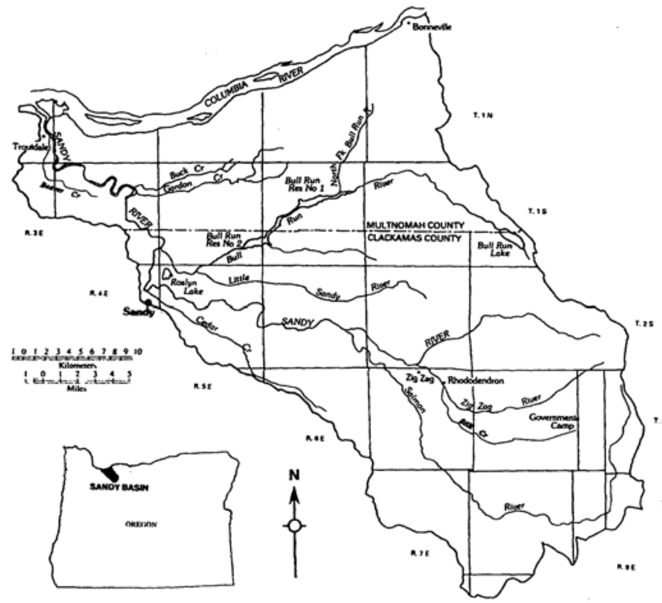
SANDY RIVER BASIN TOTAL MAXIMUM DAILY LOAD (TMDL)



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For more information contact:

Greg Geist, Natural Resources Specialist
Department of Environmental Quality
2020 SW 4th Avenue, Suite 400
Portland, OR 97201-4987
(503) 229-6991
Geist.gregory@deq.state.or.us

SANDY RIVER BASIN TOTAL MAXIMUM DAILY LOAD (TMDL)
TABLE OF CONTENTS

CHAPTER 1 – EXECUTIVE SUMMARY

BACKGROUND AND PROPOSED ACTION

The quality of Oregon's streams, lakes, estuaries and groundwater is monitored by the Oregon Department of Environmental Quality (ODEQ) and other agencies. This information is used to determine whether water quality standards are being violated and, consequently, whether the *beneficial uses* of the waters are *impaired*. Section 303(d) of the Federal Clean Water Act (CWA) requires that a list be developed of all impaired or threatened waters within each state. This list is called the 303(d)[1] list after the section of the CWA that requires it. ODEQ is responsible for assessing data, compiling the 303(d) list and submitting the 303(d) list to the Environmental Protection Agency (EPA) for federal approval. Section 303(d) also requires that the state establish a Total Maximum Daily Load (TMDL) for any waterbody designated as water quality limited (with a few exceptions, such as in cases where violations are due to natural causes or pollutants cannot be defined). TMDLs are written plans with analysis that determine the total amount of a pollutant (from all sources) that can be present in a specific waterbody and still meet water quality standards. The total permissible pollutant load is allocated to point, nonpoint, background and future sources of pollution. *Waste load allocations* are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industries. The *Waste load allocations* are used to establish effluent limits in discharge permits. *Load allocations* are portions of the *Total Maximum Daily Load* that are attributed to either natural background sources or from nonpoint sources, such as urban, agriculture or forestry activities or from dams. *Allocations* can also be set aside in reserve for future uses. Simply stated, *allocations* are quantified measures designed to achieve water quality standard compliance. The *TMDL* is the integration of all these developed *waste load* and *load allocations*.

Water quality monitoring data reviewed by ODEQ indicated that portions of the Sandy River and tributaries failed to meet temperature, bacteria and dissolved oxygen water quality standards and several stream segments were included on the 2002 303d list (**Figure 1.1**). ODEQ is proposing to address temperature and bacteria limitations through TMDL development and is proposing to remove the lower Sandy River from the 303d list for dissolved oxygen.

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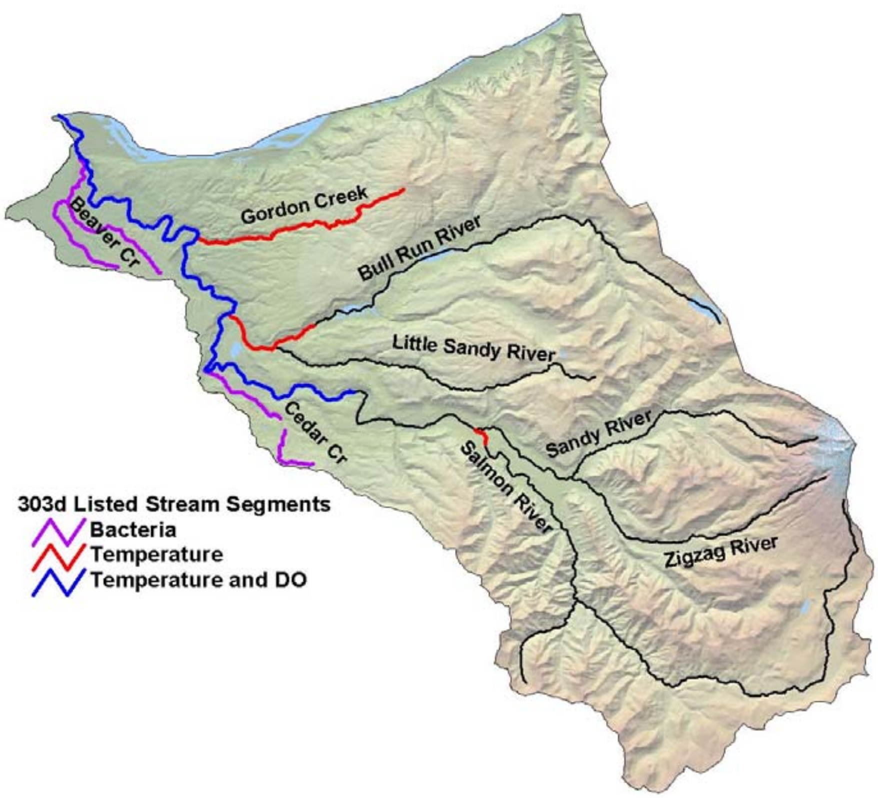
[1] The 303(d) list is a list of stream segments that do not meet water quality standards.

Table 1.1 303(d) Listed Stream Segments in the Sandy River Basin

Waterbody	Listed Reaches	Parameter	Season	TMDL?
Sandy River	Mouth to Marmot Dam (RM 30)	Temperature	Summer	YES
Sandy River	Mouth to Marmot Dam (RM 30)	Dissolved Oxygen	Sep 15 – Jun 30	NO
Salmon River	Mouth to Boulder Cr. (RM 1)	Temperature	Summer	YES
Bull Run River	Mouth to Dam #2 (RM 5)	Temperature	Summer	YES
Gordon Creek	Mouth to Headwaters (RM 11)	Temperature	Summer	YES
Cedar Creek	Mouth to RM 4	Bacteria	Summer	YES
Unnamed Tributary to Cedar Creek	Mouth to Headwaters (RM 3)	Bacteria	Summer	YES
Beaver Creek	Mouth to Headwaters (RM 8)	Bacteria	Summer	YES
Kelly Creek	Mouth to Headwaters (RM 5)	Bacteria	Summer	YES

Figure 1.1. 303d Listed Stream Segments in the Sandy Basin



TMDL SUMMARIES

Temperature

Four stream segments (approximately 48 miles) in the Sandy River basin were included on the 2002 303(d) list for exceeding numeric temperature criteria (**Figure 1.1**). Listed segments include the Salmon River from the mouth to Boulder Creek, the Bull Run River from the mouth to Bull Run Dam #2, Gordon Creek from the mouth to headwaters and the Sandy River from the mouth to Marmot Dam. Since stream temperature results from cumulative interactions between upstream and local sources, the TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies. To address the stream segments identified above, the Sandy River and all tributaries are included in the TMDL analysis and TMDL targets.

Waste load allocations were developed for 6 point sources (3 sewage treatment plants and three other NPDES-permitted facilities) in the Sandy River basin. ODEQ allocated point source loads according to the temperature and flow of the river receiving the discharge and the temperature and flow of the discharge. Point source allocations are contained in **Section 3.8**.

Load allocations were developed for anthropogenic and background nonpoint sources of heat, as well as for the City of Portland drinking water and hydroelectric facilities and the Portland General Electric Bull Run Hydroelectric Project. Oregon's temperature standard contains provisions that effectively limit the cumulative anthropogenic (point and nonpoint source) heating of surface waters to no more than 0.3 degrees Celsius at the point of maximum impact. In theory, once the system potential condition with respect to nonpoint source pollution is known, ODEQ could then calculate the amount of additional nonpoint source loading that a waterbody can assimilate without resulting in more than a 0.3°C cumulative increase in water temperature. ODEQ chose to assign 0.05°C of the 0.3°C to nonpoint sources, 0.05°C for reserve capacity and allow 0.2°C for point source allocations. However, ODEQ did not attempt to calculate this additional allowable nonpoint source heat load or incorporate the information into nonpoint source load allocations. Rather, ODEQ considers the conservative methodology that bases nonpoint source load allocations on achieving system potential shade conditions to be part of the explicit margin of safety. The means of achieving these conditions is through restoration and protection of riparian vegetation, increasing instream flows, and, where appropriate, narrowing of stream channel widths. Implementation plans submitted by each designated management agency (DMA) will address the lands and activities that impact stream segments in the watershed within their boundaries to the extent of the DMA's authority.

Percent effective shade is used as a surrogate measure for nonpoint source pollutant loading since it is easily translated into quantifiable water management objectives. This TMDL establishes site-specific shade targets for the mainstem of the Sandy River and major tributaries, and basin-wide "shade curves" that can be used to establish shade targets for all other streams in the basin.

ODEQ's analyses showed that streams in the Sandy River Basin, especially those on public lands, are generally well shaded with mature stream side vegetation. Computer modeling showed that increasing stream side vegetation would not result in significantly cooler water temperatures in most major Sandy basin tributaries. However, smaller streams, particularly in the lower portions of the basin, (e.g. Beaver Creek) would likely show significant temperature improvements by increasing mature stream side vegetation. It may take decades for trees to grow to heights that will provide the best conditions for fish, but water quality will begin to improve as soon as vegetation becomes established.

The Sandy Basin includes two examples of the ways that dams can impact stream temperature. In the case of the Portland General Electric (PGE) Bull Run Hydroelectric Project, water is diverted around certain river reaches and is discharged at a point further downstream. This reduces the amount of water within the diversion reach, increasing the rate of heating through that section of river. PGE has chosen to decommission their project and the Marmot and Little Sandy Diversion Dams are scheduled for removal in 2007 and 2008, respectively.

The City of Portland drinking water dams create two large reservoirs on the Bull Run River. They generally release cooler-than-natural water in early summer months and warmer water during late summer months when the supply of cold water is exhausted. The reservoirs, with their large surface areas exposed to direct sunlight, increase the overall heat loading to the system. Reduced flow volume below the dams also results in an increased rate of stream warming. Lastly, the increased surface area of the reservoirs increases the opportunity for thermal loading. The City was given an allocation that uses the Little Sandy River as a temperature surrogate. The City is planning on modifying water intake structures in order to improve operational flexibility and achieve the temperature target established in the TMDL.

Bacteria

Generally, Beaver Creek showed significant bacteria problems during summertime low-flow conditions when contact recreational uses are most likely to occur. Analysis of data collected in Kelly Creek showed violations under various flow and climatic conditions.

ODEQ chose to use the load duration curve approach to develop the bacteria TMDLs for 303d listed tributaries within the Sandy River basin. Load duration curves are a method of determining a flow based loading capacity, assessing current conditions, and calculating the necessary reductions to comply with water quality standards. Municipal stormwater waste load and load allocations are expressed in terms of the percent reduction necessary to achieve the numeric criteria in order to translate the acceptable loads into more applicable measures of performance. Other waste load allocations are set to achieve end of pipe concentrations that meet Oregon’s bacteria water quality criteria.

Allocations were determined conservatively by calculating a reduction based upon some confidence interval of the mean of the measured samples that ensures compliance with the geometric mean standard of 126 organisms/100ml and also results in compliance with the “do not exceed” 406 organisms/100ml criterion. The required reduction is 86% and applies to both agricultural and urban lands draining to Beaver, Kelly and Cedar Creeks. Both stormwater waste load and load allocations are expressed as a percent reduction from current levels. ODEQ believes that this approach will aid in implementation of the TMDL because it sets a tangible and common goal for both point and nonpoint source management practices and programs.

TMDL IMPLEMENTATION

The goal of the Clean Water Act and associated Oregon Administrative Rules (OARs) is to ensure that water quality standards are met or that all feasible steps will be taken towards achieving the highest quality water attainable. This is a long-term goal in many watersheds, particularly where nonpoint sources are the main concern. To achieve this goal, implementation must commence as soon as possible.

ODEQ recognizes that TMDLs are sometimes calculated from mathematical models and other analytical techniques designed to simulate and/or predict very complex physical, chemical and biological processes. Models and techniques are simplifications of these complex processes and, as such, are unlikely to produce an exact prediction of how streams and other waterbodies will respond to the application of various management measures. It is also recognized that there is a varying level of uncertainty in the TMDLs depending on factors such as amount of data that is available and how well the processes listed above are understood. It is for this reason that the TMDLs have been established with a margin of safety. Subject to available resources, ODEQ will review and, if necessary, modify TMDLs established for a basin on a five-year basis or possibly sooner if ODEQ determines that new scientific information is available that indicates significant changes to the TMDL are needed. However, given that it will take some time to effectively develop and implement management plans, a more thorough review of the TMDL will likely occur on a 10-year cycle.

Water Quality Management Plans (WQMP) are plans designed to reduce pollutant loads to meet TMDLs. ODEQ recognizes that it may take some period of time - from several years to several decades - after full implementation before management practices identified in a WQMP become fully effective in reducing and controlling pollution. In addition, ODEQ recognizes that technology for controlling nonpoint source pollution is, in many cases, in the development stages and will likely take one or more iterations to develop effective techniques. It is possible that after application of all reasonable best management practices, some TMDLs or their associated surrogates cannot be achieved as originally established.

ODEQ also recognizes that, despite the best and most sincere efforts, natural events may interfere with or delay attainment of the TMDL and/or its associated surrogates. Such events could be, but are not limited to, floods, fire, insect infestations, and drought.

In the Sandy River Basin TMDL, pollutant surrogates have been defined as targets for meeting the temperature TMDL. The surrogates are intended to provide a means to identify quantifiable temperatures that reflect the system thermal potential of a water body. These surrogates can then be used to plan for and confirm achievement of TMDL compliance on a week-to-week basis. The DMA-specific implementation plans will describe how regulated activities will be managed to meet the surrogate temperatures. The purpose of the surrogate is not to bar or eliminate human access or activity in the basin or its riparian areas. It is the expectation, however, that this WQMP and the associated DMA-specific Implementation Plans will address how human activities will be managed to achieve the surrogates. It is also recognized that full attainment of pollutant surrogates at all locations may not be feasible due to physical, legal or other regulatory constraints. To the extent possible, the implementation plans should identify potential constraints, but should also provide the ability to mitigate those constraints should the opportunity arise. For instance, at this time, the existing location of a road or highway may preclude attainment of system potential vegetation due to safety considerations. In the future, however, should the road be expanded or upgraded, consideration should be given to designs that support TMDL load allocations and pollutant surrogates such as system potential vegetation.

If a nonpoint source that is covered by the TMDL complies with its finalized Implementation Plan or applicable forest practice rules, it will be considered in compliance with the TMDL.

ODEQ intends to regularly review progress of this WQMP and the associated Implementation Plans to achieve TMDLs. If and when ODEQ determines that the WQMPs have been fully implemented, that all feasible management practices have reached maximum expected effectiveness and a TMDL or its interim targets have not been achieved, ODEQ shall reopen the TMDL and adjust it or its interim targets and the associated water quality standard(s) as necessary.

The implementation of the TMDL and the associated plans is generally enforceable by ODEQ, other state agencies and local government. However, it is envisioned that sufficient initiative exists to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers to overcome impediments to progress through education, technical support or enforcement. Enforcement may be necessary in instances of insufficient action towards progress. This could occur first through direct intervention from land management agencies (e.g. ODF, ODA, counties and cities), and secondarily through ODEQ. The latter may be based on departmental orders to implement management goals leading to water quality standards.

An unlisted point source may be issued a permit for discharge of the pollutant causing impairment, without modification of the TMDL, if it is demonstrated that the discharge will not cause or contribute to a violation of the water quality standard (See 40 CFR 122.44(d) in the NPDES permitting regulations). New discharges that achieve water quality standards at end-of-pipe would be candidates for permitting without a TMDL modification. For instance, in temperature impaired waters, it may be allowable for a new facility to discharge wastewater that is cooler than the temperature standard or that does not cause more than a

0.3°C increase in temperature without modification of the TMDL. The demonstration that the new discharge will not cause or contribute to a violation of the water quality standard would be included in the Fact Sheet for the permit in question. Lastly, pollutant trading opportunities may be available to new or existing point sources in order to offset temperature impacts to impaired waterbodies.

Adaptive Management

With respect to the adaptive management approach as it applies to this TMDL, ODEQ has the following expectations and intentions:

- Subject to available resources, ODEQ will review and, if necessary, modify TMDLs and WQMPs established for the Sandy basin on a five-year basis or possibly sooner if ODEQ determines that new scientific information is available that indicates significant changes to the TMDL are needed.
- When developing water quality-based effluent limits for NPDES permits, ODEQ will ensure that effluent limits developed are consistent with the assumptions and requirements of the waste load allocation (CFR 122.44(d)(1)(vii)(B)).
- ODEQ expects that each management agency will also monitor and document its progress in implementing the provisions of its component of the WQMP. This information will be provided to ODEQ for its use in reviewing the TMDL.
- As implementation of the WQMP proceeds, ODEQ expects that management agencies will develop benchmarks for attainment of TMDL surrogates, which can then be used to measure progress.
- Where implementation of the WQMP or effectiveness of management techniques are found to be inadequate, ODEQ expects management agencies to revise the components of the WQMP to address these deficiencies.
- When ODEQ, in consultation with the management agencies, concludes that all feasible steps have been taken to meet the TMDL and its associated surrogates and attainment of water quality standards, the TMDL, or the associated surrogates is not practicable, it will reopen the TMDL and adjust it as appropriate.

CHAPTER 2 – DESCRIPTION OF THE SANDY RIVER BASIN

The Sandy River Basin (Hydrologic Unit Code 17080001) drains approximately 508 square miles (330,000 acres) in northwestern Oregon. The Sandy River originates from glaciers on the western slopes of Mt. Hood at an approximate elevation of 6200 feet above sea level and travels 56 miles before flowing into the Columbia River near the City of Troutdale. The Sandy River is the only major glacial river draining the western Cascades in Oregon. Glacially-derived fine particulate matter, known as "glacial flour", gives the Sandy its distinctive milky-grey color during the summer. Major tributaries to the Sandy River include the Zigzag, Salmon, and Bull Run Rivers. The Little Sandy River is the largest tributary to the lower Bull Run River. Political jurisdictions include portions of Multnomah and Clackamas counties and several small, incorporated cities, including Rhododendron, Zigzag and Government Camp. Portions of the cities of Gresham, Troutdale and Sandy also lie within lower portion of the basin.

Approximately 70% of the basin is owned and managed by the U.S. Forest Service (USFS) – Mt Hood National Forest, 22% is in private ownership, 4% is owned by the Bureau of Land Management (BLM), 2% is owned by City of Portland and the remainder owned by State, local government or Portland General Electric (PGE). 19.5% is designated as Wilderness.

The Sandy is home to 19 native and 14 introduced fish species (PGE 1998). The following fish species are listed by NOAA Fisheries: Chinook salmon (Threatened), Steelhead trout (Threatened) and Coho salmon (Candidate species). In 2001, ODFW updated the Sandy Basin Fish Management Plan.

Three river segments within the basin were given various National Wild and Scenic River designations by Congress in 1988:

1. Sandy River from Dodge Park (RM 18.5) to Dabney State Park (RM 6).
2. Sandy River from the headwaters to the National Forest boundary (12.5 miles).
3. Salmon River from the headwaters to the confluence with the Sandy River (33.5 miles).

The Bull Run watershed is approximately 25% of the Sandy Basin (90,000 acres). Much of it is in the Bull Run Reserve, which was created by presidential proclamation in 1892 to protect Portland's Water Supply. The Bull Run supply consists of two storage reservoirs (Dam Numbers 1 and 2) along with an outlet structure on Bull Run Lake, a natural water body near the headwaters. The water supply is an unfiltered water source that serves over 800,000 people in the Portland Metropolitan area. Electricity is generated at the dams and the FERC license expires in 2029.

Portland General Electric operates the Bull Run Hydroelectric Project, which consists of Marmot Dam on the Sandy River, Little Sandy Diversion Dam on the Little Sandy River, the powerhouse on the Bull Run River, Roslyn Lake, and associated flumes, canals and tunnels. The Bull Run Hydroelectric Project diverts up to 600 cubic feet per second (cfs) of flow from the Sandy River and 200 cfs from the Little Sandy River, eventually returning the flow through a powerhouse on the lower Bull Run River. PGE has chosen to pursue decommissioning rather than FERC re-licensing of the Bull Run Hydroelectric Project and removal is scheduled to be completed in 2009.

Based upon data collected by ODEQ and summarized using the Oregon Water Quality Index (OWQI), the Sandy River (measured at the Troutdale Bridge) exhibits excellent water quality throughout the year. A detailed description and methodology review of the Oregon Water Quality Index can be found on the ODEQ website: http://www.deq.state.or.us/lab/wqm/wqi/wqimain.htm

There are three wastewater treatment plants (WWTPs) with permitted surface water discharges in the basin serving the Government Camp, Hoodland and Troutdale service areas. There are also two general NPDES permitted facilities, Mount Hood Community College and Legacy Mount Hood Medical Center, and one ODFW fish hatchery located within the Sandy River Basin.

2.1 GEOLOGY

The steep upper slopes of Mount Hood, the area from which Sandy, Salmon and Zigzag Rivers flow, are barren, consisting of unconsolidated pyroclastic and debris flow deposits and recent glacial deposits. The present glaciers, currently in a period of retreat, are small remnants of glacial advances that extended to the southwest as far as the town of Brightwood during previous ice ages, about 100,000 years ago. This uppermost portion of the basin is highly susceptible to landsliding and virtually guarantees a large sediment delivery to the Sandy River and tributaries (USFS 1996).

Three significant eruptive events from Crater Rock on Mt. Hood within the last 10 to 15 thousand years have produced volcanic mudflows (lahars). Most of the present-day valley-bottom topography throughout the watershed is a product of these eruptive events. Lahars are fast-moving mudflows that result when hot volcanic material melts snow and ice from the slopes of the volcano. On the Sandy River, lahars traveled as far as the confluence with the Columbia River, leaving terraces up to 150 meters high. In 1805 and 1806, shortly after the most recent lahar event, explorers Lewis and Clark noted a large debris fan and braided channel at the confluence of the Sandy and Columbia Rivers, illustrating the extreme sediment loading associated with lahars. Stillwater Sciences (2000) notes that "(*t)he ongoing influence of past laharic events, Mt. Hood glaciers, and the basin's underlying lithology result in conditions of naturally high sediment loading in the Sandy River*".

A large scale lahar-related sediment release was observed as recently as June, 2002, dramatically increasing turbidity levels throughout the Sandy River. The event was likely caused by rapid snow melt (record-breaking temperatures were observed in the Portland area) triggering a debris flow in the uppermost lahar deposits.

A notable exception to the lahar-dominated nature of the Sandy River Basin is the Bull Run watershed. The position of the Bull Run watershed within the Sandy River Basin has shielded it from significant glacial and lahar events, resulting in a more stable valley floor and reduced sediment yields (Stillwater 2000).

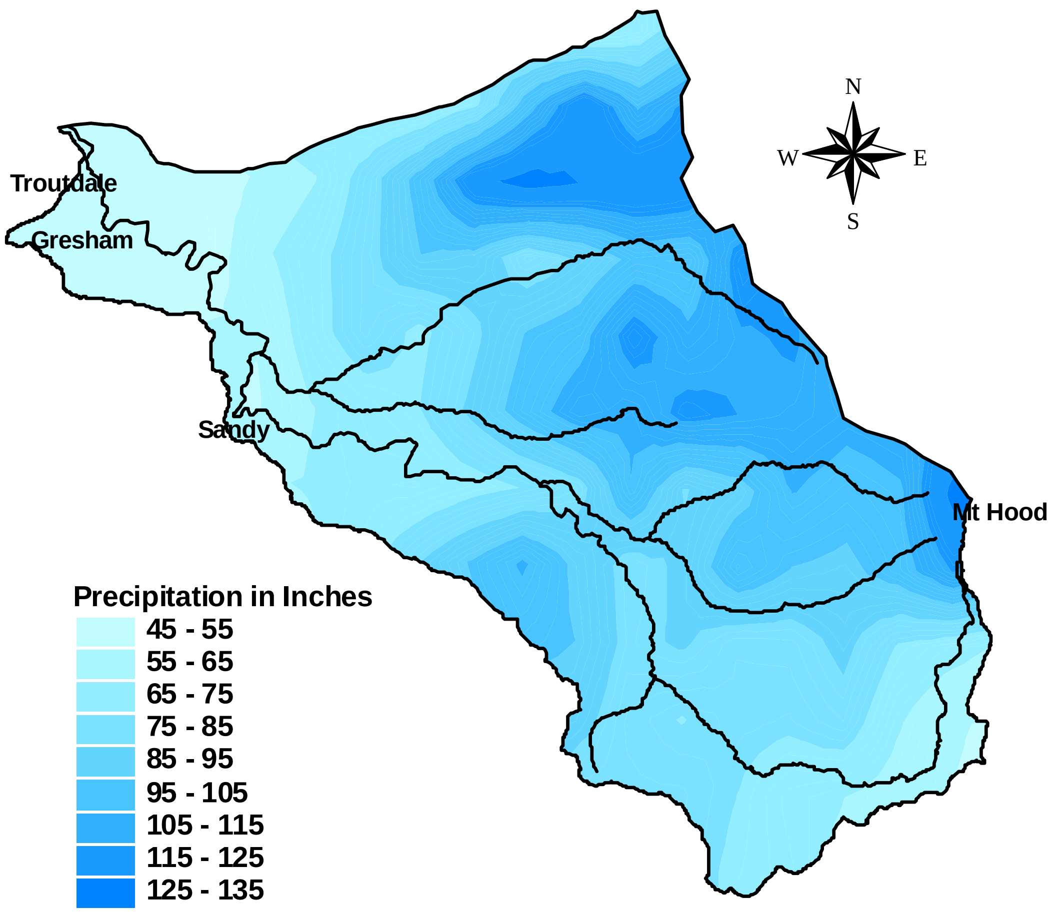
2.2 CLIMATE

The Sandy River Basin has a maritime climate that is characterized by seasonally mild temperatures and wet winters. Annual precipitation generally varies from west to east and with elevation, ranging from 45 inches near Troutdale (elev. 30 ft) to close to 140 inches at Mt. Hood (elev. 11,200 ft) (**Figure 2.1**). The heaviest precipitation occurs from November through January, and the lowest in July and August. Both temperature and precipitation vary with altitude, with higher elevations receiving much of the precipitation as snow (SRBWC, 1999). Snowfall is heavy at high elevations and can reach 30 feet deep at timberline on Mt. Hood.

Average maximum summer temperatures range from 68°F at Government Camp to 78°F at the Bull Run Dam #2 to 81°F in Troutdale. Minimum January temperatures range from 23-24°F at Government Camp to 33°F at Troutdale (Western Regional Climate Center, 2002).

As part of this TMDL effort, ODEQ contracted with Watershed Sciences, LLC to map and assess stream temperatures using Thermal Infrared Radiometry (TIR) remote sensing. Surveys were conducted from August 8-9, 2001 using a TIR sensor attached to the underside of helicopter. Meteorological conditions during the August 8-9 surveys (1:30-5:00 PM) were recorded using a field station located at the Troutdale airport. Air temperatures during the TIR flights (1:30 to 5:00 p.m.) on August 8 and 9 averaged 87.4°F and 96°F, respectively.

Figure 2.1. Sandy River Basin Precipitation (digital data from Oregon Geospatial Data Clearinghouse)

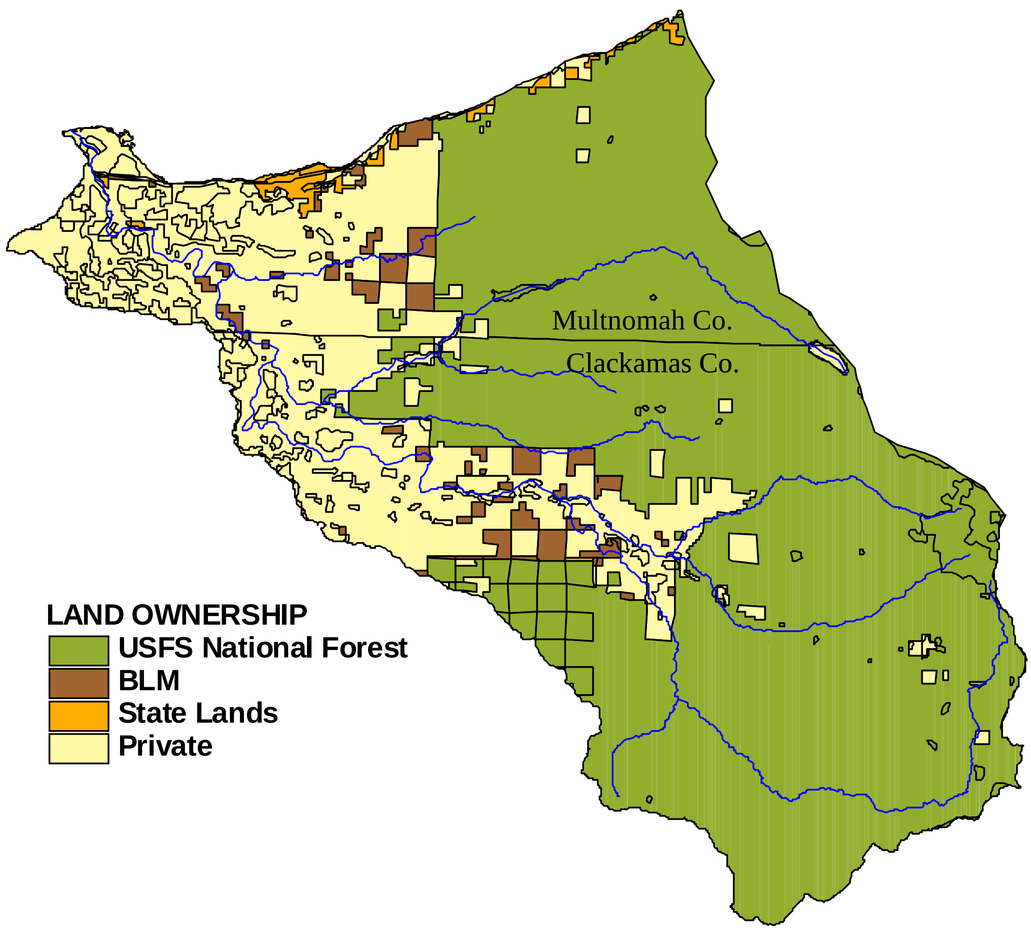


2.3 LAND USE AND OWNERSHIP

The Sandy River Basin Watershed Council (1999) generally describes land use in the basin as follows: "*Lands in the lower portions of the basin are generally privately owned and support timber, agricultural and residential uses. Above the City of Sandy, most private lands support timber production, Christmas tree farms, and some livestock use. Below the city, agricultural uses are common with widespread nursery stock production*".

Approximately 70% of the basin is owned and managed by the U.S. Forest Service (USFS) – Mt Hood National Forest, 22% is in private ownership, 4% is owned by the Bureau of Land Management (BLM), 2% is owned by City of Portland and the remainder owned by State, local government or Portland General Electric (PGE). 19.5% is designated as Wilderness. Spatial distribution of land ownership is shown in **Figure 2.2**.

Figure 2.2. Land Ownership/Management Spatial Distribution (digital data from Oregon Geospatial Data Clearinghouse)



Timber harvest on private lands is guided by the 1994 Oregon Forest Practices Act. Timber harvest on Mt. Hood National Forest lands is guided by the 1994 Northwest Forest Plan (USDA Forest Service, 1994) and the Mt. Hood National Forest's Land and Resource Management Plan (USDA Forest Service, 1990). National Forest lands are also managed for a variety of other uses, including recreation, scenic viewsheds, and deer/elk winter range. The Mt. Hood National Forest also manages three wilderness areas in the basin – the Mark O. Hatfield wilderness (approximately 4,000 acres), the Mt. Hood

Wilderness (approximately 26,000 acres) and the Salmon - Huckleberry Wilderness (approximately 36,000 acres).

Outdoor recreation and tourism have expanded into a significant portion of the economy in the watershed. The Mount Hood National Forest and Timberline Ski Resort draw visitors to the forested portions of the basin. Whitewater kayaking, angling, hiking, camping, backcountry snow sports and mountain biking are increasing watershed uses. More than 10,000 climbers a year come seeking the top of the state, making Mount Hood's summit the most visited snow-clad peak in America. During the summer months the banks of the Sandy River, primarily from Oxbow Park to Lewis and Clark State Park, are heavily utilized by recreational swimmers and picnickers.

Recreational use and urban debris on the Lower Sandy River near Troutdale.

2.4 STREAM FLOW CHARACTERISTICS

Eleven U.S. Geological Survey (USGS) flow gauging stations are currently operating in the Sandy River Basin (**Figure 2.3**). Most stations are located in the Bull Run watershed, where they help facilitate management of the City of Portland's Bull Run drinking water and hydroelectric system. **Table 2.1** shows the station number and period of record associated with current USGS flow monitoring sites. It should be noted that historical flow information has been collected at various locations throughout the Sandy River basin and is available on the USGS website at: http://or.water.usgs.gov/

Figure 2.3. Location of USGS Flow Monitoring Locations

Minimum stream flows generally occur during September or October. Many non-glacial streams in the basin have very low summer flows, while tributaries with glacial sources maintain higher summer flows. Peak flows in the watershed most often occur in December and January and are often associated with rain on snow events. The maximum flood of record at the Marmot Gage occurred on December 22, 1964, with a recorded flow of 61,400 cfs. The maximum flood of record at the Sandy below Bull Run Gage occurred on the same day, with a recorded flow 84,400 cfs.

Table 2.1. Current USGS Flow Stations

Station Number	Station Name	Period of Record
14137000	Sandy River near Marmot, Oregon	1911-present
14138560	Bull Run Lake near Brightwood	1992-present
14138720	Bull Run River at lower flume	1992-present
14138850	Bull Run River near Multnomah Falls	1966-present
14138870	Fir Creek near Brightwood	1975-present
14138900	North Fork Bull Run River near Multnomah Falls	1965-present
14139800	South Fork Bull Run River near Multnomah Falls	1974-present
14140000	Bull Run River near Bull Run	1904-present
14141500	Little Sandy River near Bull Run	1911-present
14142500	Sandy River below Bull Run River	1984-present
14142800	Beaver Creek near Troutdale, Oregon	1999-present

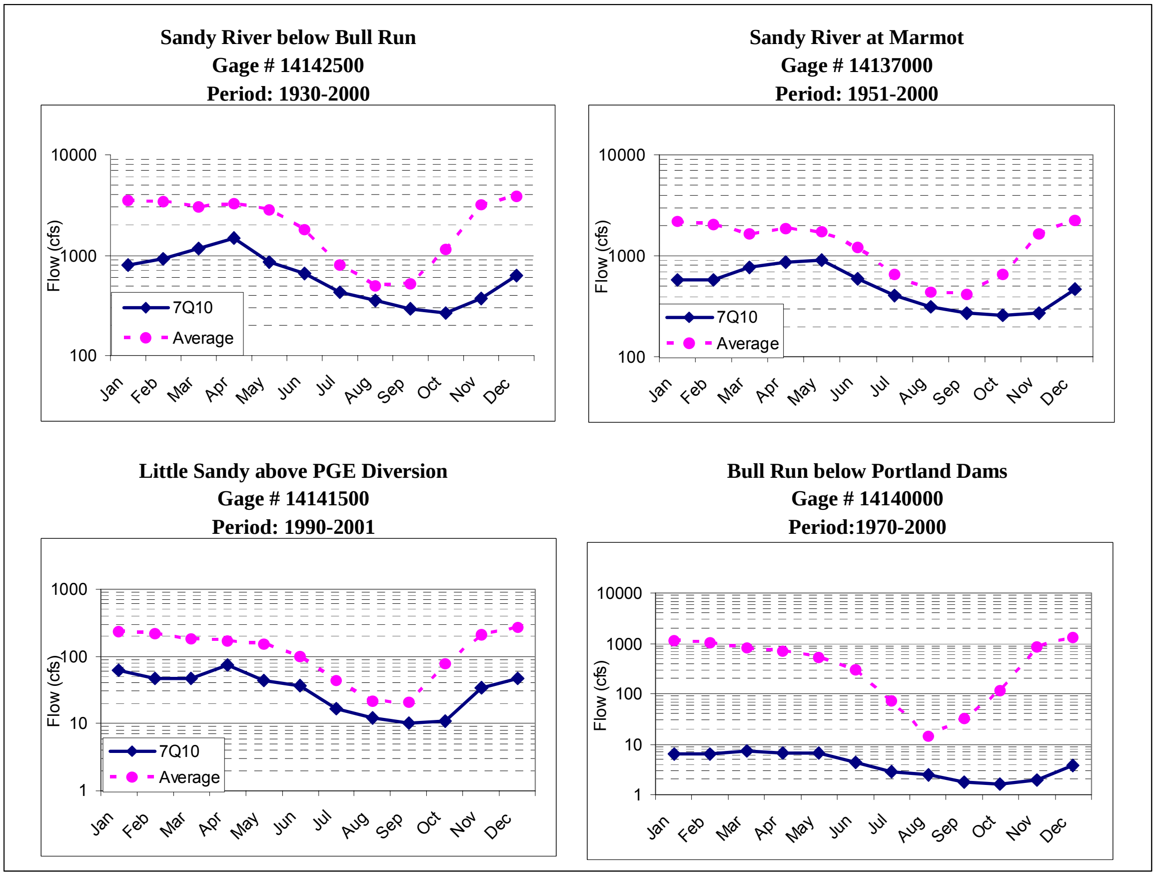
Low flow 7Q10 statistics were calculated for four current Sandy River Basin gauging stations[2] (**Table 2.2**). Monthly flow averages and 7Q10 low flow averages for several Sandy River Basin sites are presented in **Figure 2.4**.

Table 2.2. Log Pearson Type III 7Q10 Low Flows

Location	Period	Flows Averaged over 7 days with a Return Period of 10 Years
		7Q10 Low Flow (cfs)
Sandy River Below Bull Run	1930-2000	265
Sandy River at Marmot Dam	1951-2000	255
Little Sandy above PGE Diversion	1990-2001	17
Bull Run below Portland Dams	1970-2000	4

2 7Q10 refers to a seven day averaged flow condition that occurs on a ten-year return period. Mathematically, this flow has a 10% probability of occurring every year. A Log Pearson Type III distribution was used to calculate the return period.

Figure 2.4. Monthly 7Q10 Low Flow and Average Monthly Flows for Selected Monitoring Sites



The natural discharge patterns in the Sandy Basin are altered by the Portland Water Bureau municipal reservoirs in the Bull Run Watershed and by the Portland General Electric diversion dams on the Sandy and Little Sandy Rivers. These projects will be discussed further in the following sections of this document. Several sources have estimated historic or “natural” flow conditions in the Sandy River Basin. Results from these studies are presented in **Table 2.3**. Natural flows for the lower Bull Run River were derived by summing the gauged Bull Run Reservoir inflows and adding 20% to account for the ungauged area (R2 1998). GIS analysis performed by ODEQ confirmed that 20% of the total area in the Bull Run watershed is ungauged. By summing the existing gauges (which measure natural flows to the Bull Run reservoirs) and adding 20%, a reasonable estimation of natural flows results. The Lower Bull Run “existing” flow values were calculated for the time period 1963-1996, before the City of Portland began increasing summertime flow release from the Bull Run reservoirs.

Table 2.3. Estimated Natural Flows

Month	Lower Bull Run*		Sandy Below Bull Run**		Sandy at Marmot⚲	Little Sandy at Diversion⚲
	Natural	Pre-1998 with Dams	Natural	Existing	Natural	Natural
JAN	795	610	2370	2370	2020	239
FEB	730	585	2550	2300	1850	209
MAR	710	520	2800	2400	1650	187
APR	850	615	3150	3070	1880	196
MAY	685	420	2500	2300	1850	168
JUN	370	105	1500	1150	1250	104
JUL	185	7	850	625	652	39
AUG	110	7	590	450	433	23
SEP	130	7	500	390	428	41
OCT	200	7	525	490	665	89
NOV	780	500	2800	2100	1580	209
DEC	810	700	2225	2300	2090	244

***** Median monthly flow values for the lower Bull Run River between Headworks and the Bull Run Powerhouse based upon USGS Gage 14140000, 1963-1996 (R2 Resource Consultants 1998).

****** Median monthly flow values for the Sandy River below the Bull Run River based upon 1984-1993 gage record (R2 Resource Consultants 1998).

⚲ Based on mean daily discharge in cfs for the period of 1911-1987 (Miffed et al. 1990 and PGE 1998).

2.4.1 Water Rights and Use

According to the State of Oregon Water Resources Department (WRD), the amount of water produced in the Sandy Basin is adequate to meet current instream and out-of-stream demands in most months. However, future appropriation for out-of-stream uses may be severely restricted. There are 2,504 acres of irrigated agricultural lands within the Sandy River Basin, mostly in the lower watershed around Big and Beaver Creeks. WRD estimates that current irrigation in the basin requires 6,900 acre-feet of water (total Sandy river discharge is estimated at 1,954,000 acre-feet).

The most recent WRD accounting of water rights in the Sandy River Basin was completed in January, 1991. While these rights have been granted, they may or may not all be actively used. Below is the list of surface water rights of record (excluding Bull Run and Little Sandy Rivers) for the Sandy Basin (WRD 1991). Units of measure are cubic feet per second (cfs) and acre-feet. One acre foot is equal to 325,850 gallons.

	Agriculture	Industrial	Municipal	Domestic	Other*
cfs	12.96	19.97	33.72	26.04	39.66
acre-feet	11.27	116.00	0.00	0.00	29.00

***** May Include recreation, aesthetics, forest management, fire protection, pollution abatement, road construction and storage.

The State of Oregon Departments of Fish and Wildlife (ODFW), Environmental Quality and Parks and Recreation have the ability to apply for instream water rights to support aquatic life, minimize pollution and maintain recreational values. The priority dates of instream water rights are assigned according to the date of the application. ODFW has been granted instream water rights on sixteen streams in the basin, including portions of the mainstem Sandy, Salmon and Zigzag Rivers as well as several smaller tributaries. Current ODFW instream water rights are intended for the protection of Anadromous and resident fish rearing and have a priority date of 1991.

The following seasonal minimum flows must be maintained downstream of Marmot Dam: June 16 through October 15 = 200 cfs; October 16 through October 31 = 400 cfs; and November 1 through June 15 = 460 cfs.

BULL RUN AND OTHER DRINKING WATER WITHDRAWALS

In 1909 the State Legislature enacted ORS 538.420, which granted the City of Portland exclusive rights (not affecting pre-1909 claims) to the waters of the Bull Run and Little Sandy Rivers for drinking water use. ORS 538.420 reduced the jurisdiction of the Water Resources Commission and, notwithstanding pre-1909 claims, it is in Portland's discretion to decide when and how much of its right to the waters of the Bull Run and Little Sandy to develop. Portland currently utilizes about 26 percent of the annual flow of the Bull Run River, but has not made use of its right on the Little Sandy River (WRD 1991). PGE claims a pre-1909 right on the Little Sandy and currently diverts the entire flow for power generation.

The other major municipal water users getting their water from surface sources in the Sandy Basin are the Corbett Water District and the City of Sandy. The Corbett Water District has water rights for 4.5 cfs on Gordon and Elk creeks. The City of Sandy has rights on Brownell Springs and Alder Creek totaling 5.1 cfs, which will provide water for 10-12,000 people. To meet future demands, Sandy has also acquired a water right for 25 cfs on the Salmon River (WRD 1991).

2.4.2 PGE Bull Run Hydroelectric Project

Portland General Electric's (PGE) Bull Run Hydroelectric Project consists of Marmot Dam, Little Sandy Diversion Dam, associated flumes and tunnels, Roslyn Lake and the Bull Run Powerhouse (**Figure 2.5**). Water is diverted from the Sandy River, via Marmot Dam and associated flumes and tunnels, and conveyed to the Little Sandy River where the diverted Sandy River water joins the Little Sandy just upstream of the Little Sandy Diversion Dam. At the Little Sandy Diversion Dam, the combined waters of the Sandy and Little Sandy Rivers are diverted to Roslyn Lake. The Little Sandy Dam diverts the entire flow of the Little Sandy River, except in times of high water. From Roslyn Lake, water is discharged to the Bull Run River through PGE's Bull Run powerhouse, where it flows approximately 1.5 miles downstream and re-joins the mainstem Sandy River. PGE can divert up to 800 cfs of combined flows from the Sandy and Little Sandy rivers for the Bull Run Project. Additional water can be supplied directly to Roslyn Lake via the City of Portland's municipal water supply conduits, potentially supplying an additional 260 cfs of Bull Run river water into Roslyn Lake. In recent years, Portland has sent a maximum of either 175 cfs to Roslyn Lake during the winter montyhs. At full generating capacity, the Bull Run Hydroelectric Project draws approximately 900 cfs of flow from Roslyn Lake (PGE 1998).

Little Sandy Diversion Dam

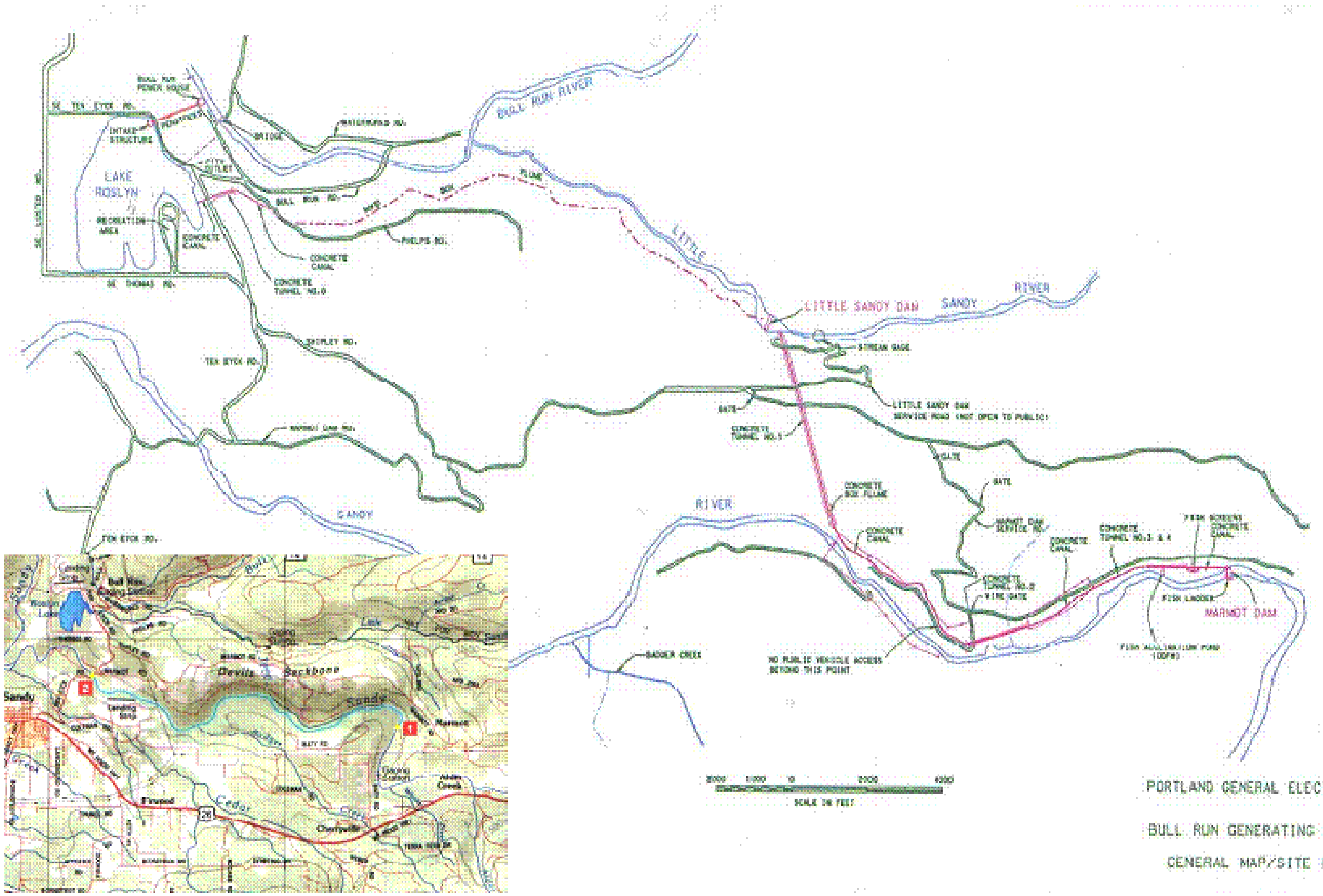
PGE's previous Federal Energy Regulatory Commission (FERC) hydropower license was set to expire on November 16, 2004. In 2000, PGE chose to pursue decommissioning rather than FERC re-licensing of the project. A decommissioning plan, formalized through a negotiated settlement between the State of Oregon, Portland General Electric, National Marine Fisheries Service, U.S. Fish and Wildlife Service and 18 other organizations, was signed and submitted to FERC. Under the Section 401 Certification issued by DEQ on 10/27/2003, PGE's license will be extended through November 16, 2017. PGE will continue generating electricity through June of 2008. In the summer of 2007, PGE will begin a three-year effort to dismantle project facilities and decommission the project. Generation will cease in 2008, facilities will be dismantled and removed by 2009, and PGE will continue monitoring the river and restoring affected lands until the FERC license expires in 2017.

Based upon the *Evaluation Report and Findings on the Application for Certification Pursuant to Section 401 of the Federal Clean Water Act for the Decommissioning of the Bull Run Hydroelectric Project in Clackamas County, Oregon, FERC No. 477*, dated October 22, 2003, the Oregon Department of Environmental Quality (DEQ) certified that the decommissioning of the Bull Run Hydroelectric Project will comply with applicable provisions of Sections 301, 302, 303, 306, and 307 of the federal Clean Water Act, Oregon water quality standards, and other appropriate requirements of state law.

Detailed information related to ODEQ's Section 401 Certification of the Bull Run Hydroelectric Project can be found at: http://www.deq.state.or.us/wq/401Cert/401CertHome.htm

By Oregon statute, water rights from a decommissioned hydroelectric project must be converted to instream rights and ODEQ, ODFW and the Oregon Water Resources Department have signed a water right agreement that returns PGE's pre-1909 claim to instream uses.

Figure 2.5. Location and Configuration of the Bull Run Hydroelectric Project (From Portland General Electric)



2.4.3 City of Portland Drinking Water and Hydroelectric Facilities

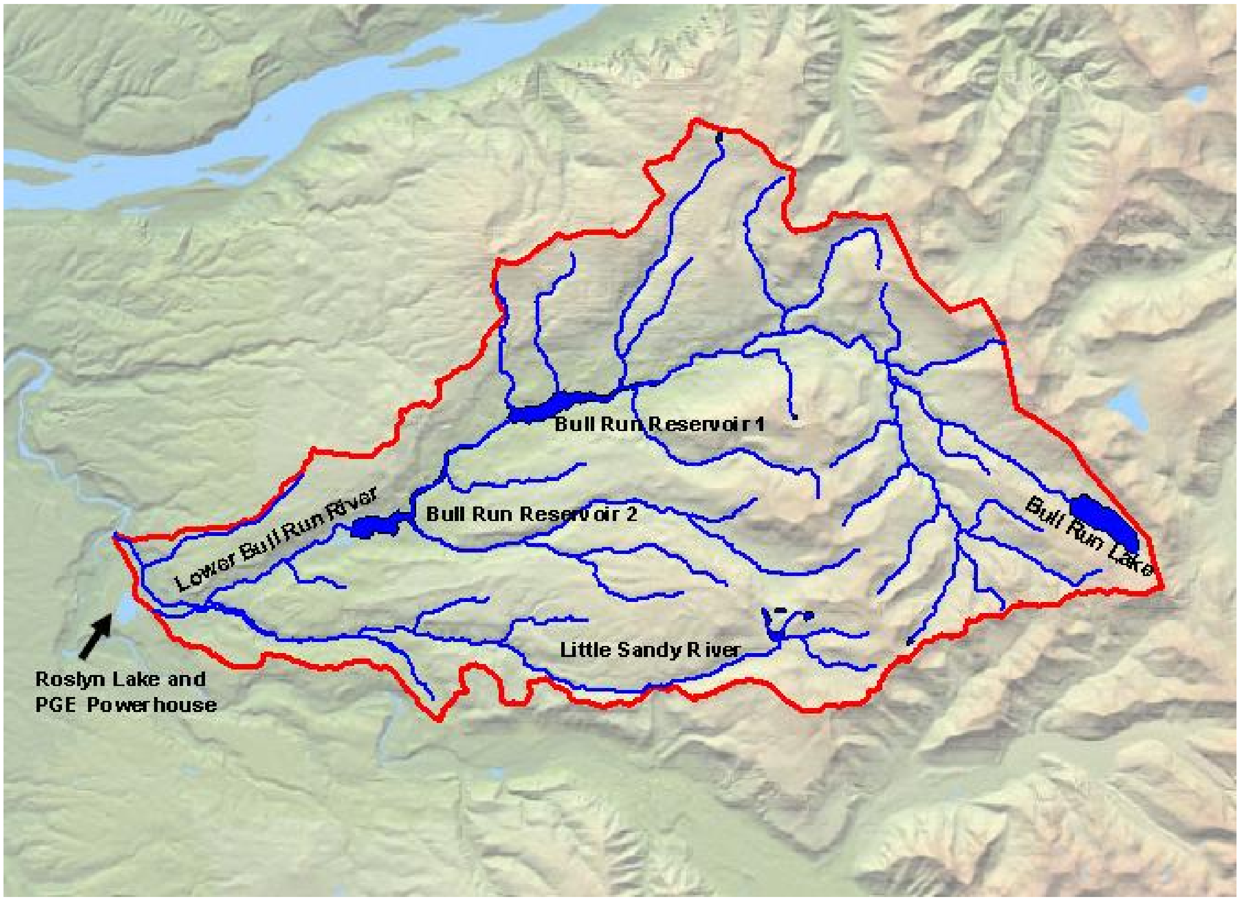
Bull Run Dam 1

The Bull Run water supply consists of two storage reservoirs (Dam Numbers 1 and 2) along with an outlet structure on Bull Run Lake, a natural water body near the headwaters (**Figure 2.6**). In 1929, the Water Bureau completed construction of Bull Run Dam 1, creating Reservoir 1 (also known as Lake Ben Morrow). Dam 2 is four miles downstream of Dam 1 and was completed in 1962. Electricity is generated at the dams and the FERC license expires in 2029.

Bull Run Lake is a natural lake above the headwaters of Bull Run River, though an outlet structure has been added to increase the elevation and subsequent storage capacity of the lake. Seepage through porous geologic features surrounding the lake contributes significant stream flow into the Bull Run River. The US Forest Service issues a special use permit to the City of Portland to release water from the lake for municipal water supplies. The permit restricts the releases to ensure adequate water is available to support the ecosystem.

Historically, the City of Portland released very little water into the lower Bull Run River during the late summer. However, every summer since 1998, the Bureau has released additional water from the Bull Run reservoirs into the Bull Run River to determine the effects on river temperatures and habitat quality. Flow measured at USGS gage #14140000 (Bull Run near Bull Run) essentially reflects the amount of water released by the City from the Bull Run reservoirs. Between 1994 and 1997 the City released, on average, 4.8 cfs during the month of August. Average flow in August between 1998 and 2003 was 32 cfs, illustrating the positive impact of the City's recent policy of summertime flow release. These post-1998 summertime flow releases have dramatically improved stream temperature conditions in the lower Bull Run River. Current water system operation decisions consider the following key factors: steelhead spawning and reservoir filling in the spring; reservoir drawdown, water temperature, and groundwater operation during the summer months; and Chinook salmon spawning and reservoir refill forecasting in the fall.

Figure 2.6. Bull Run Watershed and Location of City of Portland Reservoirs



CHAPTER 3 – TMDL FOR STREAM TEMPERATURE

Summary of Temperature TMDL

The Sandy Basin temperature TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies because stream temperature results from cumulative interactions between upstream and local sources. For example, 303d listed waterbodies in the Sandy River Basin include the Sandy River from the mouth to Marmot Dam (RM 30), the Bull Run River from the mouth to Bull Run Reservoir #2 (RM 6) and the Salmon River from the mouth to Boulder Creek (RM 1). To address this listing in the TMDL the Sandy River and all major tributaries are included in the TMDL analysis and targets.

An important step in the TMDL process is to examine the anthropogenic contributions to stream heating. Nonpoint source anthropogenic contributions of solar radiation heat loading results from varying levels of decreased stream surface shade throughout the basin. Decreased levels of stream shade are caused by near stream vegetation disturbance or removal. Dams can also contribute to anthropogenic heat loads either through stream diversions or through the heating of water in a reservoir. In some cases dams that "draw down" during the summer release water from lower portions of their reservoir, resulting in the release of cooler water in early summer months and warmer water during late summer months when the supply of cold, deep water is exhausted. Point source contributions of heat result from warm water discharges into receiving waters.

The background solar radiation heat loading condition is estimated in the TMDL by simulating the heat loading that occurs when near stream vegetation is at system potential. For clarity, system potential, as defined in the TMDL, is the near stream vegetation condition that can grow and reproduce on a site, given elevation, soil properties, plant biology and hydrologic processes. System potential does not consider management or land use as limiting factors. In essence, system potential is the design condition used for TMDL analysis that meets the temperature standard:

- System potential <u>is</u> an estimate of a condition without anthropogenic activities that disturb or remove near stream vegetation.
- System potential <u>is not</u> an estimate of pre-settlement conditions. Although it is helpful to consider historic vegetation patterns, many areas have been altered to the point that the historic condition is no longer attainable given drastic changes in stream location and hydrology (channel armoring and wetland draining).
- System potential does not account for major stochastic disturbance such as fire and flooding. However, it is the vegetation condition most likely to be resilient under such stress.

Though not addressed in detail in this TMDL, it should be noted that system potential vegetation assumes a vegetative assemblage that is native to a particular area. Many invasive non-native species are found along Oregon's waterways. These species often colonize riparian areas after flooding events, hindering or preventing the establishment of native riparian species. Invasive species such as Himalaya blackberry and Japanese knotweed spread quickly to form low, dense thickets that are poor substitutes for native riparian vegetation assemblages with respect to stream shading and are of little value to wildlife. Eliminating invasive riparian vegetation and establishing native stands is necessary to achieve the overall goals of this TMDL.

The Sandy River Basin temperature TMDL allocates heat loading to nonpoint sources (natural background and anthropogenic) and point sources. Allocated conditions are expressed as heat per unit time (kilocalories per day). The nonpoint source heat allocation is translated to effective shade and flow surrogate measures that linearly translates the nonpoint source solar radiation allocation. Effective shade surrogate measures provide site-specific targets for land managers and attainment of the surrogate measures will ensure compliance with the nonpoint source allocations. A brief summary of the Sandy River basin temperature TMDL components is provided below in **Table 3.1**.

Table 3.1. Sandy River Basin Temperature TMDL Components

Waterbodies OAR 340-042-0040(4)(a)	To perennial and to fish bearing intermittent streams (as identified by ODFW, USFW or NFMS) streams within the HUC (hydrologic unit code) 17080001 (Sandy River and its tributaries).
Pollutant Identification OAR 340-042-0040(4)(b)	*Pollutants:* Human caused temperature increases from (1) solar radiation loading, (2) warm water discharge to surface waters and (3) reduced flow due to diversions.
Target Criteria Identification OAR 340-042-0040(4)(c) OAR 340-041-0028(4)(a) OAR 340-041-0028(4)(b) OAR 340-041-0028(4)(c) *OAR* 340-041-0028(8) *CWA §303(d)(1)*	OAR 340, Division 41 provides numeric and narrative temperature criteria. Figures 286 A and B, referenced in OAR 340-041-0286 and reproduced in **Figures 3.1** and **3.2** below, specify where and when the criteria apply. Biologically based numeric criteria applicable to the Sandy basin, as measured using the seven day average of the daily maximum stream temperature, include: 13.0°C during times and at locations of salmonid and steelhead spawning. 16.0°C in streams identified as having core cold water habitat use. 18.0°C during times and at locations utilized by salmon and trout for rearing and migration.
Seasonal Variation OAR 340-042-0040(4)(j) ***CWA §303(d)(1)***	Peak temperatures typically occur in late-July and early-August, impacting salmonid rearing life stage. Species-specific spawning occurs at various times throughout the basin.
Existing Sources OAR 340-042-0040(4)(f) ***CWA §303(d)(1)***	Forestry, Agriculture, Transportation, Rural Residential, Urban, Industrial Discharge, Waste Water Treatment Facilities, Management of River Flows Associated with Dams, Hydroelectric Power
TMDL **Loading Capacity and Allocations** OAR 340-042-0040(4)(d) OAR 340-042-0040(4)(e) OAR 340-042-0040(4)(g) OAR 340-042-0040(4)(h) ***40 CFR 130.2(f)*** ***40 CFR 130.2(g)*** ***40 CFR 130.2(h)***	*Loading Capacity:* The Water Quality Standard mandates a Loading Capacity that results in no more than a 0.3°C increase in stream temperatures as a result of human activities. This condition is achieved when the cumulative effect of all point and nonpoint sources results in no greater than a 0.3 °C (0.5 °F) increase to the applicable criteria at the point of maximum impact. *Waste Load Allocations (NPDES Point Sources)*: Allowable heat load based on achieving either no greater than a 0.3°C temperature increase allowing ¼ of the 7Q10 low flow instream or 0.2 °C with full mixing where appropriate. *Load Allocations (Nonpoint Sources)*: System potential solar radiation loading. *Load Allocations (PGE Bull Run Hydroelectric Project)*: PGE is assigned a flow based load allocation. The decommissioning plan will serve as the Temperature Management Plan. *Load Allocations (City of Portland Drinking Water and Hydroelectric Facilities)*: The City is assigned an allocation based on achieving a surrogate measure. The surrogate measure is expressed as a temperature target based upon Little Sandy River stream temperatures.
Surrogate Measures OAR 340-042-0040(5)(b) 40 CFR 130.2(i)	Translates Nonpoint Source Load Allocations • *Effective Shade targets translate the nonpoint source loading capacity.* • *Temperature targets for City of Portland operations in the lower Bull Run River.*
Margins of Safety and Reserve Capacity OAR 340-042-0040(4)(i) CWA §303(d)(1)	Implicit Margins of Safety are demonstrated in critical condition assumptions and are inherent to methodology for determination of nonpoint source loads. Reserve Capacity is provided by withholding 0.05 °C from the Human Use Allowance
Standards Attainment & Reasonable Assurance OAR 340-042-0040(4)(l)(e) & (j)	• Analysis and modeling of TMDL loading capacities and required pollutant reductions demonstrates attainment of water quality standards. • Standards Attainment and Reasonable Assurance are addressed in Section 6.7 of the Water Quality Management Plan.

