoint sources and establishes a reserve capacity.

The 1992 Bear Creek TMDL established load allocations for point, nonpoint and a reserve capacity (Table 4). See appendix C for specific allocations for each source.

Table 4. TMDL Allocations – 1992 TMDLs

TMDL Parameter	Allocation Type[1]	Season	Source Description[1]
Total Phosphate as Phosphorus	Load Allocation	May 1 – October 31	Emigrant Sub-area (upstream input)
	Waste Load Allocation	May 1 – October 31	Ashland WWTF
	Load Allocation	May 1 – October 31	Ashland-Talent Sub-area
	Load Allocation	May 1 – October 31	Phoenix-Medford Sub-area
	Load Allocation	May 1 – October 31	Central Point Sub-area
	Load Allocation	May 1 – October 31	Department Reserve Allocation
Biochemical Oxygen Demand	Load Allocation	November 1- April 30	Background + Nonpoint Source
	Waste Load Allocation	November 1- April 30	Ashland WWTF
	Waste Load Allocation	November 1- April 30	Boise Cascade
	Waste Load Allocation	November 1- April 30	KOGAP
	Waste Load Allocation	November 1- April 30	MEDCO
	Waste Load Allocation	November 1- April 30	Timber Products
Nitrogenous+Carbonaceous Oxygen Demand	Load Allocation	May 1 – November 15	Emigrant Sub-area (upstream input)
	Waste Load Allocation	May 1 – November 15	Ashland WWTF
	Load Allocation	May 1 – November 15	Department Reserve Allocation

[1] All allocations and source descriptions are taken from 1992 TMDL. See Appendix C