3.1 WATER QUALITY STANDARD AND TARGET IDENTIFICATION - CWA §303(D)(1)

The purpose of Oregon's stream temperature standard is to protect designated temperature-sensitive beneficial uses in waters of the State, including specific salmonid life stages. Several biologically-based numeric criteria that are specific to these life stages are used to gage whether surface waters are "water quality limited" with respect to temperature. A seven-day moving average of daily maximum temperature (7-day statistic) was adopted as the measure of the stream temperature standard. **Table 3.2** shows the biologically-based numeric temperature criteria that are applicable to specific salmonid life stages under Oregon's standard. Oregon's standard also specifies where and when the specific salmonid life stages occur and, therefore, where and when the numeric criteria apply. A basin-wide distribution and timing map is provided in **Figures 3.1**and **3.2**, below. **Figure 3.1** delineates where the core cold water habitat criterion of 16°C and the rearing and migration criterion of 18°C apply in the watershed. The 16°C and 18°C criteria apply at all times of year except during designated spawning through fry emergence periods, during which a more stringent criterion is applied. **Figure 3.2** delineates where and when the numeric spawning through fry emergence standard of 13 °C applies.

DEQ primarily relied on the Oregon Department of Fish and Wildlife (ODFW) for information on fish distribution and life stage timing. This information can be viewed on the internet at http://osu.orst.edu/dept/nrimp/information/fishdistdata.htm. The database is the product of a multi-year effort by ODFW to develop consistent and comprehensive fish distribution data for a number of salmonid species. DEQ believes the ODFW database is scientifically sound and represents the best information readily available.

The temperature standard contains a narrative portion describing conditions under which the numeric criteria may be superseded. Language in the standard acknowledges that in some instances the biologically-based numeric criteria may not be achieved even when waters are in their natural condition and specifies that stream temperatures achieved under natural conditions shall be deemed to be the applicable temperature criteria for that water body. In other words, a stream that does not meet one or more of the numeric temperature criteria, but is free from anthropogenic influence, is considered to be at the natural thermal potential and therefore in compliance with the temperature standard.

Lastly, Oregon's temperature standard contains provisions that limit the cumulative anthropogenic heating of surface waters to no more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) in almost all instances. Oregon chose to include a 0.3 °C human use allowance for insignificant additions of heat in waters that exceed applicable numeric criteria. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (USEPA, 2003).

Table 3.2. Biologically Based Numeric Temperature Criteria Applicable to Salmonid Uses

Use	Numeric Criteria (7-day statistic)
Salmon and Steelhead Spawning	13.0°C / 55.4°F
Core Cold Water Habitat	16.0°C / 60.8°F
Salmon and Trout Rearing and Migration	18.0°C / 64.4°F
Salmon and Steelhead Migration Corridors	20.0°C / 68.0°F
Lahontan Cutthroat or redband trout use	20.0°C / 68.0°F
Bull trout spawning and juvenile rearing	12.0°C / 53.6°F

Figure 3.1. Fish Use Designations and Associated Numeric Temperature Criteria for the Sandy River Basin.

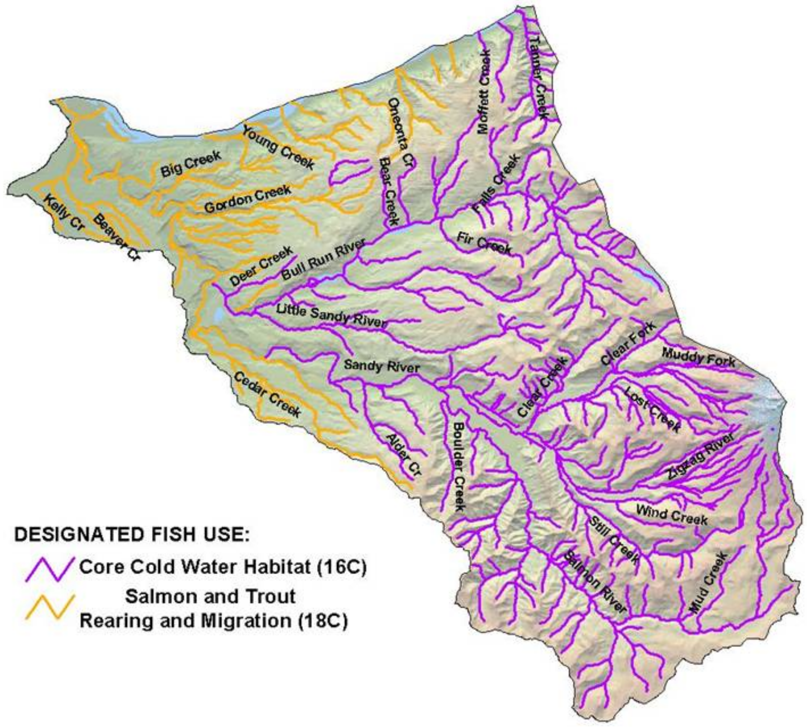
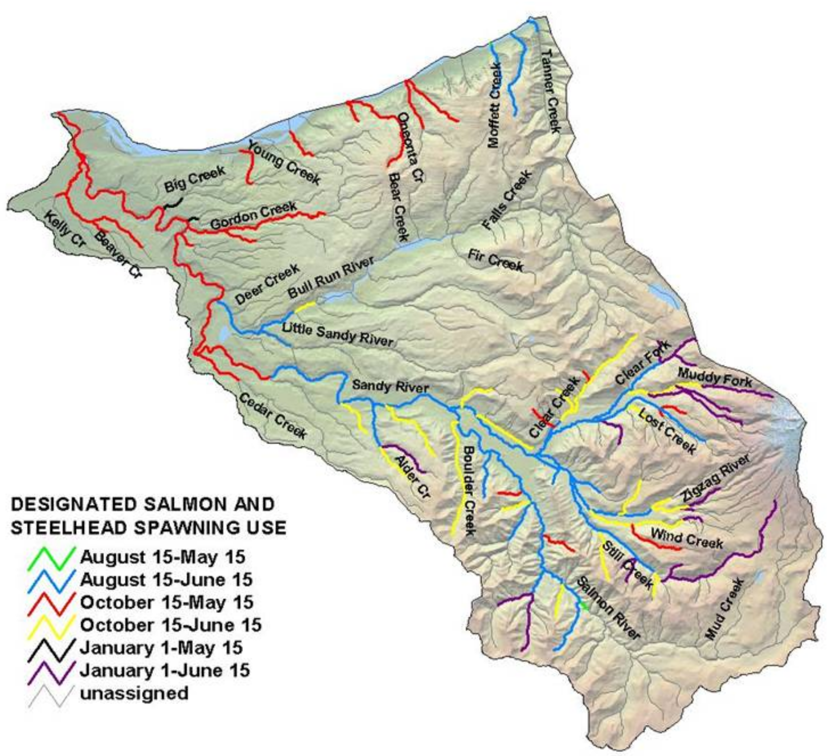


Figure 3.2. Salmon and Steelhead Spawning Through Fry Emergence Use Designations for the Sandy River Basin.



Salmonid Stream Temperature Requirements

Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, Chinook salmon (*Oncorhynchus tshawytscha*) and bull trout (*Salvelinus confluentus*) are among the most temperature sensitive of the cold water fish species. Oregon's water temperature standard employs logic that relies on using these *indicator species,* which are the most sensitive. If temperatures are protective of these *indicator species*, other species will share in this level of protection.

If stream temperatures become too hot, fish die almost instantaneously due to denaturing of critical enzyme systems in their bodies (Hogan, 1970). The ultimate *instantaneous lethal limit* occurs in high temperature ranges (upper-90°F).

In some portions of the lower Sandy River Basin, the occurrence of temperatures in the mid-70°F range (mid- to high-20°C range) was observed during the summer of 2001. These temperatures cause death of cold-water fish species during exposure times lasting a few hours to one day. The exact temperature at which a cold water fish succumbs to such a thermal stress depends on the temperature that the fish is acclimated to and on particular development life-stages. This cause of mortality, termed the *incipient lethal limit*, results from breakdown of physiological regulation of vital processes such as respiration and circulation (Heath and Hughes, 1973).

The most common and widespread cause of thermally induced fish mortality is attributed to interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior, increased exposure to pathogens (viruses, bacteria and fungus), decreased food supply (impaired macroinvertebrate populations) and increased competition from warm water tolerant species. This mode of thermally induced mortality, termed indirect or *sub-lethal*, is more delayed, and occurs weeks to months after the onset of elevated temperatures (mid-60°F to low-70°F). **Table 3.3** summarizes the modes of cold water fish mortality.

Table 3.3. Modes of Thermally Induced Cold Water Fish Mortality
(Brett, 1952; Bell, 1986, Hokanson et al., 1977)

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

3.2 TEMPERATURE POLLUTANT IDENTIFICATION

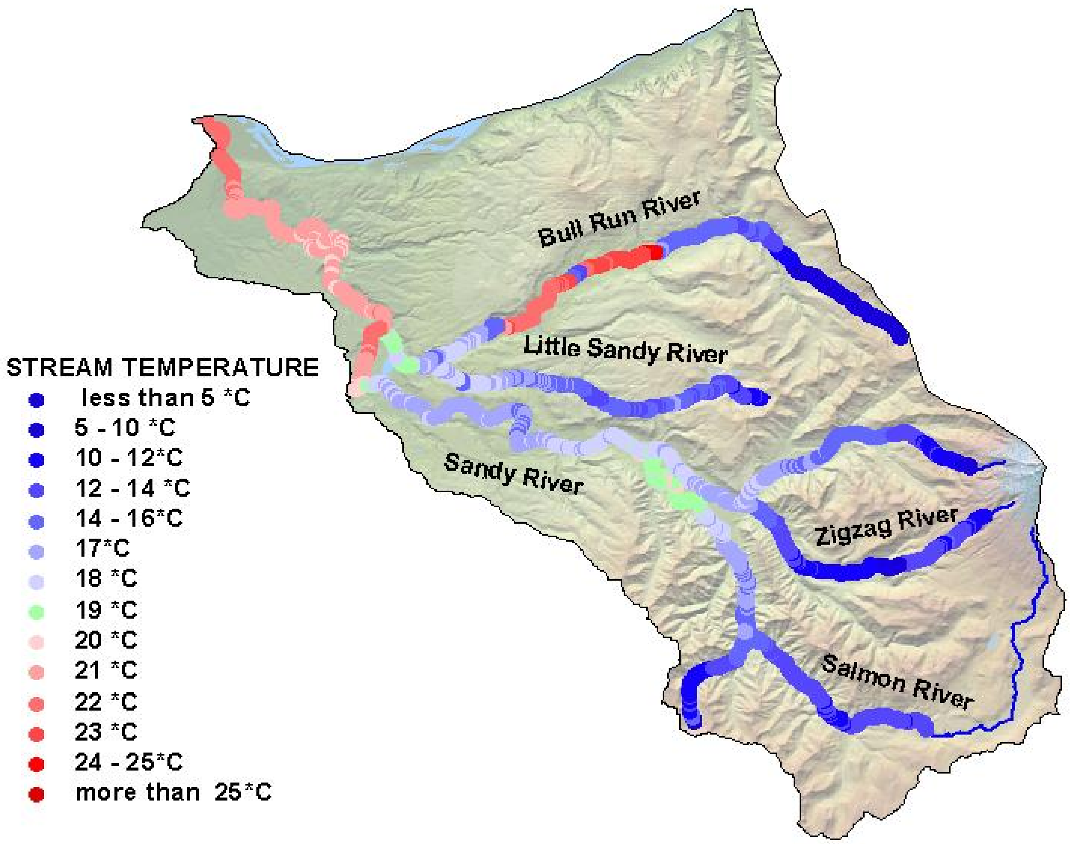
Anthropogenic increase in heat energy is derived from solar radiation as increased levels of sunlight reach the stream surface and raise water temperature and from point source warm water discharges. The pollutants targeted in this TMDL are (1) human caused increases in solar radiation loading to the stream network, (2) warm water discharges of human origin and (3) reduced flow due to diversions.

3.3 DEVIATION FROM WATER QUALITY STANDARD

Section 303(d) of the Federal Clean Water Act (1972) requires that water bodies that violate water quality standards, thereby failing to fully protect *beneficial uses*, be identified and placed on a 303(d) list. Four stream segments (approximately 48 miles) in the Sandy River Basin were included on the 2002 303(d) list for exceeding numeric temperature criteria (**Table 1.1**). For specific information regarding Oregon's 303(d) listing procedures, and to obtain more information regarding the Sandy River Basin's 303(d) listed streams, visit the ODEQ web page at **www.deq.state.or.us/**.

During the summer of 2001, temperature monitoring instruments recorded hourly stream temperatures at various locations throughout the Sandy River Basin. **Table 3.4** provides a summary of results of the 2001 monitoring and shows that water temperatures in portions of the Sandy River Basin exceed the numeric rearing criteria. Stream temperature data collected using Thermal Infrared Radiometry (TIR) technology in the Sandy basin on August 8th and 9th, 2001 shows longitudinal heating patterns for major Sandy basin tributaries (**Figure 3.3**). A detailed description of the use of TIR is provided in **Section 3.7** of this document.

Figure 3.3. TIR-derived Stream Temperatures[5] in the Sandy River Basin on August 8-9, 2001.



[5] TIR measures surface water temperatures and is most effective in well-mixed riverine systems. The longitudinal heating pattern of the Bull Run River is interrupted by surface water temperatures of the Bull Run Reservoirs #1 and #2, represented as red, or extremely warm segments.

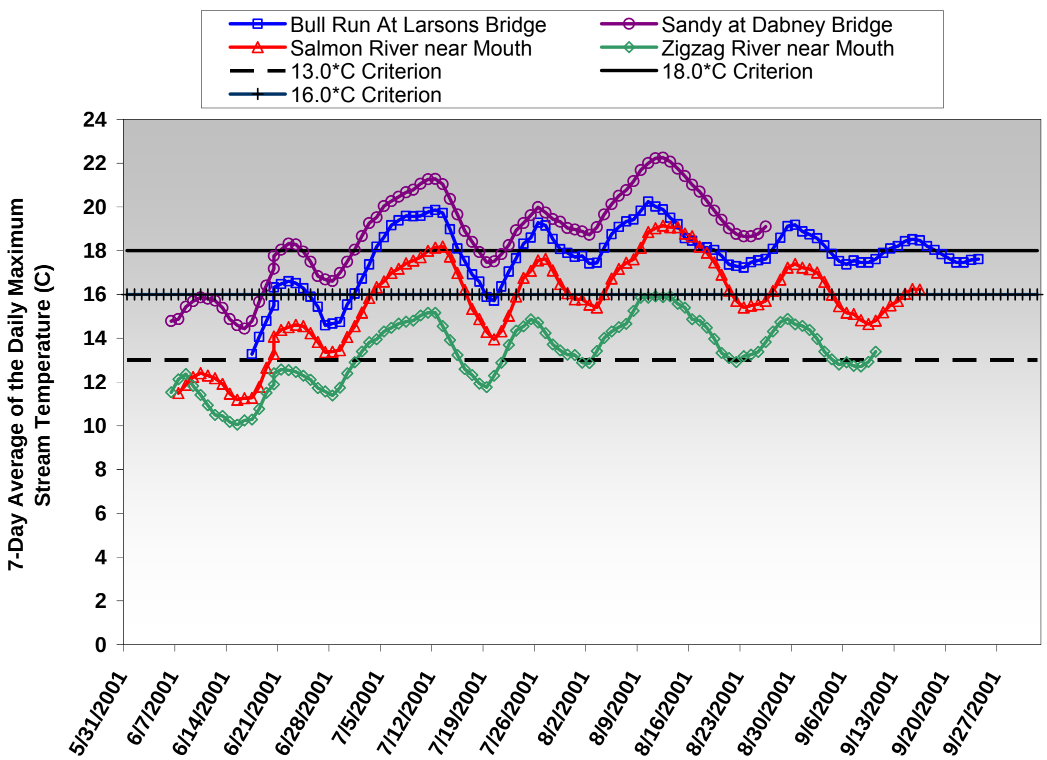
Table 3.4. Seasonal Summary of Selected ODEQ 2001 Stream Monitoring Locations

Site Name	Daily Max Date	Daily Max Value	Daily Min Date	Daily Min Value	7-Day Max Date	7-Day Max Value	Days Over 18 C
Alder Creek at Mouth	8/10/01	16.0	6/13/01	7.4	8/12/01	15.6	0
Badger Creek @ Coleman Road	8/13/01	18.8	6/13/01	8.9	8/10/01	18.1	7
Beaver Creek near Mouth	8/9/01	23.2	6/13/01	12.3	8/10/01	22.8	71
Blazed Alder at Mouth	7/12/01	17.7	6/16/01	6.7	8/12/01	17.0	0
Boulder Creek at Mouth	8/13/01	16.9	6/13/01	7.3	8/12/01	16.5	0
Buck Creek at mouth	8/10/01	18.6	8/25/01	12.1	8/11/01	18.0	5
Bull Run River above Blazed Alder	8/9/01	11.2	6/16/01	6.2	8/10/01	11.1	0
Bull Run River above Falls Creek	7/12/01	15.9	6/16/01	7.6	8/10/01	15.3	0
Bull Run River above Little Sandy	8/9/01	20.0	6/17/01	10.8	8/8/01	19.3	49
Bull Run River at County Bridge	8/7/01	20.3	9/28/01	12.6	8/8/01	19.5	34
Bull Run River at Bowman's Bridge	8/7/01	19.4	6/17/01	10.8	8/9/01	18.8	28
Bull Run River at bridge below headworks	9/20/01	17.2	6/15/01	11.7	9/22/01	16.9	0
Bull Run River at Larson's Bridge	8/9/01	20.8	6/17/01	10.9	8/8/01	20.2	62
Bull Run River at USGS Gage 1410000	8/6/01	19.2	6/18/01	10.9	8/8/01	18.8	41
Bull Run River below Blazed Alder	7/4/01	12.4	6/16/01	6.5	7/9/01	11.8	0
Bull Run River below Little Sandy River	8/9/01	19.9	6/17/01	10.9	8/8/01	19.2	40
Camp Cr. @ mouth	8/10/01	12.9	6/3/01	5.6	8/12/01	12.6	0
Camp Creek above Government Camp STP	8/14/01	11.1	6/3/01	3.8	8/12/01	10.8	0
Cedar Creek at Hatchery Inflow	8/10/01	19.5	6/13/01	8.7	8/10/01	19.0	13
Cedar Creek at Hatchery Outfall	8/10/01	20.0	6/13/01	9.0	8/10/01	19.3	19
Cedar Creek at Hwy 26	8/10/01	17.4	6/13/01	7.8	8/10/01	16.9	0
Cedar Creek at mouth (Ten Eyck Road)	8/10/01	19.5	9/28/01	9.8	8/11/01	18.8	8
Clear Cr @ mouth @ Barlow Tr. Road	8/10/01	17.1	6/3/01	6.8	8/10/01	16.7	0
Fall Creek at mouth	8/13/01	15.7	6/16/01	7.3	8/12/01	15.3	0
Gordon Creek at mouth	8/10/01	18.0	6/13/01	8.6	8/10/01	17.6	3
Gordon Creek at NF boundary	8/10/01	12.3	6/13/01	5.8	8/12/01	12.2	0
Little Sandy above Diversion	8/10/01	19.4	6/13/01	7.8	8/10/01	18.9	19
Little Sandy at Road 14	7/12/01	17.1	6/3/01	5.5	8/10/01	16.6	0
Little Sandy River at Mouth	7/12/01	17.8	6/13/01	9.6	8/11/01	17.4	2
PGE Bull Run Project Tailrace	8/14/01	19.9	6/13/01	9.9	8/13/01	19.4	28
Salmon River above S. Fork	8/7/01	15.0	6/3/01	6.7	8/13/01	14.7	0
Salmon River at East Bridge Road	8/10/01	17.2	6/3/01	7.4	8/12/01	16.9	0
Salmon River at Hwy 26/35 USGS Gage	8/14/01	11.7	6/3/01	3.8	8/13/01	11.3	0
Salmon River at mouth (Hwy. 26)	8/10/01	19.4	6/13/01	7.7	8/10/01	19.1	22
Sandy R. above Clear Creek @ Lolo Pass	8/10/01	18.0	9/28/01	5.9	8/12/01	17.1	1
Sandy River at Dabney Bridge	8/10/01	22.7	6/4/01	10.5	8/11/01	22.2	55
Sandy River above Bull Run	8/10/01	23.9	9/6/01	12.9	8/11/01	22.9	25
Sandy River above Salmon River	8/10/01	18.8	6/3/01	6.5	8/10/01	18.0	8
Sandy River at Marmot gage	8/10/01	19.4	6/3/01	7.7	8/10/01	18.8	22
Sandy River at Oxbow Park	8/10/01	22.6	6/4/01	10.4	8/10/01	22.1	54
South Fork Salmon R. at mouth	8/13/01	16.0	6/13/01	7.0	8/13/01	15.6	0
Still Creek at mouth Still Cr. Road	8/10/01	15.6	6/3/01	7.3	8/10/01	15.3	0
Wildcat Creek at mouth	8/13/01	15.9	6/13/01	8.0	8/12/01	15.6	0
Zigzag River @ mouth Lolo Pass Road	8/10/01	16.5	6/3/01	6.7	8/10/01	15.9	0
Zigzag River Above Camp Cr.	8/10/01	12.3	6/3/01	4.9	8/12/01	12.0	0
Zigzag River above Still Creek	8/10/01	13.2	6/3/01	5.6	8/12/01	12.9	0

3.4 SEASONAL VARIATION – CWA §303(D)(1)

Stream temperature monitoring has shown that portions of the Sandy River Basin exceed numeric criteria of the State water quality standard, which led to the 303(d) listing. During the summer of 2001, temperature monitoring instruments recorded hourly stream temperatures at various locations throughout the Sandy River Basin. **Figure 3.4** shows summertime water temperature measured at several locations within the basin and confirms that the numeric temperature criteria are exceeded in the lower Sandy River as well as in the lowermost portions of all major tributaries except the Zigzag River. Exceedance of the 16.0 °C or 18.0 °C numeric criteria typically occurs during July and August. **Figures 3.5** through **3.8** provide more detailed seasonal temperature information for select Sandy River and tributary monitoring locations and **Figure 3.9** provides a map showing the location of select monitoring sites.

Figure 3.4. Seven Day Average of the Daily Maximum Stream Temperatures at Several Monitoring Locations within the Sandy River Basin (2001)



The Sandy River mainstem and tributaries experience warming starting in late spring and extending into the fall, with maximum temperatures typically occurring in July and August. The TMDL focuses the analysis during early August, 2001 as a critical condition when the 16.0 °C or 18.0 °C numeric criteria is likely to be exceeded. Exceedance of the numeric criteria differs at different sites, but typically occurs in portions of July or August. It should also be noted that some streams may be above the 13.0 °C numeric spawning criterion during the periods when spawning is likely to occur. **Figure 3.9** shows the location of monitoring sites described in the seasonal summaries (**Figures 3.5-3.8**), below.

Figure 3.5. 2001 Observed Daily Maximum Temperatures in the Bull Run River

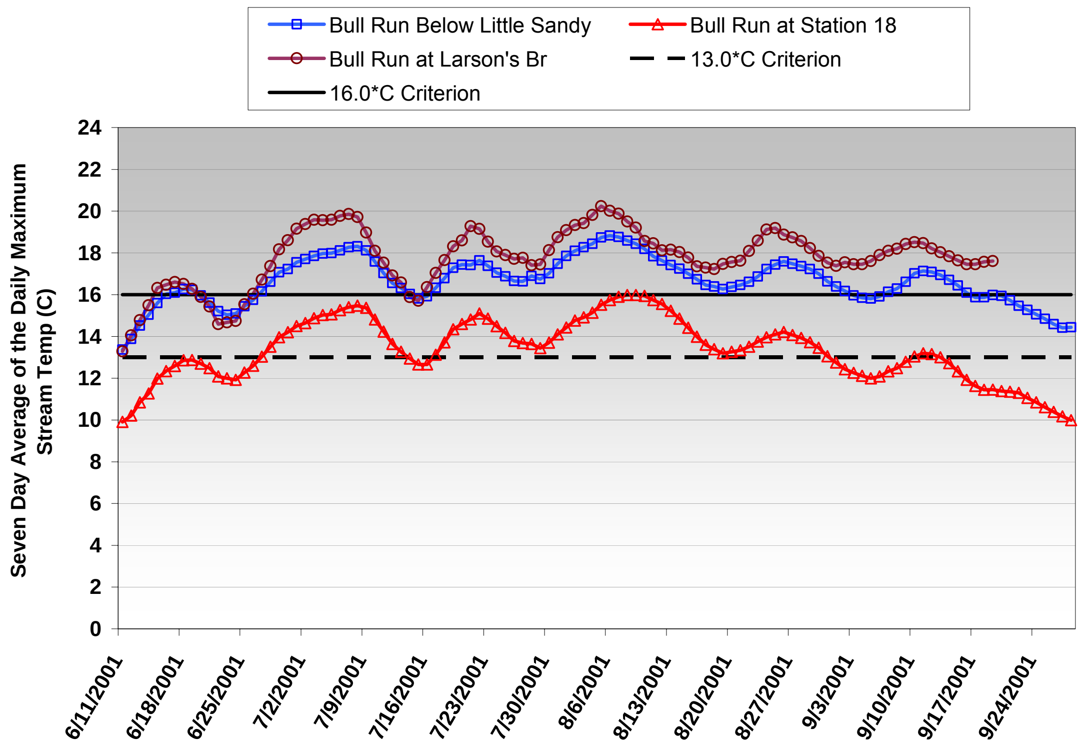


Figure 3.6. 2001 Observed Daily Maximum Temperatures in the Little Sandy River

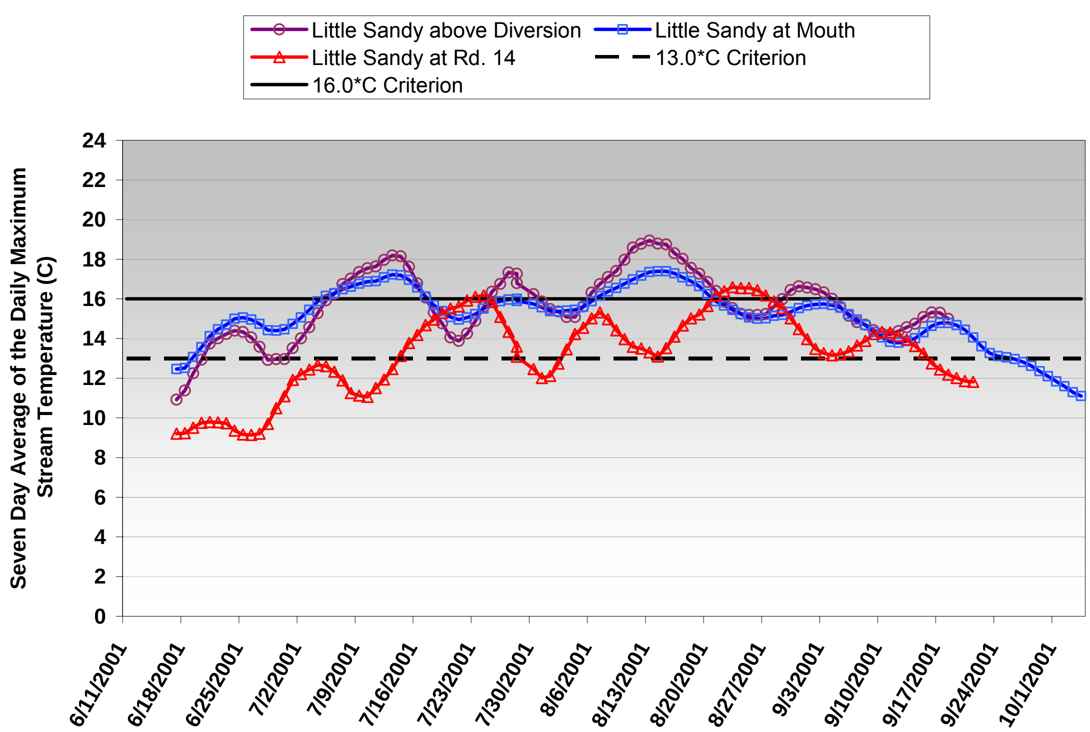


Figure 3.7. 2001 Observed Daily Maximum Temperatures in the Salmon River

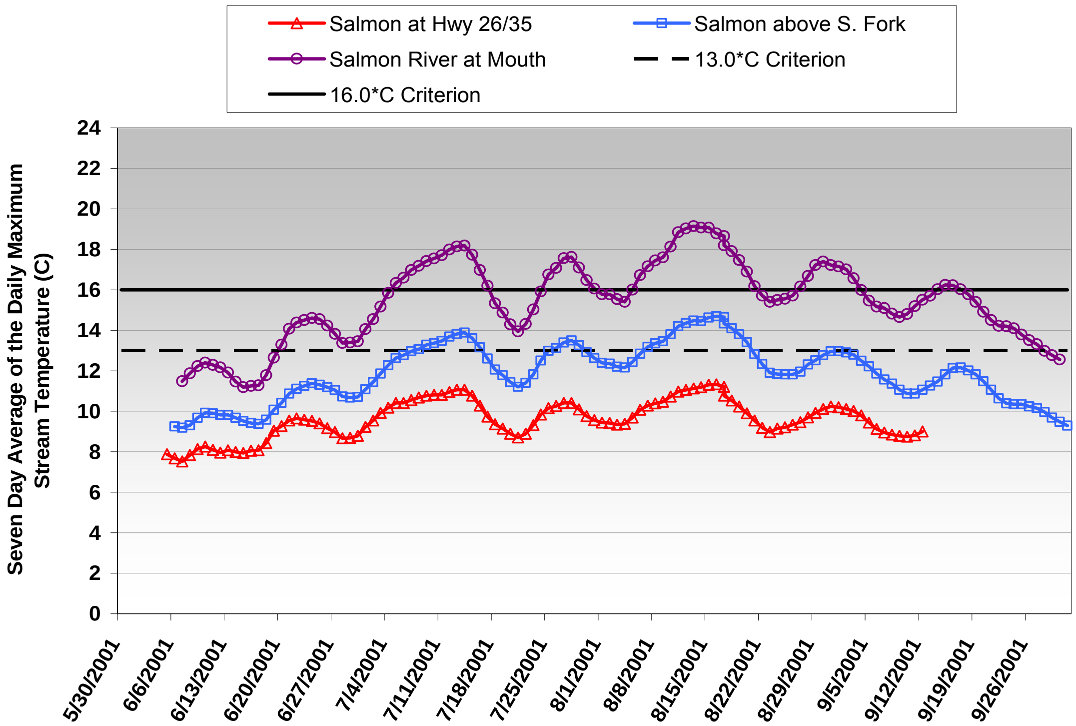


Figure 3.8. 2001 Observed Daily Maximum Temperatures in Sandy River

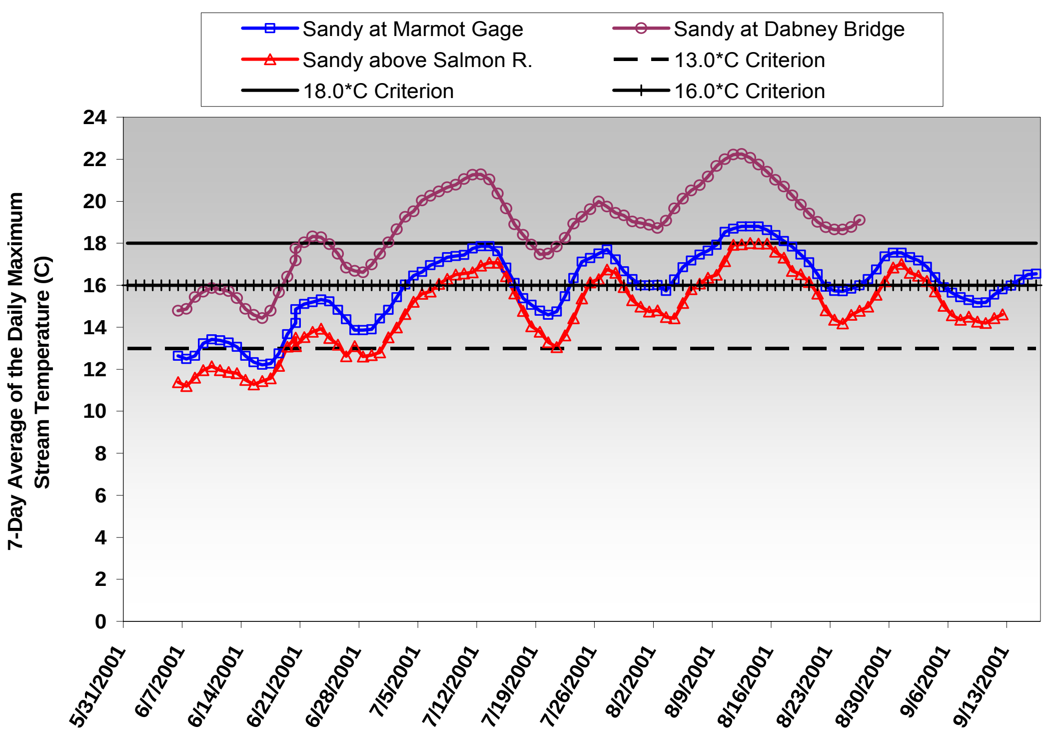
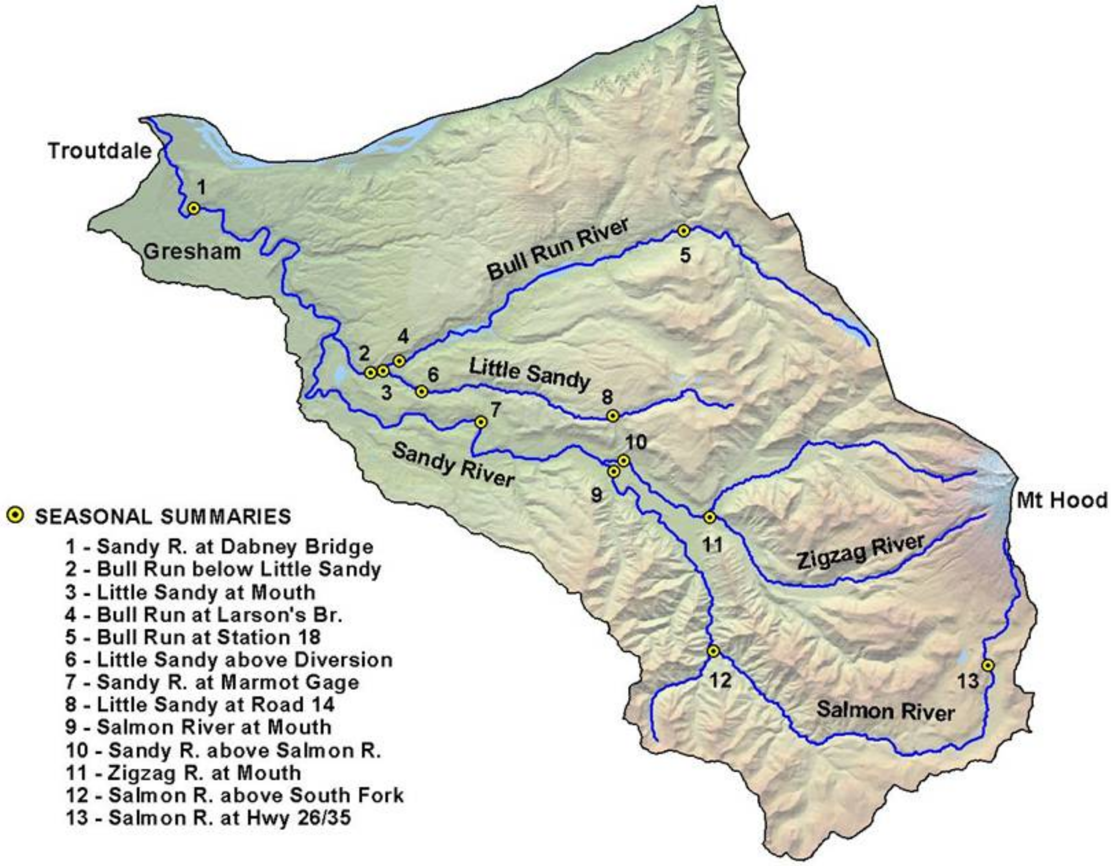


Figure 3.9. Location of 2001 Continous Temperature Monitoring Sites and Seasonal Summary Sites Indentified in Figures 3.4 through 3.8.



3.5 EXISTING HEAT SOURCES - CWA *§303(D)(1)*

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by land use activities. Specifically, the elevated summertime stream temperatures attributed to anthropogenic sources in the Sandy River basin result from the following:

- ✓ Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface;
- ✓ Stream diversions below dams decreases instream flow; and
- ✓ Impoundment of water behind dams alters the natural thermal profile of the water downstream of the dam depending on the temperature and amount of discharge as well as the timing of the discharge from the dam.

In addition, the following conditions can affect stream temperatures in the Sandy River basin:

- ✓ Reduced summertime base flows from instream withdrawals and urbanization;
- ✓ Localized channel widening (increased wetted width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation;

- ✓ Localized near-stream disturbance zone[4] (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation; and
- ✓ Point source warm water discharge.

Nonpoint Sources of Heat

Settlement in the Sandy River watershed, starting in the late-1800s, brought about changes in the near stream vegetation and hydrologic characteristics of many of the rivers and streams in that watershed. Historical agricultural and logging practices altered the stream morphology and hydrology and decreased the amount of riparian vegetation. Timber harvest cleared streams and riparian corridors of fallen trees and large woody debris, with riparian areas logged down to the streambanks. Drainage and stream channelization has occurred in some small streams in agricultural areas.

More recently, increases in population have resulted in urbanization of parts of the watershed. Conversion of forest to residential development is occurring, which can result in reduced riparian vegetation and altered hydrology. The flood plains of many rivers and streams have been affected by the development of transportation corridors. These changes cause streams to heat in the following manner:

1. ***Near stream vegetation disturbance or removal** reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface (shade is commonly measured as percent effective shade or open sky percentage). Riparian vegetation also plays an important role in shaping the channel morphology, resisting erosive high flows and maintaining floodplain roughness.*
2. ***Channel modifications and widening** (increased width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation. Near-stream disturbance zone (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation.*
3. ***Reduction of summertime flows** decrease the thermal assimilative capacity of streams, causing larger temperature increases in stream segments where flows are reduced. This is evident in the section of the Sandy River between Marmot Dam and the confluence of the Bull Run and Sandy Rivers.*

Point Sources of Heat

Point source discharges can be sources of stream heating in the Sandy River basin. Oregon's temperature standard (OAR 340-041-0028) specifies that when an applicable temperature criterion is exceeded, there shall be no more than a 0.3°C increases in stream temperature due to anthropogenic (human) activities. Point source dischargers to the Sandy River and tributaries are discussed fully in **"Loading Capacity"** section of this document.

Channel Morphology

Changes in channel morphology namely channel widening, impact stream temperatures. Channel morphology is a broad term which encompasses hydraulic geometry (shape of the cross section of a streams channel), near stream disturbance zone (distance of vegetation from the stream), sinuosity, gradient, substrate, and other physical characteristics of a stream. The characteristics of a channel can significantly influence stream heating. For example, a stream with a large width to depth ratio will receive more solar radiation on a unit volume basis than one with a narrow, deep channel, resulting in greater diel fluctuations in temperature. The distance of vegetation from the stream is very important, since vegetation too far from the stream to provide shade will do little to prevent heating. An additional benefit

[4] The term "near-stream disturbance zone" is defined for the purposes of the Sandy River basin TMDL as a Geographic Information System (GIS) estimate of the width between shade-producing near-stream vegetation.

inherent to narrower/deeper channel morphology is a higher frequency of pools that contribute to aquatic habitat or cold water refugia.

Channel morphology was not targeted directly in this TMDL. Because of glacial influences and relative lack of anthropogenic channel modifications in the Sandy River Basin, ODEQ believes that changes in channel morphology were not likely to have a significant impact on stream temperatures. ODEQ does feel that it is important to acknowledge the important role that channel morphology can play in regulating stream temperatures, particularly in smaller tributaries, such as Beaver Creek. A brief discussion of channel morphology and known anthropogenic impacts is presented below.

Concrete Channel Armoring along the Sandy River near Oxbow Park

Sandy River / Sandy Delta

Some channel modifications are evident in the lower Sandy River, especially in the Sandy Delta area. Damming of the Columbia River has limited the spring freshet from reaching the delta area and levees have been built along the east shore of the Sandy River which limits the historical interaction with the floodplain (USFS, 1995b). In 1904, floodwaters deposited large amounts of sediment and debris near the mouth. A new channel formed and fish had a difficult time finding the new mouth. As a result, the original channel was restored by clearing the deposition using explosives (USFS, 1995b). In 1930, a rock dam was built to re-channel the mouth. This was done to improve a smelt fishery and has partially isolated a slough (USFS, 1995). In the 1940's, the reach that has the I-84 bridge was dredged. After a major flooding event that occurred in 1964, the Army Corps of Engineers, USFS, other public agencies, and private individuals channelized several miles (approximately RM 33.5 to 43.5) of the lower river by closing oxbows and side channels, and the clearing of large wood and boulders. (SRBWC, 1999) This was done with the construction of berms and the removal of debris, boulders and other obstructions (Mellor, 1993).

Development along the Sandy River from Zigzag to Brightwood has lead to channel armoring and the straightening of the channel. This has resulted in less vegetative and hydrologic connectivity with the floodplain and wetlands (USFS, 1996).

Bull Run/ Little Sandy

The most dramatic channel modifications in the Bull Run watershed are the two City of Portland dams and the Little Sandy Diversion Dam (part of the PGE Bull Run Hydroelectric Project). The City of Portland reservoirs hold approximately 17 billion gallons of water. Dam No. 2 (at RM 5.8) prevents fish passage and blocks 26 miles of fish habitat (SRBWC, 1999). The Little Sandy diversion dam, located at RM 1.7 on the Little Sandy River, is 15 feet high and blocks approximately 6.5 miles of anadromous fish habitat. Specific impacts to channel morphology likely include a reduction in the amount of spawning gravel-sized substrates in the lower Bull Run River.

Salmon River

After the 1964 flood, the amount and quality of aquatic habitat was affected by the closing off of oxbows and side channels, and the in-stream clearing of large wood and boulders. On private lands many small streams and wetlands have been channelized, drained, and filled (USFS, 1995). Recreational activity and Highway 26 maintenance along the river has impacted stream banks and riparian vegetation (USFS, 1995).

Stream Flow

Stream temperature change is generally inversely related to flow volume. As flows decrease, stream temperature tends to increase if energy processes remain unchanged (Boyd, 1996). Runoff in the Sandy River Basin is primarily derived from rainfall precipitation and snow melt, with peak runoff typically occurring in the winter. Late summer low flows are common for many streams in the watershed due to low summer precipitation and water withdrawals.

In addition to the eleven active gauging stations, stream flow was sampled at approximately 30 locations throughout the Sandy River watershed in August, 2001 by ODEQ staff. Flow measurements were used to calibrate the hydrology portion of the Heat Source temperature model discussed in **Section 3.7** of this document.

It was also necessary to account for the amount of water being diverted at PGE's Marmot Dam. According to PGE flow records, Marmot Dam diverted an average of 177 cfs of water from the Sandy River during the week of August 6-10, 2001. The amount of water diverted appeared relatively constant, with a minimum amount of 149 cfs and a maximum of 213 cfs. For temperature modeling purposes it was assumed that 180 cfs was being diverted from the Sandy River and moved through the Bull Run Hydroelectric Project into the Lower Bull Run River.

While the entire flow of the Little Sandy River is diverted for hydroelectric use at river mile 2, there is some leakage and accretion flow below the dam, resulting in a typical low-flow condition of approximately 5 cfs at the confluence with the Bull Run River. For modeling purposes, it was assumed that 2 cfs made it past the Little Sandy Diversion dam and that an additional 3 cfs was gained through accretion flow between the dam and the confluence with the Bull Run River.

Beyond the simple conception of reduced flow and corresponding reduced assimilative capacity, flow modifications can be highly complex in nature. Hydropower diversions can reroute surface waters for long distances through pipes, tunnels and flumes, returning to the stream system at a lower gradient location. In the case of the Sandy River Basin this is seen at the Marmot Diversion Dam, where a portion of the Sandy River is routed through a flume and tunnel to the Little Sandy River. This flow, along with all or part of the Little Sandy River flow, is immediately diverted through a flume and tunnel to Roslyn Lake and eventually discharged to the Lower Bull Run River through PGE's Bull Run Hydroelectric Project. The length of the diversion, from Marmot Dam to Roslyn Lake, is approximately 5.2 miles.

3.6 RIPARIAN VEGETATION ANALYSIS

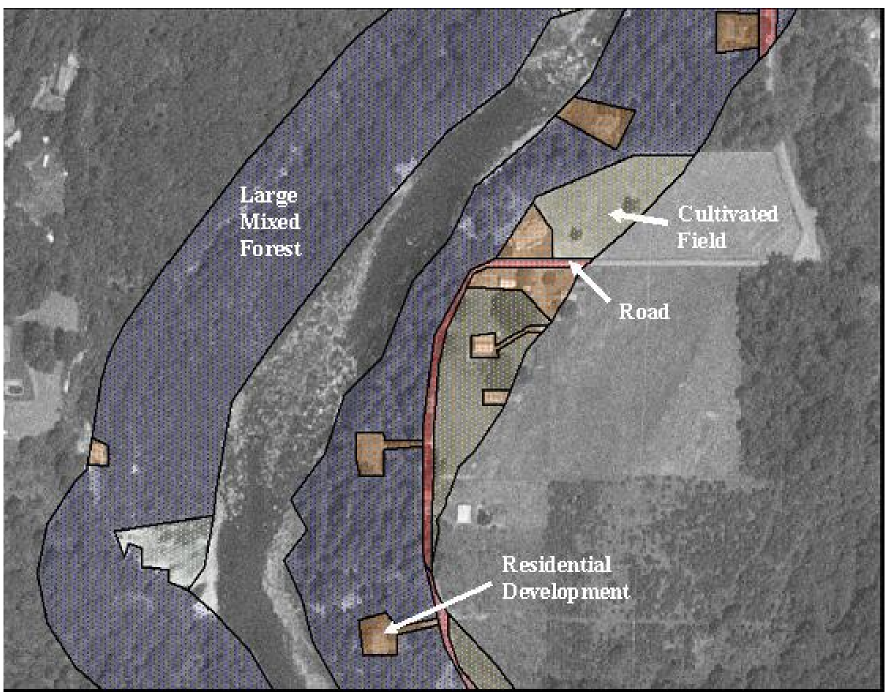
Riparian vegetation plays an important role in controlling stream temperature change. Near stream vegetation height, width and density combine to produce shadows that when, cast across the stream, reduce solar radiant loading. Bank stability is largely a function of riparian vegetation. Riparian corridors often produce a microclimate that surrounds the stream where cooler air temperatures, higher relative humidity and lower wind speeds are characteristic.

3.6.1 Current Condition

Current condition riparian vegetation was characterized using digital orthophoto quads (DOQs) taken in 1997 and 2000. Vegetation polygons were digitized in the near stream area (300 feet on either side of the stream channel) and classified by vegetation type. All classifications included an average riparian vegetation height and canopy density.

Every near-stream vegetation code was quality checked against aerial photographs by ODEQ. Ground level measurements were collected by ODEQ during the summer of 2001 throughout the Sandy River basin to assist in vegetation classifications. **Figure 3.10** displays an example of vegetation and land cover polygons derived from DOQs.

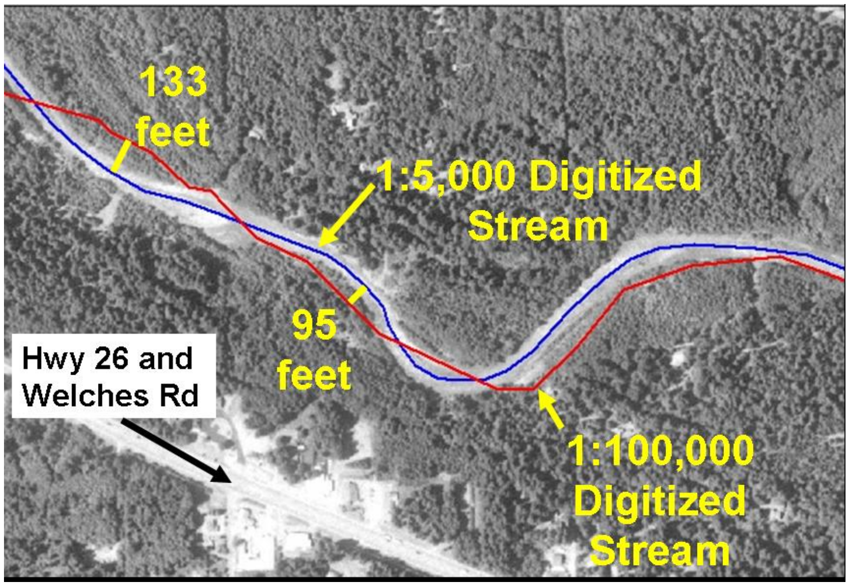
Figure 3.10. Sandy River Vegetation Mapping from Aerial Photograph (RM 20 – 1.5 miles above Dodge Park)



Stream reaches were also digitized from DOQs at a scale of less than 1:5,000. All river mile designations were calculated using this highly accurate stream delineation and, therefore, may not match historical river mile designations. **Figure 3.11** illustrates the improvement gained by digitizing stream reaches at 1:5000 versus 1:100,000. These data point layers form the basis for automated sampling performed using Ttools[6]. At every distance node (i.e. every 100 feet) along the stream, vegetation was sampled out to 120 feet from the channel edge at 15-foot intervals for both stream banks. A total of 18 vegetation samples are taken at each stream distance node.

[6] Ttools is an automated sampling tool that was developed by ODEQ to sample the following spatial data: stream aspect, channel width, near stream vegetation and topographic shade angles. Sampling resolution is user defined and was set at 100 foot intervals longitudinally (i.e. along the stream) and 15 feet in the transverse direction (i.e. perpendicular to the stream).

Figure 3.11. Stream centerline delineation



Automated near stream vegetation sampling was completed for 141.3 rivermiles in the Sandy River basin (**Figure 3.12**) including the mainstem Sandy River (55.2 miles), Salmon River (33.9 miles), South Fork Salmon River (7.3 miles), Zigzag River (13.7 miles), Lower Bull Run River (6.2 miles), Upper Bull Run River (9.3 miles)and Little Sandy River (15.7 miles).

Figure 3.12. Streams Analyzed for Riparian Vegetation and Shade

Near stream vegetation was grouped as one of the following: water or floodplains, cultivated fields or grassed areas, conifer forests, deciduous forests, mixed (conifer and deciduous) forests, scrub/shrub (woody vegetation less than 15 feet high), timber harvest, roads, developed lands (both urban and rural residential and commercial), and barren lands. Within these general vegetation types, near stream vegetation was further classified by observed differences in average tree height (taller vs. shorter forests) and in density (**Table 3.5**). Existing tree heights were determined by ODEQ using ground level data, literature on the basin and professional judgment. Mixed forest was the most prevalent land cover type found in the near stream area analyzed. ODEQ personnel made field measurements of vegetation height at 51 riparian monitoring locations. Twenty-one large conifers were measured at locations where large conifers appeared to be the dominant riparian vegetation. The average large conifer tree height was 117 feet (35.7 meters). Six small conifers were measured at locations where small conifers appeared to be the dominant riparian vegetation. The average small conifer tree height was 57 feet (17.4 meters). Fourteen large hardwoods and eleven small hardwoods were measured throughout the watershed, with averages of 46 feet (14.0 meters) and 66 feet (20.1 meters), respectively. The Bull Run River Watershed Analysis (USFS 1997) classifies small stands as 9" diameter breast height (dbh) and large stands as being dominated by trees larger than 21" dbh. Using the Chapman-Richards growth curves and forest zone assemblages produces average conifer tree heights of 16.8m (55ft) and 35.1m (115ft), respectively.

Current riparian vegetation distribution and height and potential riparian vegetation height are displayed in **Figures 4.13** through **4.17** for the six streams analyzed. The vegetation distribution is shown for both the right and left stream banks. Vegetation information presented in these figures was sampled from a GIS vegetation data layer. Note that the river miles presented in these figures were derived from a 1:5000 stream coverage used for ODEQ simulation purposes and may differ slightly from other sources (such as OWRD or USGS river miles).

Table 3.5. Classifications used to Determine Current Condition Riparian Height and Density

Code	Description	Height (m)	Height (f)	Density (%)	Overhang (m)	Overhang (f)
301	Water	0.0	0.0	0%	0.0	0.0
300	Pastures/Cultivated Field	1.6	5.2	75%	1.0	3.3
305	Barren - Embankment	0.0	0.0	0%	0.0	0.0
308	Barren - Clearcut	3.0	9.8	75%	0.0	0.0
309	Barren - Soil	0.0	0.0	0%	0.0	0.0
400	Barren - Road	0.0	0.0	0%	0.0	0.0
401	Barren - Forest Road	0.0	0.0	0%	0.0	0.0
500	Large Mixed Conifer/Hardwood	26.7	87.6	60%	3.3	10.8
501	Small Mixed Conifer/Hardwood	15.4	50.5	60%	1.9	6.2
550	Large Mixed Conifer/Hardwood	26.7	87.6	30%	3.3	10.8
551	Small Mixed Conifer/Hardwood	15.4	50.5	30%	1.9	6.2
555	Large Mixed Conifer/Hardwood	26.7	87.6	10%	3.3	10.8
600	Large Hardwood	20.1	65.9	75%	3.0	9.8
601	Small Hardwood	14.0	45.9	75%	2.1	6.9
650	Large Hardwood	20.1	65.9	30%	3.0	9.8
651	Small Hardwood	14.0	45.9	30%	2.1	6.9
700	Large Conifer	35.1	115.2	60%	3.5	11.5
701	Small Conifer	16.8	55.1	60%	1.7	5.6
750	Large Conifer	35.1	115.2	30%	3.5	11.5
751	Small Conifer	16.8	55.1	30%	1.7	5.6
800	Upland shrubs	1.8	5.9	75%	0.9	3.0
850	Upland Shrubs	1.8	5.9	25%	0.9	3.0
900	Grasses - upland	1.6	5.2	75%	0.8	2.6
3001	Active Channel Bottom	0.0	0.0	0%	0.0	0.0
3248	Development - Residential	10.0	32.8	100%	0.0	0.0
3249	Development - Industrial	15.0	49.2	100%	0.0	0.0
3252	Dam/Weir	0.0	0.0	100%	0.0	0.0
3011	Active Channel Bottom	0.0	0.0	0%	0.0	0.0
302	Grasses - upland	1.6	5.2	75%	0.8	2.6
320	Grasses - upland	1.6	5.2	75%	0.8	2.6

Figure 3.13. Sandy River Near Stream Vegetation Distribution

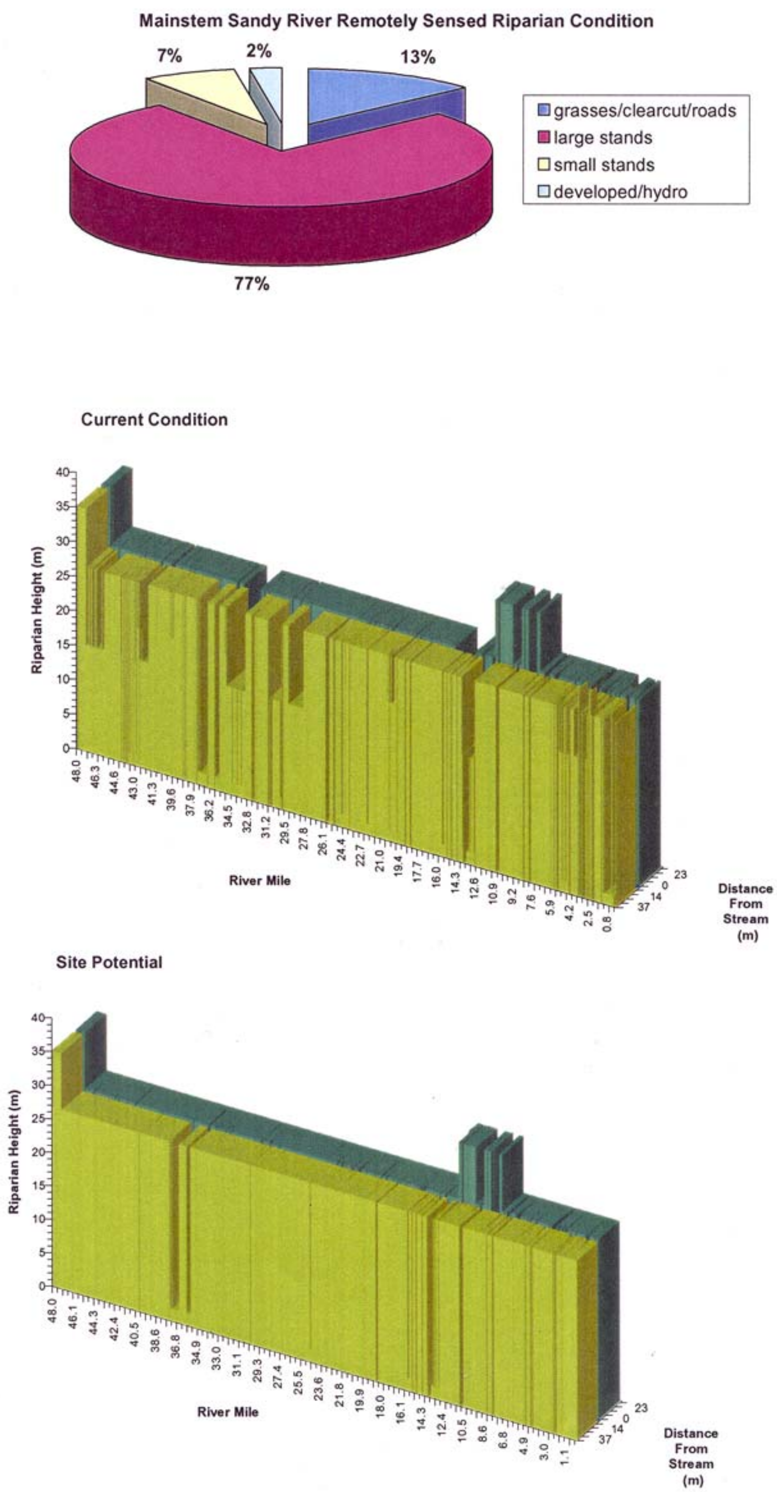


Figure 3.14. Lower Bull Run River Near Stream Vegetation Distribution

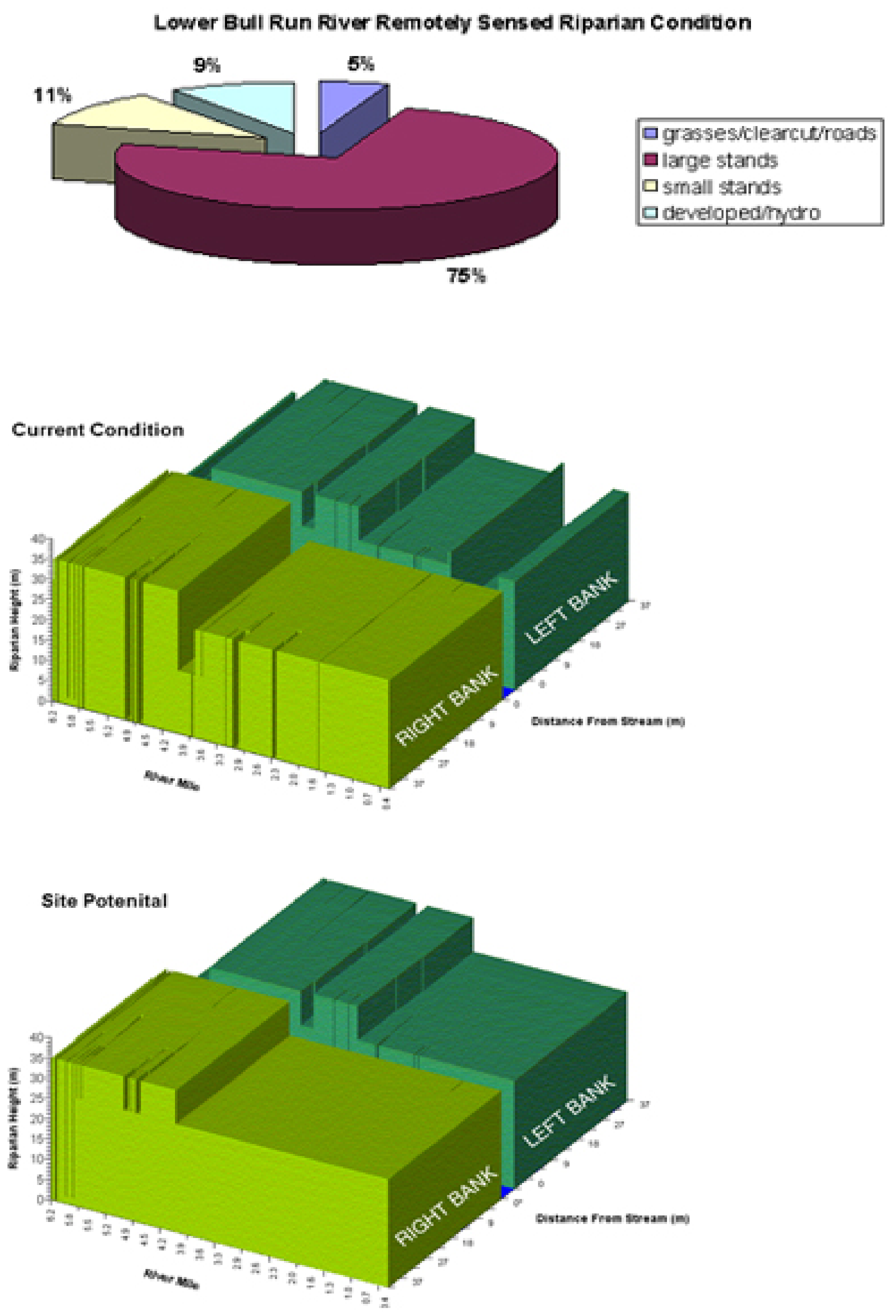


Figure 3.15. Little Sandy River Near Stream Vegetation Distribution

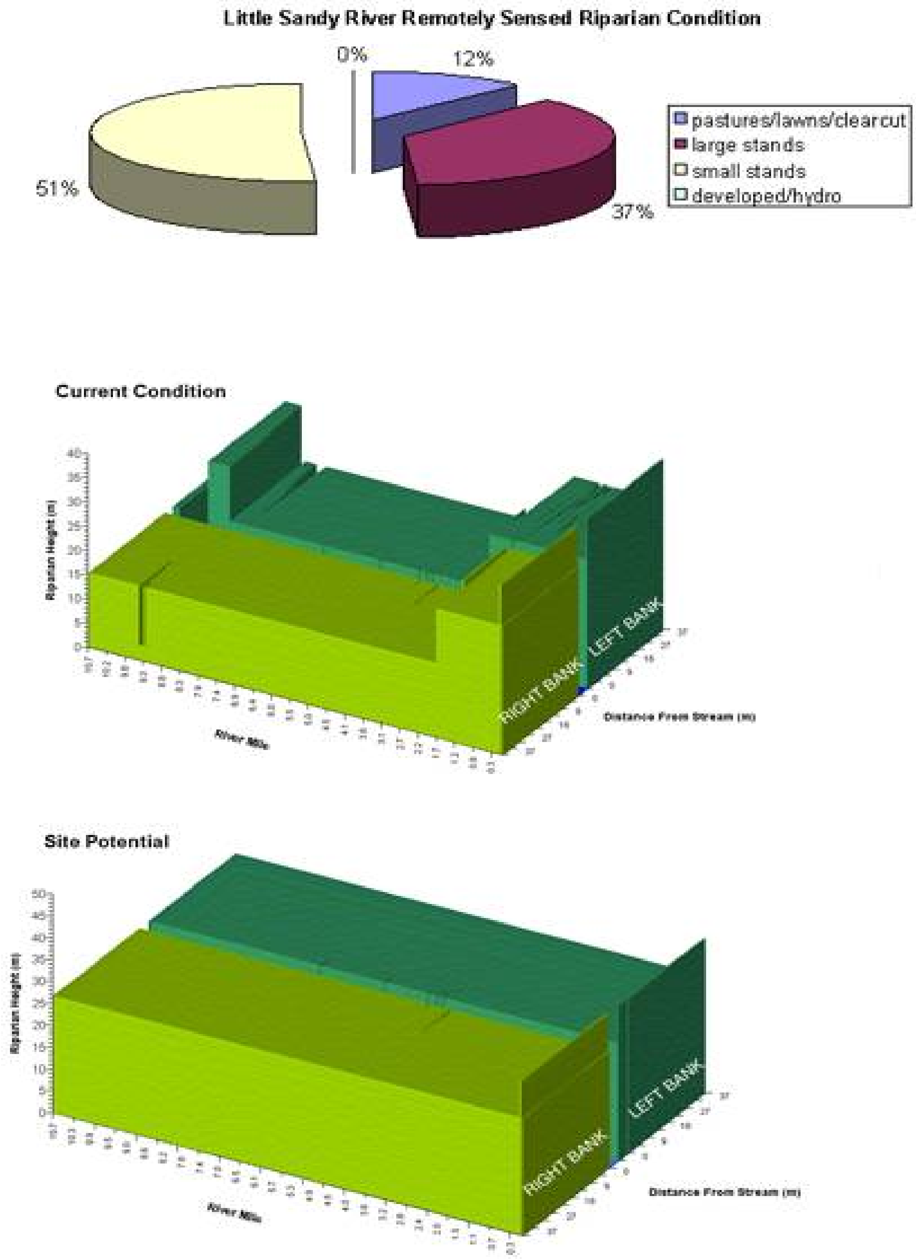


Figure 3.16. Salmon River Near Stream Vegetation Distribution

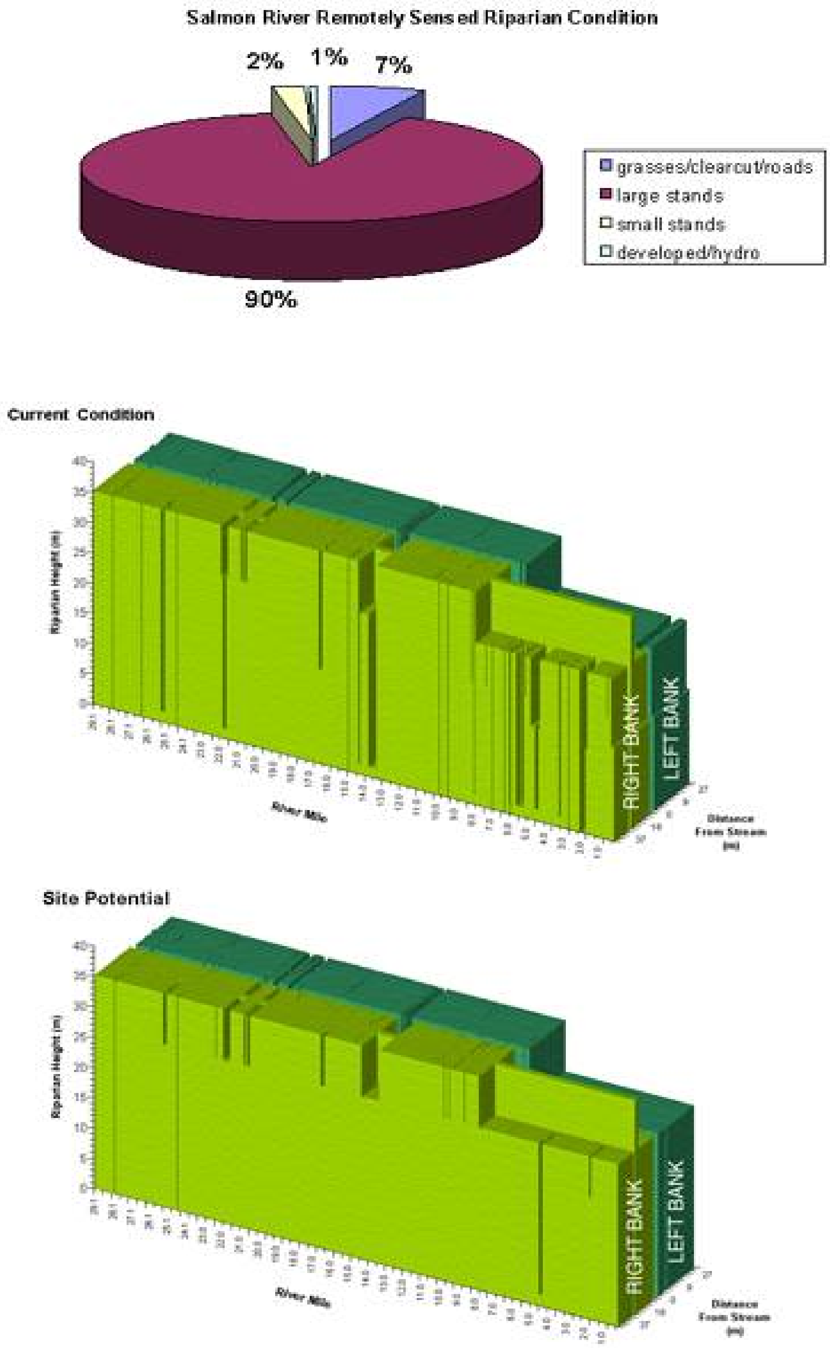
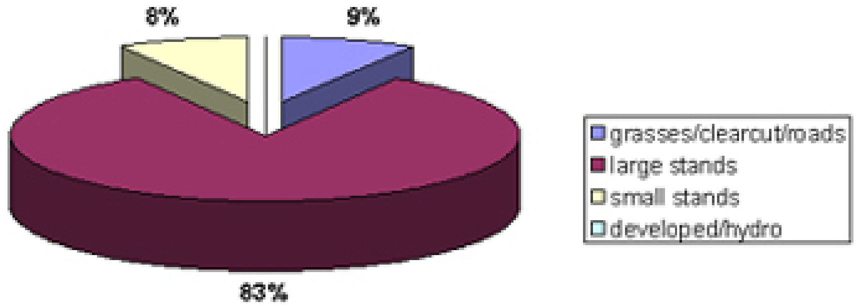
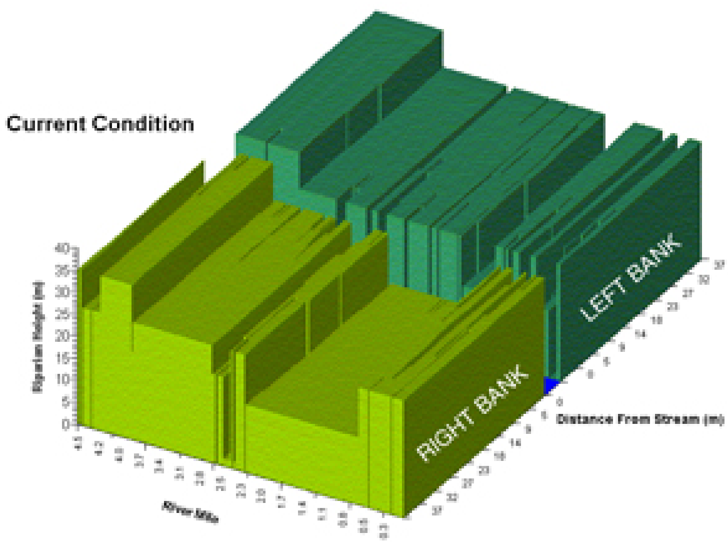
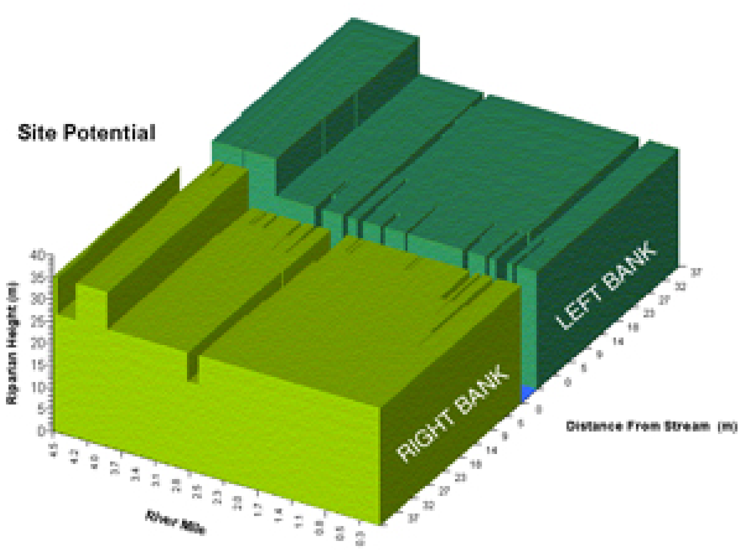


Figure 3.17. Zigzag River Near Stream Vegetation Distribution







3.6.2 Potential Condition

System potential effective shade occurs when near stream vegetaion is at a climax life stage. A climax life stage is represented by the following conditions:

- Vegetation is mature and undisturbed;
- Vegetation height and density is at or near the potential expected for the given plant community;
- Vegetation is sufficiently wide to maximize solar attenuation; and
- Vegetation width accommodates channel migrations.

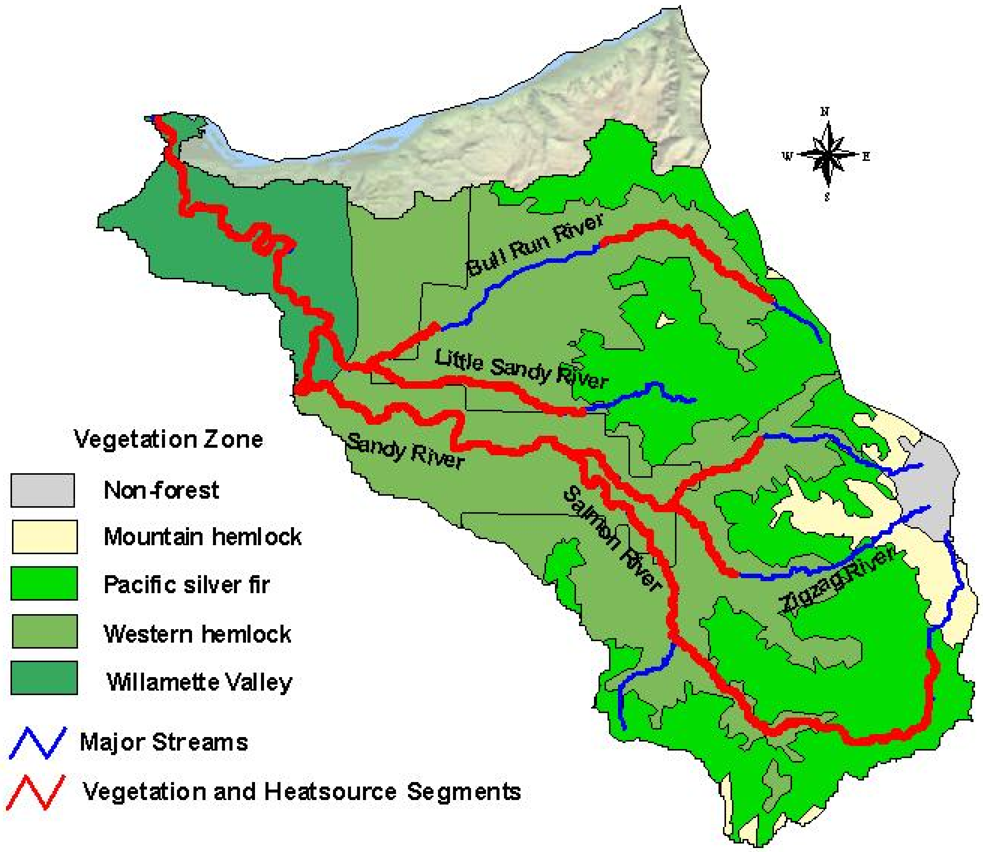
System potential vegetation in the Sandy River Basin was developed by ODEQ staff (**Table 3.6**).

Table 3.6. Sandy River Basin ODEQ Vegetation and Land Cover Classifications for Digitized Polygons and Potential Land Cover Classifications

Classification Code	Current Land Cover Description	System Potential Land Cover
301	Water	No Change
300/302/320	Pastures/Cultivated Field/lawn	Large Mixed Conifer/Hardwood
305	Barren - Embankment	Large Mixed Conifer/Hardwood
308	Barren - Clear-cut	Large Mixed Conifer/Hardwood
309	Barren - Soil	Large Mixed Conifer/Hardwood
400	Barren - Road	Large Mixed Conifer/Hardwood
401	Barren - Forest Road	Large Mixed Conifer/Hardwood
500	Large Mixed Conifer/Hardwood	No Change
501	Small Mixed Conifer/Hardwood	Large Mixed Conifer/Hardwood
550	Large Mixed Conifer/Hardwood	No Change
551	Small Mixed Conifer/Hardwood	Large Mixed Conifer/Hardwood
555	Large Mixed Conifer/Hardwood	No Change
600	Large Hardwood	No Change
601	Small Hardwood	Large Hardwood
650	Large Hardwood	No Change
651	Small Hardwood	Large Hardwood
700	Large Conifer	No Change
701	Small Conifer	Large Conifer
750	Large Conifer	No Change
751	Small Conifer	Large Conifer
800	Upland shrubs	Large Mixed Conifer/Hardwood
850	Upland Shrubs	Large Mixed Conifer/Hardwood
900	Grasses - upland	Large Mixed Conifer/Hardwood
3001/3011	Active Channel Bottom	No Change
3248	Development - Residential	Large Mixed Conifer/Hardwood
3249	Development - Industrial	Large Mixed Conifer/Hardwood
3252	Dam/Weir	Large Mixed Conifer/Hardwood

Potential vegetation zones were developed based on the Mt. Hood National Forest Plant Associations for Western Hemlock (Halverson et al., 1986), Pacific Silver Fir (Hemstrom et al., 1982), and Mountain Hemlock Zones (Diaz et al., 1997). The geographic distribution of these zones were obtained from the Mt. Hood National Forest GIS data layer and modified using best professional judgment to include lands off-forest (**Figure 3.18**). Approximately 80% of stream miles surveyed in the Sandy River Basin lie within the Western Hemlock vegetation zone.

Figure 3.18. Potential Vegetation Zones, Sandy River Basin



Automated near stream vegetation sampling was repeated to determine the system potential condition for each stream reach, replacing the land cover descriptions and densities in **Table 3.5** with those in **Table 3.7**. While riparian vegetation heights likely vary with vegetation zone, disturbance regimes and other factors, ODEQ did not feel that greater accuracy could be attained with more detailed riparian vegetation height estimates. ODEQ field measurements and observations indicated that many riparian areas in the Sandy Basin contain system potential vegetation, especially in the Bull Run watershed. Therefore, vegetation heights remain constant between current and potential conditions, but are applied to potential land cover as described above in **Table 3.6**. Vegetation zones are used to determine appropriate effective shade surrogate measures for the Sandy River Basin in **Section 3.10.2**.

Table 3.7. System Potential Vegetation Model Inputs for the Sandy River Basin

Code	Description	Height (m)	Height (f)	Density (%)	Overhang (m)	Overhang (f)
301	Water	0.0	0.0	0%	0.0	0.0
300	Pastures/Cultivated Field	26.7	87.6	60%	1.0	3.3
305	Barren - Embankment	26.7	87.6	60%	0.0	0.0
308	Barren - Clearcut	26.7	87.6	60%	0.0	0.0
309	Barren - Soil	26.7	87.6	60%	0.0	0.0
400	Barren - Road	26.7	87.6	60%	0.0	0.0
401	Barren - Forest Road	26.7	87.6	60%	0.0	0.0
500	Large Mixed Conifer/Hardwood	26.7	87.6	60%	3.3	10.8
501	Small Mixed Conifer/Hardwood	26.7	87.6	60%	1.9	6.2
550	Large Mixed Conifer/Hardwood	26.7	87.6	30%	3.3	10.8
551	Small Mixed Conifer/Hardwood	26.7	87.6	30%	1.9	6.2
555	Large Mixed Conifer/Hardwood	26.7	87.6	10%	3.3	10.8
600	Large Hardwood	20.1	65.9	75%	3.0	9.8
601	Small Hardwood	20.1	65.9	75%	2.1	6.9
650	Large Hardwood	20.1	65.9	30%	3.0	9.8
651	Small Hardwood	20.1	65.9	30%	2.1	6.9
700	Large Conifer	35.1	115.2	60%	3.5	11.5
701	Small Conifer	35.1	115.2	60%	1.7	5.6
750	Large Conifer	35.1	115.2	30%	3.5	11.5
751	Small Conifer	35.1	115.2	30%	1.7	5.6
800	Upland shrubs	1.8	5.9	75%	0.9	3.0
850	Upland Shrubs	1.8	5.9	25%	0.9	3.0
900	Grasses - upland	26.7	87.6	60%	0.8	2.6
3001	Active Channel Bottom	0.0	0.0	0%	0.0	0.0
3248	Development - Residential	10.0	32.8	60%	0.0	0.0
3249	Development - Industrial	15.0	49.2	60%	0.0	0.0
3252	Dam/Weir	26.7	87.6	60%	0.0	0.0
3011	Active Channel Bottom	0.0	0.0	0%	0.0	0.0
302	Grasses - upland	26.7	87.6	60%	0.8	2.6
320	Grasses - upland	26.7	87.6	60%	0.8	2.6

3.7 HEAT SOURCE AND THERMAL INFRARED RADIOMETRY

The temperature model utilized by ODEQ to estimate stream network thermodynamics and hydrology is Heat Source[7] (Boyd, 1996). The temperature model is designed to analyze and predict stream temperature for one day, ideally the warmest day of the year. This Sandy River basin TMDL is primarily concerned with daily prediction of the diurnal energy flux and resulting temperatures on August 8 and 9, 2001. To aid in model calibration and gain a better understanding of stream heating in the Sandy basin, Thermal Infrared Radiometry (TIR) data was collected on the major tributaries.

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[7] Heat Source was developed in 1996 as a Masters Thesis at Oregon State University in the Departments of Bioresource Engineering and Civil Engineering and has been regularly upgraded by DEQ. A more extensive discussion of the methodology for the model is can be found on the DEQ website at www.deq.state.or.us/wq/TMDLs/TMDLs.htm. Peer review comments are available on the DEQ website at: www.deq.state.or.us/wq/HeatSource/HeatSource.htm. DEQ currently supports the Heat Source methodology and computer programming.

Stream temperature was simulated for 98.5 miles of the mainstem Sandy, Little Sandy, Bull Run, Salmon and Zigzag rivers. Simulations were performed to assess the stream thermal response to: (1) current vs. system potential vegetation; (2) removal of Marmot dam and restoration of the natural flow regime; and (3) assessment of affects of various flow release scenarios on stream temperature in the lower Bull Run River.

Individual near stream vegetation and flow regime simulations were performed for each stream reach. Results from these single parameter simulations show that, on a basin scale, riparian condition is good and improvements in stream temperature are relatively modest under system potential conditions. When both system potential riparian vegetation and Marmot Dam removal were simulated together, the stream heating was affected to a greater extent. Modeling also showed that increased flow had a significant impact on temperature in the lower Bull Run River.

Thermal Infrared Radiometry

As part of this TMDL effort, ODEQ contracted with Watershed Sciences, LLC to map and assess stream temperatures using Thermal Infrared Radiometry (TIR) remote sensing. Surveys were conducted on August 8 and 9, 2001 using a TIR sensor attached to the underside of helicopter. The Bull Run and Sandy Rivers were flown on August 8 and the Little Sandy, Salmon and Zigzag Rivers were flown on August 9. TIR imagery is occasionally referred to as TIR (Thermal Infrared Radiometry) in text and images contained in the following chapter.

TIR temperature data are used in this analysis to:

- *Develop continuous spatial temperature data sets,*
- *Calculate longitudinal heating profile/gradients,*
- *Visually observe complex distributions of stream temperatures at a large landscape scale,*
- *Map/Identify significant thermal features,*
- *Develop mass balances,*
- *Validate simulated stream temperatures.*

TIR imagery displays the temperature of the outermost portions of the stream surface, as there is little, if any, penetration of the stream surface. Consequently, only surface water temperatures are recorded and interpretation of the data should be made based upon whether a water body is well mixed.

TIR data is remotely sensed from a sensor mounted on a helicopter that collects digital data directly from the sensor to an on-board computer at a rate that insures the imagery maintains a continuous image overlap of at least 40%. The TIR detects emitted radiation at wavelengths from 8-12 microns (long-wave) and records the level of emitted radiation as a digital image across the full 12-bit dynamic range of the sensor. Each image pixel contains a measured value that is directly converted to a temperature. Each thermal image has a spatial resolution of less than one-half meter/pixel. Visible video sensor captures the same field-of-view as the TIR sensor. Time of day is encoded on the recorded video as a means to correlate visible video images with the TIR images during post-processing.

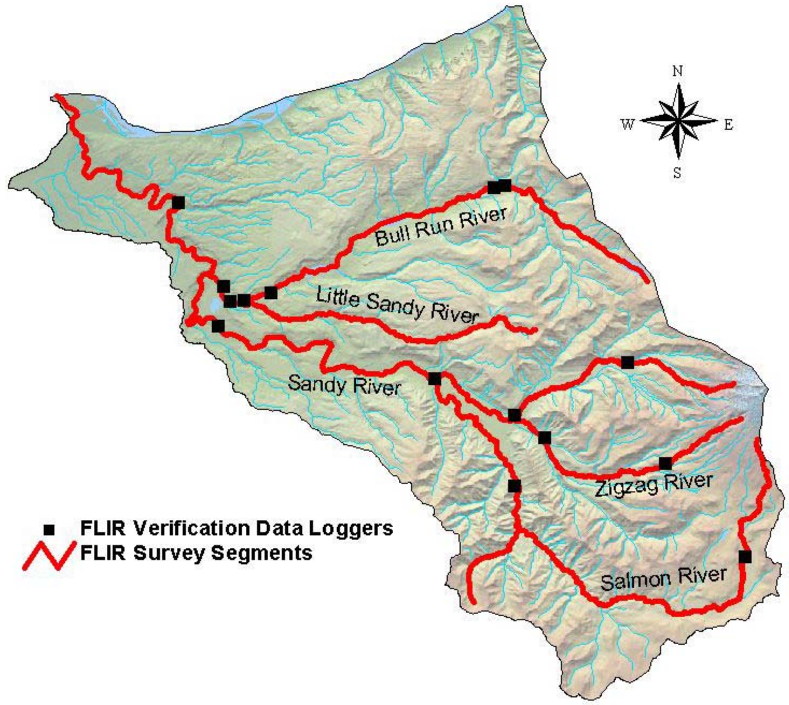
TIR represents the most accurate and preferred tool for analyzing temperature in streams of sufficient size. Coupling TIR thermal imagery with color videography and geographic positioning systems (GPS) produces spatially continuous temperature imagery. TIR and color video images are collected with instruments mounted to a helicopter that can fly as many as 100+ kilometers of streams per day. The output data consists of GPS-tagged TIR digital images that cover approximately 100 x 150 meters with less than 1 meter of spatial resolution within ±0.5°C accuracy. The spatial continuity of TIR data has made it possible to visually observe many of the thermodynamic processes associated with stream heating as they occur. Significant groundwater interactions with the stream column also register distinctly in the TIR data imagery.

Data collection is timed to capture maximum daily stream temperatures, which typically occur between 14:00 and 18:00 hours. The helicopter is flown longitudinally over the center of the stream channel with the sensors in a vertical (or near vertical) position. In general, the flight altitude is selected so that the stream channel occupies approximately 20-40% of the image frame. A minimum altitude of approximately 300 meters is used both for maneuverability and for safety reasons. If the stream splits into two channels that cannot be covered in the sensor's field of view, the survey is conducted over the larger of the two channels.

Watershed Sciences distributed eight in-stream temperature data loggers (Onset Stowaways) in the basin prior to the survey in order to ground truth (i.e. verify the accuracy of) the radiant temperatures measured by the TIR sensor. The advertised accuracy of the Onset Stowaway's is ±0.2°C. These locations were supplemented by data provided by ODEQ from 9 additional in-stream temperature loggers. In addition to deployment of thermistors, intensive monitoring of flow, wetted width and depth were performed during the week of August 6-10, 2001. **Figure 3.18** shows the streams surveyed using TIR and visible band color video. The map also shows the locations of in-stream temperature data loggers used for TIR verification.

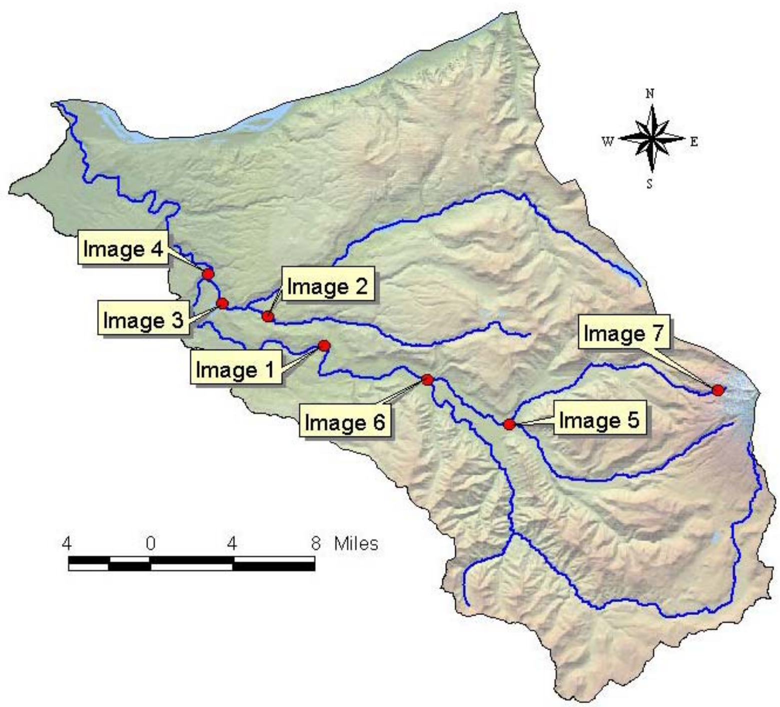
Direct observation of spatial temperature patterns and thermal gradients is a powerful application of TIR derived stream temperature data. Thermally significant areas can be identified in a longitudinal stream temperature profile and related directly to specific sources (i.e., water withdrawal, tributary confluence, land cover patterns, etc.). Thermal changes captured with TIR data can be quantified as a specific change in stream temperature or a stream temperature gradient that results in a temperature change over a specified distance.

Figure 3.18. TIR Surveyed Streams and Location of Verification Monitors



Several areas in the Sandy Basin were identified as being of particular interest with respect to the TIR data and imagery collected during the summer of 2001. These include areas along the PGE Marmot Dam complex and the confluences of major tributaries. TIR and day video images of these areas were assembled as mosaics and are presented below. **Figure 3.19** shows where the mosaic images are located in the Sandy Basin.

Figure 3.19. Sandy Basin TIR and Video Mosaic Images Locations



Summary of Selected TIR Imagery

- **Image 1**. Sandy River – Marmot Diversion Dam – River Mile 30.4. This image shows the Marmot Dam, the impounded portion of the Sandy River above the dam, and the diversion canal taking approximately 180 cfs of Sandy River toward the Little Sandy Diversion Dam. Stream temperature, measured at approximately 3:45 p.m. on August 8, was 16.4°C through this reach.
- **Image 2**. Little Sandy River – Little Sandy Diversion Dam - River Mile 1.7. The Little Sandy River enters from the top of the image and the turbid inflow of Sandy River water, diverted from Marmot Dam, enters from the right side near the center of the image. The Little Sandy Diversion Dam and flume, toward the bottom of the image, then routes the combined Sandy and Little Sandy water to Roslyn Lake and the PGE Powerhouse. The Little Sandy River temperature is 17.6°C and the inflow from Marmot Dam is 16.3°C. Approximately 1 cfs appears to be passing the Diversion Dam, quickly heating to 20.2°C.
- **Image 3**. Bull Run River – PGE Powerhouse outflow - River Mile 1.5. The combined flow from the Marmot and Little Sandy Diversion Dams (210 cfs on August 8, 2001 at 2:00 p.m.) enters the lower Bull Run River through the PGE powerhouse below Roslyn Lake. PGE outflow temperature was 18.0°C. Upstream Bull Run temperature is 19.4°C and the temperature of the combined flows downstream is 18.5°C.
- **Image 4**. Sandy River – Bull Run and Sandy Rivers Confluence – Sandy River Mile 18.4. This image shows the confluence of the Sandy and Bull Run Rivers. The Bull Run is approximately 2°C cooler than the mainstem, and a cool plume is observed downstream. The Bull Run contributes approximately 250 cfs of flow to the Sandy River, which represents 210 cfs of diverted Sandy and Little Sandy River water and 40 cfs of Bull Run River flow.
- **Image 5**. Zigzag River – Zigzag and Sandy Rivers Confluence – Sandy River Mile 42.8. The flow of the Zigzag was approximately 98 cfs and the flow of the Sandy just above the confluence with the Zigzag was approximately 123 cfs at the time the TIR imagery was collected. The temperature of the Zigzag, as measured by TIR at approximately 4:00 p.m. on August 9, 2001, is about 1°C cooler than the mainstem Sandy River.
- **Image 6**. Salmon River – Salmon and Sandy Rivers Confluence – Sandy River Mile 37.3. The flow of the Salmon was approximately 121 cfs and the flow of the Sandy just above the confluence with the Salmon was approximately 241 cfs at the time the TIR imagery was collected. Temperatures measured using TIR indicate that the Salmon is slightly warmer than the Sandy River at their confluence. This is largely due to the fact that the Salmon River has traveled a much longer distance (29 vs. 11 miles) and, therefore, has been exposed to more solar radiation.
- **Image 7**. Sandy River – Sandy River near the Headwaters – Sandy River Mile 48. This image shows the Sandy River very near the headwaters, with very cool water temperatures. Also evident is the considerable influence that past lahar-related events have had on channel morphology and potential sediment loads.

Image 1. ***Sandy River – Marmot Dam and Diversion at River Mile 30.4***

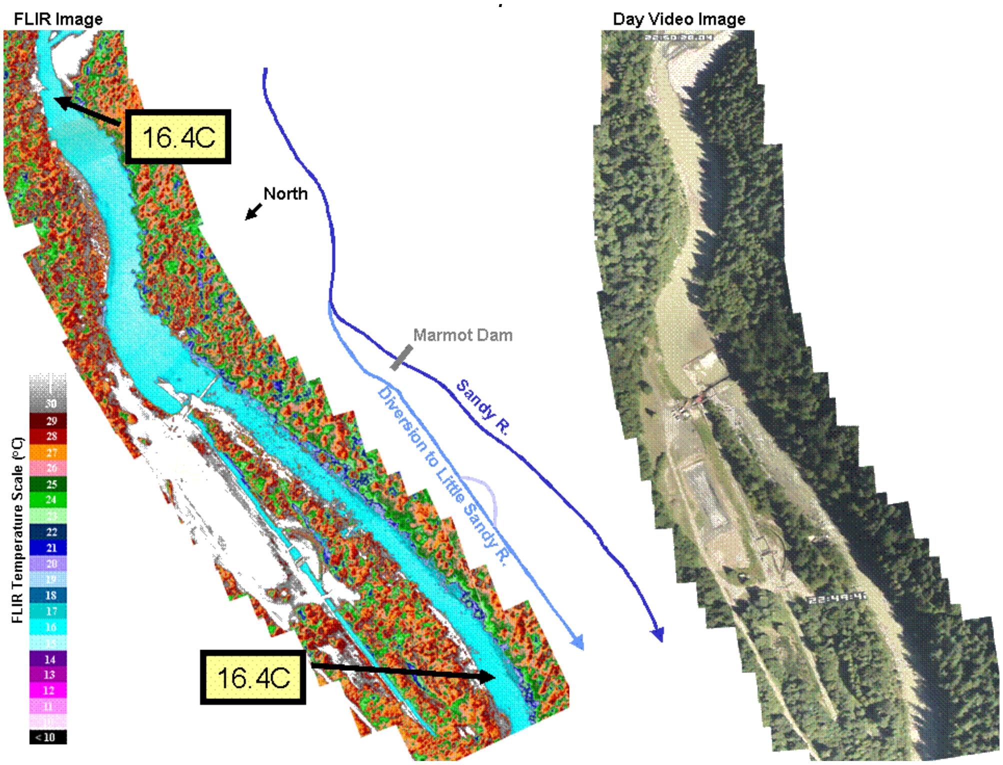


Image 2. ***Little Sandy River - Diversion Dam and Marmot Diversion Inflow***

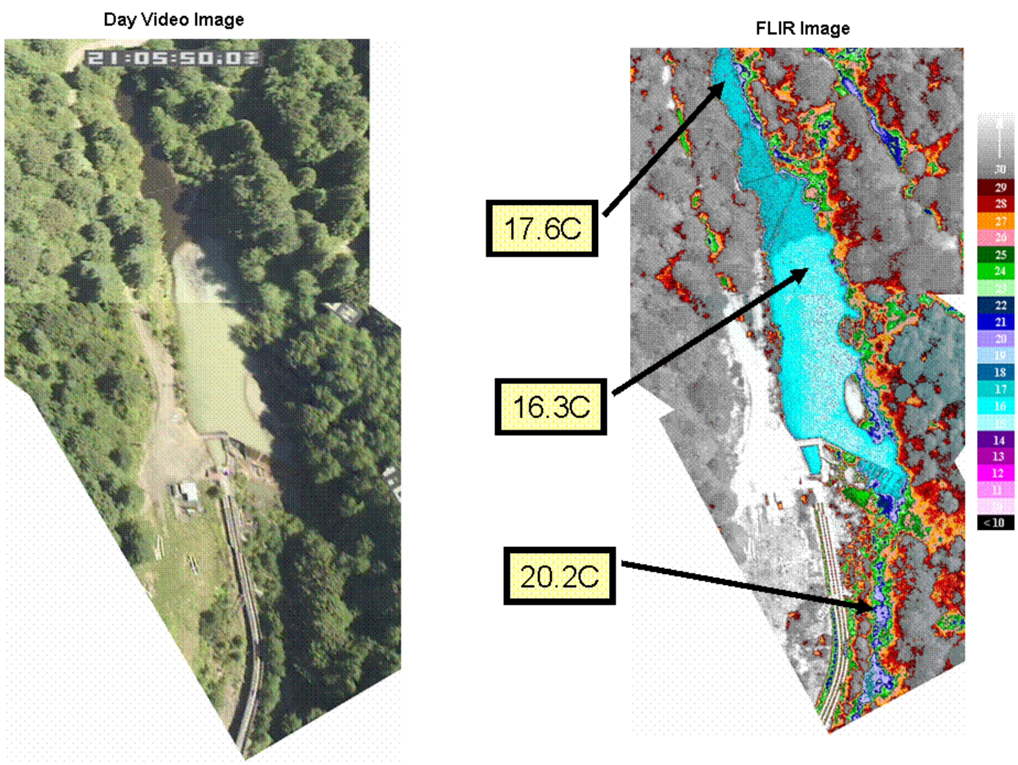


Image 3. ***Lower Bull Run River - PGE Powerhouse outflow***

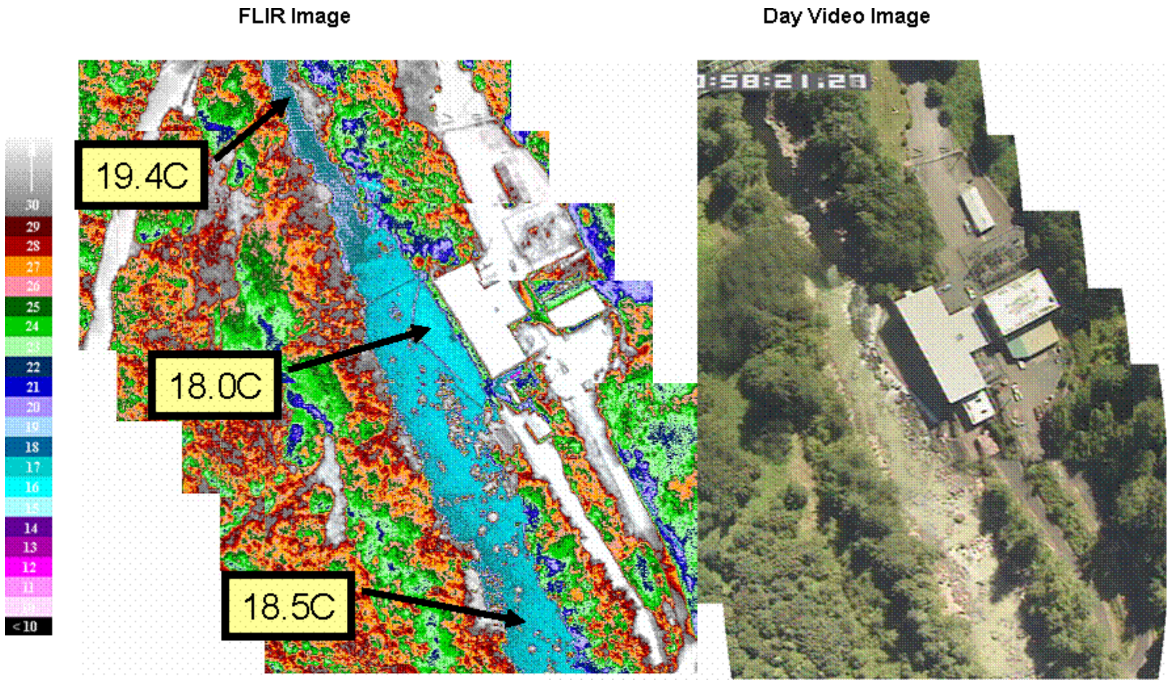


Image 4. ***Confluence of the Bull Run and Sandy Rivers***

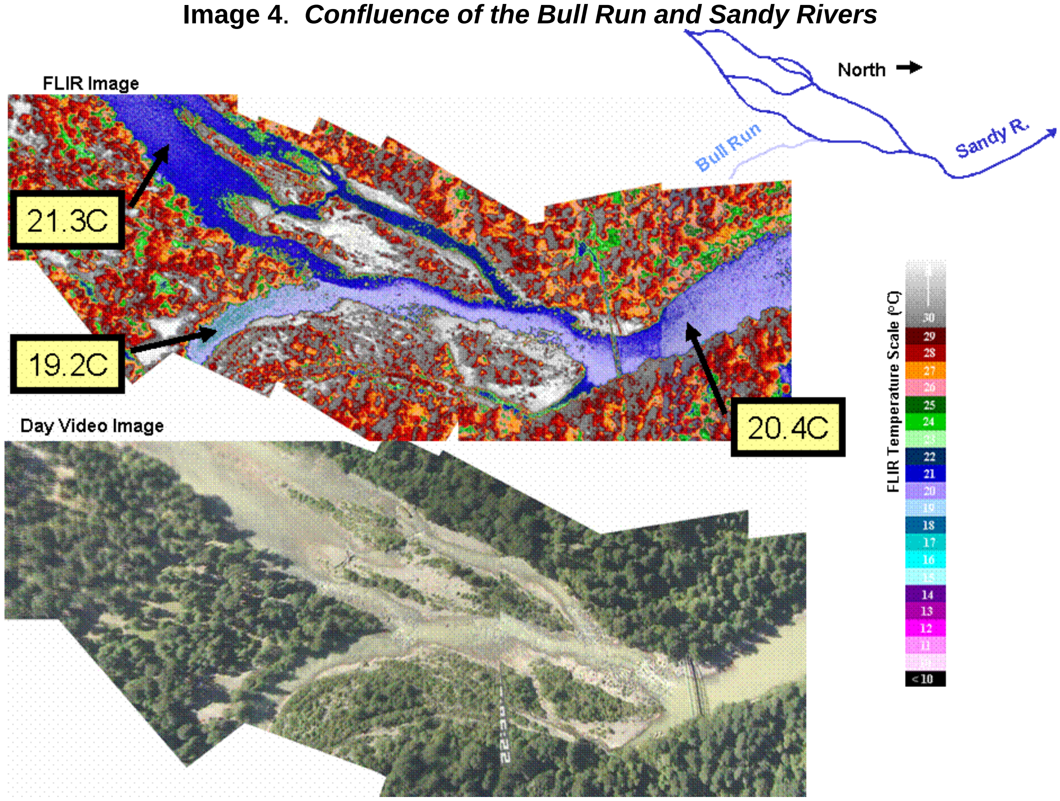


Image 5. Zigzag - *Confluence of the Zigzag and Sandy Rivers*

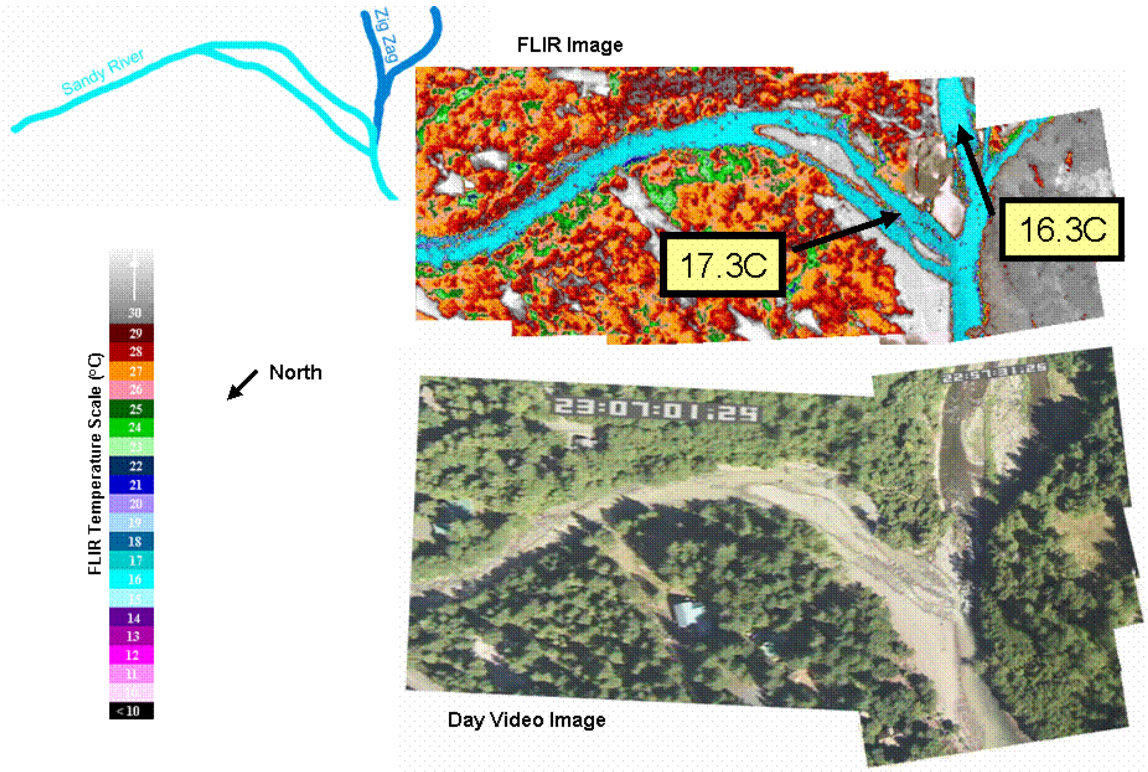


Image 6. Salmon - *Confluence of the Salmon and Sandy Rivers*

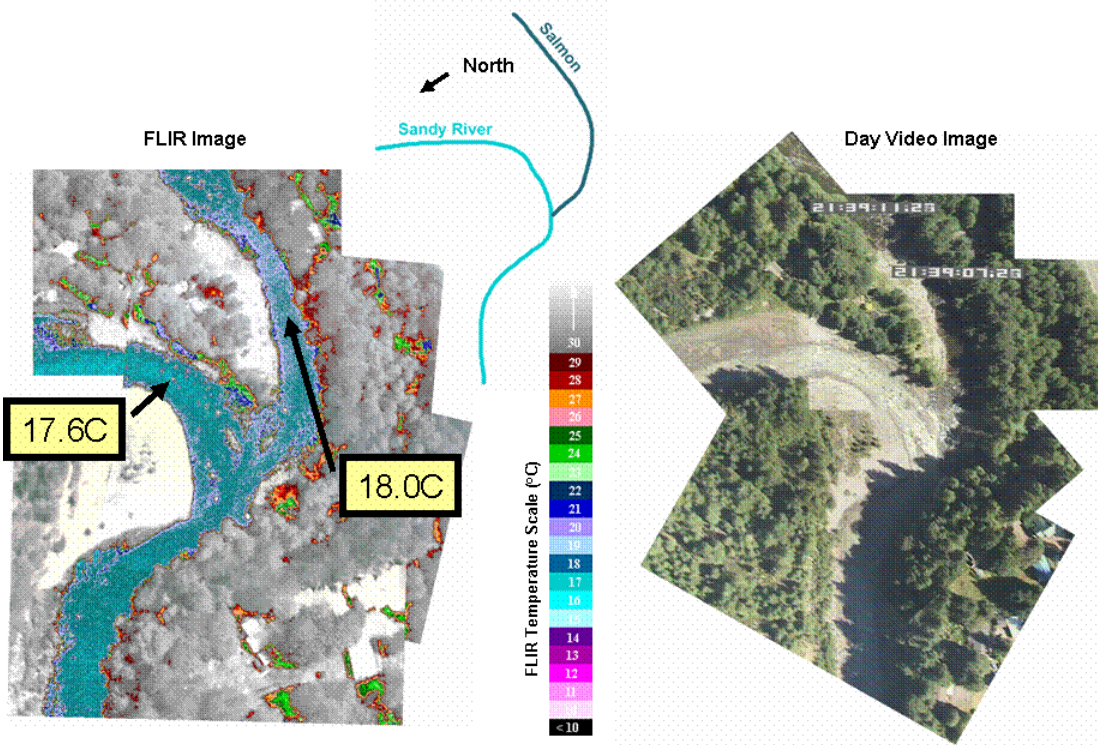
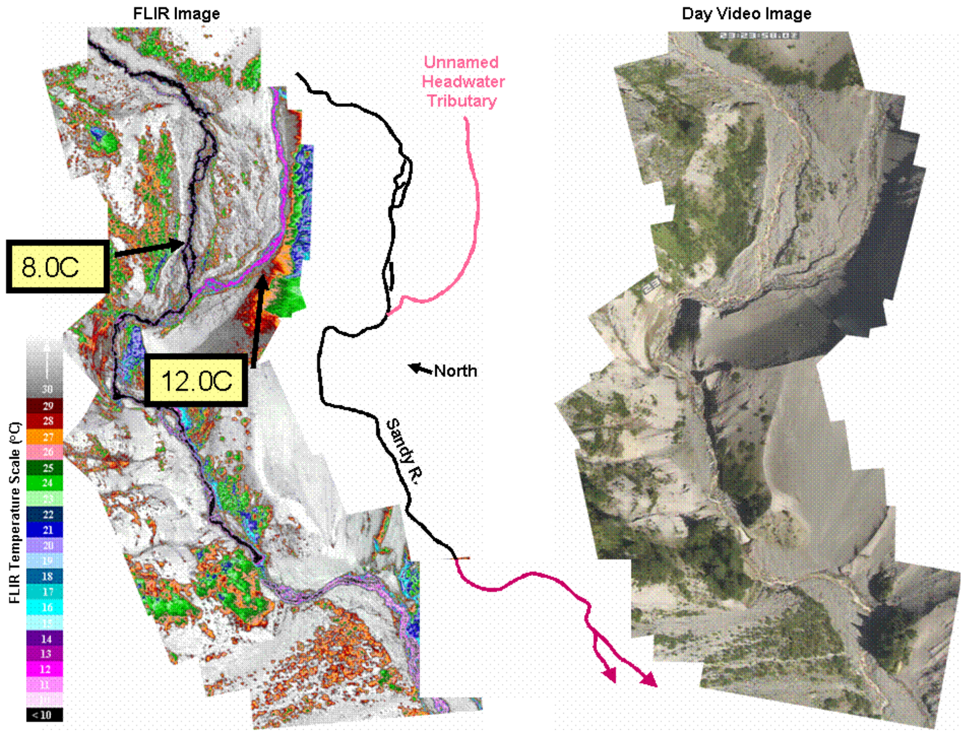


Image 7 ***Headwaters region of the Sandy River***



3.7.1 Sandy River Basin Thermal Response Simulations

To assess the thermal response of stream temperature to changes in vegetation, simulations were performed with the Heat Source model using current vegetation conditions and system potential vegetation conditions. August 8 and 9, 2001 were used to represent critical summer temperature conditions to use in running model simulations. Simulations were performed on several stream reaches where TIR data had been collected during August 8 and 9, 2001.

Recall that automated near stream vegetation sampling and TIR was completed for 141.3 rivermiles in the Sandy River basin (**Figure 3.18**) including the mainstem Sandy River (55.2 miles), Salmon River (33.9 miles), South Fork Salmon River (7.3 miles), Zigzag River (13.7 miles), Lower Bull Run River (6.2 miles), Upper Bull Run River (9.3 miles)and Little Sandy River (15.7 miles). Heat Source modeling was completed for all stream reaches except the Upper Bull Run and South Fork Salmon Rivers. Simulations at system potential were performed by adjusting stream vegetation to potential height, width and density as described above. The results of the simulations are presented in **Figures 3.20** – **3.24**.

Sandy River

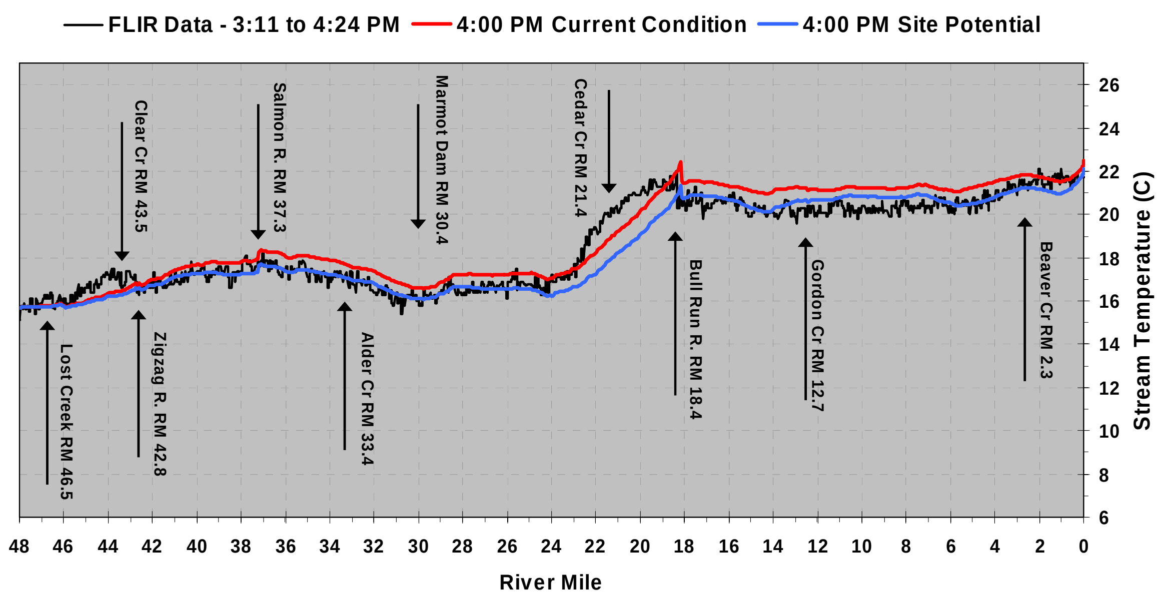
A longitudinal temperature profile was developed using TIR data for the Sandy River (black line on **Figure 3.20**) from its confluence with the Columbia River to the headwaters on the west slope of Mt. Hood. In general, the tributary temperatures were either cooler or equal to main stem temperatures. One tributary, Beaver Creek, contributed water significantly warmer than the main stem. Twelve side-channels and off-channel features were also sampled. The side channels detected in the lower 12 river miles were generally warmer than the mainstem. However, due to their low flow volumes, they did not have a detectable influence on mainstem water temperatures.

As might be expected due to the proximity of the snowfields, cool water temperatures were measured near the headwaters on Mt. Hood. From this point, the Sandy River warms steadily in a downstream direction for the first 10 miles reaching approximately 17 °C near the confluence of the Zigzag River at river mile 42. Over the next 18 miles, stream temperatures remain relatively consistent, varying less than ±1 °C over this reach. At river mile 23, stream temperatures begin to increase rapidly, with a 4 °C increase between river miles 23 to river mile 18.4 at the confluence of the Bull Run River (Watershed Sciences 2002). Marmot Dam at river mile 30.4 was diverting approximately 180 cfs from the Sandy on August 8, 2001. The stream shows a slight cooling at river mile 18.4 due at least in part to the influence of the Bull Run River and Walker Creek further downstream. Recall that flows diverted from the Sandy River at Marmot Dam are returned to the lower Bull Run River. The stream temperatures then remain relatively constant (20.5 °C) to approximately river mile 5.0. A slight increase of 1.5 °C is observed in the lower five miles of the river.

The Sandy River was modeled from river mile 48 to the mouth (confluence with the Columbia River). The model was calibrated to the TIR temperatures measured on August 8, 2001 from 15:11 to 16:24 and with data collected by numerous instream temperature recorders. Simulations were performed with both current and system potential riparian vegetation conditions. Model output, displayed in **Figure 3.20,** shows only the slightest difference in stream temperature under current (red line) and system potential (blue line) riparian condition, with the difference likely within the margin of error for the model.

Section 3.8.4 contains model output showing the temperature impact of restoring flows currently diverted at Marmot Dam.

Figure 3.20. Sandy River Temperatures: Modeled Current Condition and Modeled System Potential Shade (August 8, 2001)

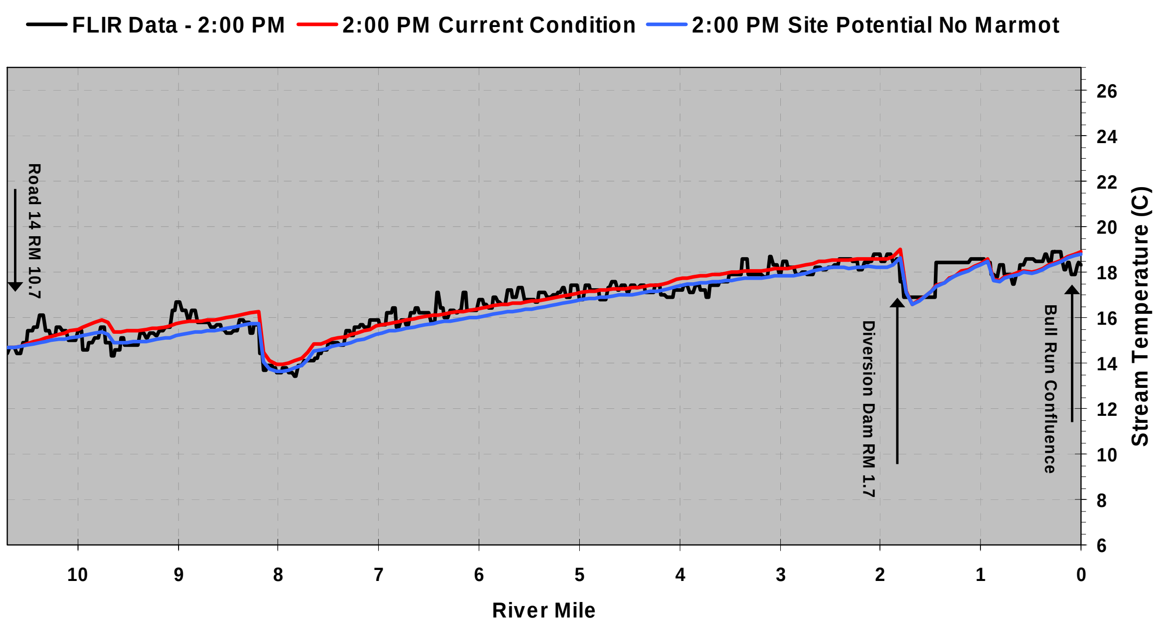


Little Sandy River

A TIR-derived longitudinal temperature profile was developed for the Little Sandy River from its mouth to headwaters (black line in **Figure 3.21**). The Little Sandy River is small in size and partially masked by canopy from the Little Sandy Dam to the confluence with the Bull Run River. Several cold areas were noted along the right bank near river mile 8.2, which were sampled as springs. The level of canopy and shadowing made positive identification of these springs difficult. However, there was an observed drop in stream temperatures along this reach. Generally, there was a very gradual increase in stream temperature from upstream to downstream. The upper portions of the Little Sandy River were below the 18 ^{o}C (64.4 ^{o}F) temperature criterion during this time, while the lower 4 to 5 miles exceeded the criterion. Image 2, above, includes TIR imagery of the Little Sandy Dam.

The Little Sandy River was modeled from river mile 10.7 to the mouth (confluence with the Bull Run River). The model was calibrated to the TIR temperatures measured on August 9, 2001 from 14:02 to 14:31 and with continuous instream data collected at three locations. Model output, displayed in **Figure 3.21,** indicates only the slightest difference in stream temperature under current (red line) and system potential (blue line) riparian condition. With the exception of a small area in the uppermost portion of the watershed, the Little Sandy River riparian vegetation condition is good and further improvements are not likely to have a demonstrable impact on stream temperature.

Figure 3.21. Little Sandy River Temperatures: Modeled Current Condition and Modeled System Potential Shade (August 9, 2001)



Lower Bull Run River

A TIR-derived longitudinal temperature profile was developed for the Bull Run River from its mouth to river mile 6.2 (black line in **Figure 3.22**). TIR data was also collected from river mile 6.2 to Bull Run Lake and on the South Fork Bull Run River, but was not included in this analysis. The complete TIR data collection report can be found on ODEQ's website at: http://www.deq.state.or.us/wq/TMDLs/TMDLs.htm

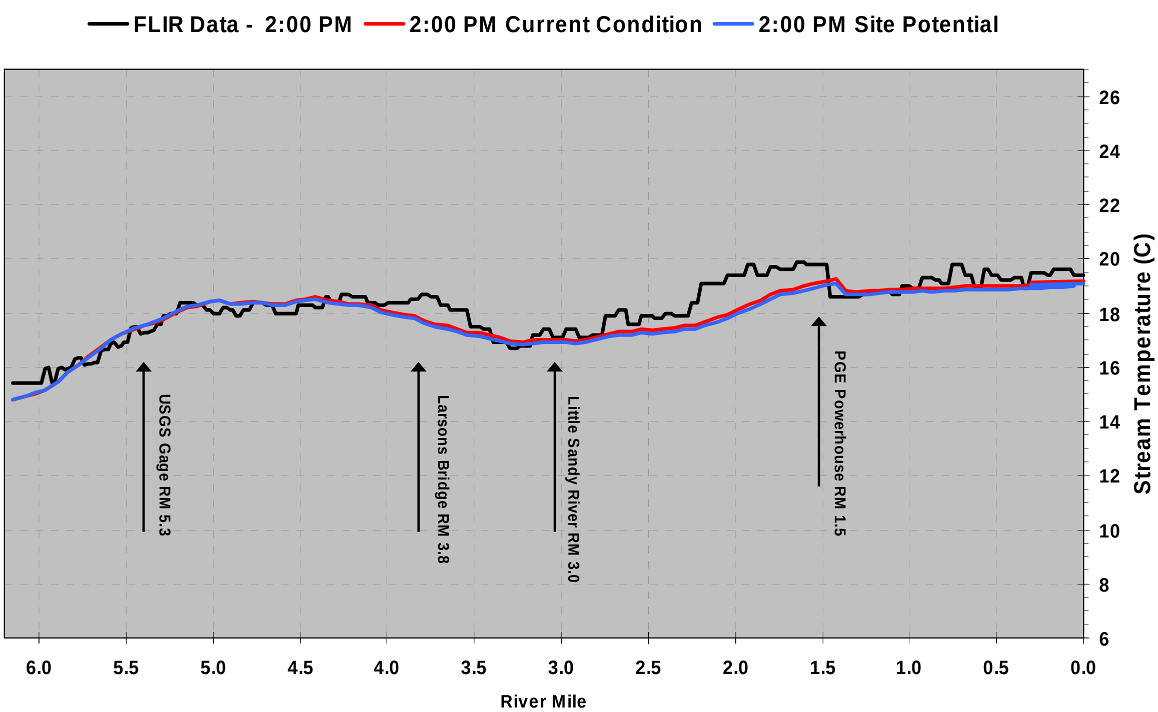
The lower Bull Run River was modeled from river mile 6.2 (City of Portland Dam #2) to the confluence with the Sandy River. The model was calibrated to the TIR temperatures measured on August 8, 2001 from 13:54 to 14:36 and with data collected by numerous instream continuous temperature recorders.

Model output, displayed in **Figure 3.22,** indicates only the slightest difference in stream temperature under current (red line) and system potential (blue line) riparian condition.

Summertime lows in the lower Bull Run River are governed by the amount and temperature of water that the City of Portland Bureau of Water Works allows to be released from Bull Run Dam #2. The flow on August 8, 2001 was 30 cfs at USGS gage #1414000, equating to approximately 25 cfs release from Dam #2. The temperature of the Dam #2 release water was 14.8 °C at 14:00. Flow that is diverted from the Sandy River at Marmot Dam and the Little Sandy River at the Little Sandy Dam is returned to the lower Bull Run at river mile 1.5 via the PGE powerhouse. A sharp drop in temperature is seen at river mile 1.5 as roughly 210 cfs of cooler water enters the 38 cfs flowing down the lower Bull Run. This combined flow warms only slightly before entering the Sandy River.

Images 3 and 4, above, show TIR and video imagery of the PGE powerhouse area and the confluence of the Bull Run and Sandy Rivers, respectively.

Figure 3.22. Lower Bull Run River Temperatures: Modeled Current Condition and Modeled System Potential Shade (August 8, 2001)



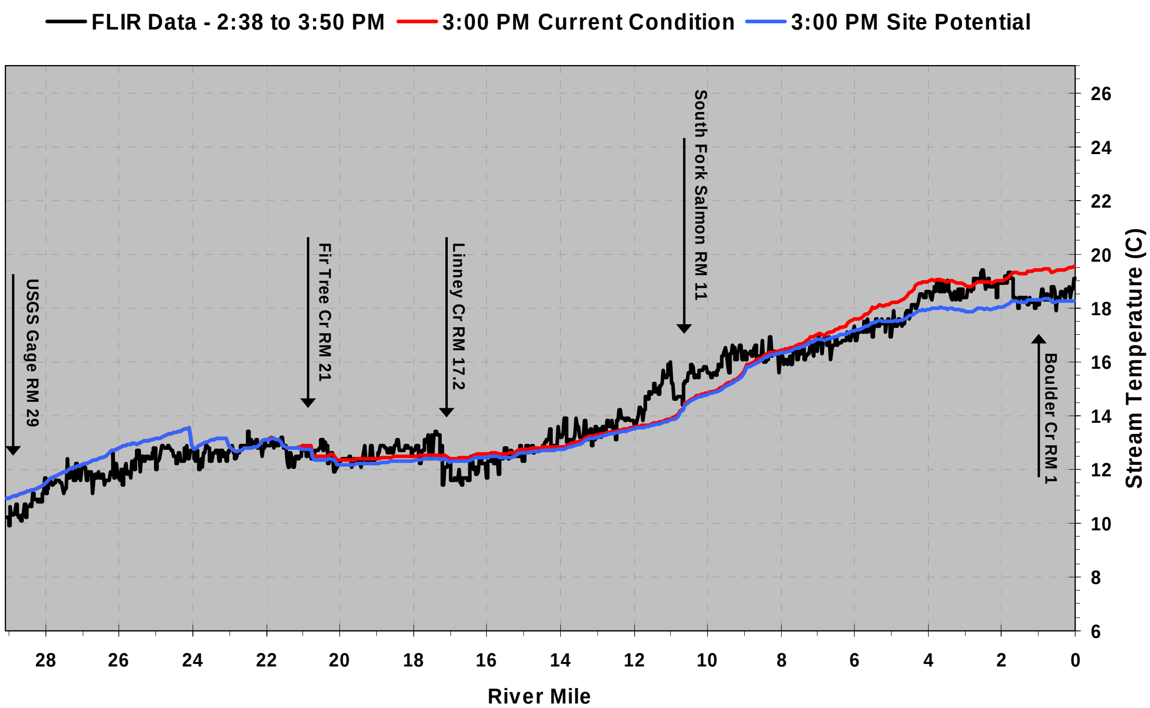
Salmon River

A TIR-derived longitudinal temperature profile was developed for the Salmon River from its mouth to river mile 29.1 (black line in **Figure 3.23**). TIR data was also collected from the mouth to headwaters on the South Fork Salmon River, but was not included in this analysis.

A total of 37 tributaries were detected and sampled during the analysis of the Salmon River. Of these tributaries, 24 contributed water that was cooler than the main stem. In addition, eight apparent springs were detected and sampled. The springs varied in size and appeared contribute cooler water to the Salmon River. However, the canopy and associated shadows precluded positive identification of these sources. Stream temperatures are cool in the headwaters and gradually warm downstream to river mile 24. Stream temperatures remain relatively constant to between river miles 24 and 14, with temperature variations within ±1.0 °C. Temperatures rise steadily from river mile 14 to the mouth with the exception of a 2 °C drop observed at the confluence of Linney Creek at river mile 17.2 (Watershed Sciences 2002).

The Salmon River was modeled from river mile 29.1 to the mouth (confluence with the Sandy River). The model was calibrated to the TIR temperatures measured on August 9, 2001 from 14:38 to 15:50 and with continuous instream data collected at four locations. Model output, displayed in **Figure 3.23,** indicates only the slightest difference in stream temperature under current (red line) and system potential (blue line) riparian condition from the headwaters to river mile 6. System potential vegetation results in an approximately 2 °C decrease in stream temperatures between river mile 6 and the mouth.

Figure 3.23. Salmon River Temperatures: Modeled Current Condition and Modeled System Potential Shade (August 9, 2001)



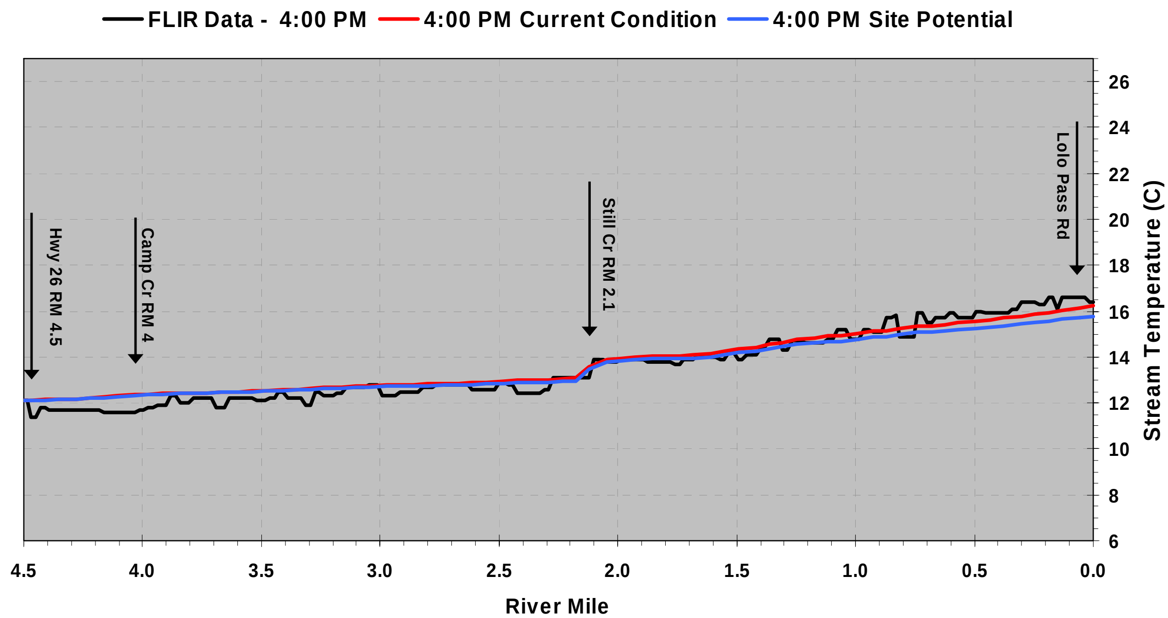
Zigzag River

A TIR-derived longitudinal temperature profile was developed for the Zigzag River from its mouth to river mile 12.5. The black line in **Figure 3.24** shows the TIR profile from the mouth to river mile 4.5, which corresponds to the portion of the river that ODEQ modeled. The complete TIR data collection report can be found on ODEQ's website at: http://www.deq.state.or.us/wq/TMDLs/TMDLs.htm

Still Creek at river mile 2.1 is a source of thermal loading and caused an observed 1.0 °C jump in the main stem temperatures.

The Zigzag River was modeled from river mile 4.5 to the mouth (confluence with the Sandy River). The model was calibrated to the TIR temperatures measured on August 9, 2001 from 15:57 to 16:19 and with continuous instream data collected at two locations. Again, only a very slight difference in stream temperature under current (red line) and system potential (blue line) riparian condition was predicted. The Zigzag River was approximately 1.0 °C cooler than the mainstem Sandy River at their confluence.

Figure 3.24. Zigzag River Temperatures: Modeled Current Condition and Modeled System Potential Shade (August 9, 2001)



3.8 LOADING CAPACITY AND ALLOCATIONS – 40 CFR 130.2(F)

This section first describes the loading capacity, followed by load allocations for nonpoint sources, wasteload allocations for point sources and load allocations for the Portland General Electric Bull Run Hydroelectric Project and the City of Portland Bull Run facilities. A summary of the load and wasteload allocations are presented in **Section 3.9**.

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with water quality 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)). Oregon's temperature standard allows a cumulative surface water temperature increase of 0.3°C over the applicable temperature criteria at the point of maximum impact. The temperature criteria can either be the natural thermal potential or the biologically based numeric criteria. The pollutants are human influenced increases in solar radiation loading (nonpoint sources) and heat loading from warm water discharge (point sources). An increased heating rate due to the diversion of flow below Marmot Dam also has a significant impact on stream temperature in the lower Sandy and Bull Run Rivers.

The loading capacity is dependent on the available assimilative capacity of the receiving water. The loading capacity is the sum of the natural background heat load and the allowable heat loads from point and nonpoint sources and dams. A portion of the loading capacity may also be reserved to accommodate for future growth. In this document, the loading capacity is expressed in terms of kilocalories per day (kcals/day). This represents the amount of energy that can be added to a waterbody and while still achieving water quality standards. However, in order for the TMDL to be more meaningful to the public and guide implementation efforts, allocations are also expressed in terms of percent effective shade and/or the allowable change in the seven day average of daily maximum temperature.

Model simulations demonstrate that the natural thermal potential stream temperatures for some reaches of the Sandy River and its tributaries exceed the biological based numeric criteria during the summer months. Thus, a temperature increase of 0.3°C above the lowest natural thermal potential temperature defines the loading capacity. When the biological criterion applies, a temperature increase of 0.3°C similarly defines the loading capacity. Within this TMDL, the human use allowance has been divided up as shown in **Table 3.11**.

3.8.1 Nonpoint Sources

The total nonpoint source solar radiation heat load was derived for the Sandy, Little Sandy, Lower Bull Run, Salmon, and Zigzag Rivers, as these rivers account for the majority of the flow in the basin (**Table 3.8**). Current solar radiation loading was calculated by simulating current stream and vegetation conditions. Background loading was calculated by simulating the solar radiation heat loading that resulted with system potential near stream vegetation. This background condition, based on system potential, reflects an estimate of nonpoint source heat load that would occur while meeting the temperature standard. In theory, once the system potential condition with respect to nonpoint source pollution is known, ODEQ could then calculate the amount of additional nonpoint source loading that a waterbody can assimilate within the Human Use Allowance. While one-sixth (0.05°C) of the Human Use Allowance was set-aside for nonpoint sources, ODEQ did not attempt to calculate this additional allowable heat load or incorporate the information into nonpoint source load allocations. Rather, ODEQ considers the conservative methodology that bases nonpoint source load allocations on system potential conditions to be part of the explicit margin of safety. Moreover, any allocation to nonpoint sources would occur only after restoration efforts had reduced solar radiation to near system potential conditions: a matter of decades in most cases. Thus, the nonpoint source load allocation was established at the background heat load.

The relationships below were used to determine solar radiation heat loads for the current condition, system potential condition and anthropogenic contributions.

Total Solar Radiation Heat Load from <u>All Nonpoint Sources,</u>

$$H_{Total\ NPS} = H_{SP\ NPS} + H_{Anthro\ NPS} = \Phi_{Total\ Solar} \cdot A$$

Solar Radiation Heat Load from <u>Background Nonpoint Sources (System Potential),</u>

$$H_{SP\ NPS} = \Phi_{SP\ Solar} \cdot A$$

Solar Radiation Heat Load from <u>Anthropogenic Nonpoint Sources,</u>

$$H_{Anthro\ NPS} = H_{Total\ NPS} - H_{SP\ NPS}$$

**All solar radiation loads are the clear sky received loads that account for Julian time, elevation, atmospheric attenuation and scattering, stream aspect, topographic shading, near stream vegetation stream surface reflection, water column absorption and stream bed absorption.*

where,

$H_{Total\ NPS}$: Total Nonpoint Source Heat Load (kcal/day)
$H_{SP\ NPS}$: Background Nonpoint Source Heat Load based on System Potential (kcal/day)
$H_{Anthro\ NPS}$: Anthropogenic Nonpoint Source Heat Load (kcal/day)
$\Phi_{Total\ Solar}$: Total Daily Solar Radiation Load (ly/day)
$\Phi_{SP\ Solar}$: Background Daily Solar Radiation Load based on System Potential (ly/day)
$\Phi_{Anthro\ Solar}$: Anthropogenic Daily Solar Radiation Load (ly/day)
A: Stream Surface Area - calculated at each 100 foot stream segment node (cm^2)

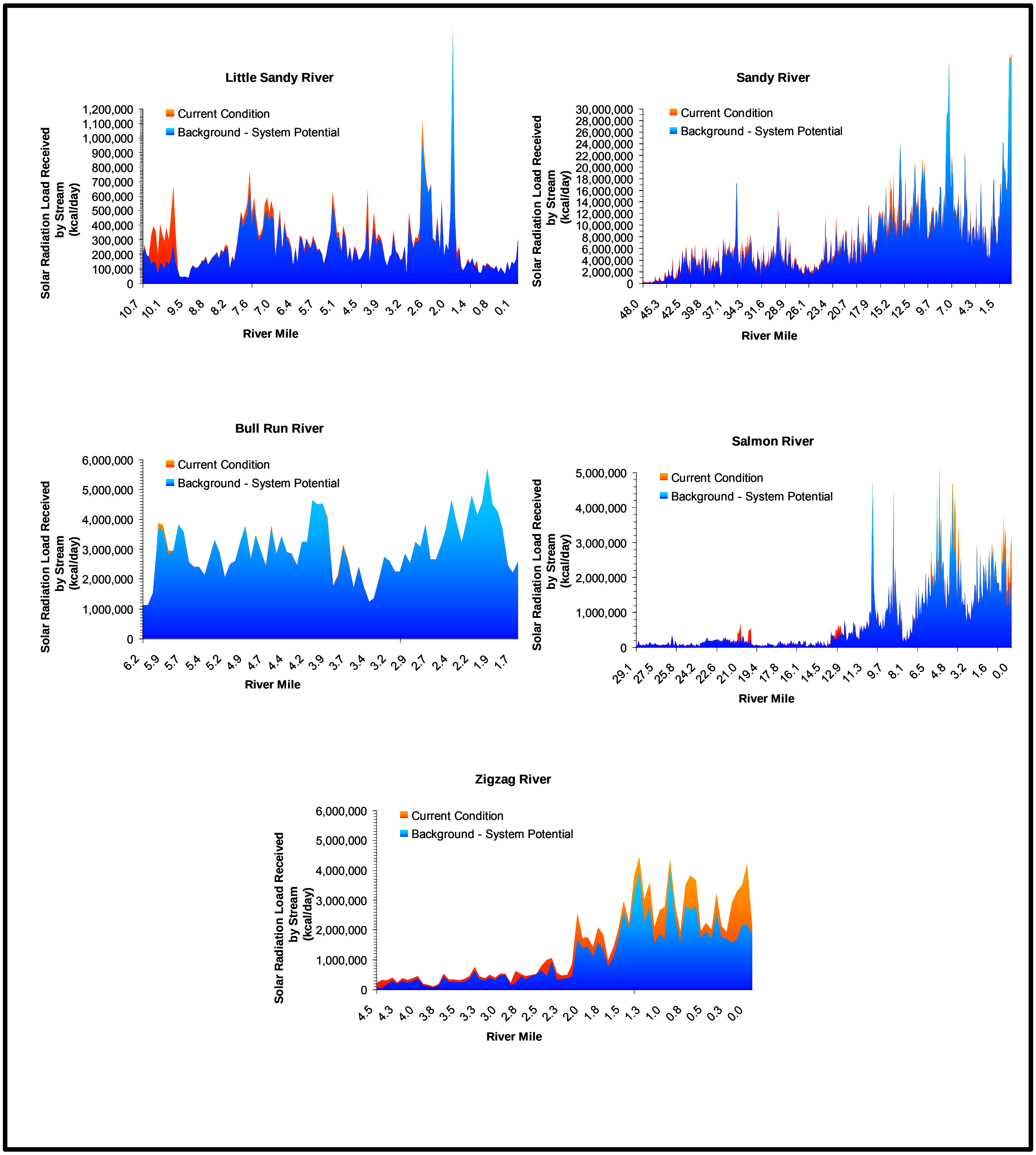
Table 3.8. Nonpoint Source Solar Radiation Heat Loading - Current Condition with Background (Load Allocation) and Anthropogenic Contributions (Excess Load)

	$H_{Total\ NPS}$	$H_{SP\ NPS}$	$H_{Anthro\ NPS}$	
Stream	**Current Condition** Solar Radiation Heat Loading (10^8 kcal/day)	**Background** System Potential Solar Radiation Heat Loading[8] (10^8 kcal/day)	**Anthropogenic (Excess Load)** Nonpoint Source Solar Radiation Heat Loading (10^8 kcal/day)	Portion of Current Solar Radiation Load from Anthropogenic Nonpoint Sources
Sandy River	60.15	56.68	3.47	5.8%
Little Sandy River	0.50	0.44	0.06	12%
Lower Bull Run River	3.19	3.16	0.03	1%
Salmon River	3.55	3.33	0.22	6.2%
Zigzag River	1.11	0.84	0.27	24.3%
Totals	**68.5**	**64.45**	**4.05**	**5.9%**

Figure 3.25 contrasts the longitudinal profile of the current solar radiation heat loading with the solar radiation heat loading that occurs with system potential land cover. Notice that solar radiation loading at system potential (load allocation) is generally only slightly less than levels currently observed, although the difference varies by stream and stream reach. The solar radiation heat load calculated for system potential near stream vegetation is considered the background condition with anthropogenic sources removed.

[8] Background solar radiation heat loading is based on effective shade resulting from system potential near stream vegetation.

Figure 3.25. Solar Radiation Loading – Current Condition and System Potential Condition

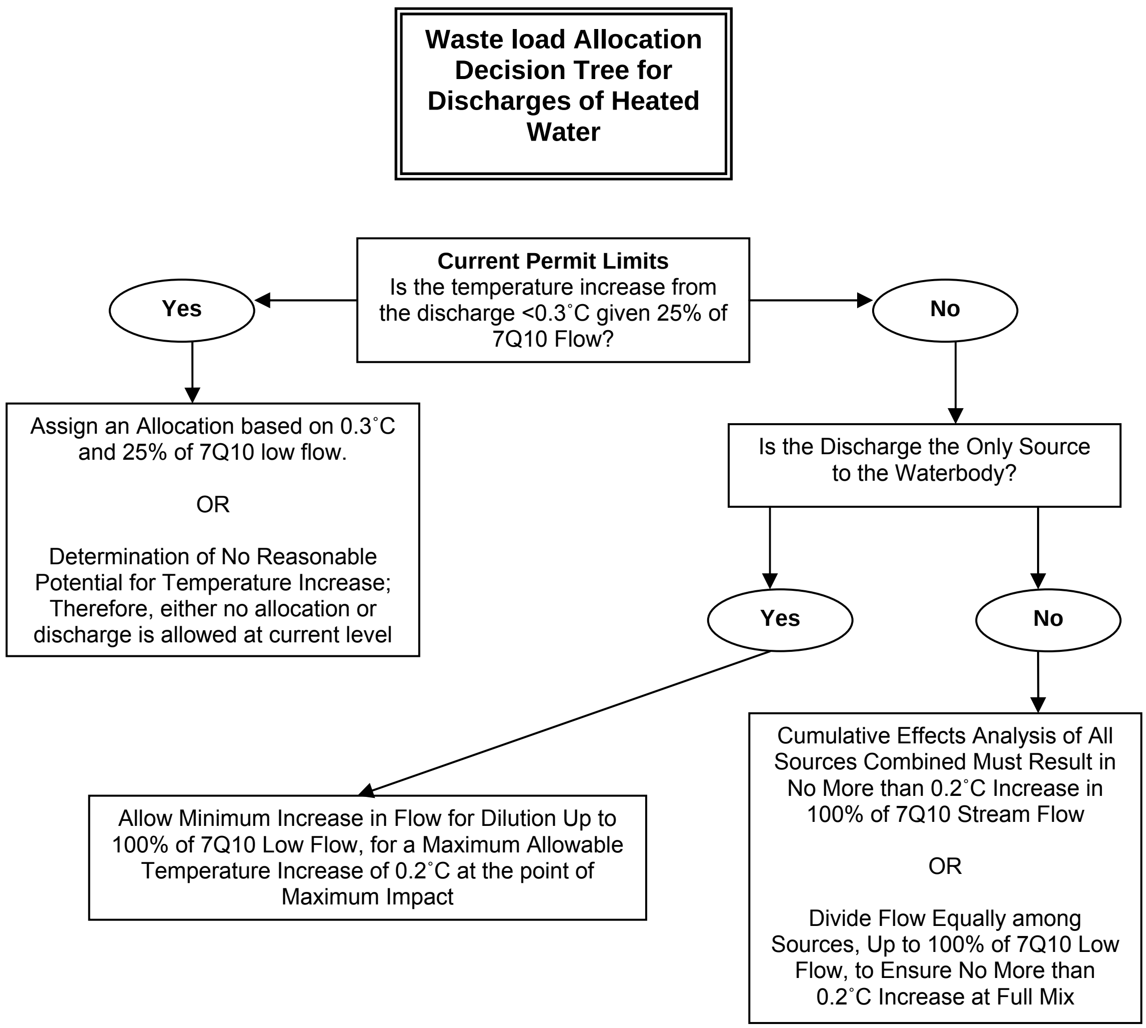


3.8.2 Point Source Methodology

Waste load allocations are heat load limits assigned to individual point sources of treated industrial and domestic waste. Waste load allocations are provided for all NPDES facilities that have reasonable potential to warm the receiving stream when the applicable criteria are exceeded. Point source facilities in the Sandy River Basin that are allocated heat load limits in this TMDL are shown below in **Table 3.9**.

Discharges were screened to determine which would likely receive a waste load allocation based on the type of discharge, and the volume and temperature of effluent. General permits that discharge heated effluent (e.g., non-contact cooling water) were considered as potential sources. General permits that are unlikely to discharge significant volumes of warm water during critical periods (e.g., stormwater permits) are not expected to have a reasonable potential to increase instream temperatures. Thus, no allocation has been provided for these sources and they may continue to discharge at current levels.

Depending upon the amount of information available, discharge heat loading was assessed by the following process.



As mentioned in **Section 3.8.1**, 0.2°C of the HUA has been allocated to point sources. Thus, all discharges have been evaluated to ensure that their individual and cumulative effects would not exceed 0.2°C at the point of maximum impact.

As noted in the methodology flow chart, all point sources were first evaluated to determine their potential to impact instream temperatures at current discharge temperature and 25% of the 7Q10 flow. Calculations for four of the six NPDES permitted point sources in the Sandy Basin result in temperature increases in a fully mixed receiving water of not more than 0.075°C (less than 0.3° at 25% of flow). Only two of the discharges (Government Camp STP and the Sandy Fish Hatchery) had a maximum impact of greater than 0.3°C at 25% of the 7Q10 flow. These two discharges were further evaluated per the criteria outlined on the right side of the flow chart.

During non-critical periods, temperature limits must still be set to avoid violating water quality standards in the receiving stream or in water bodies down stream of the receiving stream. Pollutant trading opportunities may be available to new or existing point sources in order to offset temperature impacts.

The following equations were used to determine allowable point source waste load allocations (heat loads) and maximum allowable effluent temperatures:

Maximum Effluent Temperature

The following equation was used to determine maximum effluent temperatures for point sources. It is the basis for setting flow-based temperature limitations:

$$T_{WLA} = \frac{\left[\left(Q_{PS} + Q_{ZOD}\right)\cdot\left(T_R + \Delta T_{ZOD}\right)\right] - \left(Q_{ZOD} \cdot T_R\right)}{Q_{PS}}$$

where:

T_R: Temperature Criterion or Upstream potential river temperature (^oF)
T_{WLA}: Maximum allowable point source effluent temperature (^oF)
ΔT_{ZOD}: Change in river temperature at edge of zone of dilution - 0.54^{o}F allowable (^oF)
Q_{ZOD}: Upstream river flow volume through zone of dilution - ¼ of7Q10 low flow statistic (cfs) or 100% of flow, when appropriate
Q_{PS}: Point source effluent discharge flow volume (cfs)

Heat Load in kcals/day

The equation for calculating the allowable heat load from point sources is provided below.

Load (kcal/day) = (ΔT *5/9)*(Q_{PS}+Q_R)*(86400000/35.3)

ΔT = allowable increase (0.3°C)
Q_R = ¼ of the 7Q10 Low Flow (cfs) or 100% of flow, when appropriate
Q_{PS} = Point Source Flow (cfs)

The equation uses ¼ of the 7Q10 low flow as a conservative assumption for the Hoodland STP, Troutdale STP, Mount Hood Community College, and Legacy Mount Hood Medical Center. The Government Camp STP and Sandy Fish Hatchery waste load allocations were derived using 100% of the 7Q10 flow. Actual instream flows will be higher most of the time. Permit writers, when calculating permit limits, may base effluent limitations on actual instream flow volume at the point and time of discharge. These flow-based effluent limits will also address the appropriate numeric criteria and/or the system thermal potential temperature expressed in the TMDL.

3.8.3 NPDES Permits

Six NPDES permitted discharge points, are mapped and identified below (**Table 3.9**, **Figure 3.26**). These facilities discharge into streams which are either on the 303(d) list or are tributaries to other streams on the list. Discharge temperature data is limited for some facilities and flow rates are generally low. More detailed information on individual facilities is provided below. Flow rates noted in various tables are the design capacity for the Hoodland and Troutdale sewage treatment plants and the summertime flow rate as determined by a mixing zone study for the Government Camp sewage treatment plant. The Sandy River Fish Hatchery does not have any NPDES-related flow requirements so ODEQ assumed that the facility diverts the entire summertime flow of Cedar Creek through the facility. ODEQ assumed the maximum reported discharge rate for the other dischargers (worst case scenario) when calculating waste load allocations. In development of the waste load allocations for most of the facilities, the receiving stream flow was estimated from several sources, as noted in **Table 3.10**.

In some cases additional information may be necessary to ensure that specific NPDES permit limits comply with TMDL waste load allocations under varying flow and temperature conditions.

Table 3.9. NPDES Permitted Facilities for Wastewater Discharge

FACILITY NAME	DESCRIPTION	RECEIVING WATER	RIVER MILE	Flow Rate (cfs)
GOVERNMENT CAMP STP	NPDES - Domestic Wastewater	Camp Creek	4.0	0.25
HOODLAND STP	NPDES - Domestic Wastewater	Sandy River	41.0	1.39
TROUTDALE STP	NPDES - Domestic Wastewater	Sandy River	2.3	4.64
LEGACY MOUNT HOOD MEDICAL CENTER	GEN01 – Non-contact Cooling Water	Kelly Creek	1	0.01
MT. HOOD COMMUNITY COLLEGE	GEN02 - Filter Backwash Water (Swimming Pools)	Kelly Creek	1	0.45
ODFW SANDY RIVER. HATCHERY	GEN02 - Fish Hatchery	Cedar Creek	2.1	NA

Figure 3.26. Location of Sandy River Basin NPDES Permitted Facilities

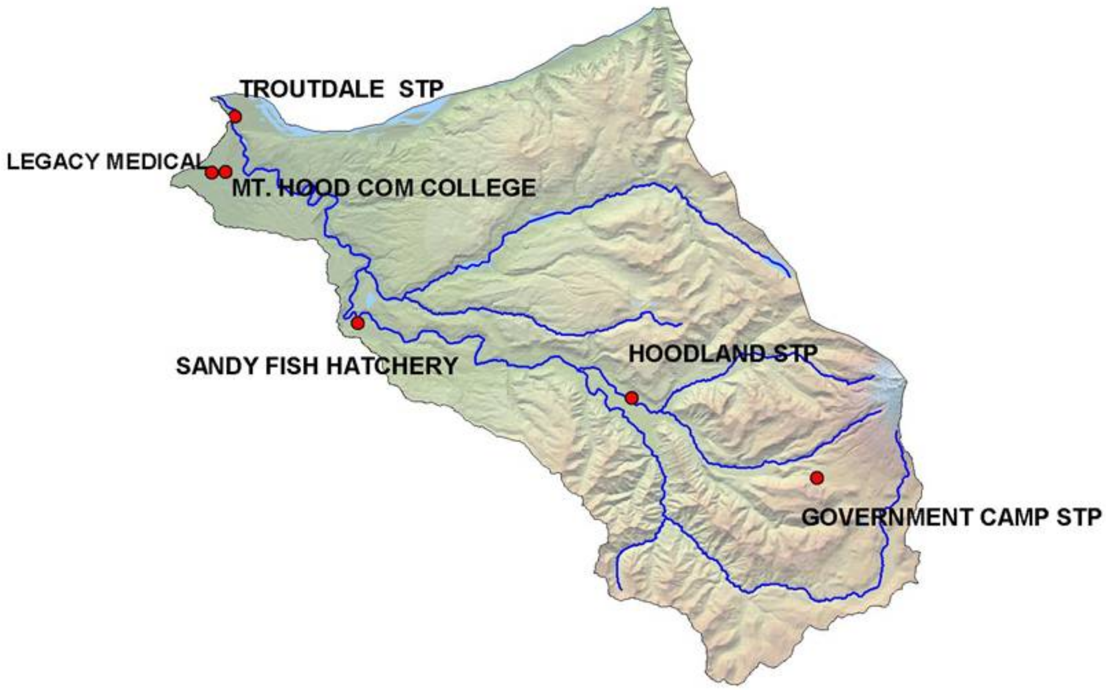


Table 3.10 is a list of the thermal point sources that discharge in the Sandy River Basin, the flow conditions used to calculate their waste load allocations, maximum allowable effluent temperatures and the calculated waste load allocations.

Table 3.10. Calculated Waste Load Allocations for NPDES Permitted Point Sources in the Sandy River Basin

Source Name	Dry Weather or Permitted Flow (cfs)	Stream Flow (7Q10) (cfs)	WLA Flow Assumption	Maximum Effluent Temperature (F)/(C)	Waste Load Allocation (kcals/day)
Government Camp STP	0.25	5.7**	Full Mix	69.4 / 20.8	2.91×10^6
Hoodland STP	1.39	179‡	¼ 7Q10	78.4 / 25.8	29.9×10^6
Troutdale STP	4.64	314†	¼ 7Q10	80.5 / 27.0	61.1×10^6
Mt Hood Community College	0.45	1.2*	¼ 7Q10	65.3 / 18.5	0.55×10^6
Legacy Mt Hood Medical Center	0.01	1.2*	¼ 7Q10	81.1 / 27.3	0.23×10^6
ODFW Sandy Fish Hatchery	NA	5†	Full Mix	no more than a 0.2°C increase in stream temperature	4.90×10^6
Total					**99.6×10^6**

* Estimated using flow information collected by the City of Gresham in 2000 and 2001
** Curran-McLeod Consulting Inc. (1993)
† Calculated by ODEQ using historical USGS flow data
‡ Hoodland STF Outfall Diffuser Predesign Report (March 1998)

Government Camp Sewage Treatment Plant

The Government Camp STP discharges treated municipal wastewater to Camp Creek, a small tributary to the Zigzag River.

A 1993 study by the consulting firm Curran-McLeod Inc. reported a 7Q10 low flow of 5.7 cubic feet per second (cfs) for Camp Creek. Effluent flows of 0.16 MGD (0.25 cfs) were determined by the ODEQ Government Camp STP Mixing Zone Study in August of 1993. The resulting calculations yielded a maximum effluent temperature of 20.8 ^{o}C (69.4^{o}F) and a waste load allocation of 2.91x 10^6 kilocalories per day.

Hoodland Sewage Treatment Plant

The Hoodland STP discharges treated municipal wastewater from communities along the HWY 26 corridor into the Sandy River near Welches. The diffuser-type outfall is located at river mile 41, upstream from the confluence of the Salmon River and downstream from the confluence of the Zigzag River.

ODEQ deployed a continuous temperature monitor in the STP outfall during the summer of 2001. The daily maximum temperature measured was 21^{o}C (70 ^{o}F). The dry weather design flow for this facility is 1.39 cfs, though maximum reported discharge flows for August have been approximately 0.5 cfs in recent years. While the WLAs were developed based on dry weather design flow, actual effluent and instream flow volumes may be used in NPDES permit limits if these values are monitored as part of the permit requirements. Since ODEQ simulated stream temperature in the mainstem Sandy River using Heatsource it was possible to determine the “natural thermal potential” at the point where the Hoodland STP discharges to the Sandy River. ODEQ predicted a daily maximum instream temperature of 17.0 ^{o}C (62.6^{o}F) under system potential conditions at this location. Therefore, the calculation of the summertime waste load allocation for the Hoodland STP is based upon natural thermal potential. The resulting calculations yielded a maximum effluent temperature of 25.8 ^{o}C (78.4^{o}F) and a waste load allocation of 29.9 x 10^6 kilocalories per day.

Troutdale Sewage Treatment Plant

The City of Troutdale Sewage Treatment Plant provides municipal wastewater treatment for approximately 15,000 people in the Troutdale area and discharges treated effluent to the Sandy River at river mile 2.3.

Historical flow data from USGS gage 14142500 (Sandy below Bull Run River) was used to calculate stream flow return periods. An additional 10% was added to the gage flow measurements to account for minor tributaries that enter the lower Sandy River between the gage and Troutdale’s outfall. The maximum point source effluent temperature was 21.2 ^{o}C (72 ^{o}F), as reported by Troutdale STP. The dry weather design flow for this facility is 4.64 cfs and 25% of the stream flow was allowed for mixing.

Since ODEQ simulated stream temperature in the mainstem Sandy River using Heatsource it was possible to determine the “natural thermal potential” at the point where the Troutdale STP discharges to the Sandy River. ODEQ predicted a daily maximum instream temperature of 20.0^{o}C (68.0^{o}F) under system potential conditions at this location. Therefore, the calculation of the summertime waste load allocation for the Troutdale STP is based upon natural thermal potential. The maximum allowable effluent temperature is 25.4 ^{o}C (77.7^{o}F).

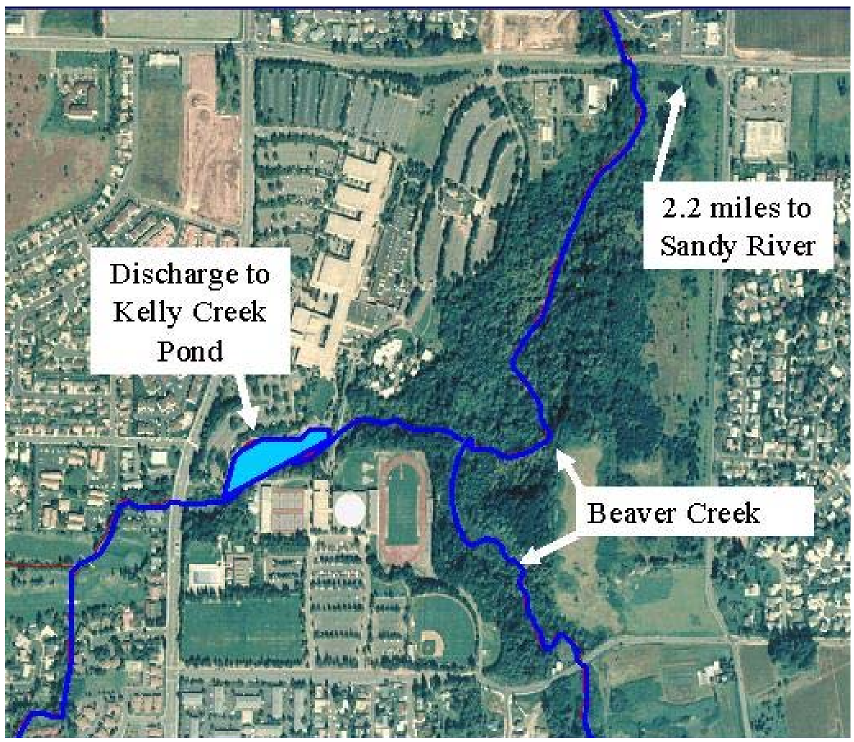
The City of Troutdale submitted a temperature management plan (TMP) that was approved by the Department on 12/26/2002. The TMP includes a discussion on timing and presence of salmonids, a summary of available effluent and ambient temperature data, analysis of temperature impacts in the river, proposed effluent monitoring, and a discussion of possible alternatives to reduce their effluent heat load if necessary.

Mount Hood Community College

Mount Hood Community College currently holds a Filter Backwash General NPDES permit that allows them to periodically discharge swimming pool filter backwash water to Kelly Creek. Kelly Creek is a tributary to Beaver Creek, which enters the lower Sandy River at river mile 2.3. The facility discharges to an in-stream reservoir on their property (**Figure 3.27**).

An effluent flow of 0.45 cfs was determined by ODEQ – Mt. Hood Community College Lake Survey, in June of 1987. The 7Q10 low flow of Kelly Creek was estimated using flow information collected by the City of Gresham in 2000 and 2001. ODEQ chose to use 1.2 cfs, the lowest measured flow during that time period, to calculate the waste load allocation. This yielded a maximum effluent temperature of 18.5 ^{o}C (65.3 ^{o}F) and a waste load allocation of 0.55 x 10^6 kilocalories per day.

Figure 3.27. Location of Mount Hood Community College Discharge



Legacy Mount Hood Medical Center

Legacy Mt. Hood Medical Center's permitted discharge of non-contact cooling water is very small (.011 cfs) and is directed to a sump on their property. The sump is equipped with an overflow that discharges to the City of Gresham storm sewer system. The facility is operated during regular business hours, and discharge to surface waters only occurs at times of year when there are heavy rain events, typically winter and spring. There is a very low likelihood that discharge will occur during the summer months when the temperature water quality limitations are present. This facility is very near the Mount Hood Community College, so the assumption was made that overflow discharges to the storm sewer would eventually be discharged to Kelly Creek, a tributary to the Sandy River. The 7Q10 low flow of Kelly Creek was estimated using flow information collected by the City of Gresham in 2000 and 2001. ODEQ chose to use 1.2 cfs, the lowest measured flow during that time period, to calculate the waste load allocation. This yielded a maximum effluent temperature of 27.3 ^{o}C (81.1 ^{o}F) and a waste load allocation of 0.23 x 10^6 kilocalories per day.

Sandy River Fish Hatchery

The Oregon Department of Fish and Wildlife operates the Sandy River Fish Hatchery and currently holds a Fish Hatchery General NPDES permit that allows them to discharge water used in hatchery operations to Cedar Creek, a tributary that enters the Sandy River at river mile 21.4. The Hatchery diverts water from Cedar Creek, routes the water through the facility, and discharges it back to the stream approximately ½ mile downstream (**Figure 3.28**). Under normal summertime operations most of the flow of Cedar Creek is diverted through the hatchery. Temperature data collected by ODEQ during the summer of 2001 shows that the hatchery, as it is currently operated during the summer months, has little if any impact on stream temperature, especially considering that some instream heating would likely occur in the ½ mile stream segment that is bypassed (**Figure 3.29**). A 7Q10 low flow of 5 cfs was calculated using historical (1970-1985) flow data collected at USGS gage 14138400. This yielded a waste load allocation of 4.90×10^6 kilocalories per day and allows for a maximum of 0.2 ^{o}C stream heating. Since Cedar Creek was not modeled for this TMDL effort, the "point of maximum impact" for the Hatchery discharge was not determined and is assumed to be at the point of discharge. The flow volume of Cedar Creek is insignificant with respect to the flow volume of the Sandy River (7Q10 of 5 cfs versus a 7Q10 of 255 cfs) and thus the temperature impact of this source is insignificant with respect to the temperature in the Sandy River. Future permit limits and waste load allocations may need to be updated as additional information on the nature of the discharge and its impact to Cedar Creek is developed.

Figure 3.28. ODFW Sandy Fish Hatchery

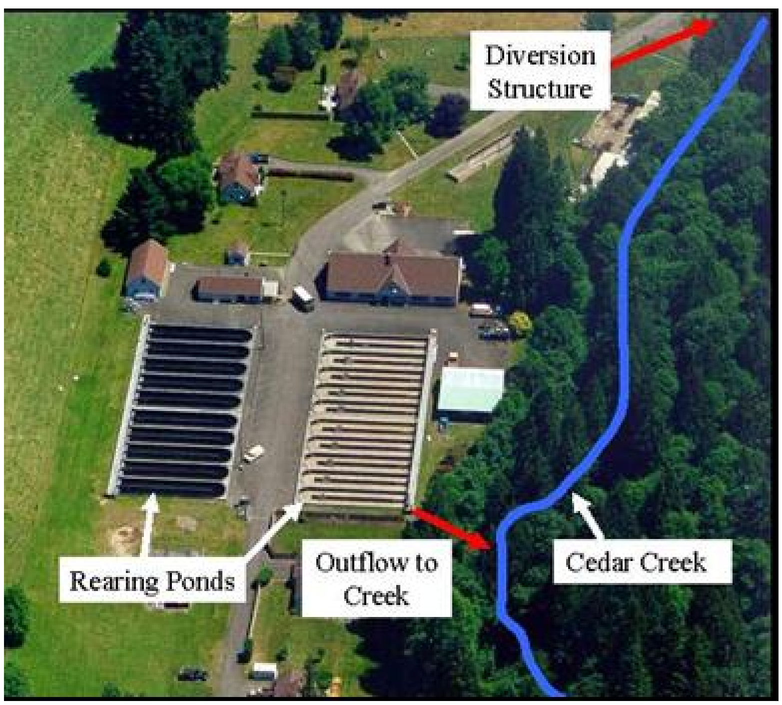
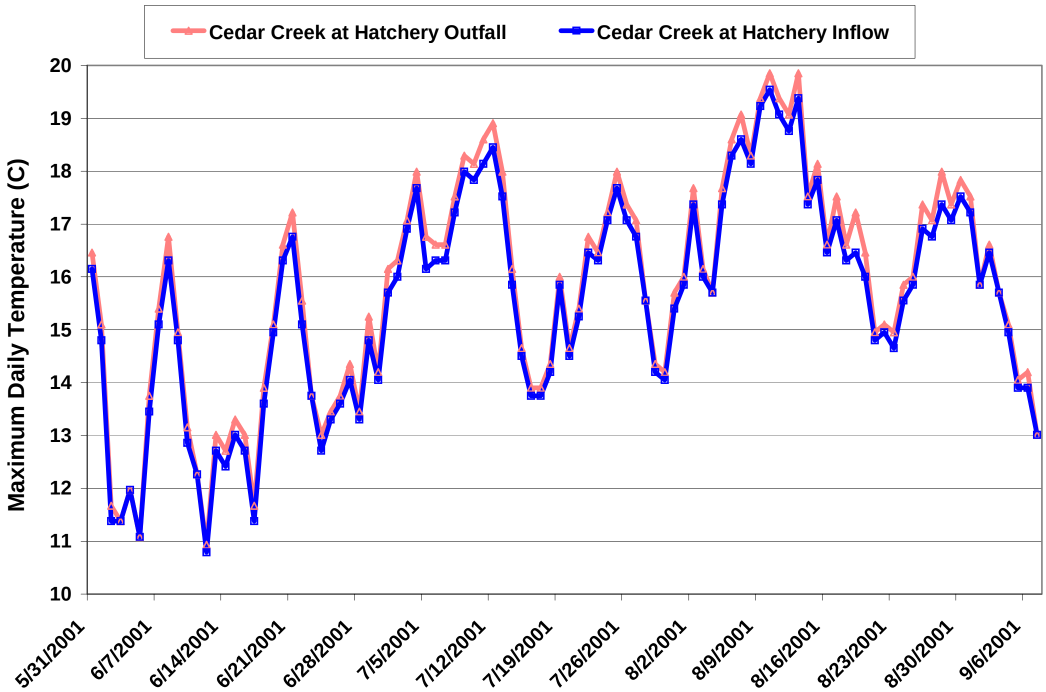


Figure 3.29. **Temperature Data Collected at Sandy Fish Hatchery Inflow and Outfall, 2001 (Daily Maximum)**



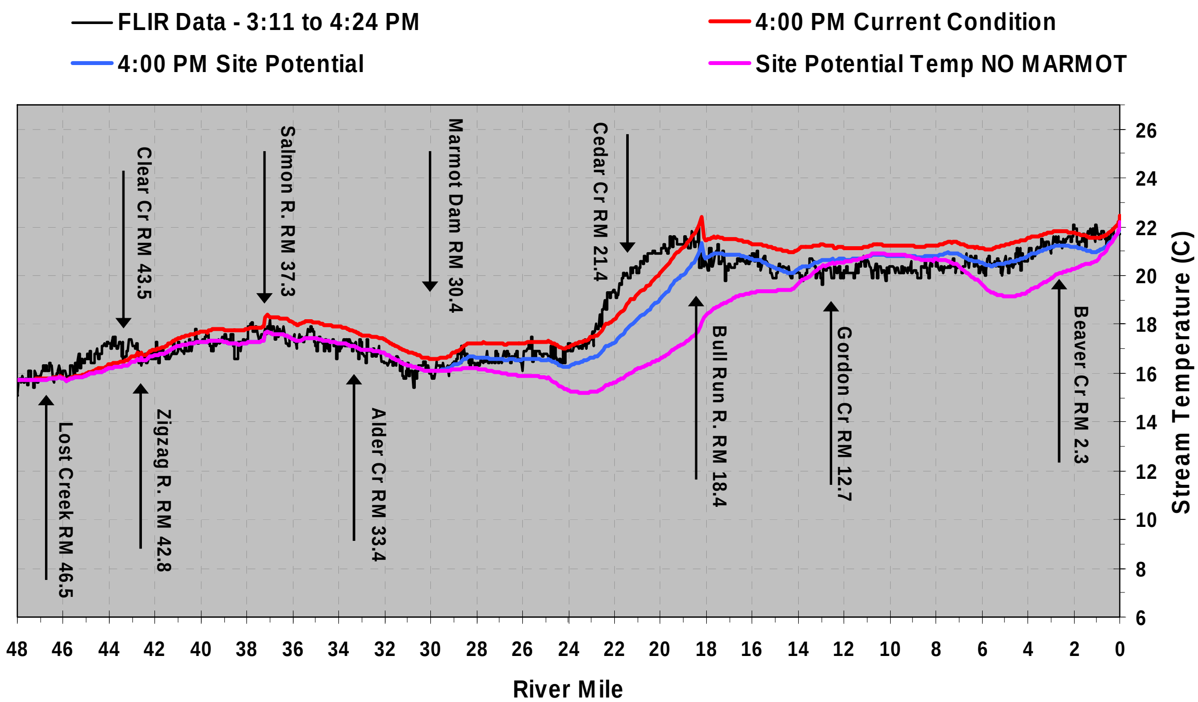
3.8.4 Portland General Electric Bull Run Hydroelectric Project

As noted in **Section 2.4.2**, PGE's Bull Run Hydroelectric Project diverts water from the Sandy (up to 600 cfs) and Little Sandy Rivers (up to 200 cfs), delivers it to Roslyn Lake, the project forebay, and discharges water from the project power house into the Bull Run River about 1 mile upstream of its confluence with the Sandy River. The project is scheduled for removal by 2009, rendering the Sandy River, both a state and federal wild and scenic river system, a dam-free system. Dam removal is expected to improve water temperature in the mainstem Sandy River in the reach below the dam, as well as improving temperature in the lower reach of the Little Sandy. Dam removal will also eliminate some of the intermittent turbidity extremes witnessed in the lower Bull Run River between the project power house and the mouth of the Bull Run River, as the glacial fed Sandy River will no longer be discharged through the power house.

The removal of the PGE project, and subsequent restoration of river flows, was modeled using Heat Source to assess the impacts on stream temperature in the mainstem Sandy River. Since the model was calibrated for August 8, 2001, an additional 180 cfs of water was routed down the Sandy River, rather than being diverted through the PGE project into the Bull Run River. Simulation results are presented in **Figure 3.30**. The simulation results predict significantly cooler stream temperatures when the flow volume that is diverted at Marmot Dam is allowed to remain in the Sandy River. Cooler instream temperatures were observed from the Marmot Dam site at river mile 30.4 downstream approximately to Gordon Creek at river mile 12.7.

This analysis of stream flow relative to temperature provides a good approximation of the temperature impact of Marmot Dam removal.

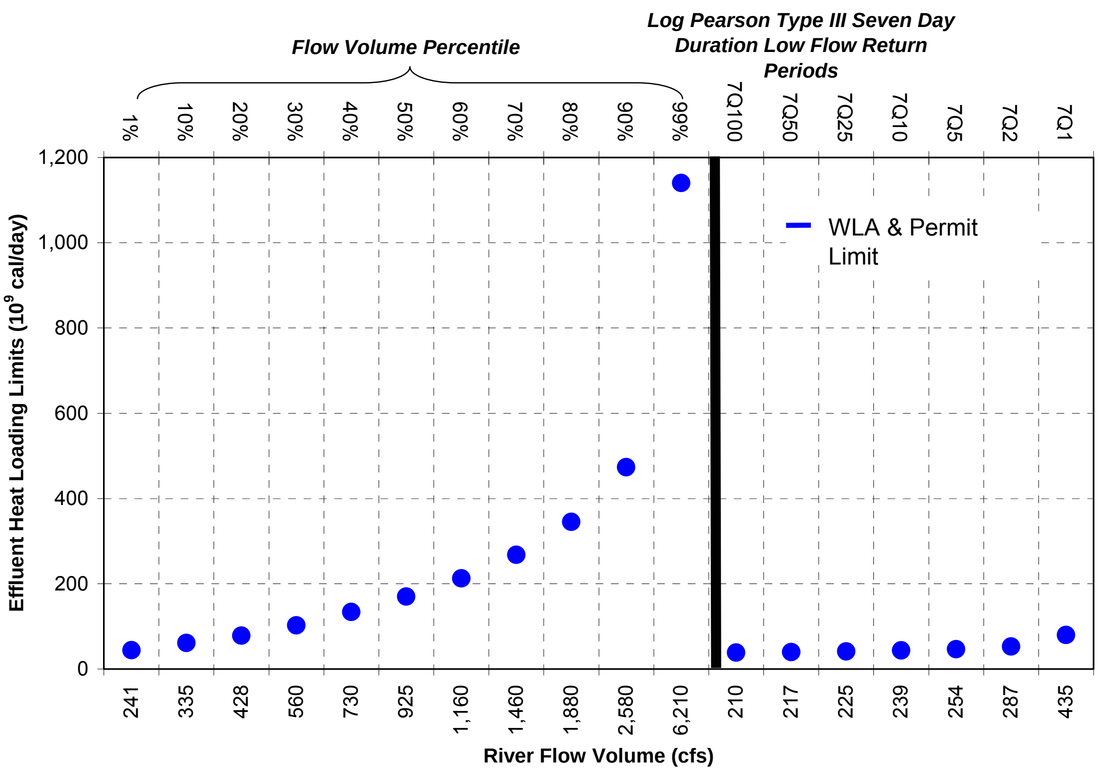
Figure 3.30. Simulated Sandy River Stream Temperatures with Removal of Marmot Dam



ODEQ determined the appropriate flow-based load allocation for the PGE project. Results are presented graphically in **Figure 3.31** and in table form in **Section 3.9**. Historical flow data from USGS gage 14137000 (Sandy River near Marmot, Oregon) was used to calculate stream flow return periods. ODEQ did not attempt to determine the "point of maximum impact" relative to the PGE Project for this temperature TMDL because the project is scheduled for removal. Rather, the flow based load allocations are based upon allowing a 0.075°C increase and 25% of the stream flow for mixing and should be considered provisional. It will be assimilated into the reserve capacity when the project is decommissioned.

OAR 340-41-0028(12)(h) allows the department to require a Temperature Management Plan (TMP) for private hydropower facilities regulated by a 401 water quality certification. PGE would be required to develop and implement a TMP to achieve compliance with the load allocation established in this TMDL. Since the PGE Bull Run Hydroelectric Project is scheduled for decommissioning and removal by 2009, their decommissioning plan, as described in the Settlement Agreement dated October 24, 2002, will serve as their TMP. In the event that the decommissioning is either significantly delayed or cancelled, ODEQ will require a flow-based Temperature Management Plan which may allow the facility to continue to produce power albeit at a lower capacity by allowing more flow in the diversion reach (Marmot Dam to the confluence of the Bull Run River).

Figure 3.31. **Portland General Electric Bull Run Hydroelectric Facility Load Allocations**



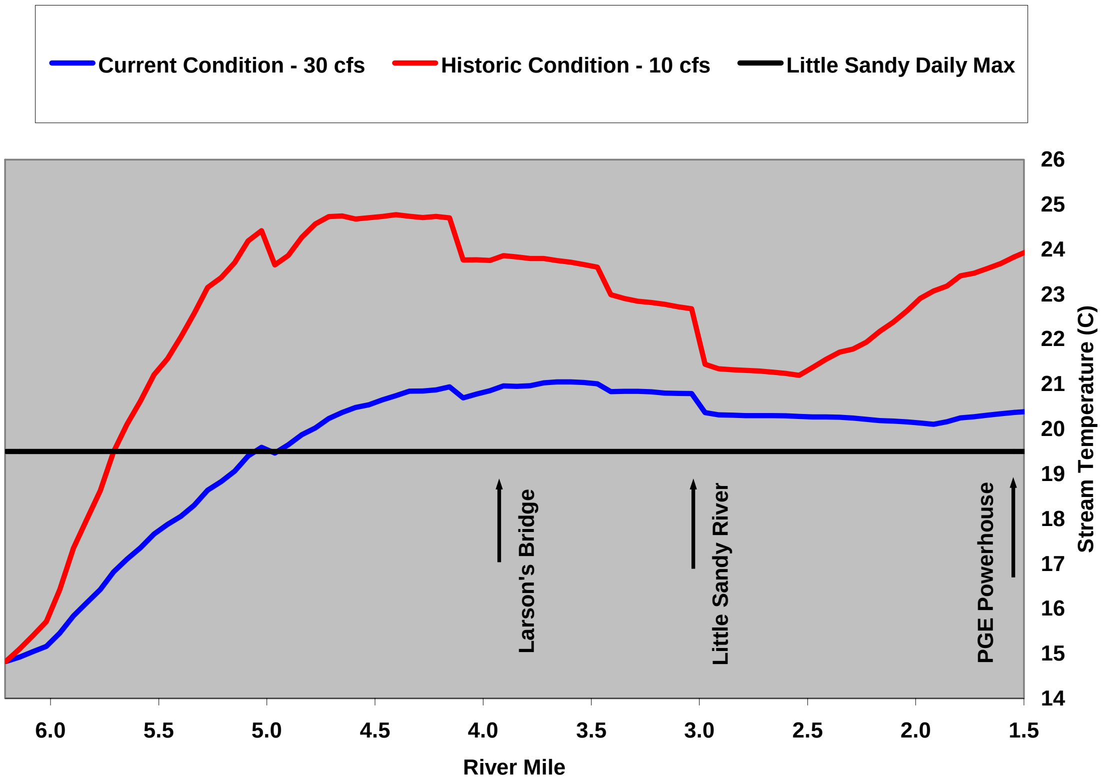
3.8.5 City of Portland Bull Run Facilities

The Bull Run watershed is the primary drinking water source for the Portland metropolitan area and currently provides water to over 800,000 people. The Bull Run supply consists of two storage reservoirs along with an outlet structure on Bull Run Lake, a natural water body that forms the headwaters of the Bull Run River. In 1909 the State Legislature enacted ORS 538.420, which granted the City of Portland exclusive rights (not affecting pre-1909 claims) to the waters of the Bull Run and Little Sandy Rivers for drinking water use. Approximately 26% of the average annual Bull Run discharge is impounded and transported to the Portland area for municipal consumption (WRD 1991).

Historically, the City of Portland released very little water into the lower Bull Run River during the late summer months. The reservoirs are typically “topped off” in late June, gradually draw down during the summer months, and begin to fill again around October when the winter storms arrive. Flow releases to the lower Bull Run River were typically kept to an absolute minimum in order to maximize the amount of available drinking water in the late summer, when demand is high and reservoir capacity is low (typically less than 5 cfs was released in August). Since 1998, however, the Bureau has released additional water from the Bull Run reservoirs into the lower Bull Run River to determine the effects on river temperatures and habitat quality. The City of Portland draws water from near the bottom of Reservoir #2. During summer months in recent years most of this water is diverted into the City’s drinking water distribution system, and a portion is released downstream into the lower Bull Run River. August releases between 1998 and 2003 have averaged slightly over 30 cfs. The supply of cool bottom water is exhausted later in the summer, typically by mid August, under current flow release conditions and the existing infrastructure. Once this supply of cool water is exhausted, outflow temperatures tend to rise above inflow temperatures.

Figure 3.32 shows predicted lower Bull Run River temperatures under two flow regimes on August 8, 2001. This analysis, using the Heat Source stream temperature model, is focused on a defined critical condition, the period of time when stream temperatures are warmest. Historic flow releases, assumed to be 10 cfs for modeling purposes, would have resulted in extremely high stream temperatures in the lower Bull Run (red line depicted in **Figure 3.32**). Current flow releases result in significantly cooler stream temperatures in the lower Bull Run, indicating an improving trend (blue line depicted in **Figure 3.32**).

Figure 3.32. Lower Bull Run Model Outputs – Daily Maximum Stream Temperatures

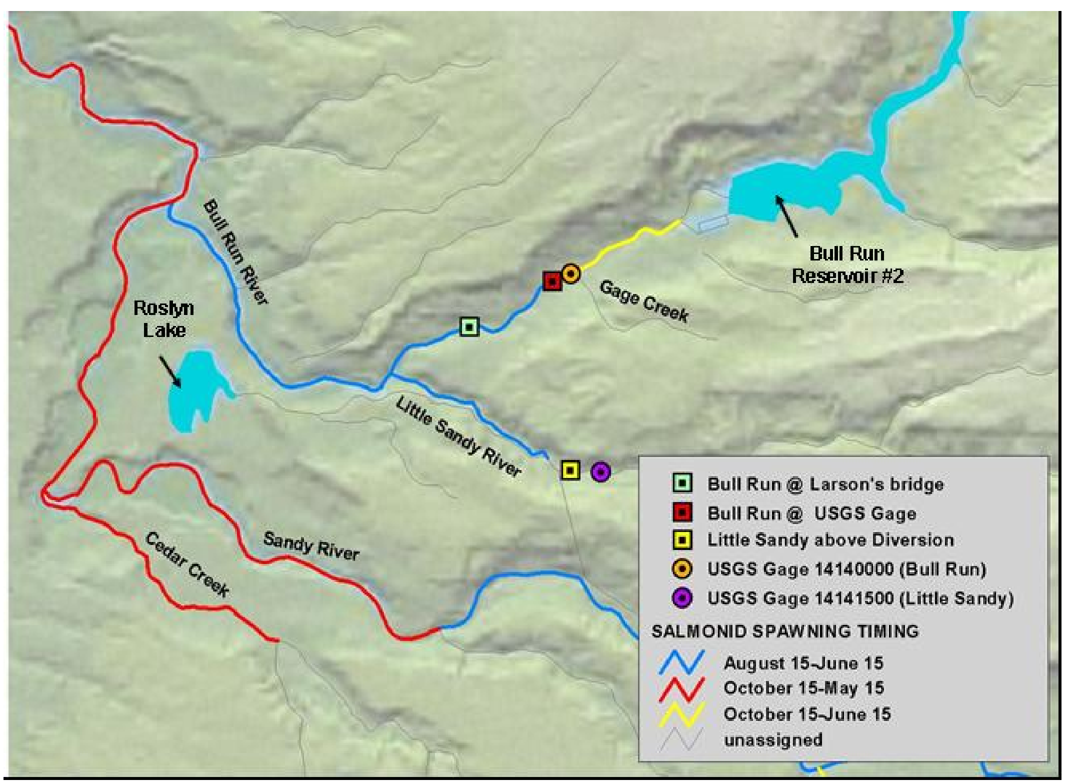


3.8.5.1 Bull Run and Oregon's Temperature Standard

The City of Portland generally releases cooler water from Bull Run Reservoir #2 (**Figure 3.33**) in early summer months and warmer water during late summer months when the supply of cold water is exhausted. Historically, reduced flow volume into the lower Bull Run also caused high stream temperatures. Exceedances of Oregon's numeric stream temperature criteria led to 303d listing and subsequent TMDL development. Chinook, Steelhead and Coho are present in the basin and in the lower Bull Run River. Spring Chinook may begin to spawn in the lower Bull Run River below Gage Creek as early as August 15th (**Figure 3.33**). Spawning surveys conducted from 1997 to 1999 found that actual spawning of Spring Chinook occurred from approximately September 20 to mid-October. While Spring Chinook spawn in the Bull Run River, it is not considered to be a major producer of the species. In fact, the ODFW Sandy Basin Fishery Plan proposes a split fishery where the lower Sandy, including the lower Bull Run would be mostly hatchery stock. Coho typically begin to spawn in October.

Recall that Oregon's stream temperature standard contains both numeric and narrative components. For example, the standard includes a numeric criterion of 16.0°C, which is designed to protect cold water fish species during the rearing phase of their life cycle in stream segments identified as "core habitat". The standard also contains a 13.0°C criterion, which is applied during the spawning phase of the salmonid life cycle. When one or more of the numeric criteria are exceeded, the standard provides a narrative portion describing conditions under which the numeric criteria may be superseded. Specifically, when numeric criteria are exceeded, OAR 340-041-0028(8) specifies that where the department determines that the natural thermal potential of all or a portion of a water body exceeds the numeric criteria, the natural thermal potential temperatures are deemed to be the applicable temperature criteria for that water body. In short, where ODEQ determines through the development of a TMDL that system potential, or "natural thermal potential" stream temperatures exceed the numeric criteria, the system potential thermal regime becomes the numeric criteria.

Figure 3.33. Lower Bull Run and Little Sandy Watersheds



3.8.6 City of Portland Load Allocation – Little Sandy Surrogate

The regulations governing TMDL development (40CFR 130.2(h)) allow for TMDLs to be expressed as mass per time, toxicity, or other appropriate measures. The traditional mass per time allocation is of limited value in guiding management activities needed to solve identified water quality problems associated with the City's operation of their Bull Run drinking water facilities.

The City of Portland Bureau of Water Works used the CE-QUAL-W2 water quality model to predict "natural condition" stream temperatures in the Lower Bull Run River. The model was developed by Portland State University (Annear, *et al* 1999). The Bull Run system was modeled to predict seasonal stream temperatures in the lower Bull Run River without the presence of the City's dams. A natural flow regime was approximated using USGS gage information. Stream channel characteristics through the reservoir reaches were estimated by reference to adjacent natural stream reaches and using reservoir bathymetry data. Since it is not possible to measure the stream channel characteristics through the reservoir reaches, two different scenarios were run to approximate the likely range of channel characteristics. Assuming a rather narrow channel, the City's model predicted a daily maximum stream temperature in the Lower Bull Run River of 19.3° C. Assuming a wider channel through the reservoir reaches resulted in a daily maximum temperature of 20.2° C. Using model output from City's "narrow channel" model, ODEQ's Heat Source model predicted a maximum daily temperature of 19.5° C, indicating agreement between the models.

The City of Portland model predicted that maximum stream temperatures would occur at Larson's Bridge (RM 3.8) in the lower Bull Run. The model extended downstream to the County Bridge (RM 1.6), just above the PGE Powerhouse where the combined Little Sandy/Sandy flows enter. ODEQ modeling of current conditions agreed with the City's model and measured data indicating that maximum stream temperatures typically occur at or near Larson's Bridge, again showing good agreement between the two models.

Oregon's Water Quality Standard for Temperature recognizes that natural surface water temperatures may at times exceed the numeric criteria due to natural conditions and allows numeric temperature criteria to be set to the natural surface water temperature. OAR 340-041-0028(8) provides a description of natural conditions:

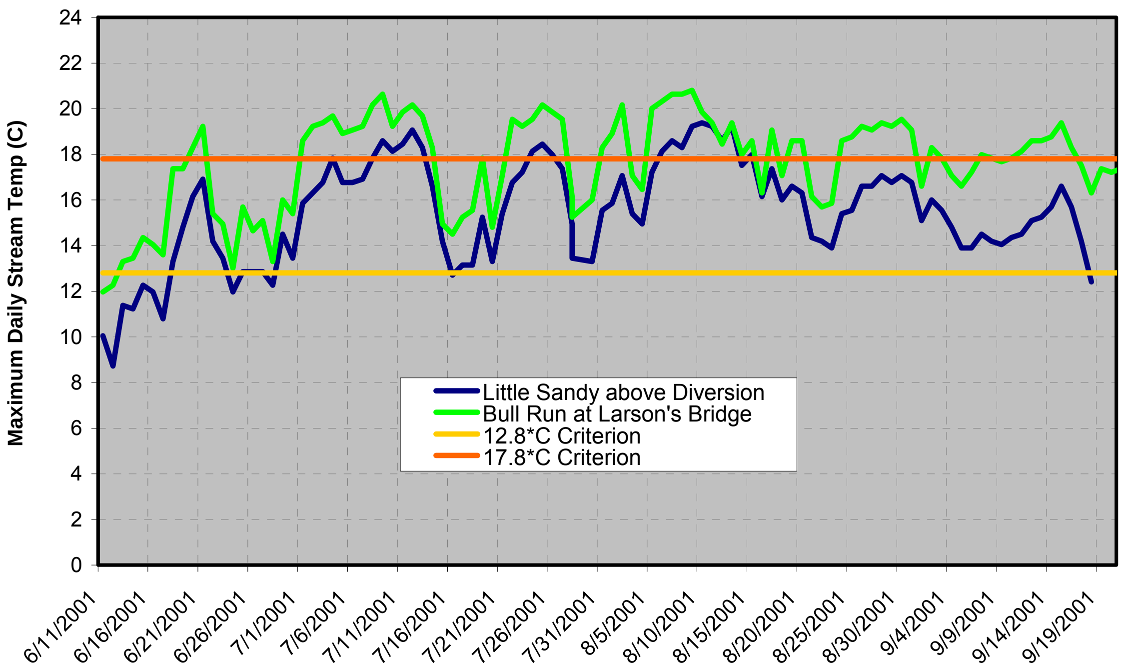
> *Where the department determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria in section (4) of this rule, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body.*

ODEQ sought to find a simple and accurate way to determine what stream temperature conditions would exist in the lower Bull Run River under natural conditions. ODEQ examined measured and modeled stream temperature information collected on the lower Little Sandy River, just above the diversion dam. The Heat Source model predicted that, under system potential vegetation conditions, the Little Sandy River daily maximum temperature would be 19.2° C, only a very slight decrease from the measured daily maximum value of 19.5° C. No data indicate that the Little Sandy River water temperature is impacted by water withdrawals, changes in channel morphology or other anthropogenic impacts. Therefore, the current temperature regime of the Little Sandy River, though occasionally in exceedance of the 16.0° C numeric criterion, is considered to achieve the natural thermal potential for the water body. It should be noted that the Little Sandy River is only appropriate as a surrogate as long as the temperature regime remains essentially free from anthropogenic sources of heating.

Since ODEQ and City of Portland modeling predicted that stream temperatures in the Lower Bull Run River would be approximately 19.5° C under system potential or "natural thermal potential" conditions, it is reasonable to assume that 19.5° C is a good estimate of system potential temperatures in the lower Bull

Run during the critical temperature period. In order to evaluate whether this relationship is valid on a seasonal scale, ODEQ examined temperature patterns observed at the Larson's Bridge and Little Sandy River above Diversion Dam monitoring locations during the summer of 2001. **Figure 3.34** shows that, on a seasonal scale, the two monitoring locations show remarkably similar responses in stream temperature.

Figure 3.34. Seasonal Temperature Profiles for Lower Little Sandy River and Bull Run River at Larson's Bridge



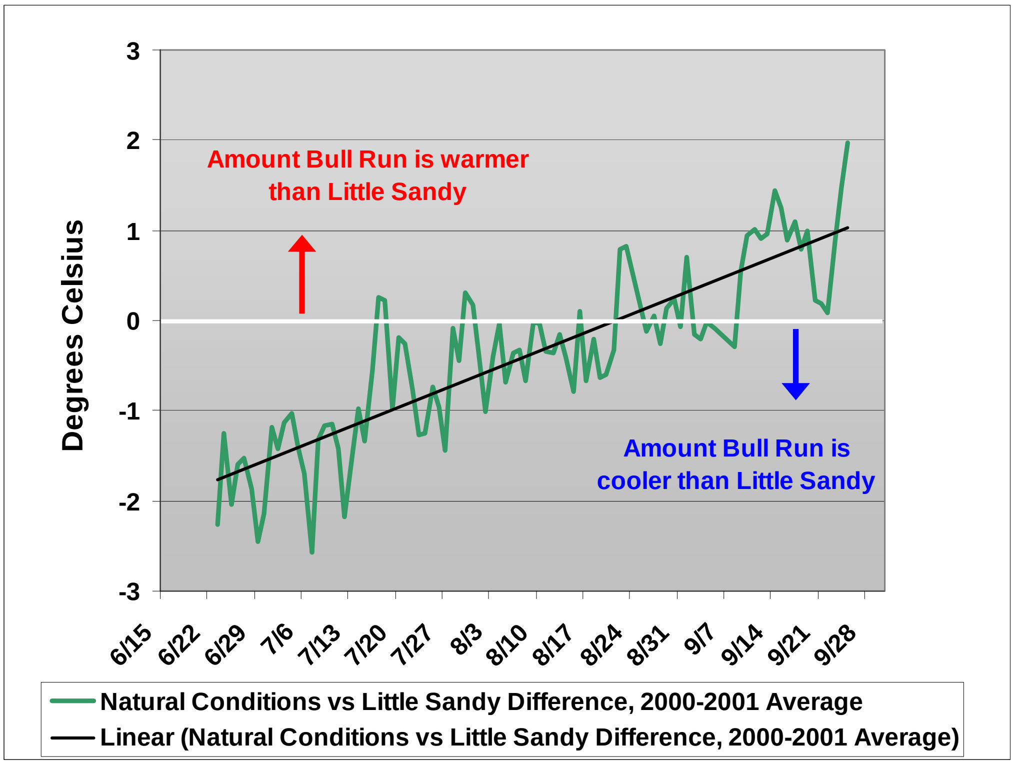
The Little Sandy River above the PGE diversion dam is much like the "natural" Bull Run River with respect to many factors that influence stream temperature. While the Little Sandy River is shorter than the Bull Run (15 versus 25 miles) and drains less acreage, they share similar watershed characteristics including a predominantly east-west orientation that exposes them to significant solar radiation during the day. The Little Sandy River drainage is, with the exception of the Little Sandy diversion dam at river mile 1.7 and some past logging activity in the upper watershed, undeveloped and absent the large reservoirs found in the Bull Run.

Given the consistency in modeling results and the overall similarities of the two basins, ODEQ believes that natural stream temperatures in the lower Bull Run River can best be approximated by simply observing the stream temperature of the lower Little Sandy River. More specifically, the 7-day average of the daily maximum stream temperatures measured at a monitoring location just above the Little Sandy Diversion Dam will be used as a basis for establishing stream temperature targets for the lower Bull Run River at Larson's Bridge.

However, there are two exceptions to this condition:

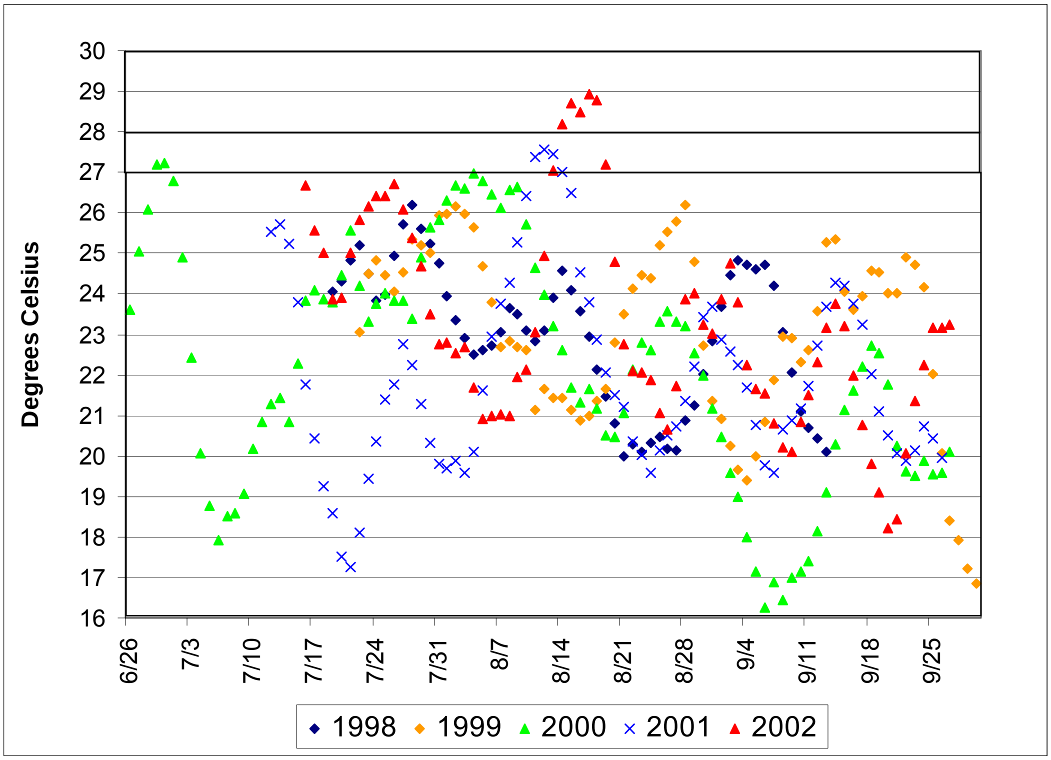
1). Recall that the temperature model used by the City of Portland is capable of simulating conditions for extended periods of time, on the scale of months and even years, whereas the ODEQ Heat Source model was used to evaluate stream temperature conditions in the Bull Run River on a single day, August 8, 2001, the critical temperature period. As described above, the two models produced very similar results when simulating conditions on August 8, 2001. However, the City's modeling results predict that the Little Sandy and Lower Bull Run stream temperatures would differ predictably through the summer season. The City's CE-QUAL-W2 model was used to predict stream temperatures in the lower Bull Run under natural conditions (no dams) during the summers of 2000 and 2001 and the results were compared with measured stream temperatures collected on the Little Sandy River above the PGE Diversion Dam during the same time period. As described graphically in **Figure 3.35**, the model predicted that natural stream temperatures in the lower Bull Run River would tend to be cooler than the Little Sandy during the early summer and warmer than the Little Sandy during late summer months. Note that the model output during time period when the Heat Source and CE-QUAL-W2 models were compared (August 8) showed a difference of near zero. Given this consistency, ODEQ chose to incorporate the trend into the temperature target (allocation) for the City of Portland by allowing a 1°C departure above measured Little Sandy stream temperatures between August 16th and October 15th. The City will collect additional data to assess the difference between the natural stream temperatures of the lower Bull Run and Little Sandy surrogate during October. ODEQ will evaluate this data to assess the need for future revisions to the TMDL.

Figure 3.35. Temperature Differences between Modeled Natural Conditions at Larson's Bridge and Measured Temperature at Little Sandy above the PGE Diversion Dam



2.) The City's modeling results also predict that the lower Bull Run River (under "natural" conditions) would get slightly warmer than the Little Sandy River during extremely warm atmospheric conditions. The City identified thresholds of 27 and 28° C, above which a difference in stream temperatures between the lower Bull Run and Little Sandy Rivers was predicted. Based upon a review of their data and modeling results, ODEQ concurs that this phenomena exists and should be accounted for when determining the temperature target (and allocation) for the lower Bull Run River. This condition occurs infrequently, with the 27° C threshold being reached on 8 days and the 28° C threshold being reached on 5 days between 1998 and 2002 at the USGS gage #1414000 monitoring location (**Figure 3.36**). If the 7-day moving average of the daily maximum ambient air temperature, as measured at the lower Bull Run USGS gage #1414000, is above 27°C the lower Bull Run stream temperature target will be the lower Little Sandy River stream temperature plus 1°C . If the 7-day moving average of the daily maximum ambient air temperature is above 28°C the lower Bull Run stream temperature target will be the lower Little Sandy River stream temperature plus 1.5°C.

Figure 3.36. 7-day Average of the Daily Maximum Air Temperature Measured at USGS Gage #1414000 – 1998-2002



In summary, the TMDL allocation for the City of Portland uses the Little Sandy River temperature as a surrogate and calls for stream temperature, as measured at Larson's Bridge, to attain the appropriate numeric criteria when the Little Sandy River temperature is below the criteria and be at or below the Little Sandy River temperature when temperatures are above the numeric criteria. Allowances will be made, as described above, for a 1°C departure above the Little Sandy between August 16th and October 15th and a 1° to 1.5°C difference during extremely warm atmospheric conditions. For example, if measured Little Sandy River temperatures are 15°C in July, the City's allocation require that the temperature in the Bull Run River at Larson's Bridge be at or below 16°C, and when Little Sandy River temperature exceeds 16°C the City's allocation requires that the Bull Run River temperature be at or below the measured Little Sandy River temperature. Consistent with Oregon's temperature standard language, targeted temperatures are expressed as the 7-day moving average of the daily maximum temperature (7-day statistic).

The City of Portland Water Bureau is currently developing a Habitat Conservation Plan (HCP) for the Bull Run water supply system in order to document compliance with the Endangered Species Act. The HCP will describe measures that the City will take to protect listed fish species and will also address the stream temperature target described above. The City's HCP is expected to include instream flow commitments, temperature control measures, and habitat improvement and protection measures. It will likely function as the City's Temperature Management Plan. The City has provided ODEQ with a detailed description of their temperature modeling efforts to date and an outline of their proposal for compliance with this TMDL (Portland Water Bureau 2004).

3.9 SUMMARY OF LOAD AND WASTE LOAD ALLOCATIONS – 40 CFR 130.2(G) AND 40 CFR 130.2(H)

As described in **Section 3.8.1**, ODEQ assigned 0.05°C of the 0.3°C "human use allowance" to nonpoint source load allocations, 0.05°C for reserve capacity and 0.2°C for point source allocations. The PGE Hydropower facility has been given a flow-based allocation, based on an allowable increase of 0.075°C over site potential temperatures. The City of Portland has been given a surrogate allocation that targets natural stream temperature. It has been determined that the temperature increase allowed by these later two sources will not significantly impact the instream temperature in the area of any of the point source dischargers and thus the cumulative effect of this distribution will never exceed the 0.3°C increased allowed for through the Human Use Allowance. This allocation strategy is summarized in **Table 3.11**.

Table 3.11. Allocation of the Human Use Allowance

Source	Human Use Allowance
Reserve Capacity	0.05°C
Nonpoint Source and Background	0.05°C
NPDES Point Source	0.075°C allowing 25% of 7Q10 low flow for mix, up to a maximum of 0.2°C with full mix
Dams – PGE Provisional	0.075°C

Load allocations are portions of the loading capacity divided between natural, human and future nonpoint pollutant sources. A *waste load allocation* (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria. **Table 3.12** lists specific allocations for nonpoint sources and for each point source.

Table 3.12 Point Source Waste Load and Load Allocations

Subtable A: NPDES Point Source Waste Load Allocations

Facility Name	Receiving Water	Maximum Effluent Temperature (F)/(C)	Waste Load Allocation Allowable Point Source Heat Load kcal/day
Government Camp STP	Camp Cr.	69.4 / 20.8	2.91×10^6
Hoodland STP	Sandy R.	80.5 / 27.0	29.9×10^6
Troutdale STP	Sandy R.	77.7 / 25.4	61.1×10^6
Mount Hood Community College	Kelly Cr.	65.3 / 18.5	0.55×10^6
Legacy Mount Hood Medical Center	Kelly Cr.	81.1 / 27.3	0.23×10^6
ODFW Sandy River Hatchery	Cedar Cr.	no more than a 0.2°C increase	4.90×10^6
		Total	**99.6×10^6**

Subtable B: Nonpoint Sources

Source	Load Allocation Allowable Nonpoint Source Solar Radiation Heat Load kcal/day
Background	**64.45×10^8**
Nonpoint Sources	**0.05°C (not specifically allocated)**

Subtable C: Other Load Allocations

Facility Name	Load Allocation kcal/day	Flow (cfs)
Portland General Electric Bull Run Hydroelectric Project	44.2×10^6	241
	61.5×10^6	335
	78.6×10^6	428
	102.8×10^6	560
	134.0×10^6	730
	169.8×10^6	925
	212.9×10^6	1160
	268.0×10^6	1460
	345.1×10^6	1880
	473.6×10^6	2580
	1140.0×10^6	6210
City of Portland Bull Run Facilities	Allocation is a surrogate measure that targets Little Sandy River temperatures. Allocation is the biologically-based numeric criteria when the Little Sandy River temperature is below the criteria and at the Little Sandy River 7-day average of the daily maximum temperature (plus appropriate ambient air and seasonal temperature correction factors when applicable) when temperatures are above the numeric criteria.	

3.10 EXCESS LOAD

The excess load is the difference between the actual pollutant load and the loading capacity of a water body. Load allocations for nonpoint sources are based on system potential vegetation. As described above in **Table 3.8,** the Sandy Basin streams analyzed for this TMDL effort showed an excess load of 4.05×10^8 kilocalories per day. This amounts to a 5.9% increase above system potential shade conditions. In other words, the excess solar radiation loading due to anthropogenic impacts on shade increases solar radiation loading by 5.9%. Nonpoint source loading must decrease by 5.9% and point sources must meet the waste load allocations provided in **Table 3.12** in order to achieve the TMDL.

As discussed in **Section 3.8.2**, point source waste load allocations were established to assure that the allowable heat load will not exceed the loading capacity of the receiving water body (**Table 3.12**).

3.11 SURROGATE MEASURES – 40 CFR 130.2(I)

The Sandy River Basin Temperature TMDL incorporates measures other than "*daily loads*" to fulfill requirements of §303(d). Although a loading capacity for heat energy is derived [e.g. kilocalories per day], it is of limited value in guiding management activities needed to solve identified water quality problems. In addition to heat energy loads, this TMDL allocates "*other appropriate measures*" (or surrogates measures) as provided under EPA regulations [40 CFR 130.2(i)].

Water temperature warms as a result of increased solar radiation loads. A loading capacity for radiant heat energy (i.e., incoming solar radiation) can be used to define a reduction target that forms the basis for identifying a surrogate. The specific surrogate used is percent effective shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The solar radiation loading capacity is translated directly (linearly) by effective solar loading. The definition of effective shade allows direct measurement of the solar radiation loading capacity.

Because factors that affect water temperature are interrelated, the surrogate measure (percent effective shade) relies on restoring or protecting riparian vegetation to increase stream surface shade levels, reducing stream bank erosion, stabilizing channels, reducing the near-stream disturbance zone width and reducing the surface area of the stream exposed to radiant processes. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Brown 1969, Beschta et al. 1987, Holaday 1992, Li et al. 1994).

Over the years, the term shade has been used in several contexts, including its components such as shade angle or shade density. For purposes of this TMDL, shade is defined as the percent reduction of potential solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities.

3.11.1 Site Specific Effective Shade Surrogate Measures

As mentioned above, a loading capacity of heat per day is not very useful in guiding nonpoint source management practices. Percent effective shade is a surrogate measure that can be calculated directly from the loading capacity. Additionally, percent effective shade is simple to quantify in the field or through mathematical calculations. **Figures 3.37** to **3.41** display the percent effective shade values that correspond to the loading capacities throughout the Sandy River Basin (i.e., system potential).

Site specific effective shade surrogates are developed to help translate the nonpoint source solar radiation heat loading allocations. Attainment of the effective shade surrogate measures is equivalent to attainment of the nonpoint source load allocations.

Figure 3.37. Sandy River Effective Shade Surrogate Measure for Nonpoint Sources

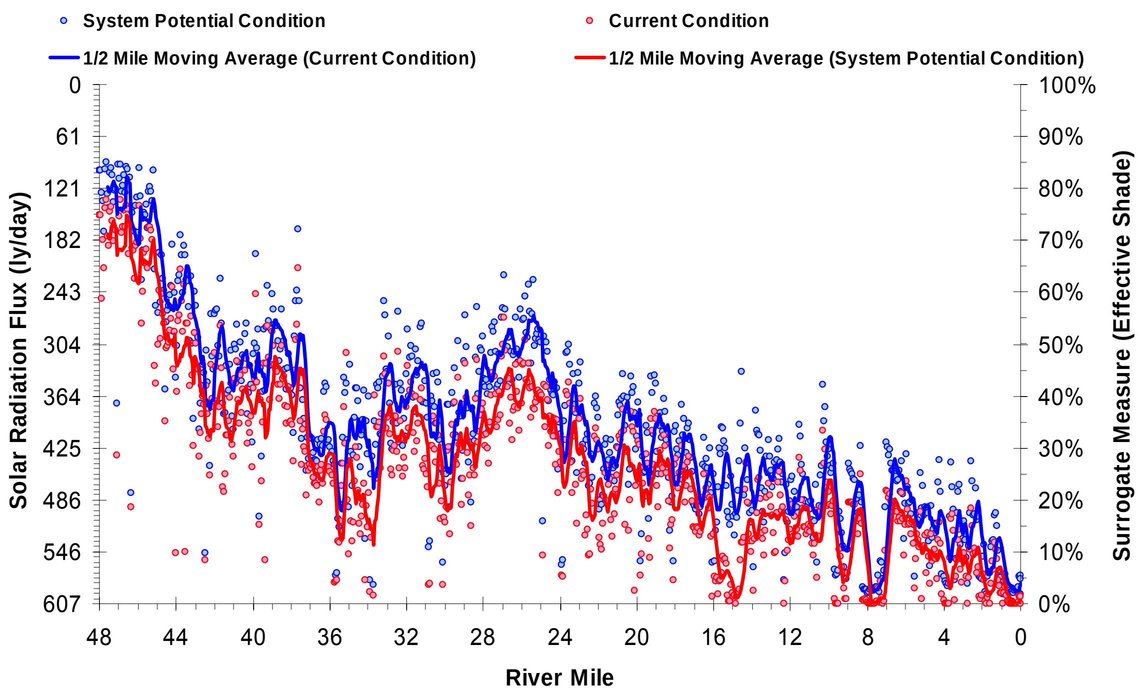


Figure 3.38. Lower Bull Run Effective Shade Surrogate Measure for Nonpoint Sources

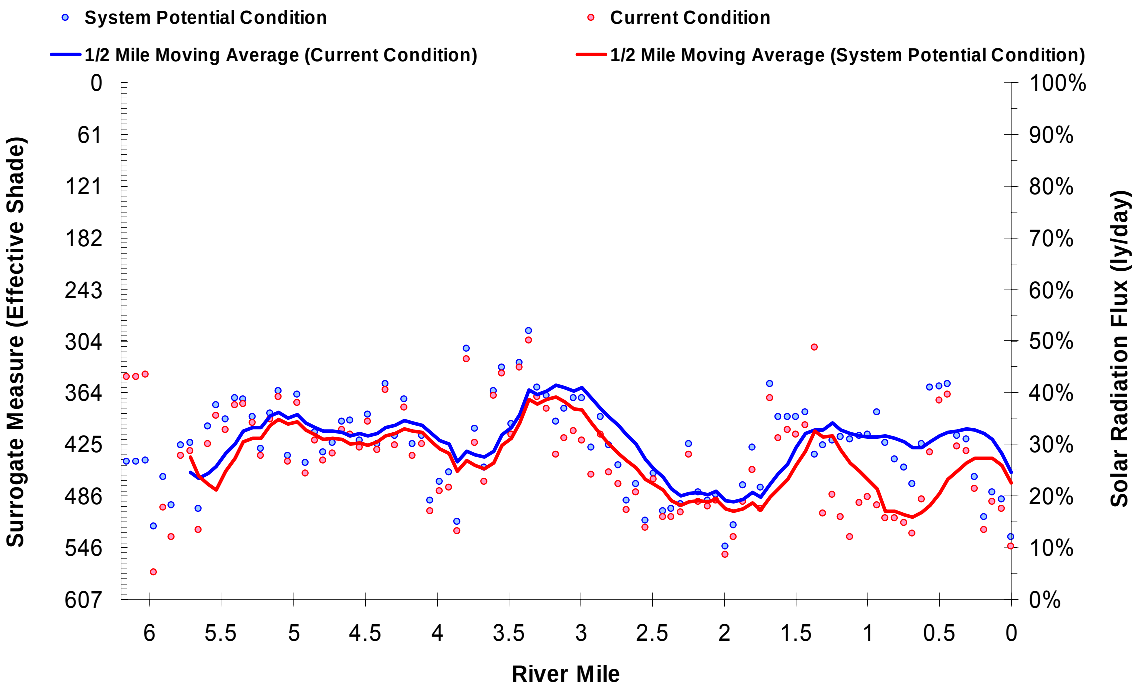


Figure 3.39. Little Sandy River Effective Shade Surrogate Measure for Nonpoint Sources

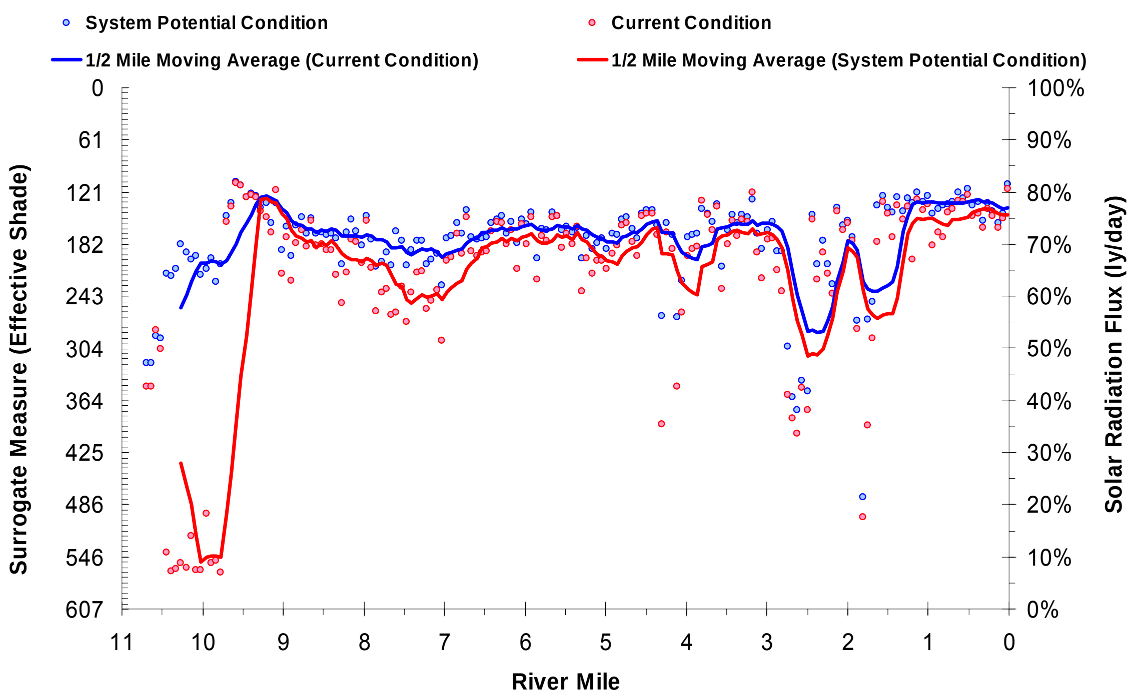


Figure 3.40. Salmon River Effective Shade Surrogate Measure for Nonpoint Sources

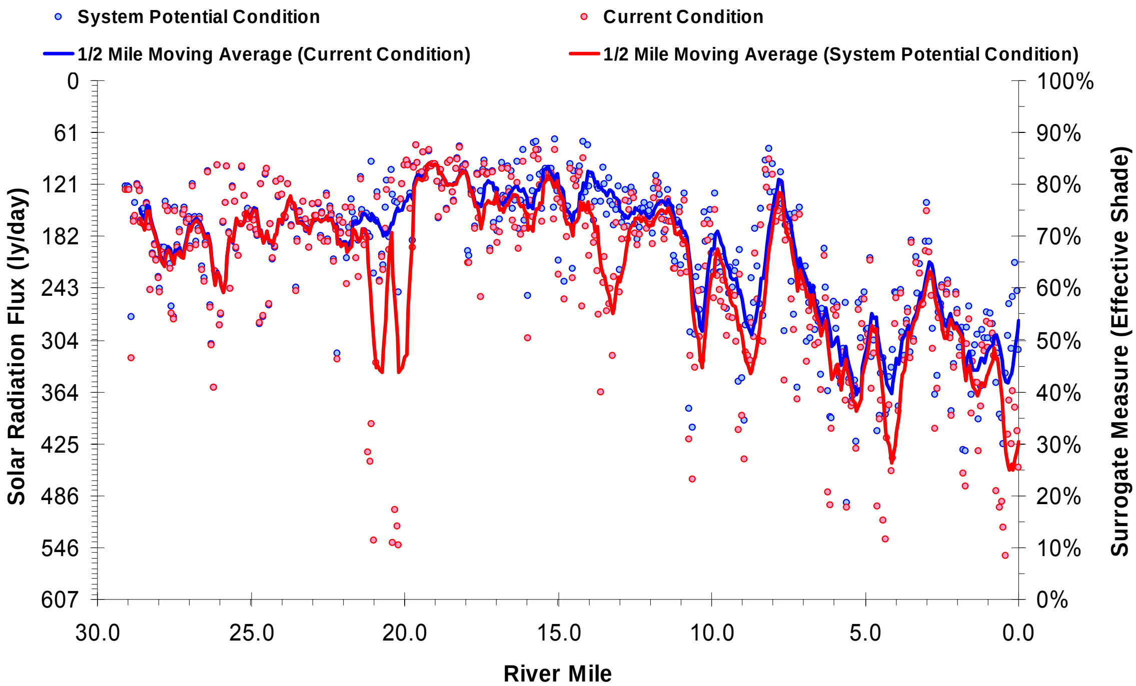
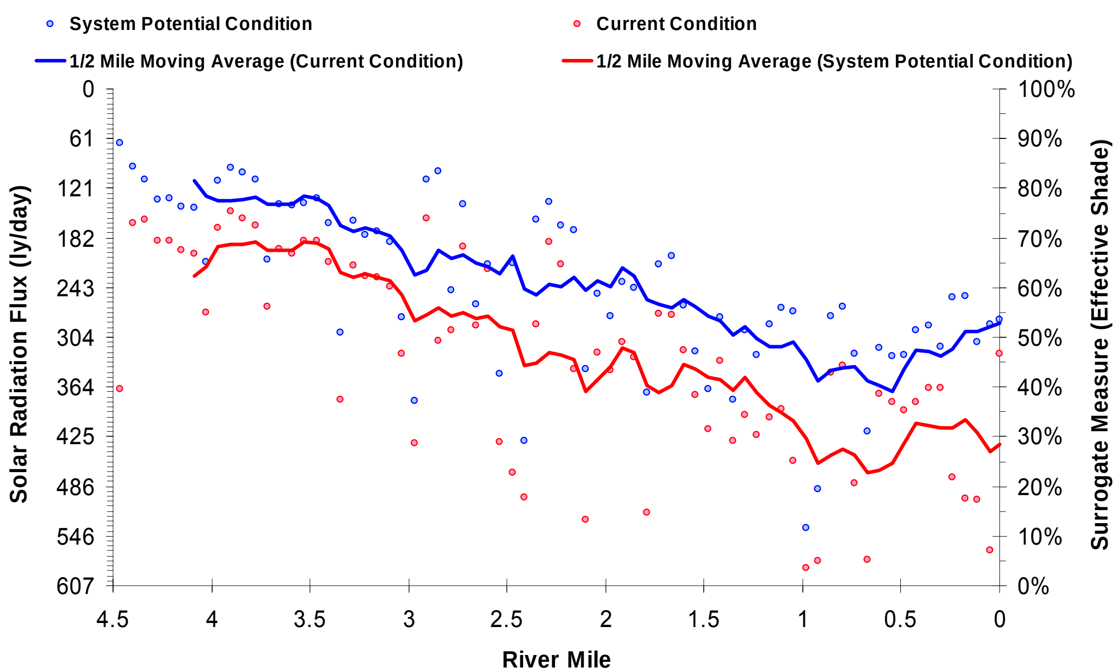


Figure 3.41. Zigzag River Effective Shade Surrogate Measure for Nonpoint Sources



ODEQ attempted to identify specific areas in the Sandy River Basin where improvements in riparian vegetation would have a significant impact on stream shading conditions. An increase in effective shade of 8% on the mainstem Sandy River and 15% on modeled tributary reaches was considered significant for the purposes of this analysis. This analysis is limited to those stream segments that were modeled using Heat Source (**Figure 3.42**). Because many riparian areas in the Sandy River Basin contain mature vegetation, relatively few areas were identified as potentially providing shade benefit. It should be noted that the areas identified as benefiting from increased riparian shading were delineated based upon remotely sensed data, have not been "ground truthed", and may or may not be appropriate for riparian planting. This analysis is intended as a guide. A detailed list of stream segments is provided in **Table 3.13**.

Figure 3.42. Streams Evaluated for Riparian Condition and Areas of Measureable Shade Benefit.

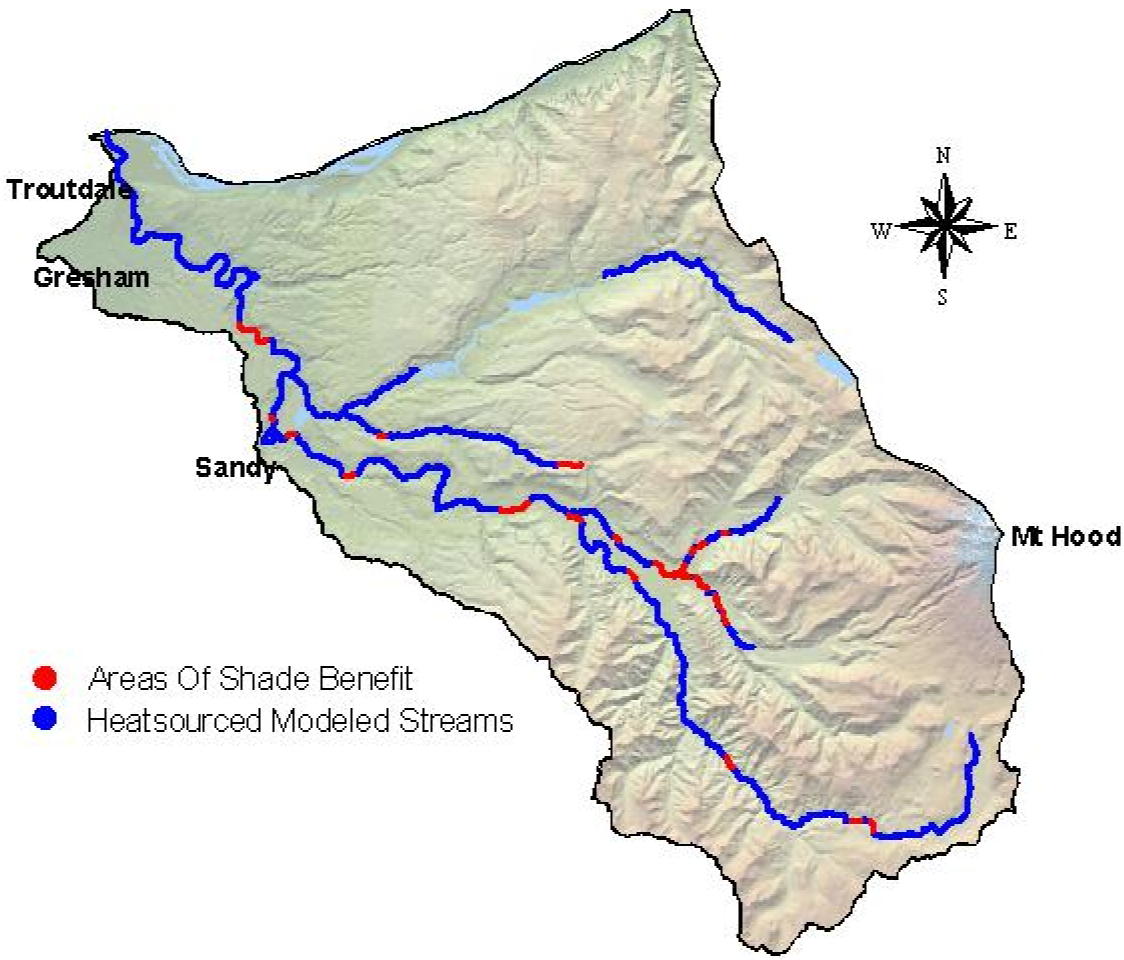
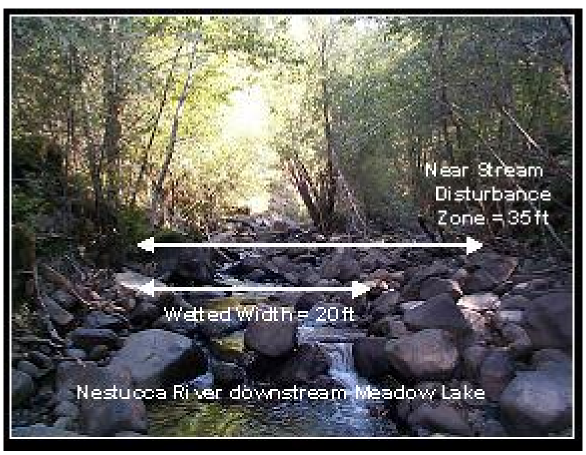


Table 3.13. Stream Reaches Identified as Benefiting from Increased Riparian Shade

	Sandy Mainstem	Little Sandy	Salmon	Zigzag
Stream Segment (River mile)	14.79-16.16	1.80-1.93	0.00-0.55	0.04-0.36
	20.38-20.51	9.76-10.56	4.15-4.45	0.72-0.85
	22.74-22.99		13.3-13.71	1.04-1.29
	25.66-25.97		20.17-20.49	1.78-1.91
	34.24-35.36		20.98-21.29	2.10-2.21
	39.64-39.77			2.46-2.59
	41.69-42.25			2.84-2.95
	43.81-43.93			
	44.30-44.43			
	45.36-45.48			
	48.16-48.28			

3.11.2 Effective Shade Curves

Where effective shade levels are not specified in **Figures 3.37** to **3.41**, effective shade for the appropriate vegetation zone (described in **Section 3.6.2**) and near stream disturbance zone width are provide in **Figures 3.43** to **3.46**. Percent effective shade is perhaps the most straightforward stream parameter to monitor/calculate and is easily translated into quantifiable water quality management and recovery objectives.



Effective shade curves represent general relationships between system potential effective shade and near stream disturbance zone (NSDZ). The curves can be applied to determine effective shade allocations. They are developed using trigonometric equations estimating the shade underneath tree canopies. The NSDZ is the distance from the edge of right bank vegetation to the edge of left bank vegetation. The particular curve that applies to a given reach depends on the expected system potential vegetation for the reach and its expected height, density, and channel overhang at maturity.

Effective shade curves can be applied to streams in the Sandy River Basin that were not modeled using Heat Source, but which a shade target is desirable. After applicable curves are developed for each system potential vegetation type, this method is easy to apply to streams with correlative characteristics. While the method provides no information on existing shade conditions or the expected system potential stream temperature, it does provide quick and accurate estimates of the allocations necessary to eliminate temperature increases resulting from anthropogenic impacts on shade.

Figure 3.43. Effective Shade Curve – Willamette Valley Potential Vegetation Zone

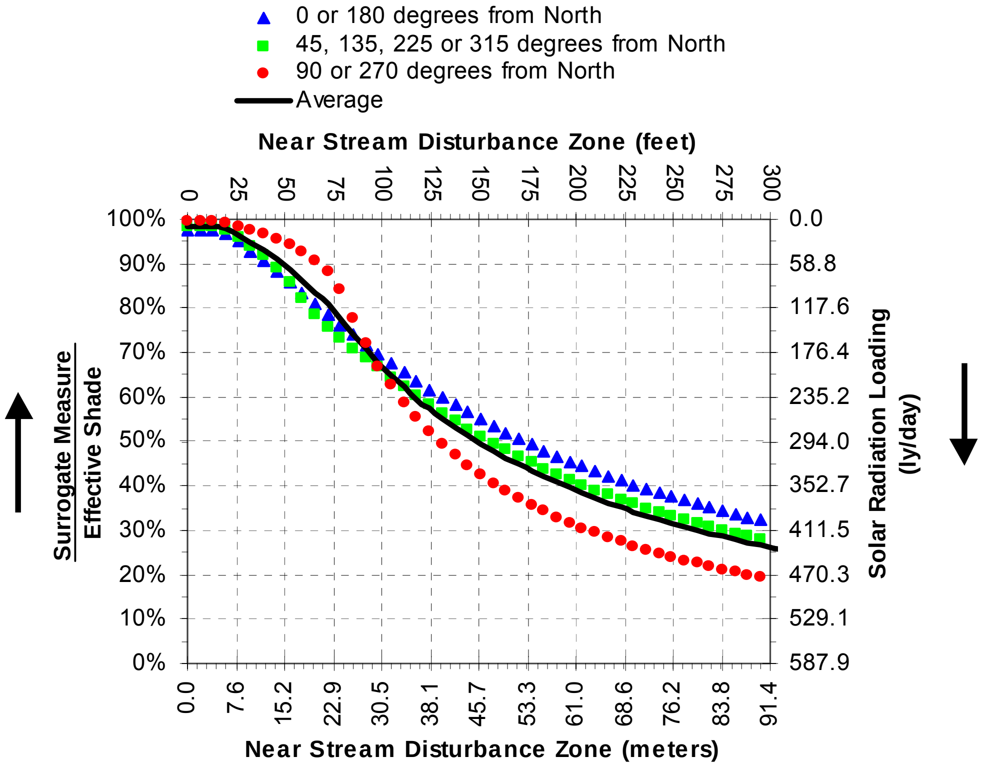


Figure 3.44. Effective Shade Curve – Western Hemlock Potential Vegetation Zone

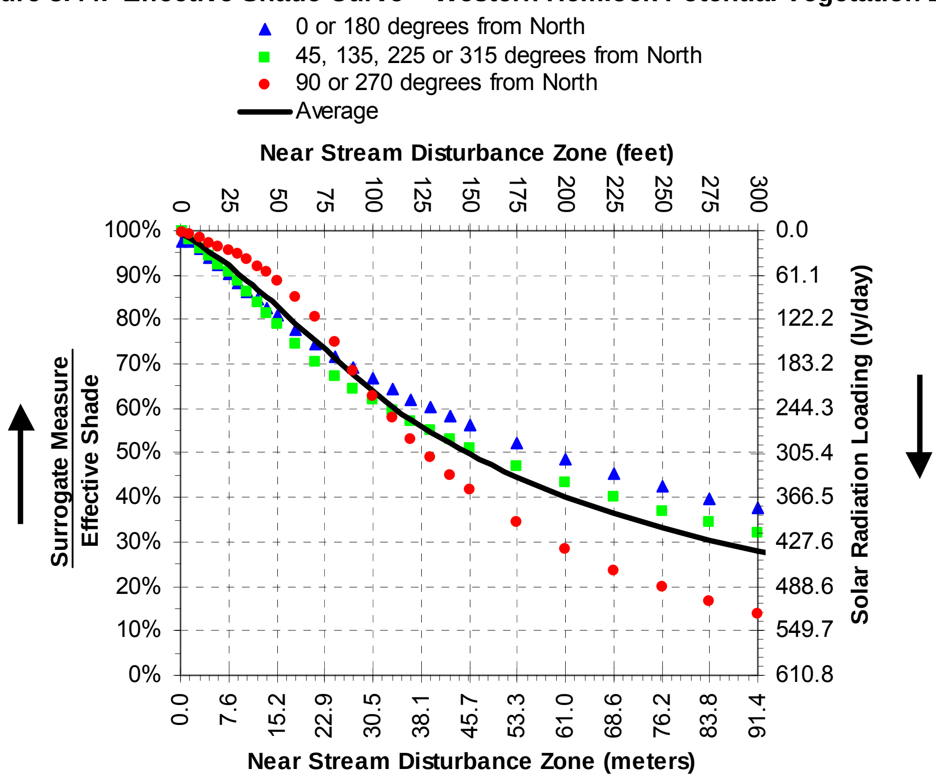


Figure 3.45. Effective Shade Curve – Pacific Silver Fir Potential Vegetation Zone

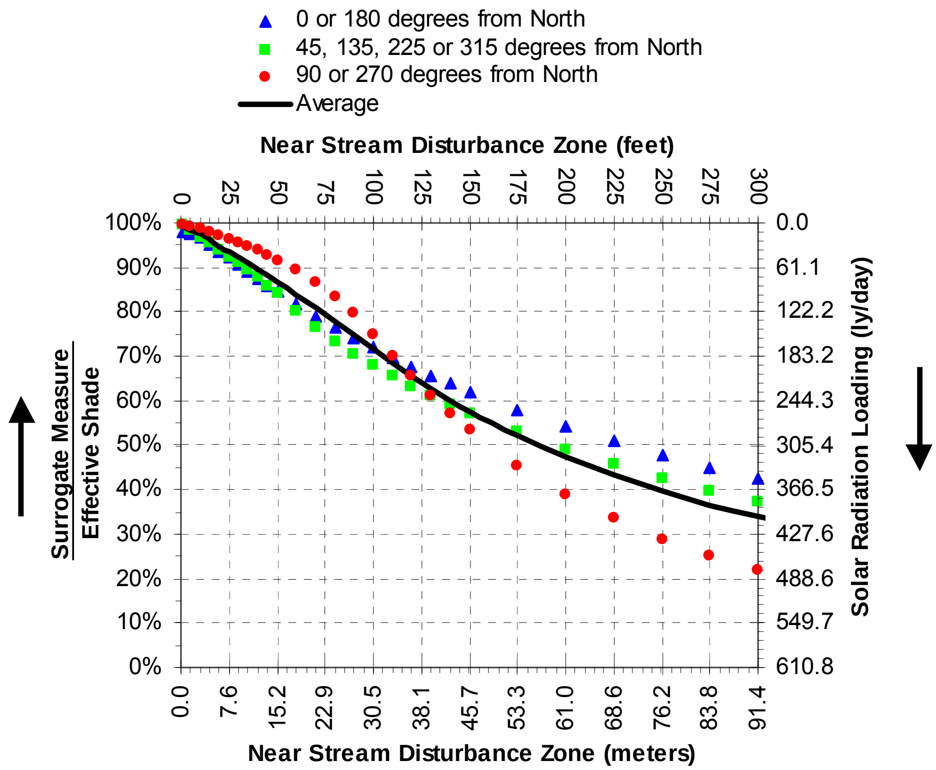
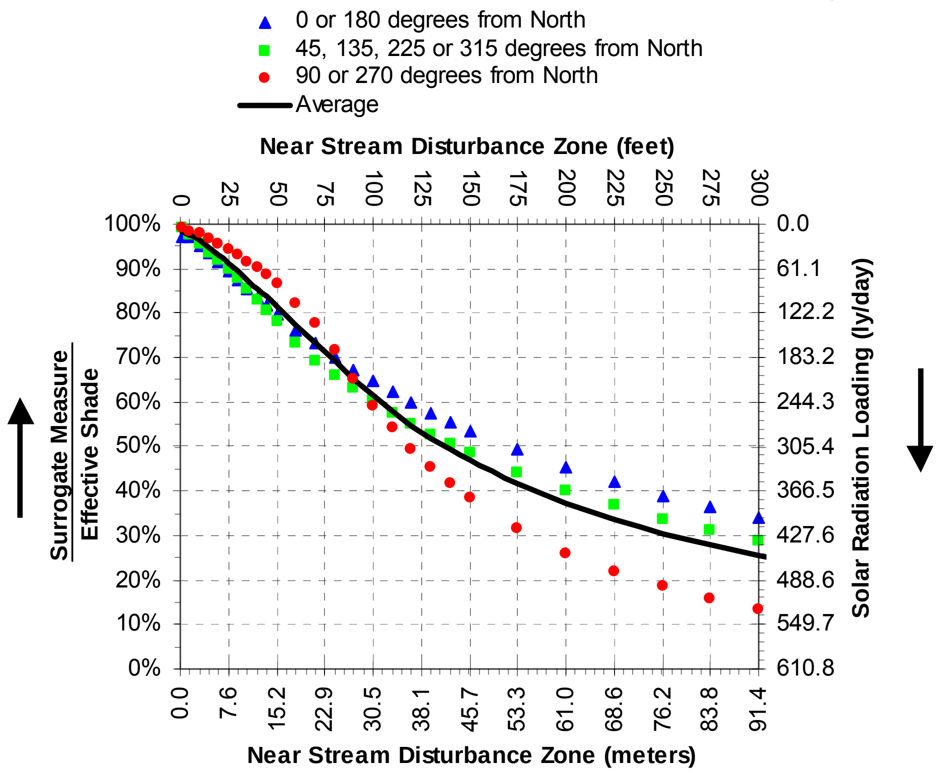


Figure 3.46. Effective Shade Curve – Mountain Hemlock Potential Vegetation Zone



3.12 MARGIN OF SAFETY AND RESERVE CAPACITY – CWA §303(D)(1)

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a MOS 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 MOS 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).

The MOS may be implicit, as in conservative assumptions used in calculating the loading capacity, waste load allocations, and load allocations. The MOS may also be explicitly stated as an added, separate quantity in the TMDL calculation. In any case, assumptions should be stated and the basis behind the MOS documented. The MOS is not meant to compensate for a failure to consider known sources. **Table 3.16** presents six approaches for incorporating a MOS into TMDLs.

The following factors may be considered in evaluating and deriving an appropriate MOS:

- ✓ *The analysis and techniques used in evaluating the components of the TMDL process and deriving an allocation scheme.*
- ✓ *Characterization and estimates of source loading (e.g., confidence regarding data limitation, analysis limitation or assumptions).*
- ✓ *Analysis of relationships between the source loading and instream impact.*
- ✓ *Prediction of response of receiving waters under various allocation scenarios (e.g., the predictive capability of the analysis, simplifications in the selected techniques).*
- ✓ *The implications of the MOS on the overall load reductions identified in terms of reduction feasibility and implementation time frames.*

A TMDL and associated MOS, which results in an overall allocation, represent the best estimate of how standards can be achieved. The selection of the MOS should clarify the implications for monitoring and implementation planning in refining the estimate if necessary (adaptive management). The TMDL process accommodates the ability to track and ultimately refine assumptions within the TMDL implementation-planning component.

Table 3.14. Approaches for Incorporating a Margin of Safety into a TMDL

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

Implicit Margins of Safety

Description of the MOS for the Sandy River Basin TMDL nonpoint source load allocations begins with a statement of assumptions. A MOS has been incorporated into the temperature assessment methodology. Conservative estimates for groundwater inflow and wind speed were used in the stream temperature simulations. Specifically, unless measured, groundwater inflow was assumed to be zero. In addition, wind speed was also assumed to be at the lower end of recorded levels for the day of sampling. Recall that groundwater directly cools stream temperatures via mass transfer/mixing. Wind speed is a controlling factor for evaporation, a cooling heat energy process. Further, cooler microclimates and channel morphology changes associated with late seral conifer riparian zones were not accounted for in the simulation methodology.

Reserve Capacity

ODEQ held 0.05°C of the 0.3°C Human Use Allowance to provide a reserve capacity for the Sandy River basin. Nonpoint sources of heat are limited to natural solar radiation levels, and point sources must ensure that cumulative increases in stream temperature resulting from permitted discharges will be no more than 0.2°C (0.54°F) at the point of maximum impact.

3.12 WATER QUALITY STANDARD ATTAINMENT ANALYSIS – CWA §303(D)(1)

Simulations were performed to calculate the temperatures that result with system potential condition riparian vegetation conditions. Since no other anthropogenic sources of heating were observed in the basin (flow, channel morphology, etc.), the resulting simulated temperatures represent attainment of the "natural conditions criteria" in the temperature standard (OAR 340-041-0028(8).

A total of 114 river miles in the Sandy River Basin were simulated during the critical period (August 8 and 9, 2001). **Figures 3.48-3.52** show the range of daily average and maximum temperatures under current and allocated conditions. Automated near stream vegetation sampling and TIR was completed for 141.3 rivermiles in the Sandy River basin including the mainstem Sandy River (55.2 miles), Salmon River (33.9 miles), South Fork Salmon River (7.3 miles), Zigzag River (13.7 miles), Lower Bull Run River (6.2 miles), Upper Bull Run River (9.3 miles)and Little Sandy River (15.7 miles). Heat Source modeling was completed for all stream reaches except the Upper Bull Run and South Fork Salmon Rivers. **Figure 3.47** compares the current maximum daily temperatures with those that result with the system at allocated conditions.

Generally speaking, only the mainstem Sandy River showed a significant shift toward cooler temperatures under system potential (allocated) conditions. A shift from the 70-75 ^{o}F toward the 60-65 ^{o}F range is seen in **Figure 3.47**. This is likely due to the fact that riparian conditions throughout much of the upper basin are good. Field observations by ODEQ staff indicate that tributaries in the lower watershed, Beaver and Kelly Creeks specifically, suffer from poor riparian and channel conditions and extremely high summertime temperatures. However, their flows represent a small fraction of the Sandy River flow in the lower basin. Therefore, they have little or no impact on mainstem Sandy River temperature.

An overriding emphasis of the temperature TMDL is the focus on spatial distributions of stream temperatures in the Sandy River Basin. Comparisons of stream temperature distributions capture the variability that naturally exists in stream thermodynamics. Spatial variability is observed in all of the stream segments sampled and analyzed. With the advent of new sampling technologies and analytical tools that include landscape scaled data and computational methodologies, an improved understanding of stream temperature dynamics is emerging (Boyd, 1996, Faux et al. (in review), Torgersen et al., 1999, Torgersen et al., 2001, ODEQ 2000a, ODEQ 2001a, ODEQ 2001b, ODEQ 2001c). This understanding accommodates spatial and temporal variability that includes departures from biologically derived temperature threshold conditions.

Figure 3.47. Distributions of Daily Average and Maximum Temperatures for Current Conditions and the Allocated Condition Sandy Basin Streams Modeled (August 8-9, 2001)

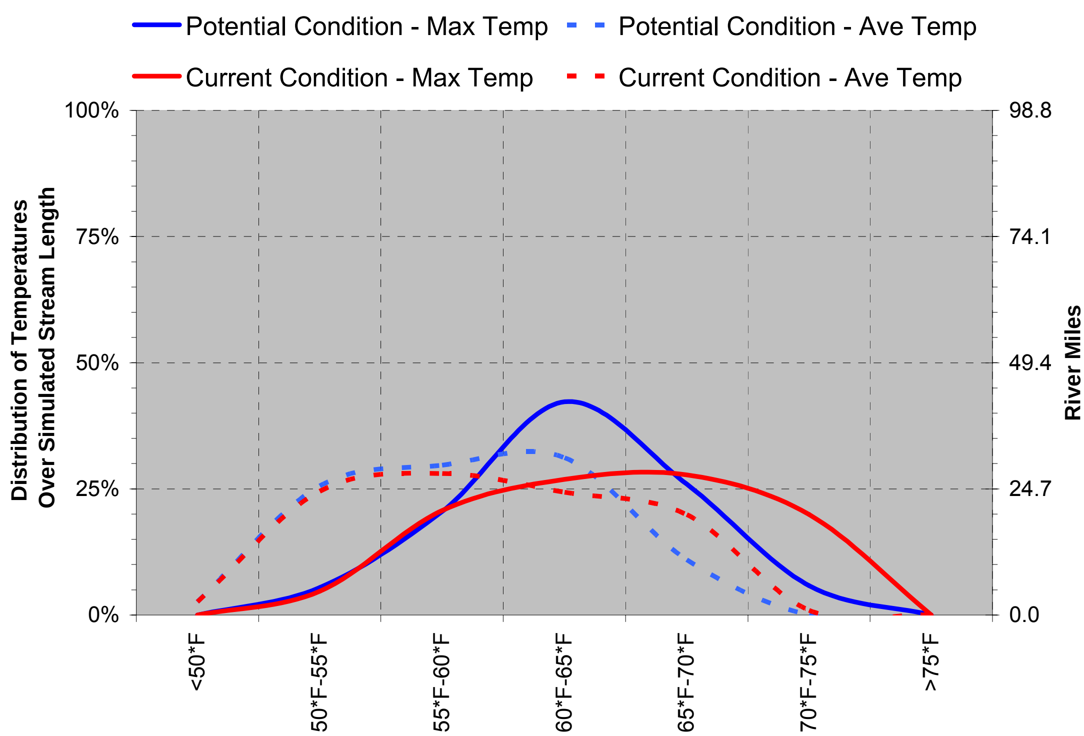


Figure 3.48. Sandy River Temperatures – Current Condition and Allocated Condition

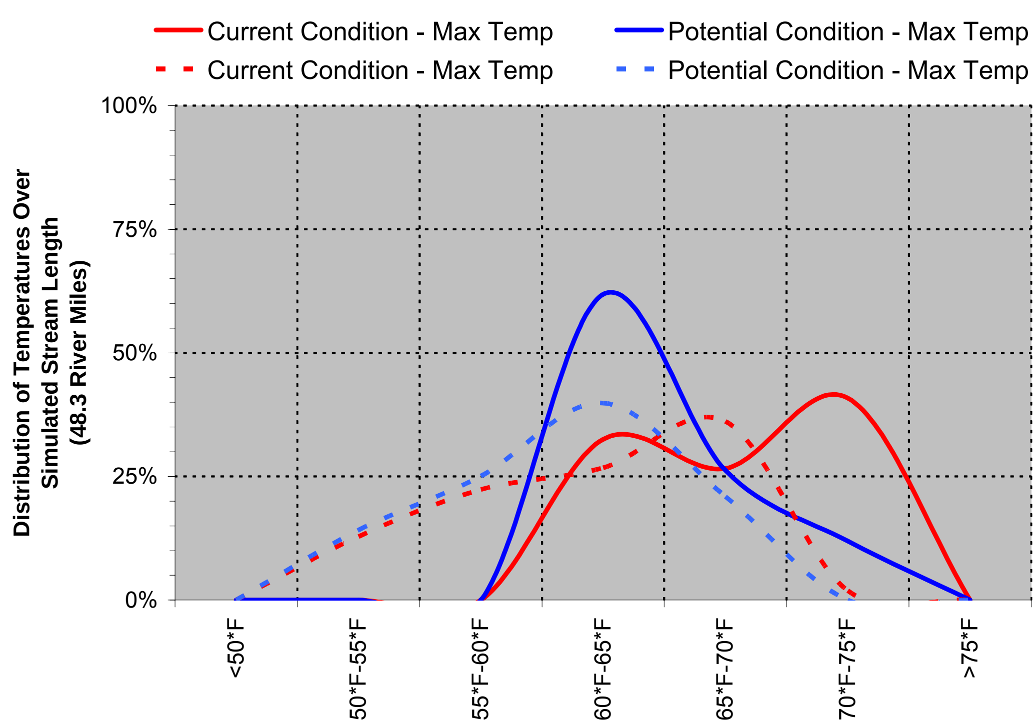


Figure 3.49. Little Sandy River Temperatures – Current Condition and Allocated Condition

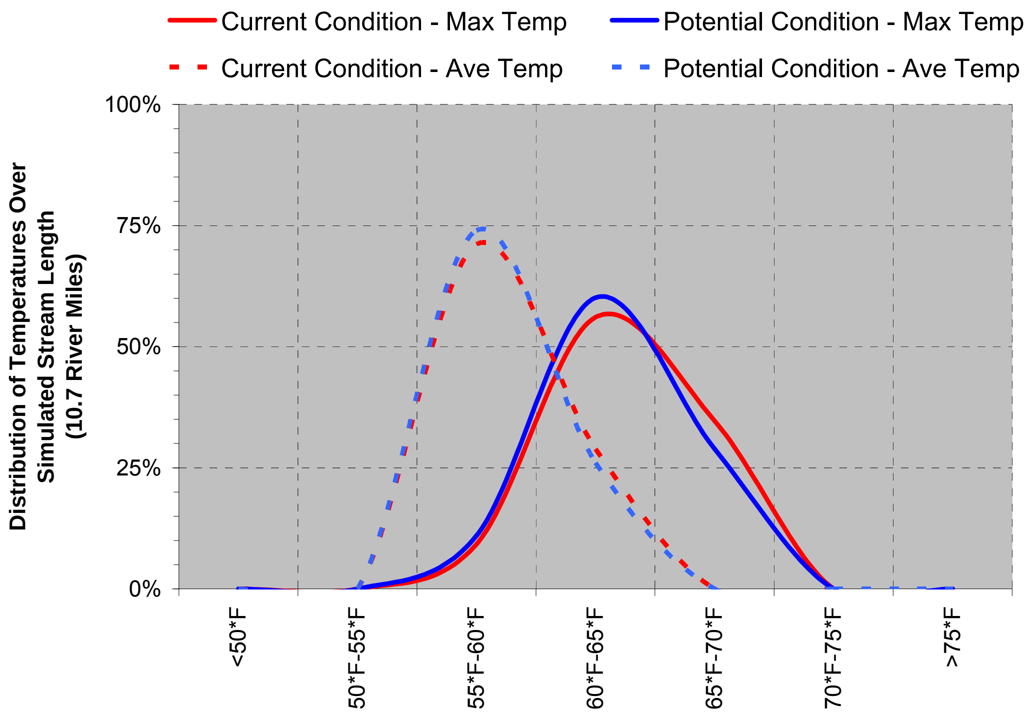


Figure 3.50. Bull Run River Temperatures – Current Condition and Allocated Condition

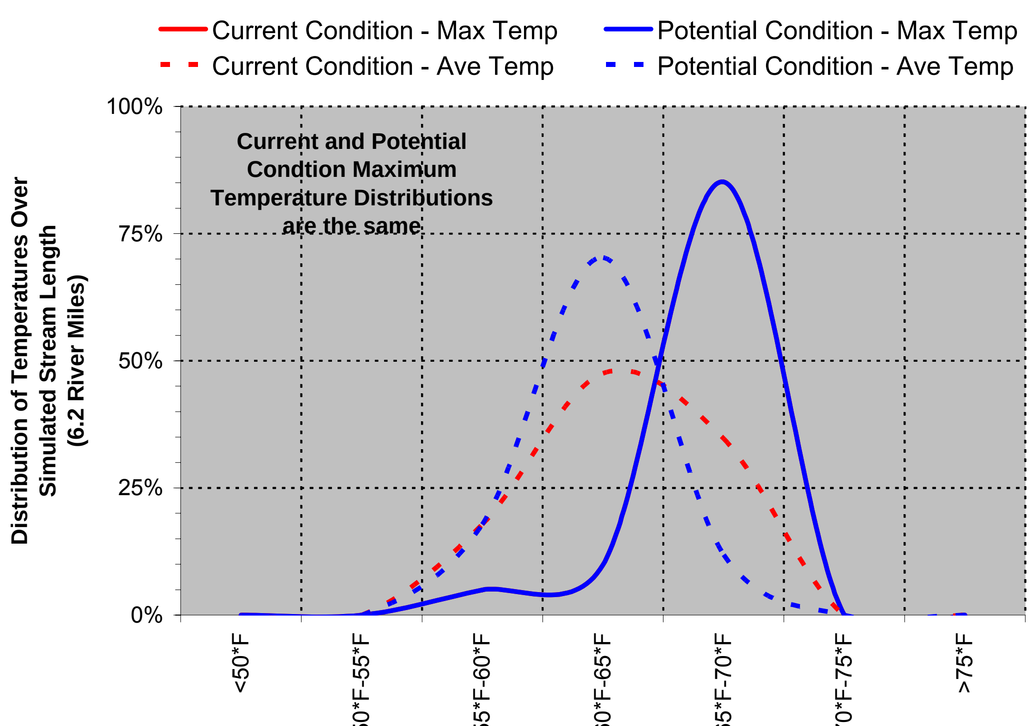


Figure 3.51. Salmon River Temperatures – Current Condition and Allocated Condition

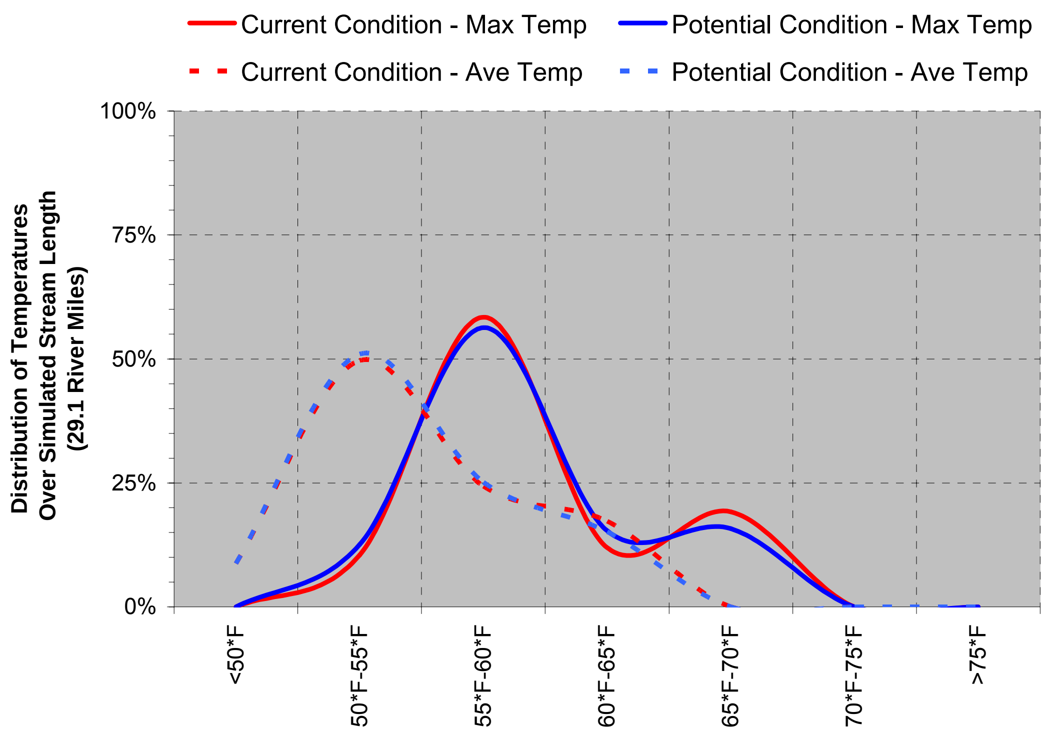
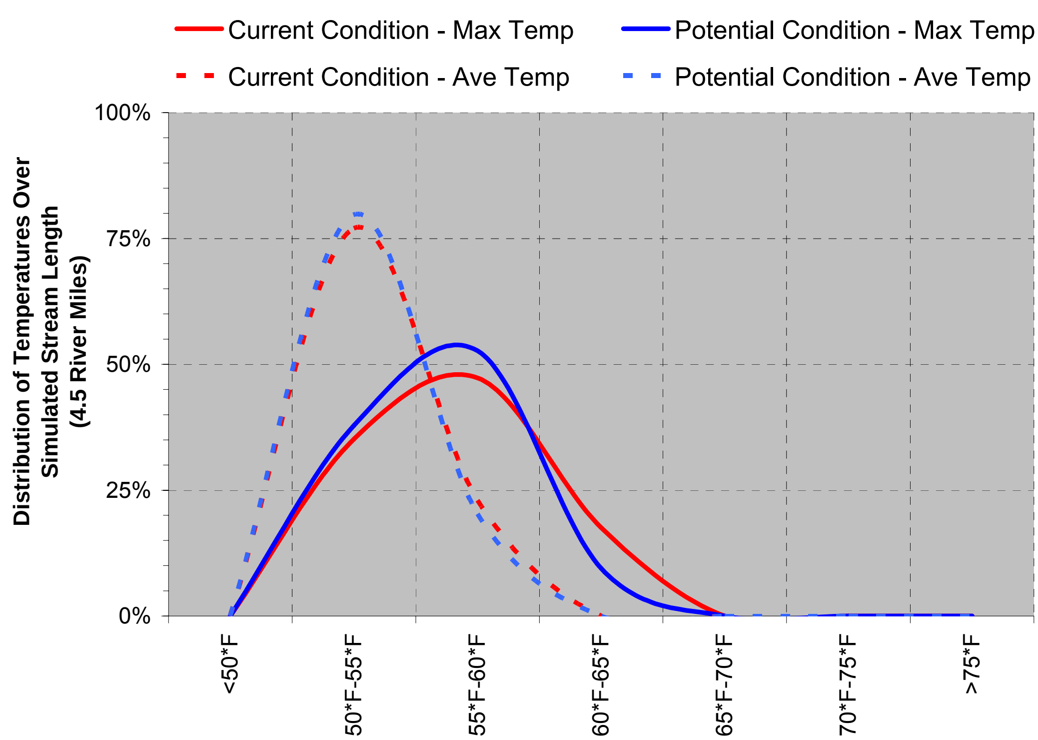


Figure 3.52. Zigzag River Temperatures – Current Condition and Allocated Condition



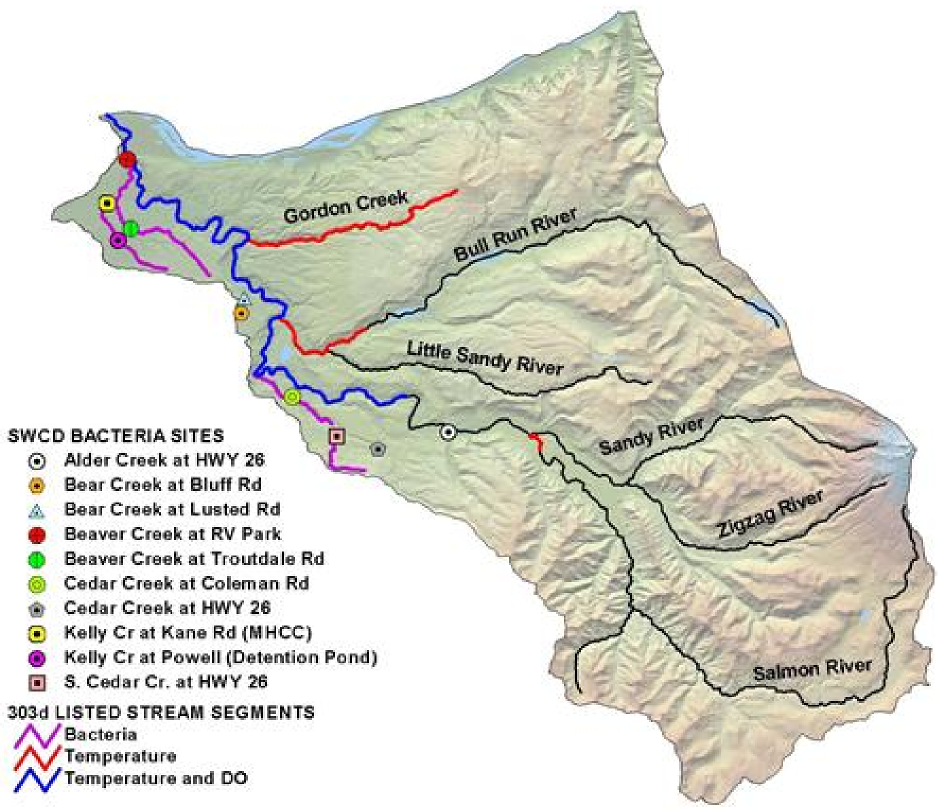
CHAPTER 4 – BACTERIA TMDL

4.1 OVERVIEW AND BACKGROUND

In 2002 ODEQ added several stream segments in the lower Sandy River basin to the 303d list of water quality impaired waters due to the presence of high levels of E coli bacteria. Bacteria data were collected as part of a monitoring project conducted by Clackamas Water Environment Services (WES) and the Clackamas Soil and Water Conservation District (SWCD), with project funding through a grant from the Oregon Watershed Enhancement Board (OWEB). Data were collected between January and October 2001 at 10 monitoring locations on tributaries to the lower Sandy River. Data were also routinely collected at the two locations along Kelly Creek between 1999 and 2003 by the City of Gresham (**Figure 4.1**).

Analysis of water quality data collected on Beaver, Kelly and Cedar Creeks shows violations of bacteria (E coli) water quality standards (Clackamas County, 2001). Portions of all three streams were subsequently included on the 2002 303d list. Analysis of data collected on Bear and Alder Creeks showed that water quality standards are being achieved. The following discussion and TMDL development will focus on those stream segments that failed to meet State water quality standards for E coli bacteria.

Figure 4.1. Location of the Bacteria Monitoring Sites and 303d listed Stream Segments



This bacteria TMDL includes a brief description of the individual watersheds with bacteria 303d listings, the pollutants responsible for impairments, standards being applied, sources of the pollutants, a description of available data, loading capacity, allocations of loads, and a margin of safety. These features are summarized below in **Table 4.1**.

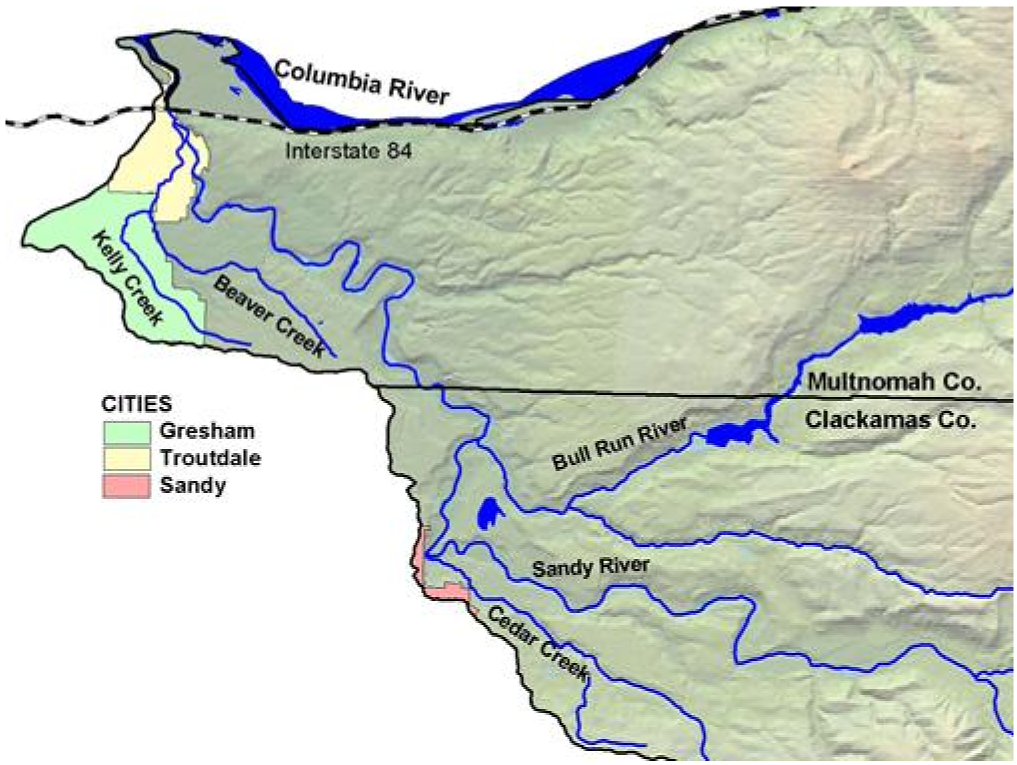
Table 4.1. Sandy Basin Bacteria TMDL Components.

Waterbodies OAR 340-042-0040(4)(a)	Beaver, Kelly and Cedar Creeks and other tributary streams to the lower Sandy River that fail to meet water quality standards protecting water contact recreation as a beneficial use as defined in OAR 340-41-009.
Pollutant Identification OAR 340-042-0040(4)(b)	*Pollutants:* Fecal bacteria from various sources. Particularly *E. coli* as an indicator of human pathogens for recreational contact.
Target Criteria Identification OAR 340-042-0040(4)(c) OAR 340-041-0028(4)(a) OAR 340-041-0028(4)(b) OAR 340-041-0028(4)(c) *OAR* 340-041-0028(8) *CWA §303(d)(1)*	Organisms of the coliform group commonly associated with fecal sources (MPN or equivalent membrane filtration using a representative number of samples) may not exceed: (A) A 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five (5) samples; and (B) No single sample shall exceed 406 E. coli organisms per 100 ml.
Existing Sources OAR 340-042-0040(4)(f) ***CWA §303(d)(1)***	Multiple, including urban stormwater, nonpoint sources and natural background
Seasonal Variation OAR 340-042-0040(4)(j) ***CWA §303(d)(1)***	Violations of the bacteria standard generally occur throughout the year and under variable flow conditions.
TMDL **Loading Capacity and Allocations** OAR 340-042-0040(4)(d) OAR 340-042-0040(4)(e) OAR 340-042-0040(4)(g) OAR 340-042-0040(4)(h) ***40 CFR 130.2(f)*** ***40 CFR 130.2(g)*** ***40 CFR 130.2(h)***	*Loading Capacity:* The loading capacity was determined through the development of load duration curves that determine the maximum bacteria load that will achieve the 126 E. coli organisms per 100 ml water quality criteria under all flow conditions, thereby protecting beneficial uses. *Waste Load Allocations (Point Sources)*: Waste load allocations applicable to municipal stormwater permits are expressed as a percent reduction necessary to meet the numeric criteria – in this case 86%. Waste load allocations for CAFOs are zero. Waste load allocations for other point sources are set to the applicable numeric criteria - 30-day log mean of 126 E. coli organisms per 100ml and no single sample above 406 E. coli organisms per 100ml. *Load Allocations (Non-Point Sources)*: Load allocations are expressed as a percent reduction necessary to meet the numeric criteria – in this case 86%.
Surrogate Measures OAR 340-042-0040(5)(b) 40 CFR 130.2(i)	Translates Non-point Source Load Allocations Allocations are in terms of percent reduction needed to achieve the numeric criteria. This translates load allocations into more applicable measures of performance.
Margins of Safety OAR 340-042-0040(4)(i) CWA §303(d)(1)	*Margins of Safety* are applied as conservative assumptions in the development and interpretation of the load duration curve. No numeric margin of safety is developed.
Standards Attainment & Reasonable Assurance OAR 340-042-0040(4)(l)(e) & (j)	• Analysis of TMDL loading capacities and the required bacteria load reductions demonstrate attainment of water quality standards. • Reasonable Assurance is addressed in Section 6.7 of the Water Quality Management Plan.

4.1.1 Watershed Descriptions

The lower portion of the Sandy River basin, which includes the Kelly, Beaver and Cedar Creek watersheds, is the most urbanized and also contains the most agricultural lands. The Beaver Creek watershed drains approximately 9600 acres and enters the lower Sandy River near Interstate 84. Kelly Creek is the major tributary to Beaver Creek, draining approximately 40% of the watershed before entering Beaver Creek near Mount Hood Community College. Political jurisdictions in the combined Beaver/Kelly watershed include the cities of Gresham and Troutdale along with portions of unincorporated Multnomah County (**Figure 4.2**).

Figure 4.2. Location of Beaver, Kelly and Cedar Creek watersheds in the lower Sandy River Basin.



Land use is highly varied in the Beaver/Kelly watershed, with a mixture of agricultural and forest land uses in the headwater areas and urban and residential land uses in the lower parts of the watershed within the Urban Growth Boundary (**Figure 4.3**).

The Cedar Creek watershed drains approximately 9300 acres before entering the lower Sandy River at river mile 21 (**Figure 4.2**). Political jurisdictions include portions of the City of Sandy as well as unincorporated Clackamas County. The Oregon Department of Fish and Wildlife (ODFW) operates the Sandy River Fish Hatchery near the mouth of Cedar Creek. The hatchery diverts water from Cedar Creek, routes the water through the facility, and discharges it back to the stream approximately ½ mile downstream. The headwaters are on private timberland, with rural residential land uses lower in the watershed (**Figure 4.4**).

Figure 4.3. Land uses within the Beaver and Kelly Creek Watersheds.

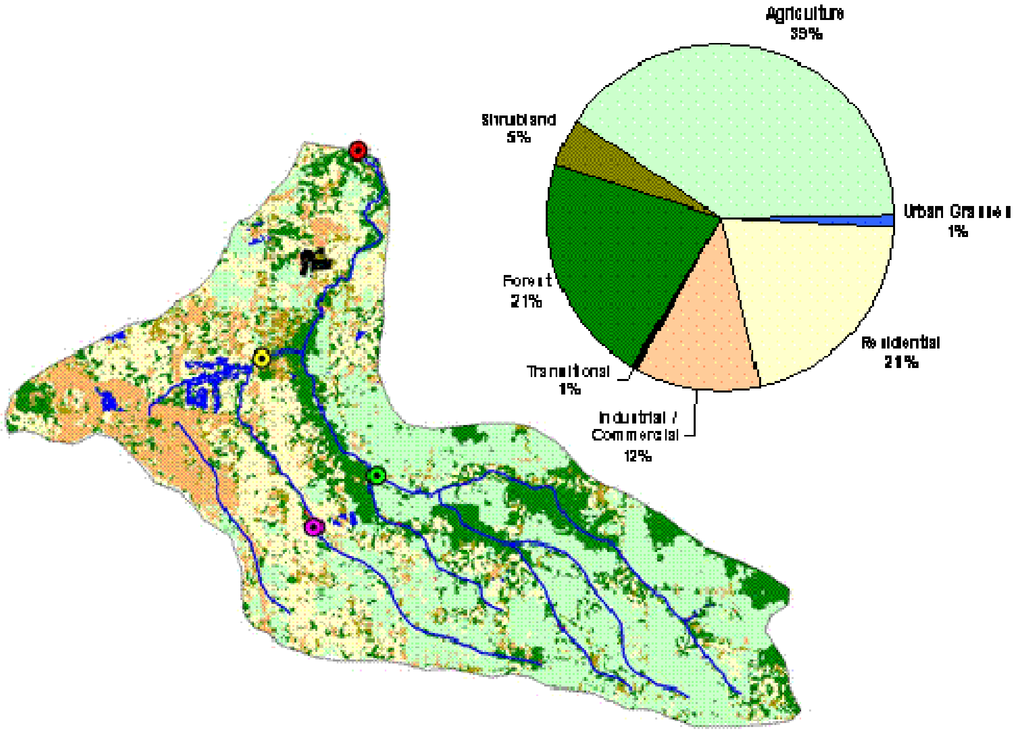
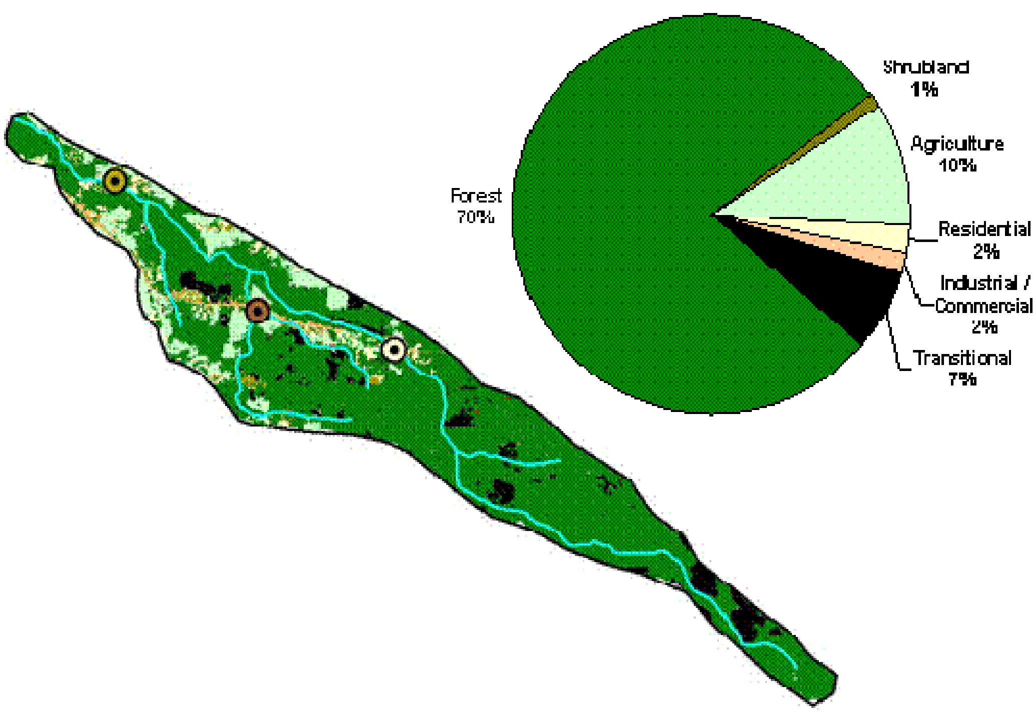


Figure 4.4. Land uses within the Cedar Creek Watershed.



4.2. ANALYTICAL APPROACH – LOAD DURATION CURVE

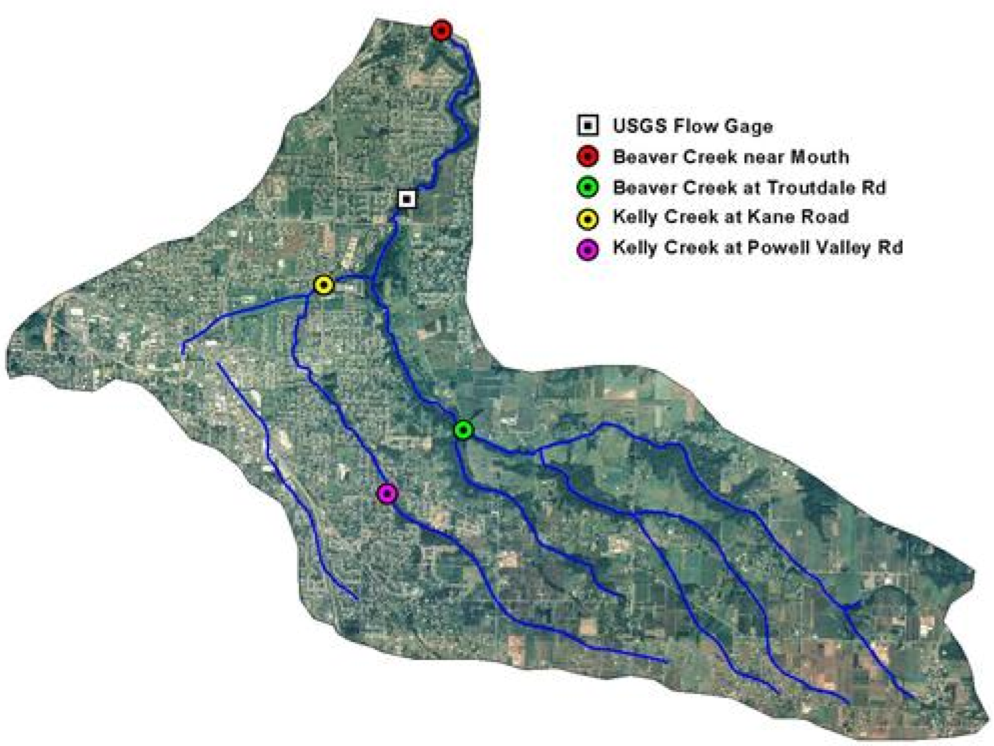
The Load Duration Curve approach was used to develop the bacteria TMDL for Sandy River tributaries

ODEQ chose to use the load duration curve approach to develop the bacteria TMDL for 303d listed streams in the Sandy River basin. Load duration curves are a method of determining a flow based loading capacity, assessing current conditions, and calculating the necessary reductions to comply with water quality standards. The methodology is primarily based on TMDLs completed by Kansas Department of Health and Environment and through technical assistance provided by Bruce Cleland of America's Clean Water Foundation (www.acwf.org). Load duration curves were chosen because they offer a relatively simple and accurate methodology for determining the degree of water quality impairment and because they are capable of illustrating relative impacts under various flow conditions and can be used in targeting appropriate water quality restoration efforts (Cleland 2002, 2003).

The TMDL for the listed tributaries within the Sandy River basin was developed using water quality monitoring data collected by the Clackamas County Soil and Water Conservation District (SWCD) and the City of Gresham. Data collected by the Clackamas SWCD was used for the 2002 303d listing process. Those data, combined with the data collected by the City of Gresham on Kelly Creek, were evaluated during TMDL development. *E. coli* samples considered for this analysis were collected during a variety of weather and flow conditions between 1999 and 2003. Data reported as "estimate", "less than" or "greater than" values were not considered.

The U.S. Geological Survey (USGS) operates a stream flow gage (#14142800) on Beaver Creek below the confluence with Kelly Creek (**Figure 4.5**). The gaging station has been in continuous operation since 1999.

Figure 4.5. Location of the Beaver Creek USGS Stream Flow Gage #14142800 and various stream monitoring locations



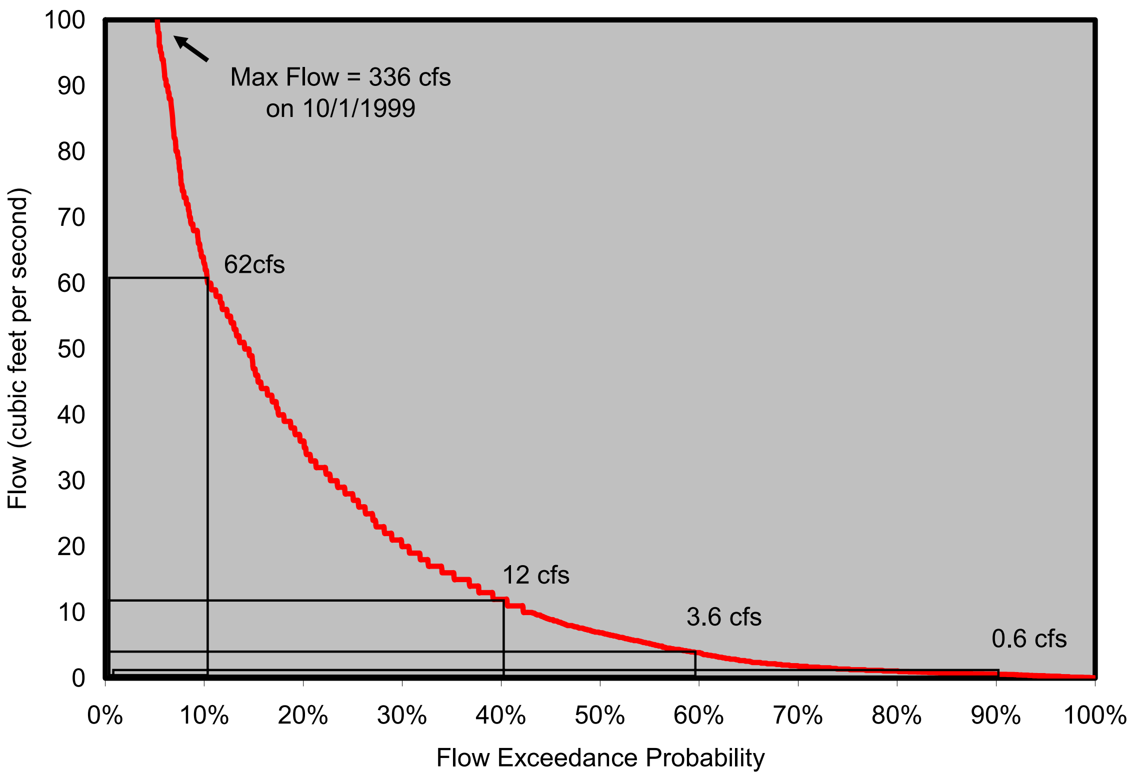
The process used to develop load duration curves for this TMDL is described below:

A flow duration curve for the appropriate stream flow monitoring location in the watershed is developed. The flow duration curve is a plot of the frequency of which a flow is exceeded. The flows are ranked from maximum to minimum for the period of record at a particular site. The exceedance probability (EP) for each flow was computed by:

$$EP = \frac{rank}{n+1}$$

where n is number of flow measurements. The "percent of days flow exceeded" is the exceedance probability multiplied by 100. The data are plotted as shown in **Figure 4.6** with the flow exceedance probability on the x-axis. A value of 5% on the x-axis indicates extremely high flows, while a value of 95% indicates drought conditions. For example, a flow of 12 cfs in Beaver Creek corresponds with a flow duration interval of 40%, indicating that 40% of all observed stream discharge values are at or above 12 cfs. The flow duration curve developed for Beaver Creek is based upon the flow record available – 1999 to 2004.

Figure 4.6. Flow Duration Curve for Beaver Creek gage #14142800



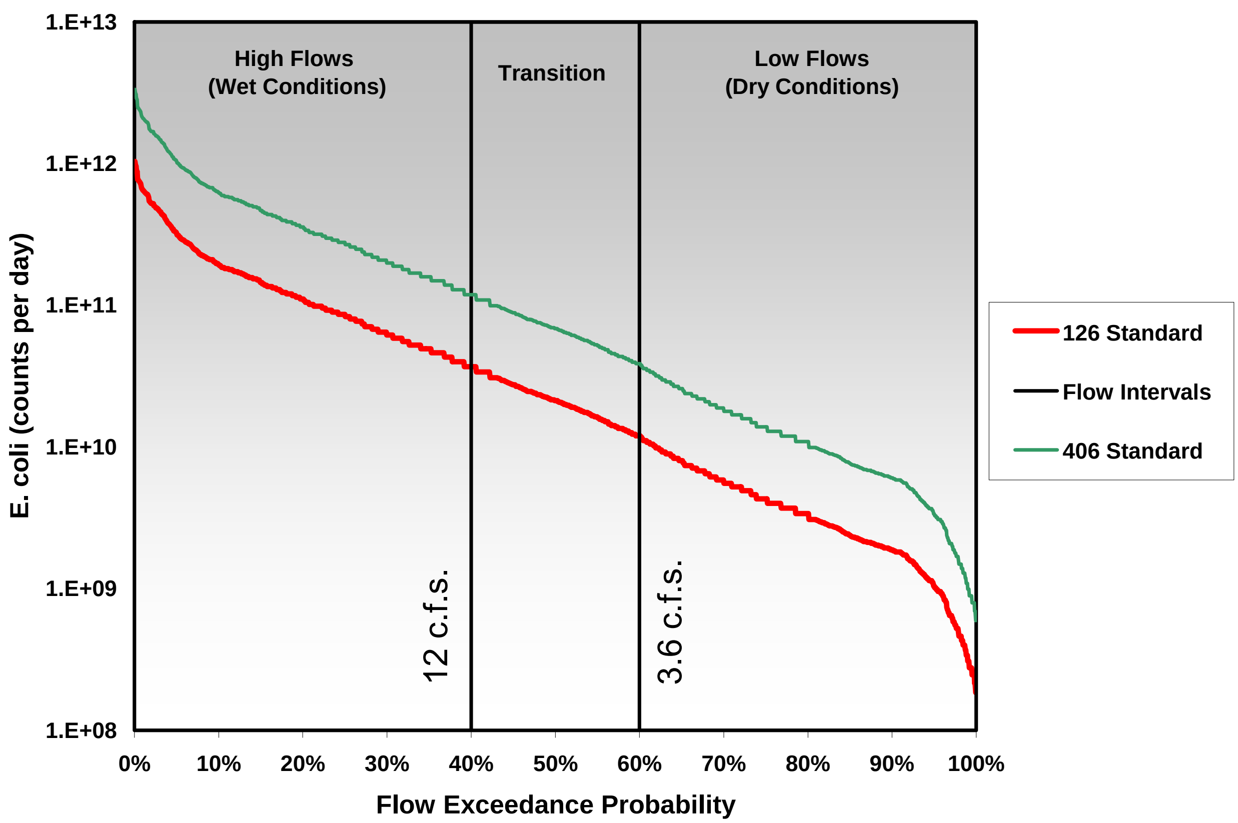
The flow curve is translated into a load duration curve. To accomplish this, the flow value is multiplied by the water quality standard and a conversion factor. The resulting loads are graphed and represent the flow-dependent loading capacity for specific numeric criteria. The curve (**Figure 4.7**) is determined by the target concentration, 126 organisms/100ml in this case, and the flow associated with the recurrence interval. For example, the log mean recreational contact standard for bacteria is 126 colonies per 100 milliliters so the loading capacity is:

Standard — Daily Avg. Flow — Conversion factors

$$Loading\ Capcity\frac{col}{day} = 126\frac{col}{100\ ml} * Q\frac{ft^3}{s} * 283.2\frac{100ml}{ft^3} * 86400\frac{s}{day}$$

The loading capacity is then plotted against the corresponding flow exceedance probability. There are two lines representing the two numeric targets: log mean of 126 organisms / 100 ml and no samples exceeding 406 organisms / 100 ml. The loading capacity increases with increased flow because of the increased assimilative capacity of the river (i.e. dilution).

Figure 4.7. Load Duration Curve showing the loading capacity for Beaver Creek



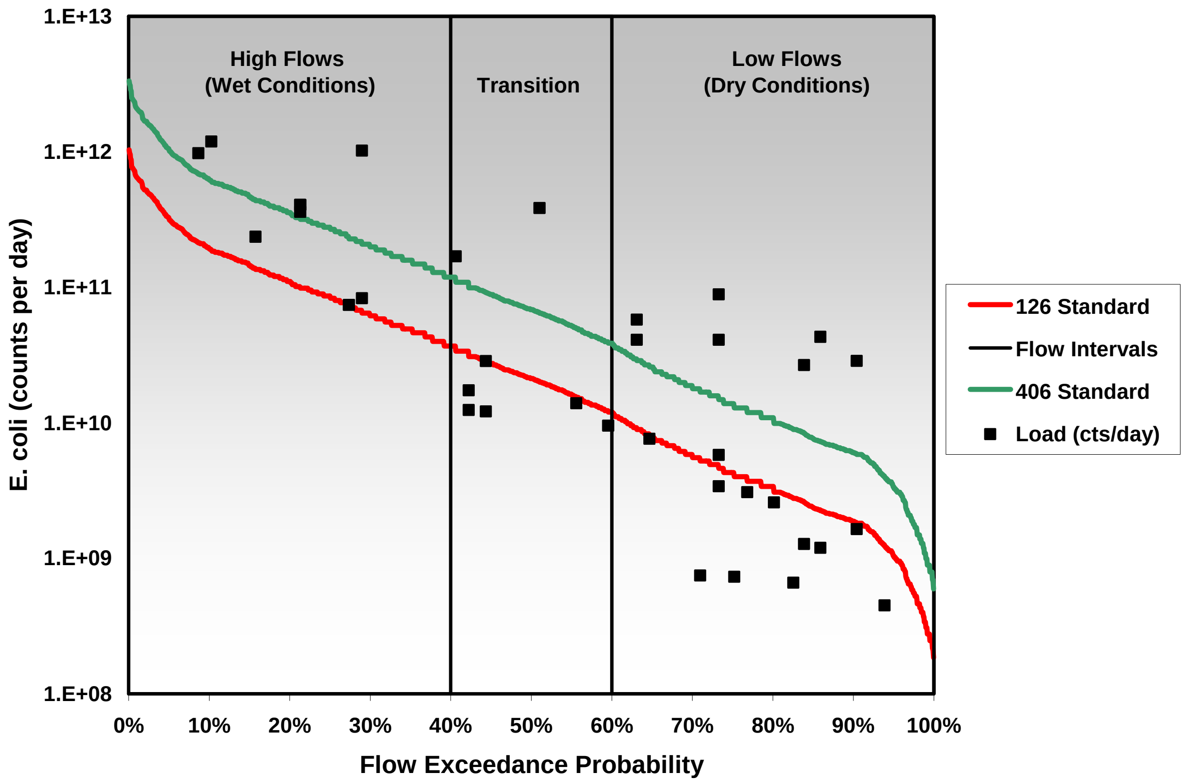
A water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was taken. Measured concentrations of *E. coli* are converted into loads using the equation above and flows from the stream gage. The "event loads" are plotted along with the standard lines to assess current conditions The y-axis becomes the water quality parameter value, load in this case, and the position of the sample on the x-axis illustrates the flow exceedance probability (**Figure 4.8**).

Points that plot above the curve represent deviations from the water quality standard and the permissible loading function. Those plotting below the curve represent compliance with water quality criteria and the appropriate designated use.

When event loads exceed the loading capacity during high flows it is likely that the loading is due to runoff related sources such as urban stormwater, sanitary sewer overflows or combined sewer overflows.

Bacterial loading tends to be less during the low-flow period. However, the loading capacity of the stream also decreases. Violations of the water quality standard at low flows are not likely runoff related. Warm-blooded animals in streams, failing septic tanks, and improper discharge of sewage are possible non-runoff related sources.

Figure 4.8. Load Duration Curve showing the loading capacity for Beaver Creek and event loads for 36 samples collected 1999 and 2003



4.3 TARGET AND SENSITIVE BENEFICIAL USE IDENTIFICATION - CWA §303(D)(1)

Water Contact Recreation is the most bacteria-sensitive beneficial use in the Sandy River basin.

Oregon Administrative Rules (OAR 340 – 41 – 286, Table 286A) lists the beneficial uses occurring within the Sandy River Basin (**Table 4.2**). Numeric and narrative water quality standards are designed to protect the most sensitive beneficial uses. Water contact recreation, highlighted in grey below, is the most sensitive beneficial use related to bacteria. Therefore, the TMDL targets river concentrations that will limit the loading and result in concentrations acceptable to protect the most sensitive beneficial use – water contact recreation.

Table 4.2. Beneficial Uses Occurring in the Sandy River Basin (OAR 340 – 41 – 286, Table 286A)

Beneficial Use	Streams Forming Waterfalls Near Columbia River Hwy	Sandy River	Bull Run River and All Tributaries	All Other Tributaries to Sandy River
Public Domestic Water Supply [1]		✓	✓	✓
Private Domestic Water Supply [1]		✓		✓
Industrial Water Supply		✓		✓
Irrigation		✓		✓
Livestock Watering		✓		✓
Anadromous Fish Passage		✓	✓	✓
Salmonid Fish Rearing	✓	✓	✓	✓
Salmonid Fish Spawning	✓	✓	✓	
Resident Fish and Aquatic Life	✓	✓	✓	✓
Wildlife and Hunting	✓	✓		✓
Fishing	✓	✓		✓
Boating		✓		✓
Water Contact Recreation	✓	✓		✓
Aesthetic Quality	✓	✓	✓	✓
Hydro Power		✓	✓	✓

[1] With adequate pretreatment (filtration and disinfection) and natural quality to meet water quality standards.

4.3.1 Water Quality Standard and Target Identification

Bacterial criteria for Oregon's waters are contained in the Oregon Administrative Rules, section 340-41. Bacteria impair the recreational use of rivers when concentrations exceed those determined through epidemiological studies to cause illness through body contact at a rate of 8 or more cases per 1000 swimmers. In 1996 Oregon replaced fecal coliform bacteria with *Escherichia coli (E. coli)* in State water quality standards. The revision followed recommendations from the U.S. Environmental Protection Agency (USEPA, 1986) and was based upon a study that demonstrated a statistically significant relationship between the rate of swimming-related illness and the concentrations of *E. coli* and enterococci at freshwater beaches (Dufour, 1984). *E. coli* was determined to be a good indicator of fecal contamination in water and wastewater because it has met a number of important criteria, including: (1) it is present in the feces of humans and warm-blooded animals at numbers exceeding those of pathogens; (2) it shows minimal growth in aquatic systems and at slower rates than pathogens; (3) it is readily detectable by simple procedures that result in unambiguous identification of the fecal coliform group; (4) it is consistently present when pathogens are present; and (5) it shows increased resistance to disinfectants as opposed to pathogens (Elmund et al., 1999). The criteria shown in **Table 4.3** are designed to achieve those concentrations, both for a single day exposure and over a long term (30-day) exposure period. Only *E. coli* data collected after 1996 were considered for this assessment.

Table 4.3. Applicable numeric State of Oregon bacteria water quality criteria.

Beneficial Use	Description
Recreational Contact in Water OAR 340-041-0009:	Organisms of the coliform group commonly associated with fecal sources (MPN or equivalent membrane filtration using a representative number of samples) may not exceed: (C) A 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five (5) samples; and (D) No single sample shall exceed 406 *E. coli* organisms per 100 ml.

The 30-day log mean of 126 *E. coli* organisms per 100 milliliters criterion was used as the target concentration in the TMDL for determining the loading capacity of a waterbody. This criterion was selected as it most directly relates to illness rates[9] and potential impacts on the beneficial use of water contact recreation.

[9] From Implementation Guidance for Ambient Water Quality Criteria for Bacteria (USEPA, 2002): For the purpose of analysis, the data collected at each of these sites were grouped into one paired data point consisting of an averaged illness rate and a geometric mean of the observed water quality. These data points were plotted to determine the relationships between illness rates and average water quality (expressed as a geometric mean). The resulting linear regression equations were used to calculate recommended geometric mean values at specific levels of protection (e.g., 8 illnesses per thousand). Using a generalized standard deviation of the data collected to develop the relationships and assuming a log normal distribution, various percentiles of the upper ranges of these distributions were calculated and presented as single sample maximum values.

EPA recognizes that the single sample maximum values in the 1986 criteria document are described as "upper confidence levels," however, the statistical equations used to calculate these values were those used to calculate percentile values. While the resultant maximum values would more appropriately be called 75th percentile values, 82nd percentile values, etc., this document will continue to use the historical term "confidence levels" to describe these values to avoid confusion."

4.3.2 Pollutant Identification

The pollutant causing impairment of 303(d) listed waters is *E. coli* bacteria (a subset of fecal coliform bacteria). These bacteria are produced in the guts of warm-blooded vertebrate animals, and indicate the presence of pathogens that cause illness in humans.

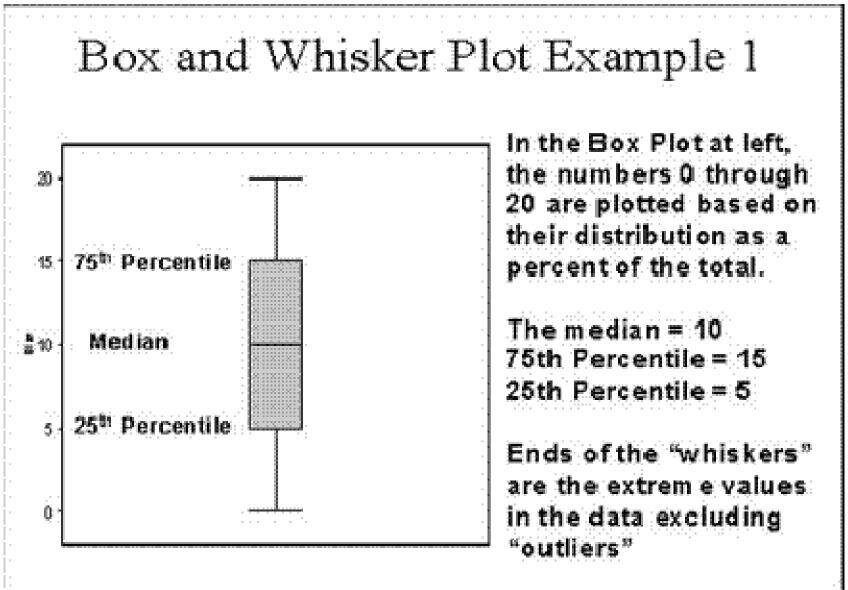
All data analyzed for development of this TMDL was of *E. coli* concentrations, though in some cases fecal coliform data are still collected. The methods of bacterial analysis have changed over time, with some samples analyzed using the Most Probable Number (MPN) technique and some analyzed using the membrane filtration technique (MF). The MF technique results are reported as “Colony Forming Units” (CFU) per 100ml, where as the MPN technique results are reported as “Most Probable Number” (MPN) per 100ml. According to *Bacterial Indicators of Pollution* (Pipes, 1982) “the differences between MPN estimates and MF counts were not of any practical significance mainly because of the inherently low degree of reproducibility of the MPN estimates.” Regardless of the analytical technique, all available *E. coli* data have been combined for this report.

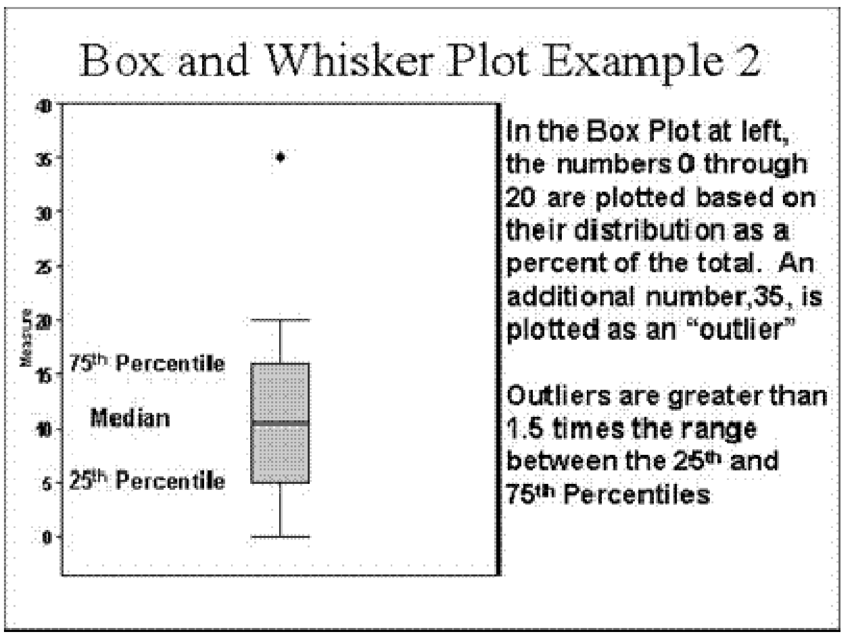
4.3.3 Deviation from Water Quality Standards

The discussion of bacterial concentrations that follows presents distributions of sample data and uses median values as approximations of geometric means. This would not be appropriate for determinations of violations of water quality criteria based on geometric means, but is reasonable as a method of discussing distributions of sample concentrations. The distributions are presented in box and whisker plots, as described in **Figure 4.9**.

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

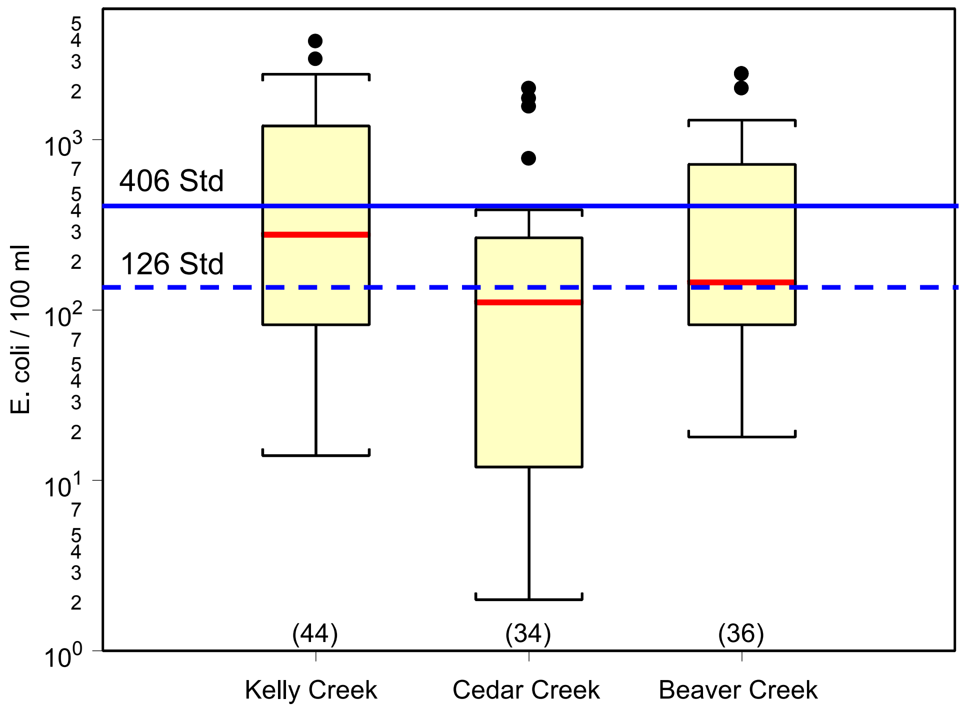
Figure 4.9. Description of Box Plots





Boxplots generated using available data (**Figure 4.10**) illustrate violations of bacteria water quality criteria in Beaver, Kelly and Cedar Creeks. Note that boxplots were generated using the results from 34 to 44 samples (number in parentheses at bottom of boxplot) collected at the sites between 1999 and 2003. Beaver and Kelly Creeks showed consistent violations of the "do not exceed" 406 organisms/100 ml criterion as well as overall geometric means above the 126 organisms/100 ml criterion. Results from Cedar Creek, however, showed significantly fewer violations of the 406 organisms/100 ml criterion (4 of 36 samples) and an overall geometric mean below the 126 organisms/100 ml criterion (**Table 4.4**).

Figure 4.10. Boxplots Illustrating Beaver, Kelly and Cedar Creek Bacteria Concentrations (1999-2003)



The information provided in **Table 4.4**, particularly the high "maximum" values, shows that Beaver, Kelly and Cedar Creeks are routinely impacted by elevated levels of bacteria and that the problem occurs more frequently in the more highly developed Beaver and Kelly Creek watersheds.

Table 4.4. Characterization of *E. coli* Monitoring Results (1999 – 2003)

Location	Geometric Mean[1] (cfu/100 ml)	Median (cfu/100 ml)	Min/Max[1] (cfu/100 ml)	Number of Samples	Number Above 406 Standard
Beaver Creek	230	145	18 / 2419	36	15
Kelly Creek	270	276	14 / 3750	44	17
Cedar Creek	66	113	2 / 1986	34	4

1=Freshwater criteria based on *E. coli*: 126 MPN/100 ml geometric mean; maximum value of 406 MPN/100 ml.

4.4 SEASONAL AND SPATIAL VARIATION

ODEQ has the ability to include waterbodies on the 303d list for portions of the year or year round. For 303d listing purposes ODEQ considers bacteria data from two time periods, "Summer" (June 1 to September 30) and "Fall-Winter-Spring" (October 1 to May 31). A stream may be listed for either "season" or year round if data indicates that water quality standards are violated during both time periods. Beaver, Kelly and Cedar Creeks are currently 303d listed for the Summer time period only. This is due to the fact that the data considered for the 303d listing, submitted to ODEQ by the Clackamas SWCD, was collected primarily during the summer months of 2001. However, additional data considered in this TMDL analysis indicates year round violations of bacteria criteria. The load duration curve presented in **Figure 4.11** shows that bacteria water quality standards violations occur year round. Samples collected during the summer months are delineated with an "X" and those collected during the winter months are delineated with a black "dot". Therefore, TMDL allocations (described below in **Section 4.7**) will apply year round.

ODEQ also examined the data for patterns associated with rainfall/runoff events. Bacteria sampling events were paired with rainfall data collected at Portland International Airport by the Oregon Climatological Service. ODEQ assumed that runoff would occur when the rainfall on the day of the sampling event was greater than 0.15 inches. Samples collected on a day with significant rainfall are shown with yellow squares and those collected on dry days are shown as blue circles in **Figures 4.11** and **4.12**.

Figure 4.11. Load Duration Curve Showing Seasonal Bacteria Concentrations in Beaver Creek

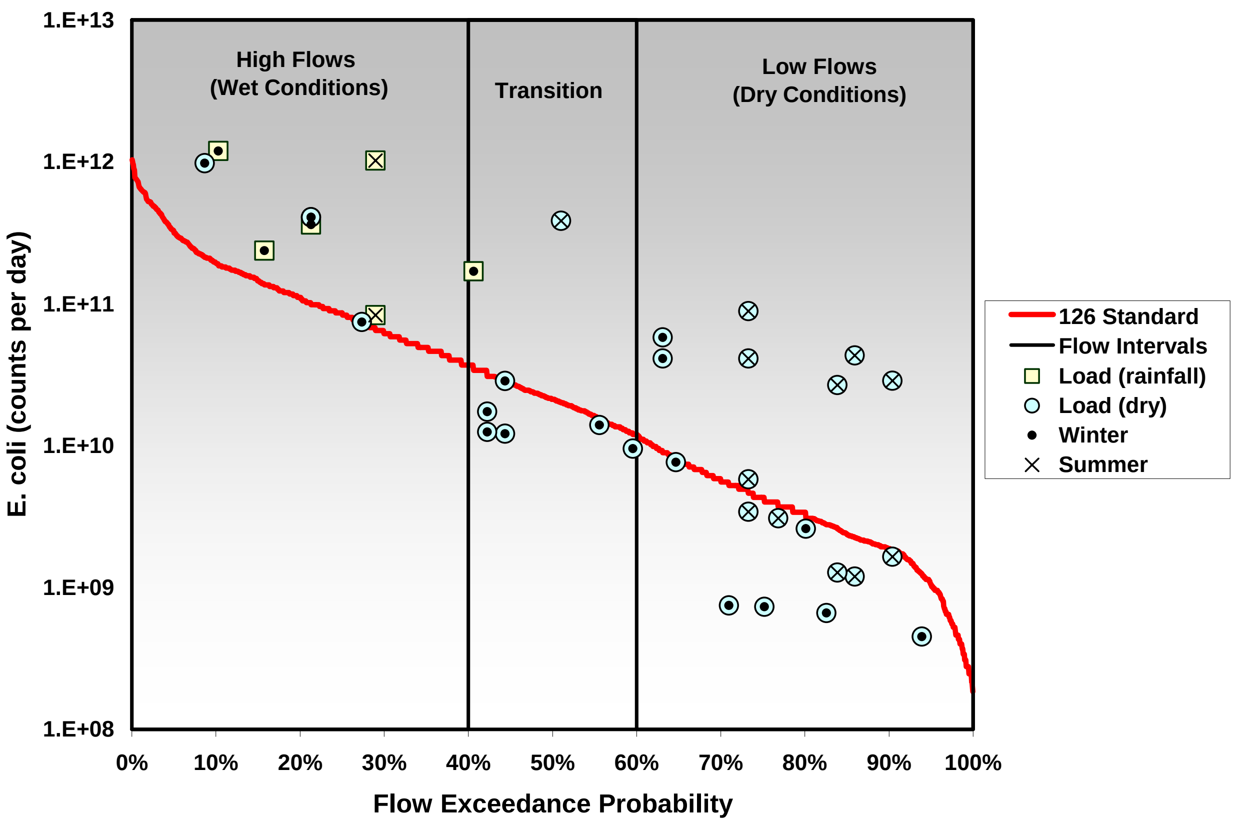


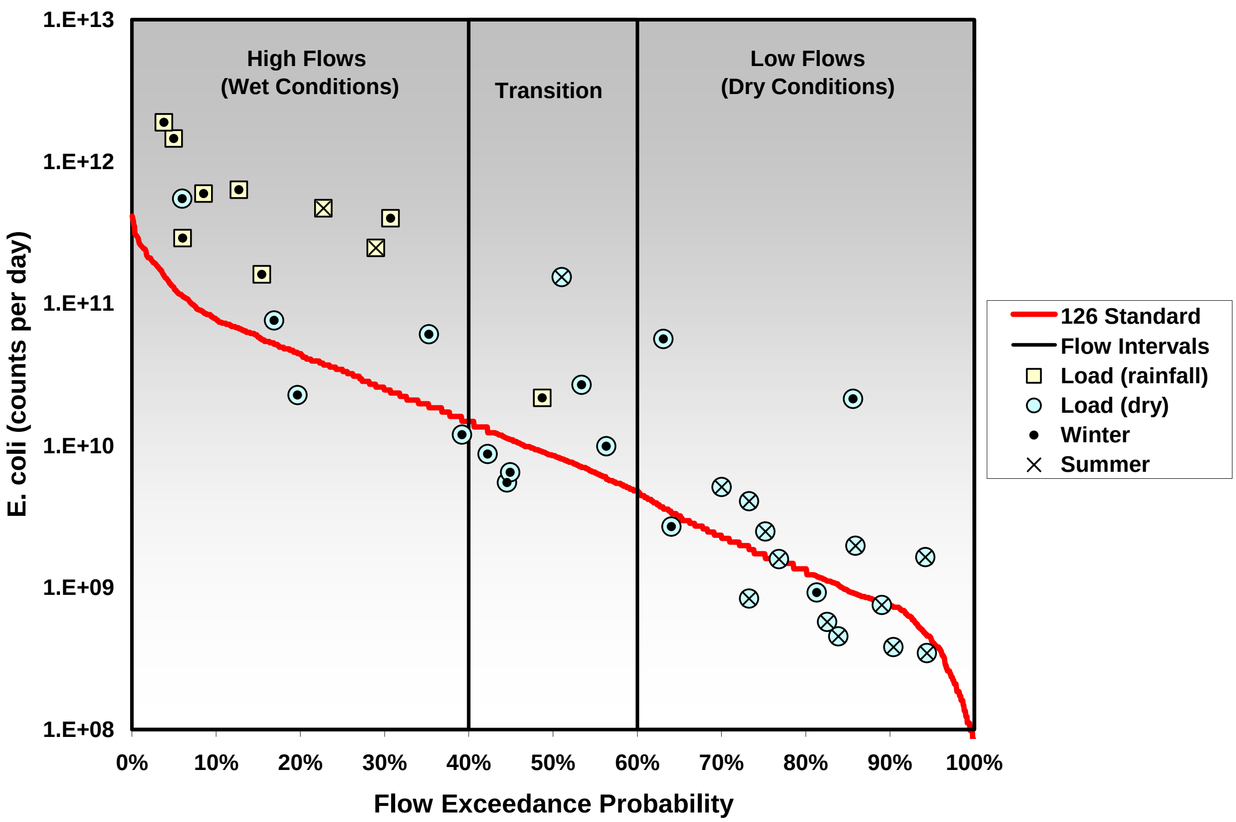
Figure 4.11 shows that E coli levels in Beaver Creek routinely exceed water quality standards under both high flow and low flow conditions and during dry and wet periods. This indicates that there are multiple sources of bacteria that enter Beaver Creek via a variety of pathways, but that those sources associated

with summertime low-flow conditions are particularly problematic and should be a priority for bacteria source control efforts. For example, if violations were only occurring during summertime low flow conditions likely sources may include failing septic systems, animals including wildlife and pets in or near the stream and/or sanitary sewer/storm sewer cross connections. Those sources could largely be excluded if violations were only occurring during wintertime high flow conditions. Conversely, a large number of violations during higher flows and during rainfall events would suggest sources such as urban stormwater, sanitary sewer overflows and manure management problems. Those sources could largely be excluded if violations were only occurring during dry summertime conditions. **Section 4.5** of this document discusses bacteria source categories in more detail.

Analysis of the available bacteria data suggests that, while both runoff-related sources (principally storm water) and non-runoff sources (such as sanitary system cross-connections) are significant sources of bacteria in Beaver Creek, initial source control strategies should focus on management practices and techniques that address summertime, non-runoff source categories.

A load duration curve was also generated for Kelly Creek in order to examine seasonal and rainfall-related patterns. Since continuous flow data are not available for Kelly Creek ODEQ assumed that Kelly Creek flow is 40% of the flow measured in Beaver Creek, based upon watershed drainage areas. Therefore, the load duration curve developed for Kelly Creek and presented in **Figure 4.12** can be used for data analysis purposes, but will not be used to develop distinct load allocations for Kelly Creek. Examination of the data shows that, while bacteria criteria exceedances occur throughout the year, Kelly Creek does not appear to be as severely impacted as Beaver Creek during the summertime low-flow conditions. Rather, the most severe exceedances tend to occur during the winter months.

Figure 4.12. Load Duration Curve showing Seasonal and Rainfall-related Bacteria Loads in Kelly Creek.



4.5 BACTERIA SOURCES

High concentrations (and loads) of bacteria in urban watersheds come from many possible human and non-human sources. This TMDL identifies the reductions necessary to meet water quality standards and will provide load and waste load allocations to appropriate sources. The individual watersheds where 303d listings are found do not contain any permitted sewage treatment plants, though several exist in the within the Sandy Basin. Stormwater discharged to Kelly Creek and the lower portions of Beaver Creek via the municipal separate storm sewer systems (MS4) is the only known NPDES-permitted discharge in the watershed that has the potential to discharge significant bacteria loads into the individual 303d listed streams.

The following sections of this document describe many likely sources of bacteria, but this source assessment is not exhaustive or necessarily specific to the Beaver, Kelly or Cedar Creek watersheds. Watershed managers from the designated management agencies must conduct further investigations of watershed-specific bacteria sources in order to develop an effective strategy for bacteria control.

4.5.1 Sources of Bacteria Associated with Runoff Events

The following is a list of potential runoff related bacteria sources:

<u>Urban Runoff</u>

As seen in **Figure 4.12**, and to a somewhat lesser degree in **Figure 4.11**, significant water quality standards violations occur during wintertime runoff events in Beaver and Kelly Creeks. This, coupled with the facts that much of the watershed is urbanized and that urban stormwater is known to contain high bacteria concentrations, points to urban runoff as a significant source of instream bacteria. The ultimate sources of urban bacteria are multiple and may include:

- Pet, wildlife and other animal waste
- Illegal dumping of sanitary waste
- Failing septic systems
- Sanitary sewer overflows

It is important to note that urban runoff, especially stormwater discharged via a system of pipes, may include bacteria from a variety of sources, both human and non-human in origin. Bacteria originating from ducks, geese, raccoons and other wildlife may well be present in large numbers in urban stormwater runoff. However, the paths that bacteria from these sources take and the time in which it takes to reach a nearby stream are often greatly altered by modern stormwater conveyance systems. For example, it is conceivable that waste (human, wildlife or domesticated animal) deposited several hundred feet away from a stream could be transported to the stream in minutes via an urban storm system – a path that may take several days under natural overland flow conditions. Since die-off rates for bacteria are typically in the order of days, the bacteria present in the waste would likely contribute to stream standards violations when transported quickly via the storm system, but would be much less likely to survive natural overland transport – as evidenced by the low bacteria numbers seen in forested watersheds with abundant wildlife.

<u>Other Runoff</u>

Rural runoff may contain bacteria from the same sources as urban runoff, with the possible exception of sanitary sewer overflows. The density of septic systems is often relatively high in rural areas on the fringe of urban areas and therefore the possibility of failing systems is quite high.

Additional potential sources are “hobby” farms, man-made instream ponds that attract wildlife and horse pastures.

4.5.2 Sources of Bacteria NOT Associated with Runoff Events

The following is a list of potential non-runoff related bacteria sources:

Urban Runoff

Non-runoff sources of urban bacteria may include such things as sanitary sewer cross connections, illicit discharge of sanitary waste from septage vacuum trucks and recreational vehicles, and episodic or chronic discharges from the local sanitary sewer system. Small scale discharges, a single residential cross connection for example, may not have much of an impact during runoff events or when stream flows are higher, but can cause water quality standards violations during the summer months in small streams like Beaver Creek.

Failing Septic Systems

Septic systems fail in a variety of different ways and may contribute to water quality problems under both runoff and non-runoff conditions. Some systems only fail when the soil is saturated or when winter storms raise the local water table. Other systems fail year round and, especially those near local streams, contribute bacteria to streams during low flow conditions when there is less assimilative capacity.

Direct Deposition

Direct deposition of pet and other animal waste into streams tends to cause water quality standards violations during lower-flow, dry conditions. Illegal dumping of sanitary waste from recreational vehicles into the storm drain system has also been tied to high bacteria levels in surface waters.

4.6 LOADING CAPACITY – 40 CFR 130.2(F)

A flow based loading capacity was determined through the development of a load duration curve for Beaver Creek. The curve (red line in **Figure 4.13**) determines the maximum bacteria load that will achieve the 126 *E. coli* organisms per 100 ml water quality criteria under all flow conditions, thereby protecting beneficial uses. The 30-day log mean of 126 *E. coli* organisms per 100 milliliters criterion was used as the target concentration in the TMDL for determining the loading capacity of a waterbody. This criterion was selected as it most directly relates to illness rates[10] and potential impacts on the beneficial use of water contact recreation. Loading capacity was determined with a load duration curve that provided an estimate of the reduction necessary to meet the log mean criterion.

The estimate of the current load and the calculated loading capacity were used to calculate a percent reduction to meet the loading capacity and thereby meet the 126 *E. coli* organisms per 100 milliliters criterion. Specific allocations were derived based on an analysis of the contribution of sources relative to the estimate of the current load. Those with similar loads received the calculated percent reduction. Those with minor loadings (e.g. treated waste water) received their current loading, set at the water quality standard which includes both criterion. Since the criterion are concentration based, new and reissued NPDES permit sources discharging at or below both criterion would not be increasing the bacteria load to the waterbody. Therefore, a specific portion of the waste load allocation need not be set aside for new sources to be consistent with this TMDL.

[10] From "Implementation Guidance for Ambient Water Quality Criteria for Bacteria" (EPA 2002): For the purpose of analysis, the data collected at each of these sites were grouped into one paired data point consisting of an averaged illness rate and a geometric mean of the observed water quality. These data points were plotted to determine the relationships between illness rates and average water quality (expressed as a geometric mean). The resulting linear regression equations were used to calculate recommended geometric mean values at specific levels of protection (e.g., 8 illnesses per thousand). Using a generalized standard deviation of the data collected to develop the relationships and assuming a log normal distribution, various percentiles of the upper ranges of these distributions were calculated and presented as single sample maximum values.

EPA recognizes that the single sample maximum values in the 1986 criteria document are described as "upper confidence levels," however, the statistical equations used to calculate these values were those used to calculate percentile values. While the resultant maximum values would more appropriately be called 75th percentile values, 82nd percentile values, etc., this document will continue to use the historical term "confidence levels" to describe these values to avoid confusion."

Figure 4.13. Load Duration Curve of Showing Loading Capacity and Percent Reduction Necessary to Meet Water Quality Standards in Beaver Creek.

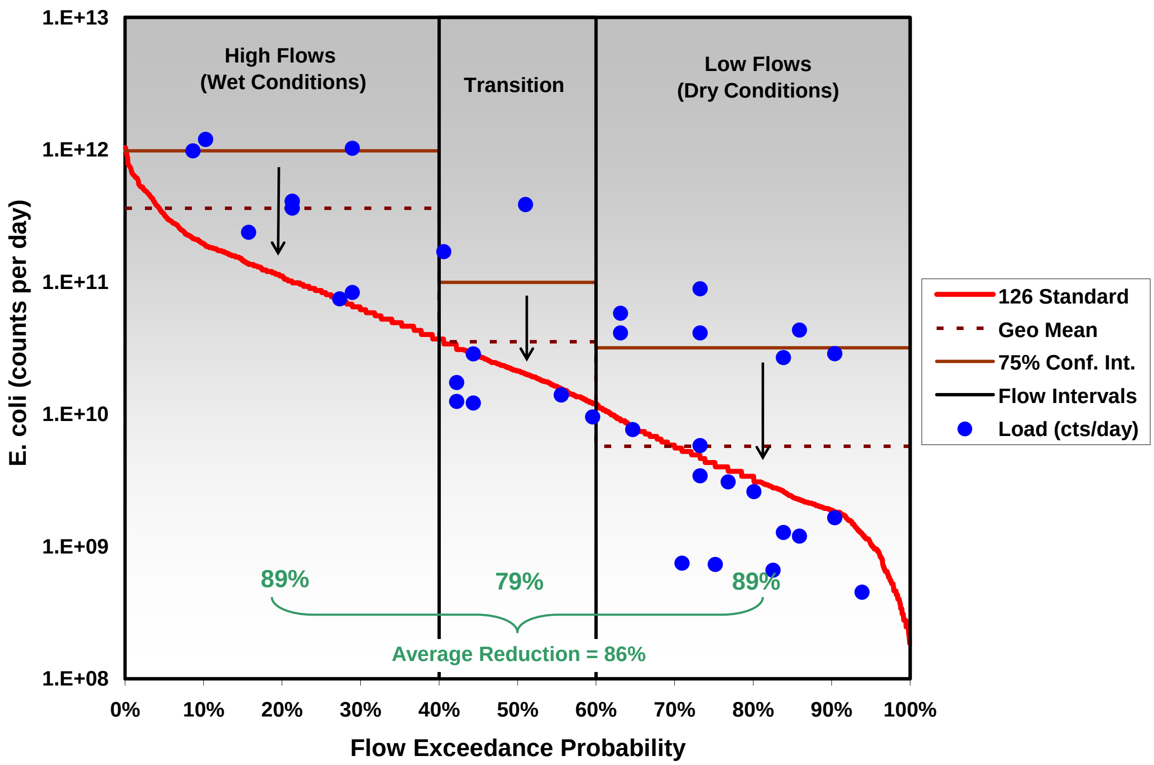


Table 4.5 shows the loading capacities necessary to achieve the 126 organisms/100 ml criterion under several flow conditions in Beaver Creek. The same information is presented graphically in **Figure 4.12**, above. Load capacity was developed for several flow intervals delineated within the Beaver Creek load duration curve.

Table 4.5. Flow Based Load Capacity to meet 126 organisms/100 ml *E. coli* criterion in Beaver Creek.

Flow (cfs)	Flow Exceedance Probability	Load to meet geometric mean of 126 cfu/100 ml (counts per day)
0.6	90%	1.88E+09
1.4	75%	4.31E+09
3.9	60%	1.20E+10
6.9	50%	2.13E+10
12	40%	3.70E+10
27	25%	8.32E+10
63	10%	1.94E+11

4.7 ALLOCATIONS AND RESERVE CAPACITY– 40 CFR 130.2(G) AND (H)

Load allocations are expressed in terms of the percent reduction necessary to achieve the numeric criteria in order to translate the acceptable loads into more applicable measures of performance. While it may be possible to tailor load allocations in some watersheds based upon dominant sources, watersheds with diverse land uses such as Beaver Creek, Kelly Creek and, to a lesser extent, Cedar Creek, do not tend to lend themselves to this type of approach due to the presence of multiple bacteria sources.

ODEQ chose to calculate the percent reduction necessary to achieve the 126 organisms/100 ml criterion and applied this reduction to nonpoint source (load) allocations. The percent reduction, determined conservatively by using the 75^{th} percentile of the measured samples (rather than the geometric mean and calculating the reduction necessary to meet the geometric mean criteria) is **86%** (**Figure 3.12**). Therefore, load allocations will be expressed as an 86% reduction from the levels observed in the 1999-2003 data. ODEQ believes that this approach will aid in implementation of the TMDL because it sets a tangible and common goal for both point and nonpoint source management practices and programs. A detailed analysis of bacteria contributions from particular land uses was not possible using existing data. Therefore, the 86% reduction applies to both urban and rural land use types. ODEQ will work with designated management agencies to develop more precise land use-based allocations as additional information becomes available.

Point Source waste load allocations reflect daily and monthly effluent bacteria concentrations designed to ensure that water quality standards are met. At least one Confined Animal Feeding Operation (CAFO), requiring an NPDES permit with oversight by the Oregon Department of Agriculture, is present in the Sandy River basin. CAFO waste load allocations have been reduced to zero (0) to reflect the permit requirement that no discharge is allowed from the confinement and manure management areas. This is distinguished from pasture lands that may be used by animals for grazing, which are given a load allocation along with other rural bacteria sources. **Table 4.6** contains a summary of the bacteria allocations.

Reserve Capacity

No reserve capacity is allotted at this time for bacteria in Sandy River basin water bodies. Future permitted sources of bacteria will be required to meet the water quality criteria or 126 E. coli counts/100 ml as a geometric mean and no sample greater than 406 E. coli counts/100ml.

Table 4.6. Bacteria Load and Waste Load Allocations

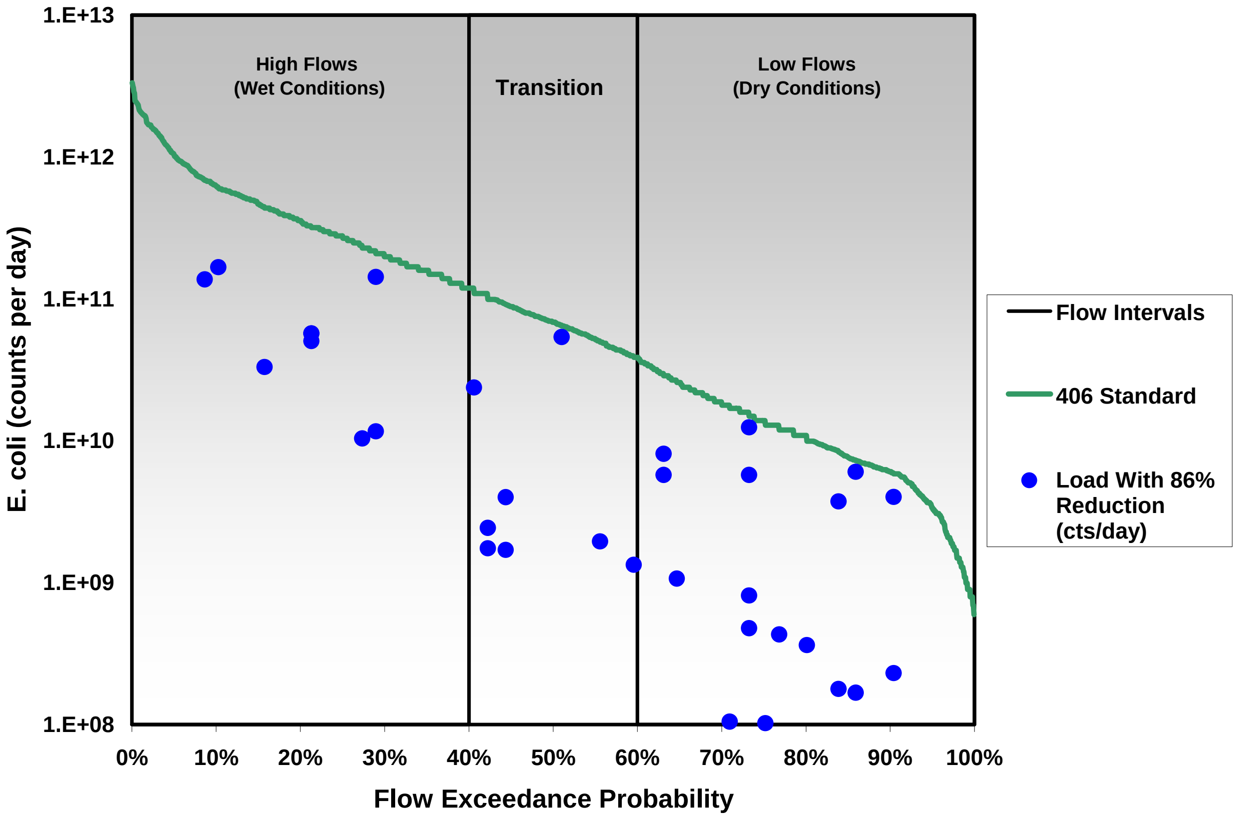
Subtable A: NPDES Point Source Waste Load Allocations	
Source Name	**Waste Load Allocation**
Sewage Treatment Plants	**Monthly log mean of 126 E. coli organisms per 100ml and no single sample above 406 E. coli organisms per 100ml**
Confined Animal Feeding Operations	**0 E. coli organisms per 100ml**
Municipal Storm Sewer System	**86% reduction**
Subtable B: Nonpoint Sources	
Source	**Load Allocation** **Percent Reduction**
All land use categories and sources	**86%**

4.8 WATER QUALITY STANDARD ATTAINMENT ANALYSIS – CWA §303(D)(1)

While the focus of many of the analyses presented in this document and in the allocations described above has been on the load reductions necessary to the 126 organisms/100 ml criterion, attainment of the criterion of 406 organisms/100 ml was also considered.

For example, the geometric mean of all samples collected Beaver Creek between 1999 and 2003 is 230 cfu/100 ml, which would require a 45% reduction in order to meet the 126 organisms/100 ml geometric mean criterion. However, analysis of the monitoring data shows that a 45% reduction would not ensure that the 406 organisms/100 ml criterion is adequately protected. To ensure that both criteria are protected, the percent reduction necessary to achieve the 126 organisms/100 ml criterion was adjusted to be protective of the 406 organisms/100 ml criterion. This was achieved by conservatively adjusting the percentile used to calculate the necessary percent reduction. In this case the 75^{th} percentile was used to calculate the necessary reduction, which raised the necessary percent reduction to 86%. Applying this percent reduction to the available data shows that the 406 organisms/100 ml criterion is also protected (**Figure 4.14**).

Figure 4.14. 86% allocated percent reduction applied to Beaver Creek bacteria data.



4.9 MARGINS OF SAFETY

The margin of safety applied to the bacteria TMDL for the Sandy River basin is implicit in assumptions made about the surrogate measure, percent reduction. The margin of safety is applied through the conservative calculation of the 75^{th} percentile to compare to the 126 *E. coli* counts / 100 mL log mean criteria. The 75^{th} percentile values were greater than the log mean values of the same data sets. The use of this “overestimation” of the log mean for purposes of defining percent reductions results in a slight overestimation of the needed reduction, giving an appropriate margin of safety to protect against under-estimation of the mean.

CHAPTER 5 – DISSOLVED OXYGEN DISCUSSION

Overview and Background

The primary benefit of maintaining adequate dissolved oxygen (DO) concentrations is to support a healthy and balanced distribution of fish, invertebrates, and other aquatic life. As with the temperature standard described in **Chapter 3** of this document, the dissolved oxygen standard is designed to protect cold water fish (salmonids) as the most sensitive beneficial use. The lower Sandy River, from the mouth to Marmot Dam at river mile 30, was listed as impaired due to low dissolved oxygen levels on Oregon's 2002 list of water quality limited water bodies (303d list).

Dissolved oxygen in streams may fall below healthy levels for a number of reasons, including carbonaceous biochemical oxygen demand (CBOD) within the water column, nitrogenous biochemical oxygen demand (NBOD), algal and/or zooplankton respiration and sediment oxygen demand (ODEQ 2000). Additionally, water temperature influences both the concentration of oxygen in water at saturation and the biological requirements for oxygen. The amount of oxygen that water can hold in a dissolved state is reduced as temperature increases while the biological demands for oxygen generally increase as temperature increases (ODEQ 1995). For example, at 10°C, 100% DO saturation is 11.3 mg/L; at 30°C the same water sample would contain only 7.6 mg/L of dissolved oxygen at 100% saturation.

Recall that **Figure 3.2** shows that salmonids utilize the lower portions of the Sandy River for spawning and incubation during the October 15 through May 15 time period. However, the Sandy River dissolved oxygen 303d listing was based upon the assumption that spawning occurred during the September 15 through June 30 time period. Oregon's recently revised water quality standards, approved by EPA on March 2, 2004, formalize the salmonid life stage timing information by which to measure compliance with the numeric dissolved oxygen criteria.

Water Quality Standard

The dissolved oxygen water quality criteria applicable to the Sandy River Basin are described in the Oregon Administrative Rules 340-041and summarized in (**Figure 5.1**).

Figure 5.1. Sandy River Basin Dissolved Oxygen Standard

Summarized from Oregon Administrative Rule 340-041-0016:

(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 in OAR 340-041-0286, Figure 286B, (as well as any active spawning area used by resident trout species), the following criteria apply:

(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 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 criterion, 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);

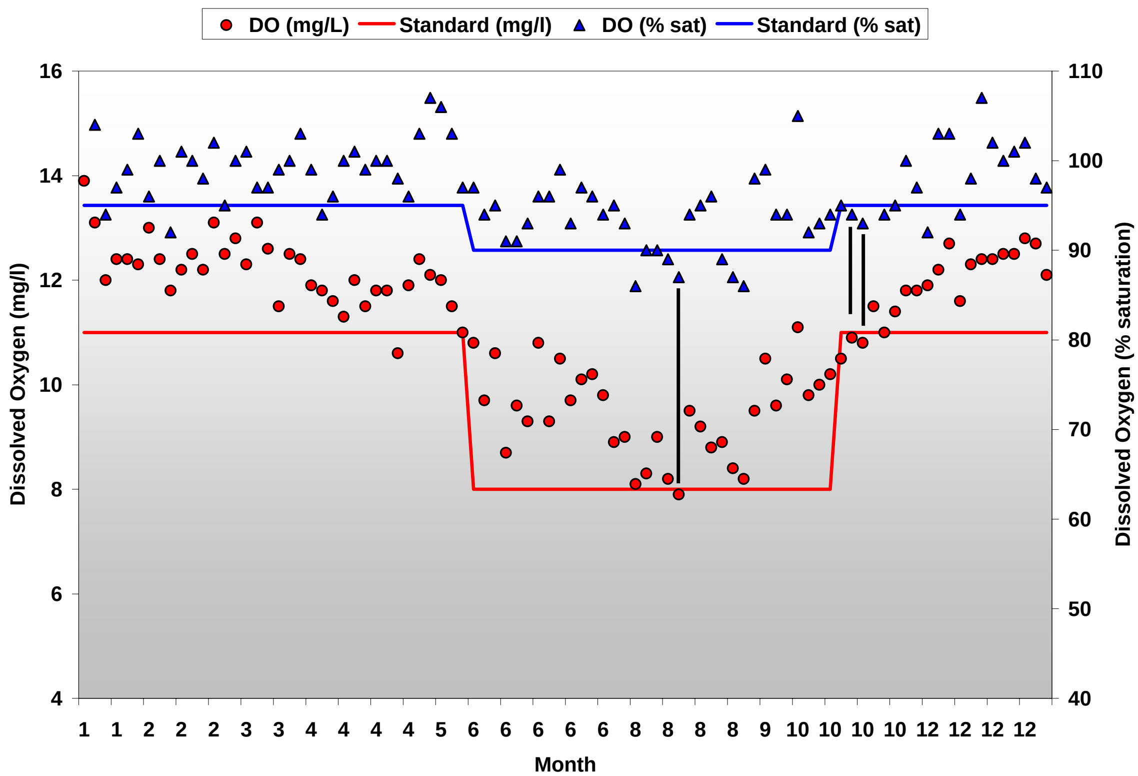
Deviation from Water Quality Standards

The ODEQ Laboratory monitors the Sandy River at Troutdale Bridge (RM 3.1) as part of the statewide ambient water quality monitoring program. In developing the 2002 303(d) list, ODEQ evaluated the data from 68 sampling events that occurred at this site between 1991 and 2000. Each sample collected was evaluated to see whether it met both the percent saturation (%) and the concentration (mg/l) criteria. Ten samples (14.7%) failed to meet standard, resulting in the 303d listing for dissolved oxygen. As noted above, however, these data were evaluated based upon the assumption that salmonid spawning was occurring during the September 15 through June 30 time frame rather than the October 15 through May 15 time frame designated in Oregon's revised water quality standards.

Results from 90 dissolved oxygen samples collected at the Troutdale Bridge monitoring location between 1991 and 2003, compared with the applicable numeric criteria that incorporate the October 15 through May 15 salmonid spawning time period, are shown in (**Figure 5.2).** The data are organized by month. The blue line represents the dissolved oxygen percent saturation criterion and the red line represents the dissolved oxygen concentration criterion. The blue and red markers depict the measured dissolved oxygen percent saturation and concentration, respectively. The three data pairs that failed to meet the dissolved oxygen criteria are bridged by a black line. Each of the 90 sampling events have two measured dissolved oxygen values associated with them, percent saturation and concentration in milligrams per liter.

The data presented in **Figure 5.2** shows that deviations from the water quality standards are very minor, with only 3 of 90 samples failing to achieve the criteria. The three samples that violated the DO standard had DO percent saturation values within 3% and concentration values within 0.2 mg/l of the applicable criteria. Based upon the latest salmonid spawning timing information, the lower Sandy River would not be 303d listed for dissolved oxygen.

Figure 5.2. Dissolved Oxygen Measurements made by ODEQ at the Troutdale Bridge, 1991-2003



Other Water Quality Indicators

Given the modest violations of the numeric DO standard observed at the Sandy River monitoring location, ODEQ attempted to identify other water quality indicators that may corroborate the existence of a dissolved oxygen problem in the lower Sandy River.

As explained above, there are several factors which may contribute to a dissolved oxygen deficit in the lower Sandy River, including Nitrogenous BOD, Carbonaceous BOD, algal growth, sediment oxygen demand and temperature. ODEQ attempted to assess the magnitude of the oxygen demand associated with these processes and/or whether they are likely to have any impact at all.

Below are a brief description of these oxygen-demanding processes (excerpted from ODEQ 2000) and an analysis of their potential to impact dissolved oxygen concentrations in the lower Sandy River:

NBOD and CBOD – 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.

Water column carbonaceous biochemical oxygen demand is the oxygen consumed by the decomposition of organic matter in water. The sources of the organic matter can be varied, either resulting from natural sources such as direct deposition of leaf litter or from anthropogenic sources such as polluted runoff.

Water quality data collected at the Troutdale Bridge monitoring location between 1990 and 2000 showed very low levels of both nitrate/nitrite and ammonia, with an overall average of 0.12 and 0.024 mg/l, respectively. Additionally, BOD_5 levels during the same time period averaged only 1.1 mg/l, discounting the likelihood of a significant pollution source impacting NBOD or CBOD oxygen demand (**Table 5.1**).

Simply put, if a pollutant source is suspected of contributing to stream dissolved oxygen depletion via CBOD or NBOD, one would expect to see elevated levels of ammonia, BOD_5, nitrate/nitrite or algal biomass at some point in the system. The water quality data does not show elevated levels of ammonia or nitrate/nitrite at the Troutdale monitoring location and algal biomass (described below) is also quite low.

Table 5.1. Average concentrations of various water quality parameters measured at the Troutdale Bridge monitoring location

	Nitrate/nitrite (mg/l)	Ammonia (mg/l)	BOD_5 (mg/l)	Chlorophyll-*a* (µg/l)	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
1990-2000 Median	0.12	0.024	1.1	3.4	0.20	0.03
ODEQ Minimum Reporting Level	0.02	0.016	0.03	1	0.16	0.01

The interplay between NBOD, CBOD and water quality can be complex, especially when trying to characterize the impact of a significant point source load to a stream. In addition to drawing conclusions from monitoring data collected at the Troutdale Bridge site, ODEQ identified two potential upstream point sources, the Hoodland and Government Camp sewage treatment plants, which could theoretically contribute to dissolved oxygen problems in the lower river. The Troutdale sewage treatment plant was not considered because it is downstream of the Troutdale Bridge monitoring location.

A Streeter/Phelps model was used to assess the potential for these two discharges to impact DO concentrations. Extremely conservative assumptions were used (7Q10 stream low flow, maximum design flow from the facilities, ammonia and BOD levels at the permit limit, and low discharge DO concentrations) in the analyses. The model predicted maximum DO sag of 0.05 mg/l (0.1 mg/l is considered “measurable”) occurring approximately 11 miles downstream of the Hoodland STP under these extreme conditions. Recall that the Hoodland STP is approximately 35 miles upstream of the Troutdale Bridge monitoring location. The same analysis on the Government Camp STP, with a much smaller capacity and located 15 miles upstream of the Hoodland facility, yielded a maximum DO sag of 0.02 mg/l occurring six miles downstream. Both analyses clearly show that, even under extreme conditions, the treatment plants do not have a negative impact on DO in the lower Sandy River.

Algal Growth – In some waterbodies, dissolved oxygen concentrations may be violated because of algae. Excessive algae concentrations can cause large diel fluctuations in DO. Such streams generally exhibit supersaturated dissolved oxygen concentrations during the day and low DO concentrations at night. The State of Oregon has designated an action level of 15 µg/L concentration of chlorophyll *a* (a measure of algal content) to indicate when algal growth may be a problem.

Chlorophyll a levels measured at the Troutdale Bridge monitoring location between 1990 and 2002 fall well below Oregon’s 15 µg/l action level, with a median value of 3.4 µg/l. Median Total Nitrogen and Total Phosphorus concentrations over the same time period are 0.2 and 0.03 mg/l, respectively. ODEQ does not currently have nutrient water quality standards for comparison, but it should be noted that the analytical methods used to measure total nitrogen and phosphorus have a minimum reporting level of 0.16 and 0.01 mg/l, respectively (**Table 5.1**). Low concentrations of chlorophyll *a* and nutrients indicate that algal productivity is not at a level which would indicate a pollution problem contributing to low DO measurements in the lower Sandy River.

Sediment Oxygen Demand – When solids containing organic matter settle to the bottom of a stream they may decompose anaerobically or aerobically, depending on conditions. The oxygen consumed in aerobic decomposition of these sediments is called sediment oxygen demand (SOD) and represents another potential dissolved oxygen demand in a stream. The SOD may differ from both water column CBOD and nitrification in that SOD will remain a DO sink for a much longer period of time.

ODEQ is not aware of any SOD measurements taken in the vicinity of the Troutdale Bridge monitoring locations and, therefore, cannot quantify the impact that SOD may have on DO levels. However, one would expect to see SOD impacts in areas that allow the deposition of fine-grained, organic rich particles – typically deeper, slow moving streams with fine substrates. **Figure 5.3** shows that the substrate at the Troutdale Bridge monitoring location is boulder, gravel and sand, not the depositional environment where SOD is likely to contribute to low dissolved oxygen levels.

Temperature – 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 the can remain dissolved in water decreases. The second is that, in general, all of the other dissolved oxygen sinks (demands) listed above increase their oxygen consumption as temperature increases.

Heat Source temperature modeling performed on the Sandy River during TMDL development showed that, under system potential conditions, the water temperature at the Troutdale Bridge monitoring location would drop approximately 1°C, from 21.5°C to 20.5°C. Cooling the water from 21.5°C to 20.5°C would allow it to hold slightly more dissolved oxygen, approximately 0.2 mg/l. Ideally, ODEQ would utilize a dissolved oxygen computer model to predict the improvement in DO concentrations resulting from the system potential temperature scenario modeled in the temperature TMDL. However, this is impractical for a couple of reasons. The model used to determine the temperature TMDL was calibrated for August 8, 2001. Therefore, the stream temperature reduction predicted is only valid for that day. It would require a great deal of effort to both develop a dissolved oxygen model for the Sandy River and to make accurate assumptions about temperature improvements in the lower river during the June and October time period when DO standard violations have been measured. Lastly, system potential temperatures resulted in a very slight increase in the amount of dissolved oxygen that can remain dissolved in water at the Troutdale monitoring locations on the day the model was calibrated.

Figure 5.3. Looking upstream from the Troutdale Bridge monitoring location

Intergravel Dissolved Oxygen (IGDO) Measurements

As an added measure of certainty, ODEQ chose to evaluate IGDO in the lower Sandy River and assess whether compliance with the IGDO criterion of the dissolved oxygen water quality standard is being achieved in the lower Sandy River. Intergravel dissolved oxygen (IGDO) is an important component of Oregon's dissolved oxygen water quality standard due to the fact that it directly influences the survival of salmonid embryos.

To assess IGDO concentrations in the lower Sandy River ODEQ personnel collected field measurements of IGDO in the mainstem Sandy River on May 30, 2003 at a location near Oxbow Park. The monitoring area is located slightly river-left of the thalweg, approximately 400 meters downstream of the Oxbow Regional Park boat ramp (RM12.3). The monitoring location was chosen in consultation with ODFW fisheries biologists and is representative of spawning habitat in the lower portion of the river. Surface water temperature was 14.0°C and ambient air temperature was 17.9°C.

Six IGDO measurements were made at three locations in the sample area. The spatial median of the six IGDO measurements was 9.4 mg/l, which is well above the IGDO spatial median criterion of 8.0 mg/l. Further, the sampling was conducted on May 30th, which is beyond the time period when the spawning criterion of 11 mg/l would apply to the lower Sandy River.

Two surface water DO measurements were also made during the May 30th sampling event. Both measured 10.2 mg/l, which is well above the 8.0 mg/l criterion applicable during salmonid rearing time periods and also protective of the 9.0 mg/l spawning criterion that applies when IGDO measurements are above 8.0 mg/l.

Conclusion

Dissolved oxygen measurements on the lower Sandy River have occasionally failed to meet the State of Oregon surface water quality criteria. Consequently, the lower Sandy River was included on Oregon's 2002 list of water quality limited water bodies (303d list) for failing to meet the dissolved oxygen standard. Oregon's revised water quality standards, approved by EPA on March 2, 2004, include refined salmonid distribution and spawning information that was not considered during the 2002 303d listing process. A review of water quality data collected between 1991 and 2003, compared with the revised use and timing information included in Oregon's water quality standards, reveals minimal (3%) violations of the dissolved oxygen standard in the lower Sandy River.

Additionally, no potential anthropogenic sources that have the ability to adversely impact dissolved oxygen concentrations in the lower Sandy River were identified, either through an examination of water quality indicators or a review of potential anthropogenic sources in the basin. In fact, the water quality of the Sandy River is considered by ODEQ to be excellent throughout the year and is one of the most pristine river systems in the State.

Further, an analysis of IGDO in the lower Sandy River revealed that the criterion is being met and that the beneficial use (salmonid spawning through fry emergence life stages) is being achieved.

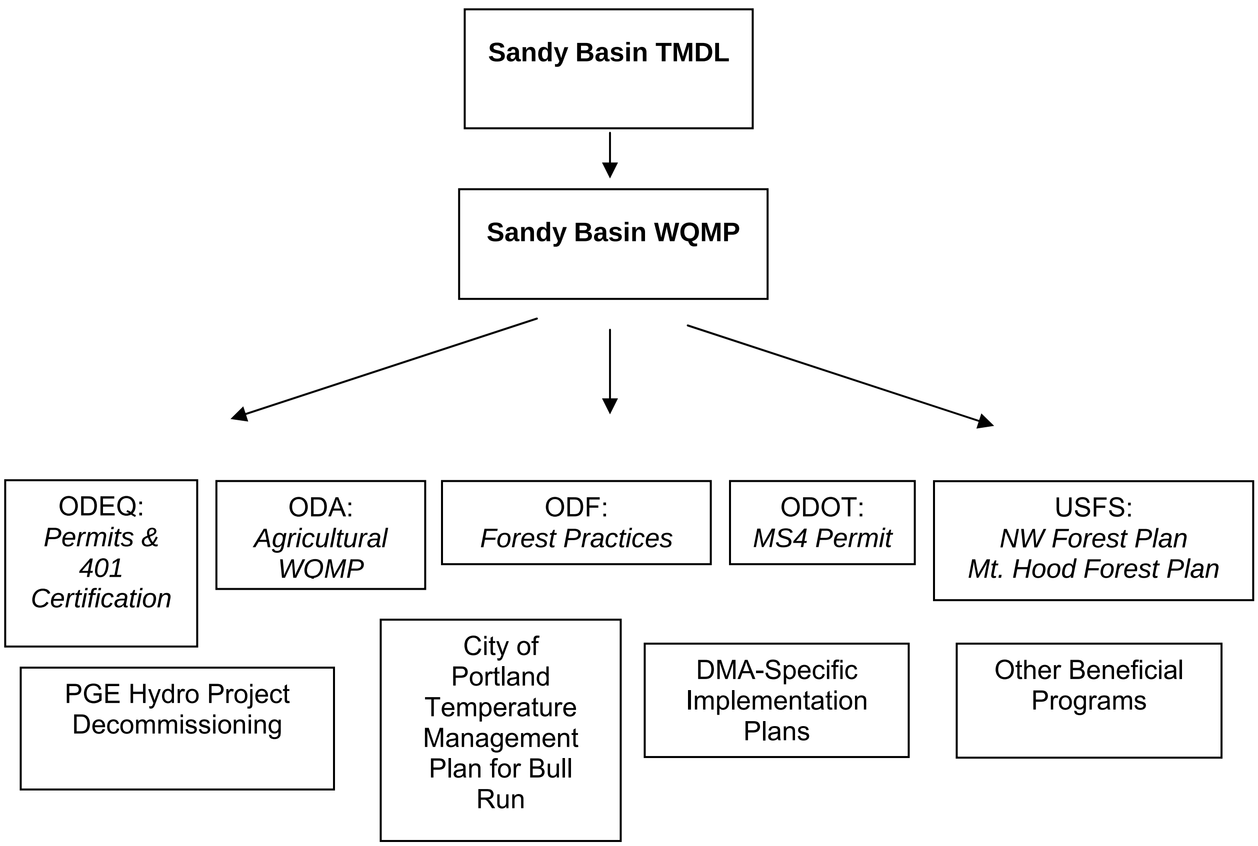
Closer examination of the data and an analysis of potential anthropogenic causes for the impairment show that the 303d listing is unwarranted and that a TMDL should not be established for dissolved oxygen at this time. ODEQ will propose to de-list the lower Sandy River for dissolved oxygen during the 2004 303d listing process based upon this analysis and will continue to routinely monitor the lower river for dissolved oxygen to ensure that the water quality standard continues to be met.

CHAPTER 6 – WATER QUALITY MANAGEMENT PLAN

6.1 INTRODUCTION

This chapter describes strategies for implementing and achieving the Sandy Basin Total Maximum Daily Load (TMDL). The main body has been prepared by the Oregon Department of Environmental Quality (ODEQ) and includes a description of activities, programs, legal authorities, and other measures for which ODEQ and the basin's designated management agencies (DMAs) have regulatory responsibilities. This Water Quality Management Plan (WQMP) is the overall framework describing the management efforts to implement the Sandy Basin TMDL. This relationship is presented schematically in **Figure 6.1**, below.

Figure 6.1. TMDL/WQMP/Implementation Plan Schematic



ODEQ recognizes that TMDL implementation is critical to the attainment of water quality standards. Additionally, the support of DMAs in TMDL implementation is essential. In instances where direct authority for implementation is, pursuant to Oregon Revised Statute, located in another agency, ODEQ will work with that agency on implementation to ensure attainment of the TMDL allocations and, ultimately, water quality standards. Where authority for implementation is not specifically established with an agency or DMA, ODEQ will use its own statutory authority to ensure attainment of the TMDL allocations (and water quality standards).

This chapter is a starting point and foundation for the WQMP elements being developed by ODEQ and Sandy Basin DMAs. DMA-specific Implementation Plans will be more fully developed once the current

TMDL is submitted to the U. S. Environmental Protection Agency (EPA) and approved. ODEQ and the DMAs will work cooperatively in the development of the TMDL Implementation Plans and ODEQ will assure that the plans adequately address the elements described below under “TMDL Water Quality Management Plan Guidance”.

6.1.1 TMDL Water Quality Management Plan Guidance

ODEQ and USEPA have a Memorandum of Agreement (MOA) defining what is to be included in an approvable Total Maximum Daily Load (TMDL) document. In December 2002 the State of Oregon’s Environmental Quality Commission (EQC) adopted OAR 340-042, commonly referred to as the Total Maximum Daily Load (TMDL) rule. The rule captures the intent of the MOA and clearly defines ODEQ’s responsibilities for developing, issuing, and implementing TMDLs as required by the federal Clean Water Act (CWA).   The elements of the original DEQ/EPA MOA, outlined below, will serve as a framework for this WQMP.

WQMP Elements

1. Condition assessment and problem description
2. Goals and objectives
3. Identification of responsible participants
4. Proposed management measures
5. Timeline for implementation
6. Reasonable assurance
7. Monitoring and evaluation
8. Public involvement
9. Costs and funding
10. Citation to legal authorities

This WQMP is organized around these plan elements and is also intended to fulfill the requirements contained in OAR 340-042-0040 – Oregon’s TMDL Rule. Reference to OAR 340-042-0040 is made in the appropriate section headings.

6.2 CONDITION ASSESSMENT AND PROBLEM DESCRIPTION – OAR 340- 42- 0040(4)(1)(A)

The Condition Assessment and Problem Description are provided above in **Chapter 2**, *Description of the Sandy River Basin* and **Chapters 3 and 4**, *TMDL for Stream Temperature* and *Bacteria TMDL,* respectively.

6.3 GOALS AND OBJECTIVES – OAR 340- 42- 0040(4)(1)(B)

The overall goal of the TMDL Water Quality Management Plan (WQMP) is to achieve compliance with water quality standards for stream temperature and bacteria in the Sandy River basin. The WQMP describes all DMA plans that are or will be in place to address the load and waste load allocations in the TMDL. The specific goal of this WQMP is to describe a strategy for reducing discharges from nonpoint sources to the level of the Load allocations and for reducing discharges from point sources to the level of the waste load allocations described in the TMDL.

In order for the WQMP to meet its goal, DEQ expects DMAs to fulfill the following objectives:

- Develop Best Management Practices (BMPs) or other management methods to achieve load allocations and waste load allocations
- Give reasonable assurance that management measures will meet load allocations; through both quantitative and qualitative analysis of management measures
- Adhere to measurable milestones for progress
- Develop a timeline for implementation, with reference to costs and funding
- Develop a monitoring plan to determine if:
  a. BMPs are being implemented
  b. BMPs are effective
  c. Load and waste load allocations are being met
  d. Water quality standards are being met

6.4 IDENTIFICATION OF RESPONSIBLE PARTICIPANTS – OAR 340-42- 0040(4)(1)(G)

The purpose of this section is to identify the organizations responsible for the implementation of the plan and to list the major responsibilities of each organization. The following list is not intended to be an exhaustive list of every participant that bears some responsibility for improving water quality in the Sandy River watershed. Because this is a community-wide effort, a complete listing would have to include every business, every industry, every farm, and ultimately every citizen living and working within the basin.

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

- NPDES Permitting[11] and Enforcement
- Section 401 Certification
- Technical Assistance
- Financial Assistance

OREGON DEPARTMENT OF AGRICULTURE

- Agricultural Water Quality Management Plan Development Implementation & Enforcement
- Technical Assistance
- Revise Agricultural AWQMP
- Rules under Senate Bill (SB) 1010 to clearly address TMDL and load allocations as necessary
- Conservation Reserve Enhancement Program
- Riparian area management

OREGON DEPARTMENT OF FORESTRY

- Forest Practices Act (FPA) Implementation
- Revise statewide FPA rules and/or adopt subbasin specific rules as necessary
- Riparian area management

[11] A list of NPDES permitted sources is on page 62 of the TMDL.

OREGON DEPARTMENT OF TRANSPORTATION

- Routine Road Maintenance, Water Quality and Habitat Guide Best Management Practices
- Pollution Control Plan and Erosion Control Plan
- Road Design and Construction

FEDERAL LAND MANAGEMENT AGENCIES

- Implementation of Northwest Forest Plan and Mt. Hood National Forest Land and Resource Management Plan
- Riparian area management
- Land acquisition, restoration

CITY OF PORTLAND WATER BUREAU

- Implement Habitat Conservation Plan or Temperature Management Plan.
- Flow management
- Riparian area management

CITIES WITHIN THE SANDY BASIN

- Construction, operation, and maintenance of the municipal separate storm sewer system within the city limits
- Construction, operation and maintenance of wastewater treatment plants and sanitary sewer system
- Land use planning/permitting
- Maintenance, construction and operation of parks and other city owned facilities and infrastructure
- Riparian area management

MULTNOMAH COUNTY

- Construction, operation and maintenance of County roads and county storm sewer system.
- Land use planning/permitting
- Maintenance, construction and operation of parks and other county owned facilities and infrastructure
- Inspection and permitting of septic systems
- Riparian area management

CLACKAMAS COUNTY

- Construction, operation and maintenance of County roads and county storm sewer system
- Construction, operation and maintenance of wastewater treatment plants and sanitary sewer system
- Land use planning/permitting

- Maintenance, construction and operation of parks and other county owned facilities and infrastructure
- Inspection and permitting of septic systems
- Riparian area management

Portland General Electric

- Decommission Bull Run Hydroelectric Project.

METRO

- Riparian area management planning
- Land acquisition

SANDY RIVER WATERSHED COUNCIL

- Implement Action Plan

Table 6.1, below, shows stream segments in the Sandy Basin watershed which exceed the state's temperature and bacteria criteria along with the responsible DMAs. Data for this table was compiled from the 2002 303(d) list and from the results of stream temperature monitoring conducted in 2001. If a stream reach exceeds the temperature criteria, then that reach plus all reaches upstream of the exceedance (and tributaries) are included in this table since anthropogenic influences will need to be addressed at points upstream.

Metro and the Sandy River Basin Watershed Council are listed above, but not included in **Table 6.1** because they either have no regulatory authority (SRBWC) or are simply purchasing riparian lands for the purposes of protection (Metro). They will not be required to submit an implementation plan, but are included because the work that they are doing has the potential to improve water and habitat quality in the watershed.

Table 6.1. Geographic Coverage of Designated Management Agencies in the Sandy River Watershed

Stream	Parameter	Included on 2002 303(d) List	Designated Management Agencies
Sandy River	Stream Temperature	yes	ODF, MHNF, ODA, BLM, ODOT, MC, PGE, Metro, CC, TD
Bull Run River	Stream Temperature	yes	PDX, MHNF
Little Sandy River	Stream Temperature	no	PGE, MHNF, PDX
Zigzag River	Stream Temperature	no	MHNF
Salmon River	Stream Temperature	yes	MHNF
Cedar Creek	Bacteria	yes	CC, SA
Beaver Creek	Bacteria	yes	MC, GR, TD
Kelly Creek	Bacteria	yes	MC, GR
PDX=City of Portland MC=Multnomah County MHNF=Mt. Hood National Forest ODA=Oregon Dept. of Agriculture ODF=Oregon Dept. of Forestry ODOT=Oregon Department of Transportation BLM=Bureau of Land Management CC=Clackamas County TD=Troutdale GR=Gresham SA= City of Sandy			

6.5 PROPOSED MANAGEMENT MEASURES – OAR 340- 42-0040(4)(1)(C)

This section of the plan outlines the proposed management measures that are designed to meet the waste load allocations and load allocations of each TMDL. The timelines for addressing these measures are given in the following section.

ODEQ acknowledges that many DMAs have already begun planning or actually implementing management strategies for improving and protecting water quality. For those DMAs just beginning the water quality improvement process, ODEQ has assembled an initial listing of management strategies that could be considered by DMAs as they develop Implementation Plans. Each DMA is responsible for source assessment and identification, which may result in additional categories. DMAs may need to develop other source categories and management strategies to meet their specific situations. ODEQ does expect that Implementation Plans will address how human activities will be managed to improve water quality with appropriate management strategies and recognizes that it is crucial that management measures be directly linked with their effectiveness at reducing pollutant loading. In addition, ODEQ is developing TMDL implementation guidance to assist DMAs.

Source Categories with Management Strategies

The following listing identifies a potential source category with proposed management strategies under that source category.

- New Development and Construction
  - Planning Procedures
  - Permitting/Design
  - Construction Control Activities
  - Inspection/Enforcement
  - Education and Outreach
- Existing Development
  - Storm Drain System
  - Street and road Maintenance
  - Operations and Maintenance
  - Septic Systems
  - Parking Lots
  - Commercial and Industrial Facilities
  - Fertilizers, Pesticides, Other Toxics
  - Animal Waste
  - Illicit Connections and Illegal Dumping
  - Education and Outreach
  - BMP Monitoring and Evaluation
  - Instream Monitoring
  - BMP Implementation Monitoring
- Residential
  - Illegal Dumping
  - Illicit Discharges and Cross Connections
  - Septic Systems
  - Animal Waste
  - Education and Outreach
- Commercial and Industrial
  - Illegal Dumping
  - Illicit Discharges and Cross Connections
  - Education and Outreach

- Riparian Area Management
  - Rural/Urban Residential Riparian
  - Protection/Enhancement
  - Stream bank Stabilization
  - Public Governmental Facilities
  - Parks/Public Waterbodies (Ponds, etc.)
  - Municipal Yard Operations and Maintenance
  - Other Public Facilities
  - Education and Outreach
  - BMP Monitoring and Evaluation
  - Instream Monitoring
  - BMP Implementation Monitoring
- Forestry Practices
  - Implement Forest Practices Act
  - Implement Federal Forest Lands & Resource Management Plans
  - Riparian Protection/Enhancement
  - Replace/Restore Roads/Culverts
  - Yard Operations and Maintenance
  - Stream bank Stabilization
  - Wildfire Prevention/Suppression
  - Uplands Management
  - Inspection/Enforcement
  - Season of Use
  - Education and Outreach
  - BMP Monitoring and Evaluation
  - Instream Monitoring
  - BMP Implementation Monitoring
- Agricultural Practices
  - Implement SB 1010 Ag Water Quality Management Area Plans
  - Animal Waste/Livestock Management
  - Nutrient Management Plans
  - Riparian Protection/Enhancement
  - Wetland Protection/Enhancement
  - Reconnect Sloughs and Rivers
  - CAFO Program Implementation
  - Uplands Management
  - Stream bank Stabilization
  - Season of Use
  - Education and Outreach
  - BMP Monitoring and Evaluation
  - Instream Monitoring
  - BMP Implementation Monitoring
- Dam Operation and Maintenance
  - Develop and Implement Temperature Management Plans (TMP)
  - Water Quality Monitoring
  - Facility Yard Operations and Maintenance
- Planning and Assessment
  - Source Assessment/Identification
  - Source Control Planning
- Transportation
  - Road Construction
  - Road Maintenance and Repair
  - Education and Outreach

6.5.1 Bacteria Source Tracking

Bacteria Source Tracking is a potentially powerful source assessment tool. Proper study design is crucial

ODEQ recognizes that, in the long term, it may be difficult to address bacteria water quality impairments in lower Sandy River tributaries without a reliable method to determine the source of contamination. However, given the known bacterial sources and the severity of bacterial water quality standards violations noted above, considerable progress can be made toward achieving water quality standards simply by targeting known sources with appropriate Best Management Practices and currently accepted source tracking techniques.

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). BST may use one of several methods to differentiate between bacterial sources, all of which follow a common sequence of analysis. First, a distinguishing characteristic (such as antibiotic resistance or differences in DNA), must be selected to identify various strains of bacteria. A representative library of bacterial strains and their fingerprints must then be generated from the human and animal sources that may impact the water body in question. Bacteria samples from the water body are then compared to those in the library and assigned to the appropriate source category based on fingerprint similarity (EPA 2002).

Several BST methodologies are currently being developed and tested, including Pulse Field Electrophoresis (PFGE), Ribotyping (RT), Amplified Fragment Length Polymorphism (AFLP) and ARA. All techniques are considered experimental. A methods comparison study, sponsored by the Southern California Coastal Water Research Project, USEPA, NOAA, USGS, and the Orange County Sanitation District is currently underway.

There are several important considerations for choosing BST methods, namely their relevance to appropriate regulations, geographic areas and the ability to allocate loadings to particular source categories. Obviously, the association accuracy of the method and geographic range of the genetic library used are extremely important, as is the overall experimental design.

Lastly, for BST analyses to be truly useful, they must be conducted over a variety of flow and precipitation regimes over the course of a year and at multiple land use-based locations within a watershed. Samples should also be submitted for BST during times when bacteria water quality standards are not being achieved and must be accompanied by stream flow measurements and bacteria counts for each sample analyzed.

6.5.2 Sewage Treatment Plants and Sandy River Hatchery

The waste load allocations (**Section 3.9**) given to the three sewage treatment plants (Government Camp, Hoodland, and Troutdale), will be implemented through actions required by their National Pollutant Discharge Elimination System (NPDES) permits. These permits will include numeric effluent limits for temperature and bacteria. The Hoodland Sewage Treatment Plant, operated by Clackamas County Water Environment Services, submitted a Temperature Management Plan (TMP) to ODEQ in November, 2002. The City of Troutdale submitted a TMP to ODEQ in 2001 as part of their permit renewal. The current thermal loading for the Hoodland and Troutdale treatment plants is less than their respective WLAs, but insufficient information (stream flow and effluent temperature data) was available to fully assess the Government Camp facility. The Government Camp facility is currently collecting stream flow and effluent temperature and flow data towards the development of a TMP. Their permit will be reissued after a temperature analysis is completed. The treatment plants were not identified as sources of bacteria water quality violations in **Chapter 4** because they do not discharge to the affected streams. However, their permits also require compliance with bacteria water quality standards.

The Sandy River fish hatchery was assigned a numeric waste load allocation (**Section 3.9**). It currently operates under a general NPDES permit, though a new general permit that includes discharge characterization monitoring, including temperature, has been developed and approved. The new general permits are in the process of being issued as of April, 2004.

6.5.3 General NPDES Permitted Sources

General NPDES permits for Mt. Hood Community College and Legacy Mt. Hood Medical Center will be reviewed and, if necessary, modified to ensure compliance with allocations. General permits classified as 100J and 200J have expired, and because of lack of available resources, may not be renewed in the near future. Sources on general permits may be converted to individual permits, or waste load allocations may be incorporated into Memoranda of Agreements (MOAs). Permittees will operate under the MOAs until their permits are modified to meet the TMDL allocations.

6.5.4 Section 401 Certification

The removal of the PGE Bull Run Hydroelectric Project requires 401 certification from DEQ. The first 401 permit accompanied the FERC Decommissioning Order for Marmot Dam in November 2003. The 401 certificate requires PGE to complete two years of turbidity monitoring, and requires PGE to comply with a zero allocation for temperature increase by the end of 2009. The November 2003 401 certificate requires PGE to submit and erosion control plan. After review of that document, DEQ will review the certification to determine whether a second dredge and fill 401 will be needed. Though not allocated under this TMDL, this second permit will restrict turbidity increases from dam removal activities.

The City of Portland, in conjunction with state and federal fisheries and land management agencies including DEQ, is currently working on a Habitat Conservation Plan (HCP) to address both Endangered Species Act and Clean Water Act requirements. It is envisioned that the HCP will also lay the technical groundwork for future 401certifications associated with their projects.

6.5.5 Other Sources and Voluntary Programs

Metro Land Acquisitions

Metro's Land Acquisition program is a program designed to permanently put desirable, privately held lands under permanent protection. Metro defines desirable lands as those that offer the ability to conserve, protect and restore natural and scenic qualities, important fish and wildlife habitats, and preserve recreation resources. Metro is working with various federal, state, regional, and private organizations to identify lands with "willing sellers" and to implement goals set forth by the program.

Under the $135.6 million open spaces, parks, and streams bond measure that passed in May of 1995, Metro government has acquired nearly 7,000 acres by July of 2001. 1,100 acres is along the Sandy River (mostly in Sandy River Gorge between Dodge Park and Stark Street Bridge) and related tributary riparian areas.

Sandy River Basin Watershed Council

The Sandy River Basin Watershed Council (SRBWC) is officially recognized and supported by the Oregon Watershed Enhancement Board. The SRBWC has completed an OWEB-funded Watershed Assessment and a Phase I Action Plan that details restoration priorities for the basin. The Council is engaged in virtually every aspect of Sandy River basin management, and has completed riparian enhancement projects in the basin that directly address the needs outlined in this TMDL. It is expected that future restoration efforts, especially those on private lands within the basin, will be led by the SRBWC.

6.6 TIMELINE FOR IMPLEMENTATION – OAR 340- 42- 0040(4)(1)(D), (F) AND (I)

The purpose of this element of the WQMP is to document the schedule for implementing and maintaining the plan and the resulting water quality improvements over the long term. Included in this section are timelines for the implementation of ODEQ activities. Each DMA-specific Implementation Plan will also include timelines for the implementation of the milestones described earlier. Timelines should be as specific as possible and should include a schedule for BMP or management activity installation and/or evaluation, monitoring schedules, reporting dates and milestones for evaluating progress. These DMA-specific Implementation Plans will be submitted to ODEQ 18 months after this TMDL is approved by EPA and adopted by ODEQ. ODEQ believes achieving appropriate water quality targets is an ongoing process. Water quality improvement, depending on the pollutant and source of that pollutant, may take several TMDL iterations, decades of habitat restoration, or years of implementing a specific management strategy before measurable improvement is achieved. NPDES permits and Implementation Plans will describe, to the extent possible, more specific schedules for achieving appropriate water quality targets.

Permit programs include specific discharge limitations and compliance schedules that ensure water quality standards are met or will be attained within a reasonable timeline. Permits are reviewed and renewed on a 5-year cycle. Implementation Plans also include specific management strategies and timelines, with annual review and assessment by ODEQ, for progress toward attaining water quality standards. In addition, Implementation Plans will address costs and funding for improving water quality. All of these actions, taken together, will result in attainment of water quality standards.

Subject to available resources, on a five-year basis, ODEQ will review the progress of the TMDL and the WQMP. ODEQ envisions that minor changes will be made to existing TMDLs and that new parameters may be added on a five-year interval. More detailed revisions to the TMDLs will take place on a 10 -15 year cycle. **Table 6.2**, below, gives the timeline for activities related to the WQMP and associated DMA Implementation Plans.

Table 6.2. Water Quality Management Plan Timeline

Activity	2005		2006		2007		2008		2009		2010	
ODEQ Establish MAOs with NPDES Permitted Sources		■										
Permitted Sources Collect Flow and Temperature Data		■	■	■	■	■	■	■	■	■		
ODEQ Incorporate WLAs into Permits	■	■										
ODEQ Renew/Modify Permits for ODFW Hatcheries to Incorporate WQ-Based Limits		■										
ODEQ Review of General Permits to Ensure WLA-Based Limits are Included		■	■									
ODEQ and DMA effectiveness monitoring					■	■	■	■	■	■		
Development and Submittal of Implementation and Monitoring Plans by Other DMAs			■	■								
DMA Implementation of Plans				■	■	■	■	■	■	■	■	■

6.7 REASONABLE ASSURANCE – OAR 340- 42- 0040(4)(1)(J)

This section of the WQMP is intended to provide reasonable assurance that the WQMP (along with the associated DMA-specific Implementation Plans) will be implemented and that the TMDL and associated allocations will be met.

There are several programs that are either already in place or will be put in place to help assure that this WQMP will be implemented. Some of these are traditional regulatory programs such as specific requirements under NPDES discharge permits. Other programs address nonpoint sources under the auspices of state law (for state and private forested and agricultural lands) and voluntary efforts.

6.7.1 NPDES Permit Program

Reasonable assurance that implementation of the point source waste load allocations will occur will be addressed through the issuance or revision of NPDES permits. The ODEQ administers the National Pollutant Discharge Elimination System (NPDES) permits for surface water discharge. The NPDES permit is also a Federal permit, which is required under the Clean Water Act for discharge of waste into waters of the United States. ODEQ has been delegated authority to issue NPDES permits by the EPA. As the permits are renewed, they will be revised to insure that all 303(d) related issues are addressed in the permit. These permit activities assure that elements of the TMDL WQMP involving urban and industrial pollution problems will be implemented.

For point sources, provisions to address the appropriate WLAs will be incorporated into NPDES permits when permits are renewed by ODEQ, typically within 18 months after the EPA approves the TMDL. The current heat loading from the Hoodland and Troutdale sewage treatment plants is less than the WLAs allowed for each under the TMDL, so treatment plant upgrade should not be necessary to meet new permit limits. Bacteria effluent limitations are also currently being achieved at all treatment plants in the basin.

New WLAs for temperature will likely be incorporated into MOAs for Mt. Hood Community College and Legacy Mt. Hood Medical Center. The MOAs may serve in place of the General permits under which these facilities currently operate until the permits are renewed. The general NPDES permit under which the ODFW Sandy River fish hatchery operates will be revised to include the new WLA.

During the permitting process for this basin, ODEQ intends to evaluate the receiving streams and revise the permits as needed to address all water quality standards. Guidance for establishing permit limits pursuant to the WLAs established in this TMDL is provided below. Adherence to permit conditions is required by State and Federal Law and ODEQ has the responsibility to ensure compliance.

Once this TMDL is approved by the USEPA, ODEQ will reissue the permits for these sources to be consistent with the intent of the designated waste load allocations. At that time, ODEQ will obtain specific information about actual flows so that the resulting permit limits reflect actual conditions. In addition, in setting permit limits for temperature, the following should be considered:

1. Permit limits must be set so that there is no more than a 0.3°C cumulative increase over the applicable temperature criterion from all sources.
2. Renewed or modified permits issued pursuant to this TMDL should provide a time schedule allowing each point source permittee to collect specific temperature and flow data on its discharge and receiving stream and to devise control strategies to meet heat load limits.
3. The applicable temperature criterion and subsequent effluent limits apply during the critical periods as established by this TMDL and other sources. During the non-critical periods, temperature limits must still be set so as to not violate water quality standards in the receiving stream or in water bodies down stream to which the receiving stream is a tributary. In addition, in setting effluent limits for temperature in individual permits, the permit writer must also ensure that the source has applied highest and best practicable treatment and control to minimize the discharge of heat to the receiving stream.
4. In some cases, the receiving stream may not be in a critical period but it may be a tributary to stream which is in a critical period. In such situations, the permit writer must ensure that effluent limitations do not cause more than a 0.3°C increase above the appropriate temperature criteria in the down stream waterbody.
5. During critical periods, when a receiving stream is cooler than the appropriate temperature criteria, the permit may allow greater than 0.3°C increase provided that the criteria is not exceeded either in the receiving stream or any water body down stream.
6. In determining appropriate heat load limits, the permit writer base effluent limits on either ¼ of the stream or a dilution analysis of the regulatory mixing zone established in the current permit, whichever is more stringent.
7. ODEQ encourages permit writers to consider flow-based limitations for thermal discharges. Flow-based limitations are essentially limitations that expand or contract based upon available dilution. Flow-based limitations allow permittees flexibility to control their thermal discharges in different ways that may be less costly, but still are protective of the environment and compliant with the WLAs.

6.7.2 Portland General Electric (PGE)

Reasonable assurance that the Bull Run Hydroelectric Project will be decommissioned is demonstrated by an Agreement for Instream Water Rights Conversion (Sept. 30, 2002) and a Decommissioning Plan submitted to FERC in November 2002. FERC issued an Order Granting Surrender Application, Adopting Proposed Terms, and Denying Application to Amend License on May 12, 2004. FERC adopted most elements of the Decommissioning Plan. According to the decommissioning plan prepared by PGE, Marmot Dam is scheduled for removal in 2007 and the Little Sandy Diversion Dam is scheduled to be removed in 2008. Conversion of water rights from hydroelectric rights to in-stream rights is described in the Agreement for Instream Conversion, which was signed by PGE and other stakeholders in the Sandy Basin. The work will be accomplished during two 17-week in-water work periods beginning in July of each year. Marmot Dam will be removed in the first in-water work period before the existing canal/tunnel system is removed so that it can be used to divert a portion of the Sandy River flow. Little Sandy Dam will be removed during the second in-water work period the year after Marmot Dam is removed. Flow will be routed around the dam, into the flume, which will be opened up to return flow to the Little Sandy streambed below the dam.

PGE plans to revegetate some sites that are occupied by project facilities and all areas disturbed by removal activities. The revegetation program has three goals: (1) control erosion; (2) prevent the establishment and control the spread of invasive/exotic species; and (3) promote the establishment of native plant communities. In addition, both the BLM and Forest Service (FS) require revegetation of disturbed sites on the lands under their management. The stream banks and riparian areas in the vicinity of the current location of Marmot Dam, as well as some distance up- and downstream, are likely to be very unstable for a number of years following dam removal. If necessary, revegetation plans will be developed in consultation with the BLM and ODFW after the river gradient at the Marmot Dam site stabilizes with river gradients up- and downstream.

The removal of the PGE project, and subsequent restoration of river flows, was modeled using Heat Source to assess the impacts on stream temperature in the mainstem Sandy River. To reflect the time period for which the model was calibrated (August 8) an additional 180 cfs of water was routed down the Sandy River, rather than being diverted through the PGE project into the Bull Run River. The model showed significant stream temperature reduction from the Marmot Dam site (RM 30.4) downstream approximately to Gordon Creek (RM 12.7) from leaving Marmot Dam-diverted flows in the Sandy River (see **Section 3.8.4**).

The PGE Bull Run Hydroelectric Project was assigned flow-based load allocations in this TMDL (**Section 3.9**). Since the PGE Bull Run Hydroelectric Project is scheduled for removal in 2007-2008, their decommissioning plan will serve as their Temperature Management Plan. Under normal circumstances the PGE facility would be assigned a flow-based load allocation and ODEQ would, through Section 401 Water Quality Standards Certification and the TMDL process, require PGE to submit Temperature Management Plan to address how operations would be adjusted to meet the allocation. In the event that the decommissioning is either significantly delayed or cancelled, ODEQ will require a Temperature Management Plan and engage in the Section 401 certification process. .

6.7.3 City of Portland Drinking Water and Hydroelectric Facilities

The City of Portland, in conjunction with state and federal fisheries and land management agencies including ODEQ, is currently working on a Habitat Conservation Plan (HCP) to address both Endangered Species Act and Clean Water Act requirements. It is envisioned that the HCP will contain all necessary components of a Temperature Management Plan and function as such. Specific allocations, expressed as temperature targets relative to the Little Sandy River, are provided in the TMDL document. The City has provided ODEQ with a detailed description of their temperature modeling efforts to date and an outline of their proposal for compliance with this TMDL (Portland Water Bureau 2004).

6.7.4 Nonpoint Sources

Responsible participants for implementing DMA specific water quality management plans for urban and rural sources were identified in **Section 6.4** of this WQMP. ODEQ expects that identified responsible participants will develop, submit to ODEQ, and implement plans that will achieve the load allocations within 18 months of TMDL adoption. These activities will be accomplished by the responsible participants in accordance with the Schedule in **Section 6.6** of this WQMP. The DMA specific water quality implementation plans must address the following items:

1) Proposed management measures tied to attainment of the load allocations and/or established surrogates of the TMDLs, such as vegetative system potential or percent reductions.
2) Timeline for implementation.
3) Timeline for attainment of load allocations.

4) Identification of responsible participants demonstrating who is responsible for implementing the various measures.
5) Reasonable assurance of implementation.
6) Monitoring and evaluation, including identification of participants responsible for implementation of monitoring, and a plan and schedule for revision of implementation plan.
7) Public involvement.
8) Maintenance effort over time.
9) Discussion of cost and funding.
10) Citation of legal authority under which the implementation will be conducted.

Should any responsible participant fail to comply with their obligations under this WQMP, ODEQ will take all necessary action to seek compliance. Such action will first include negotiation but could evolve to an appropriate enforcement mechanism.

6.7.5 State Forest Practices

The Oregon Department of Forestry (ODF) is the designated management agency for regulation of water quality on non-federal forest lands. The Oregon Board of Forestry (BOF), in consultation with the Environmental Quality Commission (EQC), establish best management practices (BMPs) and other rules to ensure that, to the maximum extent practicable, non-point source pollution resulting from forest operations does not impair the attainment of water quality standards. The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 635-660, which describe BMPs for forest operations. These rules are implemented and enforced by ODF and monitored to assure their effectiveness.

By statute, forest operators conducting operations in accordance with the BMPs are considered to be in compliance with Oregon's water quality standards. ODF provides on the ground field administration of the Forest Practices Act (FPA). For each administrative rule, guidance is provided to field administrators to insure proper, uniform and consistent application of the Statutes and Rules. The FPA requires penalties, both civil and criminal, for violation of Statutes and Rules. Additionally, whenever a violation occurs, the responsible party is obligated to repair the damage. For more information, refer to the Management Measures element of this Plan.

As the DMA for water quality management on non-federal forestlands, the ODF is working with the ODEQ through a Memorandum of Understanding (MOU) signed in April of 1998. This MOU was designed to improve the coordination between the ODF and the ODEQ in evaluating and proposing possible changes to the forest practice rules as part of the TMDL process. ODF and ODEQ are involved in several statewide efforts to analyze the existing FPA measures and to better define the relationship between the TMDL load allocations and the FPA measures designed to protect water quality.

ODF and ODEQ conducted an evaluation of rule adequacy (a "sufficiency analysis") for four parameters:

1) Temperature
2) Sediment and turbidity
3) Aquatic habitat modification
4) Bio-criteria

The Sufficiency Analysis was completed and presented to the BOF in October 2002. The summarized evaluation of the temperature standard by specific stream types and sizes follows:

- Medium and small Type F streams: Current research and monitoring results show that current Riparian Management Area (RMA) prescriptions for western Oregon may result in short-term temperature increases on some Type F streams; however the significance of the potential temperature increases at a watershed (or sub-basin) scale is uncertain.

- Small Type N streams: Current research and monitoring results show current practices may result in short-term (two to three years) temperature increases on some Type N streams. The significance of potential temperature increases on Type N streams to downstream fish-bearing streams and at a watershed (or sub-basin) scale is uncertain.

- All other streams: Influences on stream temperatures from shade levels resulting from specific BMP prescriptions for the other stream category types have not been assessed due to a lack of relevant data. However, in light of the data and findings specific to medium and small Type F streams, and given the higher level of vegetation retention on large Type F streams, it is likely that the standard is being met on large Type F streams.

Recommendations presented in the sufficiency analyses will be used as a coarse screen for common elements applicable to each individual TMDL to determine if forest practices are contributing to water quality impairment within a given watershed and to support the adaptive management process.

The purpose and goals of Oregon's Water Protection Rules (OAR 629-635-100) include protecting, maintaining, and improving the functions and values of streams, lakes, wetlands, and riparian management areas. Best management practices (BMPs) in the Oregon Forest Practices Act (FPA), including riparian zone protection measures and a host of other measures described below, are the mechanism for meeting State Water Quality Standards (WQS). There is a substantial body of scientific research and monitoring that supports an underlying assumption of the FPA, that maintaining riparian processes and functions is critical for water quality and fish and wildlife habitat. These riparian processes and functions include: shade for stream temperature and for riparian species; large wood delivery to streams and riparian areas; leaf and other organic matter inputs; riparian microclimate regulation; sediment trapping; soil moisture and temperature maintenance; providing aquatic and riparian species dependent habitat; and nutrient and mineral cycling. The FPA provides a broad array of water quality benefits and contributes to meeting water quality standards for water quality parameters such as temperature, sediment, phosphorus, dissolved oxygen, nutrients, aquatic habitat and others.

The water quality impairment(s) in the Sandy River watershed do not result solely from current forestry activities. Historic forest practices such as and the widespread removal of wood from streams may continue to influence current stream conditions and riparian functions. In addition, current forest practices occur on forestlands that simultaneously support non-forestry land uses that can affect water quality, such as grazing, recreation, and public access roads. With this noted, the TMDL demonstrates that increasing the level of riparian vegetation retained along forested reaches of these streams reduces solar loading, potentially preventing a substantial amount of stream heating. While providing high levels of shade to streams is an important aspect of meeting instream temperature standards it needs to be considered within the context of past management, stream morphology and flows, groundwater influences, site-productivity, insects, fire, and other disturbance mechanisms that vary in time and space across the landscape.

ODF and ODEQ statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, ORS 183.310, OAR 340-041-0026, OAR 629-635-110, and OAR 340-041-0120. Current adaptive management efforts under several of the above statutes and rules are described in more detail following the discussion below on the roles of the BOF and EQC in developing BMPs that will achieve water quality standards.

Generally, no tree harvesting is allowed within 20 feet of all fish bearing, all domestic-use, and all other medium and large streams unless stand restoration is needed. In addition, all snags and downed wood must be retained in every riparian management area. Provisions governing vegetation retention are designed to encourage conifer restoration on riparian forestland that is not currently in the desired conifer condition. Future supplies of conifer on these sites are deemed desirable to support stream functions and to provide fish and wildlife habitat. The rules provide incentives for landowners to place large wood in streams to immediately enhance fish habitat. Other alternatives are provided to address site-specific conditions and large-scale catastrophic events.

The goal for managing riparian forests along fish-use streams is to grow and retain vegetation so that, over time, average conditions across the riparian landscape become similar to those of mature unmanaged riparian stands. This goal is based on the following considerations:

(1) Mature riparian stands can supply large, persistent woody debris necessary to maintain adequate fish habitat. A shortage of large wood currently exists in streams on non-federal forestlands due to historic practices and a wide distribution of young, second growth forests. For most streams, mature riparian stands are able to provide more of the functions and inputs of large wood than are provided by young second-growth trees.

(2) Historically, riparian forests were periodically disturbed by wildfire, windstorms, floods, and disease. These forests were also impacted by wildlife such as beaver, deer, and elk. These disturbances maintained a forest landscape comprised of riparian stands of all ages ranging from early successional to old growth. At any given time, however, it is likely that a significant proportion of the riparian areas supported forests of mature age classes. This distribution of mature riparian forests supported a supply of large, persistent woody debris that was important in maintaining quality fish habitat.

The overall goals of the riparian vegetation retention rules along Type N and Type D streams are the following:

- Grow and retain vegetation sufficient to support the functions and processes that are important to downstream waters that have fish;
- Maintain the quality of domestic water; and
- Supplement wildlife habitat across the landscape.

These streams have reduced Riparian Management Area (RMA) widths and reduced basal area retention requirements as compared to similar sized Type F streams (**Table 6.3**). In the design of the rules this was judged appropriate based on a few assumptions. First, it was assumed that the amount of large wood entering Type N and D channels over time was not as important for maintaining fish populations within a given stream reach. And second, it was assumed that the future stand could provide some level of “functional” wood over time in terms of nutrient inputs and sediment storage. The validity of these assumptions needs to be evaluated over time through monitoring.

For all streams that require an RMA, basal area targets are established that are used for any type of management within the RMA. These targets were determined based on the data that was available at the time, with the expectation that these targets could be achieved on the ground. There is also a minimum tree number requirement of 40 trees per 1000 feet along large streams (11-inch minimum diameter at breast height), and 30 trees per 1000 feet along medium streams (8-inch minimum diameter at breast height). The specific levels of large wood inputs that the rules are designed to achieve are based on the stream size and type. The biological and physical characteristics specific to a given stream are taken into account in determining the quantity and quality of large wood that is functional for that stream. Given the potential large wood that is functional for a given stream, a combination of basal area targets, minimum tree retention, buffer widths, and future regenerated stands and ingrowth are used to achieve the appropriate large wood inputs and effective shade for a given stream.

Table 6.3. Riparian Management Area widths for streams of various sizes and beneficial uses (OAR 629-635-310).

	Type F	Type D	Type N
LARGE	100 feet	70 feet	70 feet
MEDIUM	70 feet	50 feet	50 feet

SMALL	50 feet	20 feet	Apply specified water quality protection measures, and see OAR 629-640-200

The expectation is that these vegetation retention standards will be sufficient towards maintaining stream temperatures that are within the range of natural variability. In the design of the Water Protection Rules shade data was gathered for 40 small non-fish-bearing streams to determine the shade recovery rates after harvesting. One to two years after harvest, 55 percent of these streams were at or above pre-harvest shade levels due to understory vegetation regrowth. Most of these streams had a bankfull width averaging less than six feet, and most shade was provided by shrubs and grasses within 10 feet of the bank. Since 1991 there has also been a 120-acre limit on a single clear-cut size, which is likely to result in a scattering of harvested area across a watershed over time. In the development of the rules it was assumed that this combined with the relative rapid shade recovery along smaller non-fish-bearing streams would be adequate in protecting stream temperatures and reduce possible cumulative effects. For fish bearing streams it is assumed that a 20-foot no-harvest area, combined with the tree retention requirements for the rest of the RMA, will be adequate to maintain shade levels necessary to achieve stream temperature standards. The monitoring program is currently collecting data to test these assumptions, evaluate the effectiveness of the rules, and evaluate whether or not water quality standards for temperature are being achieved.

The ODF has a monitoring program that is currently coordinating separate projects to monitor the effectiveness of the forest practice rules with regard to landslides, riparian function, stream temperature, chemical applications, sediment from roads, BMP compliance, and shade. The results from some of these projects have been released in the form of final reports.

<u>Adaptive Management Process</u>

By statute, forest operators conducting operations in accordance with the BMPs are considered to be in compliance with Oregon's water quality standards. The 1994 Water Protection Rules were adopted with the approval of the Environmental Quality Commission as not violating water quality standards. However, there are several provisions within the FPA and rules that require adaptive management.

As the designated management agency (DMA) for water quality management on nonfederal forestlands, the ODF is working with the ODEQ through a memorandum of understanding (MOU) signed in April of 1998. ODF and ODEQ completed a sufficiency analysis and submitted it to the BOF in October 2002. Recommendations for improving practices that would increase the likelihood of meeting water quality standards were:

Recommendation #1: The RMA basal area retention standards should be revised, where appropriate, to be consistent with achieving characteristics of mature forest conditions in a timely manner; and to ensure that RMAs are providing desirable amounts of large wood and shade over space and time.

Recommendation #2: Revise current practices so desirable amounts of large wood are available along small stream channels that can deliver debris torrents to Type F streams. Ensure that adequate shade is maintained or rapidly recovered for riparian areas along small perennial Type N streams with the potential to impact downstream Type F waters.

Recommendation #3: Provide additional large wood to streams by actively placing the wood in areas where it will provide the greatest benefits to salmonids.

Recommendation #4: Reduce the delivery of fine sediment to streams by installing cross drains to keep drainage waters from eroding slopes. This will allow filtering of sediments and infiltration of drainage water into undisturbed forest soils.
Cross drains should not be confused with stream crossing culverts. Cross drains take water from the road surface and ditch and route it under/across the road, discharging the water downslope from the road.

Recommendation #5: Develop specific standards for roads that will be actively used during the wet season. This would include a requirement for durable surfacing of roads in locations where fine sediment can enter streams. This would also include ceasing to haul if roads have not been constructed with effective surface materials, drainage systems, or other alternatives (paving, increased numbers of cross drains, sediment barriers, settling basins, etc.) that minimizes delivery of sediment into streams.

Recommendation #6: Develop specific guidance describing how roads in critical locations would be reviewed to reduce road length, and determining when, despite the relocation, the road location would pose unacceptable risk to resources and not be approved.

Recommendation #7: Construct stream crossings that adequately pass large wood and gravel downstream, and provide other means for passage of large wood and sediment at those crossings that restrict passage. The transport mechanisms for large wood and gravel should include both stream storm flows and channelized debris flows. This would reduce the risk of debris backing up behind the structure, potentially resulting in catastrophic sediment delivery caused by washouts.

Recommendation #8: Develop specific steep-slope, ground-based, yarding practices, or add a prior approval requirement for ground skidding in high-erosion hazard locations.

Recommendation #9: Manage locations most prone to landslides (high-risk sites) with techniques that minimize impacts to soil and water resources. To achieve this objective, best management practices to protect landslide-prone terrain currently in guidance should be incorporated into the forest practice rules, while developing a better case history for evaluating the effectiveness of those practices. These standard practices are designed to minimize ground alteration/disturbance on high-risk sites from logging practices.

Recommendation #10: Provide for riparian functions along stream reaches above impassable stream crossing structures that have a high probability of recolonization by salmonids once the structure is replaced/improved. If an upstream reach has the capacity to be a fish-bearing stream, but is currently not a fish-bearing stream because a stream crossing structure cannot pass fish, the forest practices rules should be amended so the upstream reach is classified as a fish-bearing stream.

Recommendation #11: Facilitate the identification, prioritization, and restoration of existing culverts that currently do not pass fish. Culvert replacement should be accelerated above what is currently being done, specifically for family forestland owners who often do not have adequate resources to address this issue in a timely manner.

Recommendation #12: Provide a more effective and efficient means of classifying streams for "fish use." Revise the forest practice rule definition of Type F and Type N streams using a physical habitat approach to classify fish-use and nonuse streams.

There may be circumstances unique to a watershed or information generated outside of the statewide sufficiency process that need to be considered to adequately evaluate the effectiveness of the BMPs in meeting water quality standards. Information from the TMDL, ad hoc committee process, ODF Water Protection Rule effectiveness monitoring program, and other relevant sources may address circumstances or issues not addressed by the statewide sufficiency process.

Currently the ODF and OEQ do not have adequate data to make a collective determination on the sufficiency of the current FPA BMPs in meeting water quality standards within the Sandy basin. This situation most closely resembles the scenario described under condition c of the ODF/ODEQ MOU. Therefore, the current BMPs will remain as the forestry component of the WQMP. The draft versions of the statewide FPA sufficiency analyses for the various water quality parameters will be completed as noted above.

The adaptive management process may result in findings that indicate changes are needed to the current forest practice rules to protect water quality. Any rule making that occurs must comply with the standards articulated under ORS 527.714(5). This statute requires, among other things, that regulatory and non-regulatory alternatives have been considered and that the benefits provided by a new rule are in proportion to the degree that existing forest practices contribute to the overall resource concern.

6.7.6 Agriculture

It is the Oregon Department of Agriculture's (ODA) statutory responsibility to develop agricultural water quality management (AWQM) plans and enforce rules that address water quality issues on agricultural lands. The AWQM Act directs ODA to work with local farmers and ranchers to develop water quality management area plans for specific watersheds that have been identified as violating water quality standards and having agriculture water pollution contributions. The agriculture water quality management area plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct those problems. These water quality management plans are developed at a local level, reviewed by the State Board of Agriculture, and then adopted into the Oregon Administrative Rules. It is the intent that these plans focus on education, technical assistance, and flexibility in addressing agriculture water quality issues. These plans and rules will be developed or modified to achieve water quality standards and will address the load allocations identified in the TMDL. In those cases when an operator refuses to take action, the law allows ODA to take enforcement action. ODEQ will work with ODA to ensure that rules and plans meet load allocations.

The ODA drafted an AWQMP for the Sandy River Basin with the assistance of a Local Advisory Committee (LAC). The AWQMP was adopted in June of 2001. The adopted rules need to be quantitatively evaluated in terms of load allocations in the TMDL, and pursuant to the June 1998 Memorandum of Agreement between ODA and ODEQ, ODA and the LAC will regularly revise the AWQMP. The agencies will establish the relationship between the plan and its implementing rules and the load allocations in the TMDL to determine if the rules provide reasonable assurance that the TMDLs will be achieved. The LAC will be kept apprised and consulted during this evaluation. This adaptive management process provides for review of the AWQMA plan to determine if any changes are needed to the current AWQMA rules specific to the Sandy Basin TMDL.

The Area Plan applies specifically to agricultural activities on all agricultural, rural, and forest lands within the Sandy River Agricultural Water Quality Management Area that are not owned by the federal government. The Area Plan applies to agricultural lands in current use, those lying idle or on which management has been deferred, and lands (like private roads) not strictly in agricultural use but that support agricultural activities.

The plan and the associated rules can be found on the Department of Agriculture's website: **http://www.oda.state.or.us/Natural_Resources/agwqmpr.htm**.

As specified in the MOA signed between ODA and ODEQ (1998), the Sandy River Area Plan will serve as the implementation plan for agriculture in the Sandy Basin. Because the Area Plan was developed before the TMDL was completed, the Plan does not clearly tie the proposed management measures to attainment of load allocations and/or surrogates, such as vegetation system potential or bacteria reductions.

The Area Plan does recognize the importance of shade and the maintenance of a healthy riparian vegetation community in controlling stream temperatures. In the Oregon Administrative Rules associated with the Area Plan (OAR 603-095-1100 through 603-095-1160), protection of riparian vegetation is addressed in OAR 603-095-1140 Requirements as follows:

"Effective upon adoption of these rules, agricultural activities must allow the establishment, growth, and maintenance of vegetation along streams. Vegetation must be sufficient to control water pollution by moderating solar heating, minimizing streambank erosion, filtering sediments and nutrients from overland flows, and improving the infiltration of water into the soil profile. The streambank should have sufficient vegetation to resist erosion during high stream flows, such as those reasonably expected to occur once every 25 years."

The Area Plan also describes Recommended Management Practices (Table 3 in the Plan) aimed at maintaining adequate vegetation along streams. Under the current Area Plan these practices are *recommended*, not *required*.

6.7.7 Transportation

The Oregon Department of Transportation (ODOT) has been issued an NPDES stormwater (MS4) discharge permit. Included with ODOT's application for the permit was a surface water management plan which has been approved by ODEQ and which addresses the requirements of a TMDL allocation for pollutants associated with the ODOT system. Both ODOT and ODEQ agree that the provisions of the permit and the surface water management plan will apply to ODOT's statewide system. This statewide approach for an ODOT TMDL watershed management plan addresses specific pollutants, but not specific watersheds. Instead, this plan demonstrates how ODOT will incorporate water quality protection into project development, construction, and operations and maintenance of the state and federal transportation system that is managed by ODOT, thereby meeting the elements of the National Pollutant Discharge Elimination System (NPDES) program, and the TMDL requirements.

The MS4 permit and the plan:

- Streamlines the evaluation and approval process for the watershed management plans
- Provides consistency to the ODOT highway management practices in all TMDL watersheds.
- Eliminates duplicative paperwork and staff time developing and participating in the numerous TMDL management plans.

Temperature and sediment are the primary concerns for pollutants associated with ODOT systems that impair the waters of the state. ODEQ is still in the process of developing the TMDLs for water bodies and determining pollutant levels that limit their beneficial uses. As TMDL allocations are established by watershed, rather than by pollutants, ODOT is aware that individual watersheds may have pollutants that may require additional consideration as part of the ODOT watershed management plan. When these circumstances arise, ODOT will work with ODEQ to incorporate these concerns into the statewide plan.

ODOT Limitations

The primary mission of ODOT is to provide a safe and effective transportation system, while balancing the requirements of environmental laws. ODOT is a dedicated funding agency, restricted by the Oregon Constitution in its legal authority and use of resources in managing and operating the state and federal highway system. ODOT can only expend gas tax resources within the right of way for the operation, maintenance and construction of the highway system.

ODOT and ODEQ recognize that the ODOT system has the potential to negatively impact the beneficial uses of the waters of the state, primarily through surface water runoff. However, removal of vegetative cover to provide for safety, and undermining of the road associated with bank failure may impact temperature and sediment allocations.

As defined in the TMDL program, ODOT is a DMA because highways have the potential to pollute waterways and negatively impact watershed health. With this definition of a DMA, ODOT is required to participate in developing and implementing watershed management plans that will reduce the daily pollutant loads generated from ODOT highways to acceptable TMDL levels.

ODOT is not a land use or natural resource management agency. ODOT has no legal authority or jurisdiction over lands, waterways, or natural resources that are located outside of its right of way. ODOT's contribution to the TMDL management plan is directed at the development, design, construction, operations and maintenance of the ODOT system.

Related Clean Water Regulations
There are various water quality laws and regulations that overlap with the TMDL program. In a TMDL Memorandum of Agreement with the EPA (July 2000), ODEQ states that; "ODEQ will implement point source TMDLs through the issuance or re-issuance of National Pollutant Discharge Elimination System (NPDES) permits". The ODEQ NPDES municipal permit program was established in 1994 and requires owners and operators of public stormwater systems to reduce or eliminate stormwater pollutants to the maximum extent practicable.

On June 9, 2000, ODOT received an NPDES permit from ODEQ that covers all new and existing discharges of stormwater from the Municipal Separated Storm Sewer associated with the ODOT owned and maintained facilities and properties located within the highway right of way and maintenance facilities for all basins in Oregon. This permit required the development of a statewide ODOT stormwater management plan.

Other environmental regulations that overlap with the intent of the TMDL program include the federal and state Endangered Species Act, Corps of Engineers Wetland 404 permit regulations, state cut and fill removal laws, erosion control regulations, ground water protection rules, etc. Many federal, state, and local agencies join ODEQ in administering and enforcing these various environmental regulations related to water quality.

ODOT Programs
ODOT established a Clean Water program in 1994 that works to develop tools and processes that will minimize the potential negative impacts of activities associated with ODOT facilities on Oregon's water resources. The ODOT Clean Water program is based on developing and implementing Best Management Practices (BMPs) for construction and maintenance activities. ODOT has developed, or is developing the following documents, best management practices, or reviews, that reduce sediment and temperature impacts:

- **ODOT Routine Road Maintenance Water Quality and Habitat Guide, Best Management Practices, July 1999 (ESA 4(d) Rule)**
  ODOT has worked with National Marine Fisheries Service (NMFS) and Oregon Department of Fish and Wildlife (ODFW) to develop Best Management Practices (BMPs) that minimize negative environmental impacts of routine road maintenance activities on fish habitat and water quality. The National Marine Fisheries Service has determined that routine road maintenance, performed under the above mentioned guide, does not constitute a 'take' of anadromous species listed under the federal Endangered Species Act, and therefore additional federal oversight is not required. This determination has been finalized as part of the Federal Register, Volume 65, Number 132, dated Monday, July 10, 2000, pages 42471-42472. In addition, the Oregon Department of Fish and Wildlife has determined that the guide, and BMPs are adequate to protect habitat during routine maintenance activities.

- **NPDES Municipal Separated Storm Sewer System (MS4) Permit**
  ODOT worked with ODEQ to develop a statewide NPDES MS4 permit and stormwater management program that reduces pollutant loads in the ODOT stormwater system. The permit was issued to ODOT on June 9, 2000.

- **NPDES 1200CA Permit**
  ODOT has developed an extensive erosion control program that is implemented on all ODOT construction projects. The program addresses erosion and works to keep sediment loads in surface waters to a minimum. ODOT currently holds 5 regional permits that cover highway construction.

- **Erosion and Sediment Control Manual**
  ODOT Geotechnical/Hydraulic staff have developed erosion and sediment control manuals and training for construction and maintenance personnel. Included in the manual are designs for different types of erosion control measures.

- **National Environmental Policy Act (NEPA) Reviews**
  ODOT is an agent of the Federal Highway Administration, consequently, ODOT must meet NEPA requirements during project development. Included in the project development process are reviews to avoid, minimize and mitigate project impacts to natural resources, including wetlands and waters of the state.

- **Integrated Vegetation Management (IVM) District Plans**
  ODOT works with the Oregon Department of Agriculture and other agencies to develop activities that comply with regulations that pertain to the management of roadside vegetation. Vegetation management BMPs can directly effect watershed health. Each ODOT district develops an integrated vegetation management plan.

- **Forestry Program**
  ODOT manages trees located within its right of way in compliance with the Oregon Forest Practices Act and other federal, state, and local regulations. Temperature, erosion, and land stability are watershed issues associated with this program. ODOT is currently working with ODFW on a prototype for managing hazardous trees along riparian corridors.

- **Cut/Fill Slope Failure Programmatic Biologic Assessment**
  ODOT has been in formal consultation with the National Marine Fisheries Service, the US Fish and Wildlife Service and the Oregon Department of Fish and Wildlife Service in the development of a programmatic biological assessment for how ODOT will repair cut/fill slope failures in riparian corridors. The draft document outlines best management practices to be used in stabilizing failed stream banks, and bio-engineered design solutions for the failed banks.

- **Disposal Site Research Documentation and Programmatic Biological Assessment**
  ODOT has been working with ODEQ in researching alternatives and impacts associated with the disposal of materials generated from the construction, operation and maintenance of the ODOT system. ODOT has begun the process of entering into formal consultation with NMFS, USFWS, and ODFW on disposing of clean fill material.

ODOT TMDL Pollutants
ODOT and ODEQ have identified temperature and sediment as the primary TMDL pollutants of concern associated with highways. While ODEQ may identify other TMDL pollutants within the watershed, many historical pollutants, or pollutants not associated with ODOT activities, are outside the control or responsibility of ODOT. In some circumstances, such as historical pollutants within the right of way, it is expected that ODOT will control these pollutants through the best management practices associated with sediment control. ODOT is expecting that by controlling sediment load these TMDL pollutants will be controlled. Research has indicated that controlling sediment also controls heavy metals, oils and grease, and other pollutants such as bacteria.

Oregon's limited summer rainfall makes it highly unlikely that ODOT stormwater discharges elevate watershed temperatures. Management of roadside vegetation adjacent to waterways can directly affect water temperature. ODOT has begun to incorporate temperature concerns into its vegetation management programs and project development process.

Other TMDL concerns, such as dissolved oxygen, or chlorophyll A, can be associated with increased temperature. These TMDLs are not associated with the operation and maintenance of the transportation system, and are outside the authority of ODOT. Specific TMDL concerns that are directly related to the transportation system will be incorporated into the ODOT management plan.

ODOT NPDES characterization monitoring indicates ODOT pollutant levels associated with surface water runoff are below currently developed TMDL standards. This indication is based on ODOT 1993-95 characterization monitoring and current TMDLs.

ODOT TMDL Implementation Plan

1) Proposed Management Measures tied to attainment of TMDLs
ODOT has two business lines: project development and construction, and maintenance. There are management measures, processes, requirements and reviews included with each business line that are tied to the TMDL programs. These include:

- The ODOT MS4 NPDES permit and permit application- addresses sediment and temperature TMDL, includes project development and construction, and maintenance.
- The ODOT NPDES 1200 CA Permit- addresses sediment TMDL for construction.
- The ODOT Erosion and Sediment Control Manual-addresses sediment TMDL for construction and maintenance.
- The ODOT Routine Road Maintenance Water Quality and Habitat Guide, Best Management Practices, July 1999- addresses sediment and temperature TMDL.
- National Environmental Policy Act: addresses sediment and temperature TMDL, and habitat issues.
- Endangered Species Act requirements for project development: addresses sediment and temperature TMDL, and habitat issues.

2) Timeline for Implementation
ODOT already implements many water quality management measures as directed by state and federal law. Implementation timelines for currently developing measures are described in ODOT's MS4 NPDES permit. The ODOT MS4 permit was recently issued and is valid until May 31, 2005. ODOT's regional construction permits (1200 CA) are scheduled for renewal in December 2000.

3) Timeline for Attainment of Water Quality Standards
The complete attainment of load allocations applicable to ODOT corridors may not be feasible, certainly in the short term, and likely in the long term due to safety concerns and other important factors. However, ODOT expects to implement every practicable and reasonable effort to achieve the load allocations when considering new or modifications to existing corridors, and changes in operation and maintenance activities.

4) Identification of Responsible Participants
Implementing the ODOT best management measures is the responsibility of every ODOT employee. ODOT Managers are held accountable for ensuring employees and actions meet agency policy, and state and federal law, including the Clean Water Act.

5) Reasonable Assurance of Implementation
ODOT is required by its state NPDES MS4 permit to implement a stormwater management plan. In addition, as a federally funded agency, ODOT is required to comply with the Endangered Species act and the Clean Water Act as part of project development. Recent agreements with NMFS require ODOT to implement best management practices for routine road maintenance.

6) Monitoring and Evaluation (see MS4 Permit Application)
ODOT's monitoring and evaluation program is tied to performing research projects that address best management practices and effectiveness of the practices.

7) Public Involvement
ODEQ held public hearings on the ODOT MS4 Stormwater Management Plan throughout Oregon. In addition, NMFS held a series of public hearings on the ESA 4(d) rule, which included the ODOT Routine Road Maintenance Best Management Practices. ODOT project development under goes a public involvement process that includes review by regulating agencies, and public hearings and meetings.

8) Maintenance of Effort Over Time
The elements of the ODOT water quality and habitat programs are bound in state and federal law, and state and agency directives. Consequently, the ODOT programs are standard operating practice.

9) Discussion of Cost and Funding
ODOT revenue comes primarily from dedicated funds collected as state and federal gasoline taxes. The Oregon Constitution dedicates taxes associated with motor vehicle fuel, and the ownership, operation and use of motor vehicles for the construction, reconstruction, improvement, repair, maintenance, operation and use of public highways. Consequently, ODOT is unable to expend resources outside its rights of way, or on activities not directly related to ODOT highways. ODOT construction projects are funded through a variety of Federal Highway Administration funding programs, including the Transportation Equity Act (TEA-21), state gas tax dollars, local and matching funds and bond.

ODOT budgets are identified the preceding year for the following biennium. Each ODOT section or district budgets as necessary to fulfill the requirements of its identified programs. ODOT determines the budget for its MS4 permit as program needs develop and as agency funds allow. ODOT Office of Maintenance, through the Clean Water/Salmon Recovery Program allocates funds to maintenance forces for betterment projects that improve water quality and salmon habitat.

10) Citation to Legal Authorities - See MS4 Permit Application
ODOT has legal authority only over ODOT right of way.

Conclusion
ODOT programs are adaptive and are expected to change as new information becomes available. ODOT will continue to work with the ODEQ, NMFS, USFWS, and ODFW in best management practices, research opportunities, training, etc. The ODOT program meets the requirements of the TMDL management plans, and will be attached as appropriate to individual watershed plans.

6.7.8 Federal Forest Lands

All management activities on federal lands managed by the U.S. Forest Service (USFS) and the Bureau of Land Management must follow standards and guidelines as listed in the respective Land Use and Management Plans, as amended, for the specific land management units. In the Mount Hood National Forest, management activities are guided by the Northwest Forest Plan (USDA Forest Service, 1994) and the Mt Hood National Forest Land and Resource Management Plan (Mt. Hood Forest Plan, USDA Forest Service, 1990). A Reconciliation Document was drafted in 1995 (USDA Forest Service, 1995). This document indicates that all standards and guidelines in the Mt. Hood Forest Plan apply unless superseded by the Northwest Forest Plan standards. When standards and guidelines from both documents apply, the one which controls is the one more restrictive or which provides greater benefits to late-successional forest related species.

ODEQ and USFS signed a memorandum of Understanding (MOU) in May 2002. The MOU defines the process by which ODEQ and the Pacific Northwest Region of the USFS will cooperatively meet State and Federal water quality rules and regulations.

In its review of these management plans, ODEQ believes that they meet the requirements of a TMDL management. Although developed before the completion of this TMDL, both the Mt. Hood Forest Plan and the Northwest Forest Plan address proposed management measures tied to attaining system potential shade. As part of the public involvement process for the development and approval of both plans, most of the other requirements of a TMDL management plan have also been addressed. As they have in the past, it is expected that the Mt. Hood National Forest will continue to work with the ODEQ, NMFS, USFWS, and ODFW in best management practices, research opportunities, training, etc. A summary of each of the plans is provided below.

Northwest Forest Plan. Under the standards and guidelines, the Northwest Forest Plan lays out an *Aquatic Conservation Strategy* (USDA Forest Service 1994). The aquatic conservation strategy contains four components: riparian reserves; key watersheds; watershed analysis; and watershed restoration. Each part is expected to play an important role in improving the health of the region's aquatic ecosystems. The four components are listed below:

1. **Riparian Reserves**: Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Initial boundary widths for riparian reserves identified in the Northwest Forest Plan are listed below. These widths remain in effect until they are modified following watershed analysis. The Northwest Forest Plan (1994) further describes standards and guidelines for Riparian reserves which generally prohibit or regulate activities within the Reserves which retard or prevent attainment of the Aquatic Conservation Strategy Objectives.

- <u>Fish-bearing streams</u> – includes the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge; or to the outer edges of the 100-year floodplain; or to the outer edges of riparian vegetation; or to the distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet, including both sides of the stream channel), whichever is greatest.

- <u>Permanently flowing nonfish-bearing streams</u> – includes the stream and area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge; or to the outer edges of the 100-year flood plain; or to the outer edges of riparian vegetation; or to a distance equal to the height of one site-potential tree; or 150 feet slope distance (300 feet, including both sides of the stream channel), whichever is greatest.

- <u>Lakes and natural ponds</u> – includes the body of water and the area to the outer edges of riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.

- <u>Constructed ponds and reservoirs and wetlands greater than one acre</u> – includes the body of water or wetland and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.

- <u>Seasonally flowing or intermittent streams, wetlands less than one acre and unstable and potentially unstable areas</u> – at a minimum, includes the extent of unstable and potentially unstable areas, the stream channel to the top of the inner gorge, the stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and the area on each side of the stream to a distance equal to the height of one site-potential tree or 100 feet slope distance, whichever is greatest.

2. **Key Watersheds**: Three categories of watersheds are designated and listed below.
   - Tier 1 key watersheds – those to be managed for at-risk anadromous salmonids, bull trout, and resident fish
   - Tier 2 key watersheds – those where high water quality is important
   - non-key watersheds – all other watersheds

3. **Watershed Analysis**: Watershed analysis is a systematic procedure to characterize the aquatic, riparian, and terrestrial features within a watershed. Managers will use information gathered during the watershed analyses to refine riparian reserve boundaries and prescribe land management activities.

4. **Watershed Restoration**: Watershed restoration is designed to restore currently degraded habitat. The most important components are control and restoration of road-related runoff and sediment production, restoration of riparian vegetation, and restoration of instream habitat complexity.

In the *Sandy River Watershed Analysis* (1996a), Riparian Reserve widths beyond those required by the Northwest Forest Plan are recommended for some locations. A list of criteria used for adjusting the riparian reserve widths is identified.

Mt. Hood Forest Plan. The Plan states that: “a key goal of the Forest Plan is to manage the forest resources to protect and maintain the character and quality of water; provide long-term sustained production of water; and provide a favorable flow from the Forest for both on-Forest and off-Forest water users. An additional goal is to protect the unique and valuable characteristics of floodplain and riparian zones; maintain or increase aquatic habitat complexity and diversity; and assure the long-term production of associated wildlife and plant species within the full spectrum of forest riparian areas. Included is the goal to maintain or increase fish habitat capability”.

The Forest Plan further details standards and guidelines specific to Riparian Areas (FW-080 through FW-136). These standards and guidelines are divided into five categories based on the type of stream or riparian area. The specific standards and guidelines that pertain to management of riparian vegetation are listed below.

1. **All Riparian Areas**
   - At least 95 percent ground cover (e.g. vegetation, duff or litter) shall be maintained within all project activity areas (within riparian areas).

2. **Class I, II and Fish Bearing Class III Streams**
   - At least 95 percent effective ground cover (e.g. adapted trees, shrubs, sedges, and grasses) in a project activity area should be maintained.
   - At least 80 percent of riparian management areas shall be maintained with, or restored to, a fully-stocked, multi-layered canopy of old growth and/or mature forest.
   - Non-forested riparian areas should be maintained.
   - Summer water temperatures shall be maintained to protect existing on and off-Forest beneficial uses.
   - Stream shading shall be increased where: (1) state water quality standards are routinely exceeded (e.g. annual occurrence) during summer low water flow periods; and (2) elevated water temperatures, due to management activities, are likely to reduce on-Forest or off-Forest water related values.

3. **Non-fish Bearing Class III Streams**
   - At least 90 percent effective ground cover (e.g. adapted trees, shrubs, sedges, and grasses) in a project activity area should be maintained. Non-forested riparian areas should be maintained.
   - Forest management activities shall not cause water temperatures to exceed water quality standards established for fish bearing streams.
   - Stream shading shall be increased where: (1) state water quality standards are routinely exceeded (e.g. annual occurrence) during summer low water flow periods; and (2) elevated water temperatures, due to management activities, are likely to effect downstream water related values.

4. **Lakes and Wetlands**
   - Terrestrial habitat (floodplain/riparian vegetation) and water quality (sediment) Standards and Guidelines for lakes and wetlands shall be the same as the Standards and Guidelines for Class I, II and fish bearing Class III streams.

5. **Class IV Seeps, Springs and Headwaters**
   - Conifer and hardwood trees necessary for stream stability, long term wood input, and diversity of wildlife and plant communities should be maintained.

The Forest Plan then details management prescriptions for 46 different "Management Areas" (MAs). Each MA management prescription includes four components: a Goal Statement, Location, Desired Future Condition and a set of Standards and Guidelines. Two of the 46 MAs appear to deal directly with protection of riparian habitat: Key Site Riparian Area (A9) and General Riparian Area (B7).

The goal of the *Key Site Riparian Area* is to "maintain or enhance habitat and hydrologic conditions of selected riparian areas, notable for their exceptional diversity, high natural quality and key role in providing for the continued production of riparian dependent resource values" (USDA Forest Service, 1990). These areas are relatively large (greater than 20 acres) and exhibit characteristics of high habitat diversity and outstanding capabilities for producing high quality water, generally associated with streams, lakes, and wetlands. Some of the features for the Desired Future Condition include: provides consistently excellent water quality; soil, water, fish, wildlife management activities predominate; summer stream temperatures are well-moderated with limited day to night variation; generally cool summer water temperatures are well within the tolerances of aquatic organisms indigenous to the systems; channels are maintained at or restored to inherent (historic) conditions; riparian areas are typically fully occupied by native plant community types; and multi-layered canopy including large tall green trees, snags, intermediate size trees, and understory vegetation. The water quality standards and guidelines are as described above. In addition, regulated timber harvest is prohibited under the Vegetation Management standards and guidelines. Silvicultural techniques, including timber harvest, may occur only to maintain or enhance riparian resource values. Several Key Site Riparian Areas are identified in the watershed analyses developed for the Sandy River Basin (USDA Forest Service 1995, 1995a,1995b, 1996, 1997).

The goal of the General Riparian Area is to "achieve and maintain riparian and aquatic habitat conditions for the sustained, long-term production of fish, selected wildlife and plant species, and high quality water for the full spectrum of the Forest's riparian and aquatic areas. A secondary goal is to maintain a healthy forest condition through a variety of timber management practices. This designation includes riparian and aquatic ecosystems and the upland transition zones. Some of the features for the Desired Future Condition include: provide consistently excellent water quality; water quality consistently meets or exceeds requirements of downstream beneficial uses; summer stream temperatures are well-moderated with limited day to night variation; generally cool summer water temperatures are well within the tolerances of native aquatic organisms indigenous to the systems; riparian areas are fully occupied by historic plant community types; and multi-layered canopy including large tall green trees, snags, intermediate size trees, and understory vegetation. The water quality standards and guidelines are as described above. Regulated timber harvest is allowed to occur as detailed under the Timber Management standards and guidelines. However, General Riparian Area Management Areas shall first be delineated and evaluated as part of area analyses and project planning.

6.7.9 Federal Bureau of Land Management

The Bureau of Land Management (BLM) in conjunction with private organizations such as The River Network and The Nature Conservancy already manage about 20 miles within the Sandy and Salmon watersheds (designated as Wild and Scenic Rivers), as well as 9,000 acres in the Mt. Hood Corridor. The BLM is proceeding to acquire lands in the Middle Sandy River/Salmon River corridors under the direction of The Conservation and Land Tenure Strategy for the Sandy River and Mt. Hood Corridor, and the Oregon Resources Conservation Act of 1996. They are also in negations to purchase the 1,183 acre

Minsinger Bottom Ranch along 1.5 miles of the Wild and scenic segment of the Sandy River. This property will be a combination exchange and acquisition.

BLM land management activities are required to comply with Northwest Forest Plan requirements, described in **Section 6.7.8**, above.

6.7.10 Urban and Rural Sources

Responsible participants for implementing DMA specific implementation plans for urban and rural sources were identified in **Section 6.4** of this WQMP. Upon approval of the Sandy Basin TMDL, ODEQ expects that identified, responsible participants will develop, submit to ODEQ, and implement individual temperature management plans that will achieve the load allocations established by the TMDLs. These activities will be accomplished by the responsible participants in accordance with the Schedule in **Section 6.6** of this WQMP.

6.7.10.1 Multnomah County

The portion of Multnomah County that lies within the Sandy Basin totals approximately 22,000 acres of rural land that is on the west and east side of the lower river. Multnomah County land use jurisdiction on the west bank of the Sandy stops at the Troutdale City limits. On the east bank, Multnomah County continues to have jurisdiction in the area opposite Troutdale down to near I-84 under the provisions of the Columbia River Gorge National Scenic Area Act.

Most of the Sandy Basin in Multnomah County is in two Rural Planning Areas, the East and West of Sandy River Plan areas. Zoning in these unincorporated areas of the watershed requires that new parcels meet relatively large sizes, ranging from 5 to 80 acre minimums in most cases. Over 90% of the land area in the two rural planning areas of the lower Sandy basin is zoned for either farm or forest resource use, with minimum parcel sizes of 20 to 80 acres. Due to these large parcel size requirements, partitions have become relatively infrequent.

Regulation of land uses and development is subject to rules promulgated by several entities, including Oregon Department of Agriculture, Oregon Department of Forestry, Metro, and the County. As noted above, much of this unincorporated land is in either agricultural or forest use. Multnomah County is precluded from regulating any effects to water quality from farm or forest activities on these lands. The County does regulate development associated with other land uses such as new dwellings in these areas. As is the case with partitions, the amount of new development in these areas is relatively low due to the farm or forest resources zoning.

Multnomah County is working on a plan that will result in enhanced water quality and fish and wildlife habitat protection measures in the Sandy Basin east and west of the river. West of the Sandy River, the County has proposed extending Metro's Title III water quality and floodplain management standards beyond the Metro boundary to the river. The plan for the West of Sandy River area also includes a Statewide Planning Goal 5 program to protect riparian corridors and wildlife habitat using a watershed approach that extends protection to intermittent streams. In this case, a Significant Environmental Concern (SEC) overlay is proposed for riparian corridors, and a 200-foot riparian buffer or management area is proposed to minimize development impacts. The SEC overlay zone incorporates the Metro Title III provisions that require mitigation in the form of re-establishing or extending vegetated corridors as a condition of development approval.

The County has completed a Goal 5 riparian corridor protection plan on the east side of the Sandy River. In the East of Sandy River plan area, development of new residential uses within 150' of designated significant streams is prohibited, and other development is limited by the adopted policy. The County also has a Hillside Development Overlay zone in place county wide. This zone requires geotechnical review for development in areas with slopes steeper than 25%, and includes vegetation protection and replacement requirements. Property on the east side is also subject to County grading and erosion control ordinances.

Multnomah County is a co-permittee on the City of Gresham Municipal Separate Storm Sewer System (MS4) NPDES permit issued by the Department on March 3, 2004.

6.7.10.2 Clackamas County

Clackamas County will implement BMPs through its road maintenance and planning departments. Road maintenance BMPs will likely include vegetating road shoulders and ditches.

Development that occurs outside the urban growth boundary is subject to county review. The current County Zoning and Development Ordinance regulates development in flood plains (Section 703) and River and Stream Conservation Areas (Section 704). Section 704 establishes minimum setbacks for structures depending on the size of the stream (50 to 100 ft). At least 75% of the setback area must be preserved with native vegetation. With few exceptions, tree cutting is not allowed in the setback area.

Section 703 requires permitting for development in floodplain areas. In reviewing the permit, the county takes into consideration factors such as the requirements of the facility for a waterfront location, the availability of alternative locations not subject to flooding, the development's relationship to the Comprehensive Plan. The county may impose conditions of use, such as times of year or operation controls.

6.7.11 The Oregon Plan

The Oregon Plan for Salmon and Watersheds represents a major effort, unique to Oregon, to improve watersheds and restore endangered fish species. The Oregon Plan is a major component of the demonstration of "reasonable assurance " that this TMDL WQMP will be implemented.

The Plan consists of four essential elements:

(1) Coordinated Agency Programs: Many state and federal agencies administer laws, policies, and management programs that have an impact on salmon and water quality. These agencies are responsible for fishery harvest management, production of hatchery fish, water quality, water quantity, and a wide variety of habitat protection, alteration, and restoration activities. Previously, agencies conducted business independently. Water quality and salmon suffered because they were affected by the actions of all the agencies, but no single agency was responsible for comprehensive, life-cycle management. Under the Oregon Plan, all government agencies that impact salmon are accountable for coordinated programs in a manner that is consistent with conservation and restoration efforts.

(2) Community-Based Action: Government, alone, cannot conserve and restore salmon across the landscape. The Oregon Plan recognizes that actions to conserve and restore salmon must be worked out by communities and landowners, with local knowledge of problems and ownership in solutions. Watershed councils, soil and water conservation districts, and other grassroots efforts are vehicles for getting the work done. Government programs will provide regulatory and technical support to these efforts, but local people will do the bulk of the work to conserve and restore watersheds. Education is a fundamental part of the community based action. People must understand the needs of salmon in order to make informed decisions about how to make changes to their way of life that will accommodate clean water and the needs of fish.

(3) Monitoring: The monitoring program combines an annual appraisal of work accomplished and results achieved. Work plans will be used to determine whether agencies meet their goals as promised. Biological and physical sampling will be conducted to determine whether water quality and salmon habitats and populations respond as expected to conservation and restoration efforts.

(4) Appropriate Corrective Measures: The Oregon Plan includes an explicit process for learning from experience, discussing alternative approaches, and making changes to current programs. The Plan emphasizes improving compliance with existing laws rather than arbitrarily establishing new protective laws. Compliance will be achieved through a combination of education and prioritized enforcement of laws that are expected to yield the greatest benefits for salmon.

*Voluntary Measures***.** There are many voluntary, non-regulatory, watershed improvement programs (Actions) that are in place and are addressing water quality concerns in the Sandy Basin. Both technical expertise and partial funding are provided through these programs. Examples of activities promoted and accomplished through these programs include: planting of conifers, hardwoods, shrubs, grasses and forbs along streams; relocating legacy roads that may be detrimental to water quality; replacing problem culverts with adequately sized structures, and improvement or maintenance of legacy roads known to cause water quality problems. These activities have been and are being implemented to improve watersheds and enhance water quality. Many of these efforts are helping resolve water quality related legacy issues.

Landowner Assistance Programs. A variety of grants and incentive programs are available to landowners in the Sandy Basin. These incentive programs are aimed at improving the health of the watershed, particularly on private lands. They include technical and financial assistance, provided through a mix of state and federal funding. Local natural resource agencies administer this assistance, including the Oregon Department of Forestry, the Oregon Department of Fish and Wildlife, ODEQ, the National Resources Conservation Service, OWEB and Metro.

Field staff from the administrative agencies provides technical assistance and advice to individual landowners, watershed councils, local governments, and organizations interested in enhancing the Basin. These services include on-site evaluations, technical project design, stewardship/conservation plans, and referrals for funding as appropriate. This assistance and funding is further assurance of implementation of the TMDL WQMP.

Financial assistance is provided through a mix of cost-share, tax credit, and grant funded incentive programs designed to improve on-the-ground watershed conditions. Some of these programs, due to source of funds, have specific qualifying factors and priorities. Cost share programs include the Forestry Incentive Program (FIP), Stewardship Incentive Program (SIP), Environmental Quality Incentives Program (EQIP), the State Revolving Fund (SRF) and the Wildlife Habitat Incentive Program (WHIP).

6.8 MONITORING AND EVALUATION – OAR 340- 42- 0040(4)(1)(K)

Monitoring and evaluation has two basic components: 1) implementation of DMA specific implementation plans identified in this document, and 2) monitoring of physical, chemical and biological parameters for water quality and specific management measures. This information will provide information on progress being made toward achieving TMDL allocations and achieving water quality standards.

The objectives of this monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the “reasonable assurance of implementation” for the Sandy Basin TMDL WQMP. There has been a significant water quality monitoring program implemented within the basin over the past ten years, with programs implemented by the Mount Hood National Forest, PGE, City of Portland and Clackamas County. It is expected that these programs will continue and that the information generated by each of the agencies/entities gathering data in the Sandy Basin will be pooled and used to determine whether management actions are having the desired effects or if changes in management actions and/or TMDLs are needed. This detailed evaluation will typically occur on a 5 year cycle. ODEQ will work with DMAs to develop a coordinated monitoring plan for the basin within 18 months after TMDL adoption.

This WQMP and the DMA-specific Implementation Plans will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. The mechanism for tracking DMA implementation efforts will be annual reports to be submitted to ODEQ.

The following are examples of specific monitoring and evaluation programs in the Sandy River Basin:

- **Oregon Department of Environmental Quality**: In support of the ODEQ mission statement of restoring and protecting Oregon's water, air, and land, the Watershed Assessment section of the Laboratory Division collects representative, valid environmental data through physical, chemical, and biological sampling and assessment. The Watershed Assessment section conducts water quality monitoring on several scales; ambient water quality monitoring of 151 fixed sites statewide, TMDL location-specific monitoring studies conducted on a TMDL priority schedule, and through support of over 40 watershed councils statewide and their volunteer monitoring studies. The ongoing ambient effort provides data for trends analyses.

- **Oregon Department of Forestry***:* The Forest Practices Monitoring Program (FPMP) is responsible for monitoring the implementation and effectiveness of the forest practice rules and reporting those findings and recommendations to the Board of Forestry on an annual basis (OAR 629-635-0110 3d). The Board of Forestry considers the findings and recommendations and takes appropriate action with regard to rule revision. The role of monitoring is further articulated in the forest practice rules with regard to the water protection rules (OAR 629-635-0110 (3)) and under statute with regard to stewardship plans (527.662 (d)) and sensitive resource sites (527.710 (3)).

  The monitoring strategy (ODF 2002a) focuses on four types of monitoring to address forest practice program and OPSW goals and objectives. The monitoring types include implementation, effectiveness, trend, and validation.

  Implementation - The process of evaluating whether forest practice rules were complied with and whether voluntary measures were implemented. The objective is to assess whether the activities or rules were carried out as intended. An example of an implementation monitoring question is: Was streamside vegetation maintained in accordance with the water protection rules?

  Effectiveness - The process of evaluating whether forest practices regulations achieve the desired goals for resource protection. The objective of this type of monitoring is to assess whether forest practice rules had the anticipated effect. An example of an effectiveness question is: Are the water protection rules effective at preventing increases in stream temperatures that otherwise might occur from forest management activities?

  Trend - The process of evaluating patterns over time and space. The objective in this type of monitoring is to determine the range of conditions across the landscape and how such conditions change over time in response to management, restoration, and the OPSW. An example of a trend monitoring question is: What are the riparian conditions in the Coast Range and how do those vary over time?

  Validation **-** The process of evaluating whether the original assumptions used to build the regulations were correct. The objective is to assess whether the assumptions underlying the design of the Forest Practices Act or specific rules were valid. An example of a validation monitoring question is: Will the desired future condition of riparian area be met under the forest practices riparian management strategies? Because validation monitoring requires addressing complex cause-and-effect questions, these issues will usually be pursued through research and other studies.

  As part of the FPMP, ODF completed an analysis of forest practice compliance on non-federal forest lands in Oregon. This study determined rates of compliance for a large suite of forest practice rules, and the occurrence of water quality violations resulting from non-compliance. The report (ODF, 2002b) is available on the ODF website at: http://159.121.125.11/FP/fpmp/default.htm

- **Oregon Department of Agriculture**: Under Senate Bill (SB) 1010 legislation, ODA is responsible to develop basin plans and rules known as Agricultural Water Quality Management Area Plans and Rules (Plans and Rules). These plans and rules are developed in consultation with Local Advisory Committees (LACs). Monitoring and reporting of plan and rules implementation and water quality improvements, with respect to agricultural lands in the basin, is the responsibility of ODA. Water quality and landscape monitoring is being conducted by ODA to evaluate plan and rules effectiveness and in support of the plan and rules reviews. ODA will use all available data to assess instream concentrations of nitrate/nitrite, dissolved oxygen, total phosphorus, E. coli, TSS, and pH for trend monitoring.

  ODA is also collecting data from aerial photographs on landscape conditions including extent and type of riparian vegetation, streambank stability, amount of shade, erosion (upland and riparian), indications of waste discharge, and livestock access to streams. These data will be consolidated to assess the condition of watersheds in the planning area.

- **Oregon Department of Transportation**: ODOT's monitoring and evaluation program is tied to performing research projects that address best management practices and effectiveness of the practices and refining practices as appropriate based on results.

- **Cities and Counties**: Larger entities conduct their own water quality monitoring assessments and may maintain permanent monitoring networks. Smaller communities may need to partner with local watershed councils, Soil and Water Conservation Districts, or other partners. The Portland, Salem, and Eugene urban areas will be required to conduct specific stormwater monitoring in conjunction with their MS4 Phase 1 permits. It should be noted that the MS4 monitoring requirements might not fully cover all TMDL parameters, such as temperature. The MS4 monitoring plans may need to be augmented to cover other pollutants within their jurisdictions.

- **BLM and USFS**: Districts and regional offices are responsible for developing Water Quality Restoration Plans (WQRP) that describe any monitoring activities to be conducted by either agency.

- **Dams**: Portland General Electric will monitor water quality conditions related to dam removal operations, as described in their decommissioning plan. The City of Portland will establish real-time temperature monitoring locations on the Little Sandy River and lower Bull Run River at Larson's Bridge in order to assess compliance with the TMDL allocation.

6.9 PUBLIC INVOLVEMENT – OAR 340- 42- 0040(4)(1)(L)

To be successful at improving water quality a TMDL WQMP must include a process to involve interested and affected stakeholders in both the development and the implementation of the plan. In addition to the ODEQ public notice policy and public comment periods associated with TMDLs, Section 401 certifications and permit applications, future Sandy Basin TMDL public involvement efforts will focus specifically on urban, agricultural and forestry activities. DMA-specific public involvement efforts will be detailed within the Implementation Plans included in the appendices.

6.10 ADAPTIVE MANAGEMENT – OAR 340- 42- 0040(4)(1)(M)

ODEQ and DMAs will use adaptive management to achieve water quality standards or the highest quality water attainable. Adaptive management allows responsible parties to implement a plan and continually revise it as they evaluate its effectiveness in achieving long-term goals (**Figure 6.2**). This flexible approach is appropriate because:

- TMDL development is based on mathematical models and analytical techniques that simplify complex physical, chemical and biological processes. Modeled predictions of waterbody response to different management measures are not certain.

- Management practices identified in a WQMP (e.g. riparian vegetation planting) may take years to fully reduce and control pollution.

- Technology for controlling nonpoint source pollution continues to develop.

- Natural events (e.g. floods, fire, insect infestations, and drought) may interfere with or delay attainment of the TMDL and/or its associated surrogates.

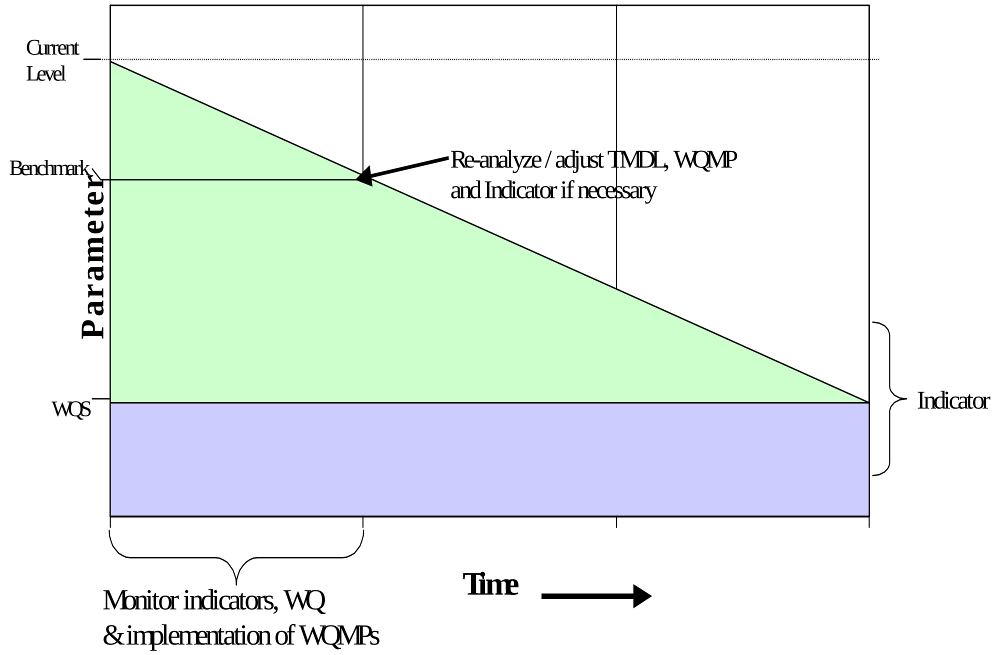
- Full attainment of pollutant surrogates (i. e. system potential vegetation) may not be feasible at all locations due to physical, legal or other regulatory constraints.

Implementation Plans should identify potential constraints, but should also provide the ability to mitigate those constraints should the opportunity arise. For instance, at this time, safety considerations may preclude attainment of system potential vegetation along a road. In the future, should the road be expanded or upgraded, the DMA should consider designs that allow attainment of system potential vegetation.

If a source is not given a load allocation, it does not necessarily mean that the source is prohibited from discharging any wastes. A source may be permitted to discharge by ODEQ if the holder can adequately demonstrate that the discharge will not have a significant impact on water quality over that achieved by a zero allocation.

ODEQ intends to regularly review progress of this WQMP and the associated Implementation Plans. If and when ODEQ determines that the WQMP has been fully implemented, that all feasible management practices have reached maximum expected effectiveness and a TMDL or its interim targets have not been achieved, ODEQ shall reopen the TMDL and adjust it or its interim targets and the associated water quality standard(s) as necessary.

Figure 6.2. Adaptive Management



If a nonpoint source that is covered by the TMDL follows its final Implementation Plan or applicable land management rules, it will comply with the TMDL. ODEQ, other state agencies and local government can enforce implementation of TMDL and the associated plans. If no action is taken despite education and technical support, the appropriate land management agency (e.g. ODF, ODA, counties and cities), would likely intervene before ODEQ. ODEQ intervention may be based on departmental orders to implement management goals leading to water quality standards.

In employing an adaptive management approach to the TMDL and the WQMP, ODEQ expects that:

- Subject to available resources, on a five-year basis, ODEQ will review the progress of the TMDL and the WQMP.
- In conducting this review, ODEQ will evaluate the progress towards achieving the TMDL (and water quality standards) and the success of implementing the WQMP.
- Each DMA will also monitor and document its progress in implementing its plan and this information will be provided to ODEQ.
- DMAs will develop benchmarks for attainment of TMDL surrogates, which can then be used to measure progress.
- Where the Implementation Plans or management techniques are found to be inadequate, DMAs will revise the components of their Implementation Plan to address these deficiencies.
- If ODEQ and DMAs conclude that all feasible steps have been taken to meet the TMDL (or surrogates) but attainment of water quality standards, the TMDL, or the associated surrogates is not practicable, ODEQ will reopen and revise the TMDL. ODEQ would also consider reopening the TMDL if new information becomes available indicating that the TMDL or its associated surrogates should be modified.

6.11 COSTS AND FUNDING – OAR 340- 42- 0040(4)(1)(N)

Designated Management Agencies will be expected to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs described in their Implementation Plans.

The purpose of this element is to describe estimated costs and demonstrate there is sufficient funding available to begin implementation of the WQMP. Another purpose is to identify potential future funding sources for project implementation. There are many natural resource enhancement efforts and projects occurring in the basin which are relevant to the goals of the plan. These efforts, in addition to proposed future actions are described in the Management Measurers element of this Plan.

Potential Sources of Project Funding

Funding is essential to implementing projects associated with this WQMP. There are many sources of local, state, and federal funds. The following is a partial list of assistance programs available in the Sandy Basin.

Program	Agency/Source
Oregon Plan for Salmon and Watersheds	OWEB
Environmental Quality Incentives Program	USDA-NRCS
Wetland Reserve Program	USDA-NRCS
Conservation Reserve Enhancement Program	USDA-NRCS
Stewardship Incentive Program	ODF
Access and Habitat Program	ODFW
Partners for Wildlife Program	USDI-FSA
Conservation Implementation Grants	ODA
Water Projects	WRD
Nonpoint Source Water Quality Control (EPA 319)	ODEQ-EPA
Riparian Protection/Enhancement	COE
Oregon Community Foundation	OCF

Grant funds are available for improvement projects on a competitive basis. Field agency personnel assist landowners in identifying, designing, and submitting eligible projects for these grant funds. For private landowners, the recipient and administrator of these grants is generally the local Soil and Water Conservation District. Grant fund sources include:

Oregon Watershed Enhancement Board (OWEB) which funds watershed improvement projects with state money. This is an important piece in the implementation of Oregon's Salmon Plan. Current and past projects have included road relocation/closure/improvement projects, instream structure work, riparian fencing and revegetation, off stream water developments, and other management practices.

Bonneville Power Administration funds are federal funds for fish habitat and water quality improvement projects. These have also included projects addressing road conditions, grazing management, instream structure, and other tools.

Individual grant sources for special projects have included Forest Health money available through the State and Private arm of the USDA Forest Service.

6.12 CITATION TO LEGAL AUTHORITIES – OAR 340- 42- 0040(4)(1)(O)

6.12.1 Clean Water Act Section 303(d)

Section 303(d) of the 1972 federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. Waters that need this additional help are referred to as "water quality limited". Water quality limited waterbodies must be identified by the Environmental Protection Agency (EPA) or by a state agency which has been delegated this responsibility by EPA. In Oregon, this responsibility rests with the ODEQ. The ODEQ updates the list of water quality limited waters every two years. The list is referred to as the 303(d) list. Section 303 of the Clean Water Act further requires that Total Maximum Daily Loads (TMDLs) be developed for all waters on the 303(d) list. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A WQMP is developed to describe a strategy for reducing water pollution to the level of the load allocations and waste load allocations prescribed in the TMDL, which is designed to restore the water quality and result in compliance with the water quality standards. In this way, the designated beneficial uses of the water will be protected for all citizens.

6.12.2 Oregon Revised Statute

The Oregon Department of Environmental Quality is authorized by law to prevent and abate water pollution within the State of Oregon pursuant to the following statute:

ORS 468B.020 **Prevention of pollution** (1) Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State or Oregon, as set forth in ORS 468B.015.

(2) In order to carry out the public policy set forth in ORS 468B.015, ODEQ shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:

- (a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and
- (b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

6.12.3 NPDES and WPCF Permit Programs

The ODEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the National Pollution Discharge Elimination System (NPDES) permits for waste discharge; and Water Pollution Control Facilities (WPCF) permits for waste disposal. The NPDES permit is also a Federal permit and is required under the Clean Water Act. The WPCF permit is a state program. As permits are renewed they will be revised to insure that all 303(d) related issues are addressed in the permit.

6.12.4 Section 401 Certification Program

Some federally licensed or permitted activities or facilities have potential to cause impacts to waters of the state. Section 401 of the Clean Water Act requires applicants of such activities or facilities to obtain certification that the activities or facilities will comply with Sections 301, 302, 303, 306, and 307 of the Clean Water Act. Before the Federal Energy Regulatory Commission may renew a license, the applicant must show that the proposed Project will comply with the state's water quality standards and policies as evidenced by a Section 401 certification.

6.12.5 Oregon Forest Practices Act

The Oregon Department of Forestry (ODF) is the designated management agency for regulation of water quality on non-federal forest lands. The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 635-660, which describes BMPs for forest operations. The Environmental Quality Commission (EQC), Board of Forestry, ODEQ and ODF have agreed that these pollution control measurers will be relied upon to result in achievement of state water quality standards.

ODF and ODEQ statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, ORS 183.310, OAR 629-635-110, and OAR 340-041-0120.

6.12.6 Senate Bill 1010

The Oregon Department of Agriculture has primary responsibility for control of pollution from agriculture sources. This is accomplished through the Agriculture Water Quality Management (AWQM) program authorities granted ODA under Senate Bill 1010 Adopted by the Oregon State Legislature in 1993. The AWQM Act directs the ODA to work with local farmers and ranchers to develop water quality management plans for specific watersheds that have been identified as violating water quality standards and have agriculture water pollution contributions. The agriculture water quality management plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct the problems.

6.12.7 Local Ordinances

Within their implementation plans, the DMAs are expected to describe their specific legal authorities to carry out the management measures they choose to meet the TMDL allocations. Legal authority to enforce the provisions of a City's NPDES permit would be a specific example of legal authority to carry out management measures.

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