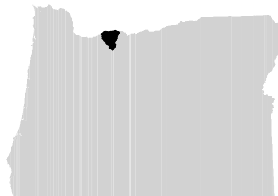
WESTERN HOOD SUBBASIN TOTAL MAXIMUM DAILY LOAD (TMDL)



December 2001
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WESTERN HOOD SUBBASIN TOTAL MAXIMUM DAILY LOAD (TMDL)
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CHAPTER 1 - EXECUTIVE SUMMARY

1.1 WATER QUALITY SUMMARY

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. In Oregon, the Oregon Department of Environmental Quality (ODEQ) is responsible for this work. 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). TMDLs are written plans and analyses established to ensure that waterbodies will attain and maintain water quality standards.

The Western Hood Subbasin, specifically the Hood River watershed, has stream segments listed on the 1998 Oregon 303(d) list for temperature (seven stream segments), and elevated pH (the Hood River below the Powerdale Dam). ODEQ is proposing to establish a TMDL for temperature for streams in the Hood River watershed. ODEQ is proposing to develop a TMDL for pH during the next TMDL review of the Hood River watershed.

1.2 TMDL SUMMARIES

Temperature: The temperature water quality standard uses numeric and qualitative triggers to invoke a condition that requires "no measurable surface water increase resulting from anthropogenic activities." The temperature TMDL targets anthropogenic sources of heat from two sources: increased solar radiation heat loading and heat from point source warm water discharges. The loading capacity is the total allowable daily heat loading. Load allocations are developed for anthropogenic and background nonpoint sources of heat, as well as for the Powerdale Hydroelectric Project and the Laurance Lake Reservoir. The load allocations for the Powerdale Project and Laurance Reservoir are based on limiting thermal heating so that there is no measurable increase (0.25^{o}F) in stream temperatures during critical periods. Waste load allocations are developed for 13 point sources and are also based on limiting thermal impact so that there is no measurable increase (0.25^{o}F) in stream temperatures. Both implicit and explicit margins of safety are provided in the temperature TMDL.

Threatened and endangered cold water salmonids reside in the Western Hood Subbasin and numeric and narrative triggers for the temperature standard apply. Approximately 16.7% of the stream network modeled (Hood River, portions of East Fork Hood River and portions of Neal Creek) currently experience maximum daily temperatures above 64^{o}F (17.8^{o}C) in early-August during the salmonid rearing period.

Temperature modeling which minimized human sources of heat on the Hood River, the East Fork Hood River and Neal Creek found that 100% of the streams modeled would be below 64^{o}F (17.8^{o}C) during the rearing period. Generally speaking, the East Fork Hood River, Hood River and Neal Creek currently experience critical condition maximum daily temperatures in the low- to mid-60^{o}F range. Under the allocated system potential condition, maximum daily temperatures shifted to the mid-50^{o}F to low-60^{o}F range.

Simulations were only done for the rearing period. The determination of spawning time periods and locations for application of the 55^{o}F state temperature criterion were not identified for the Hood River watershed until September, 2000 to address State Conservation Measure 4 (ODEQ, 2000). Because of this late determination, insufficient flow data was collected during the salmonid spawning period to enable simulations to be performed. Attainment of the 55^{o}F criterion is addressed in this TMDL in the development of load allocations through making conservative assumptions about thermal conditions and assigning a "no measurable increase" load to point sources and the Powerdale Project during the spawning period.

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

Percent effective shade is used as a surrogate measure for nonpoint source pollutant thermal loading since it offers a more straightforward parameter to monitor and measure than a load of kcal/day. Percent effective shade is more easily translated into quantifiable water management objectives. Site specific effective shade surrogates can be used to assess TMDL nonpoint source load allocation attainment. Attainment of surrogate measures ensures attainment of the nonpoint source allocations.

pH: Hood River below the Powerdale Hydroelectric Project diversion (the "bypass reach") is listed as violating the pH standard based on data collected in 1995 and 1996 by PacifiCorp. The pH levels which resulted in the 303(d) listing were values of 8.85 (observed on May 10, 1995) and of 8.55-9.0 (observed on June 10-16, 1996). In anticipation of developing a TMDL for pH, ODEQ and PacifiCorp developed a monitoring plan to collect the necessary data for running a pH model and determining load allocations. During May and/or June in 1999, 2000 and 2001, PacifiCorp collected grab samples at the bottom of their bypass reach and analyzed them for pH. If an exceedance of the 8.5 standard was observed, ODEQ was prepared to mobilize and collect the much broader suite of parameters required to run the model. Data was to be collected at numerous points in the Hood River and at the mouths of all the major tributaries in the bypass reach. However, in their water quality monitoring efforts since 1999, ODEQ and PacifiCorp have not observed a pH violation and have therefore not been able to collect the data necessary to develop load allocations.

Based on an initial assessment of the data collected, it appears that pH levels in the Hood River are related to the amount of instream flow as well as nutrient inputs, glacial turbidity and instream temperature. It is hypothesized that there is a window in the late spring or early summer when the river experiences increased algal growth and is susceptible to pH violations. During this period, instream temperatures start to increase and flows start to decrease. This window closes when the glacial turbidity enters the river in early summer, effectively blocking off light for algal production.

During 1999 and 2000, flows at Tucker bridge were generally higher in May and early June than they were during 1995 and 1996. This could be a possible explanation for the lower pH values observed in 1999 and 2000. And in 2001, turbidity remained unusually high in the Hood River during the spring because of the re-release of sediment deposited during the Newton glacial event in September, 2000.

ODEQ, in conjunction with PacifiCorp, intends to continue monitoring this segment of the river to determine if pH exceedances do occur. PacifiCorp is required to do this monitoring under their Section 401 water quality certification granted by ODEQ as part of PacifiCorp's new Federal Energy Regulatory Commission (FERC) relicense of the Powerdale Hydroelectric Project. If and when this occurs, ODEQ will collect sufficient data, as described above, to develop a TMDL to address pH. A pH TMDL would be completed as soon as resources allow if a TMDL is deemed necessary, but certainly no later than the next time the Hood TMDL is reviewed by ODEQ.

Water Quality Management Plan (WQMP): To address this TMDL, a WQMP has been developed focusing on the following areas:

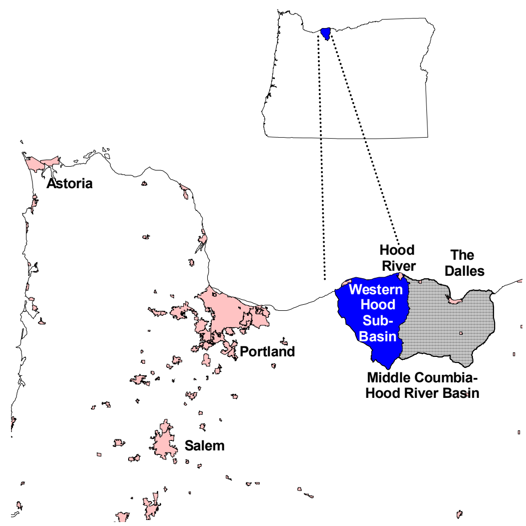
- Establishing and protecting riparian area vegetation;
- Temperature control in permitted discharges
- Temperature control relative to flow management below dams.

The Designated Management Agencies (DMAs) include: Mount Hood National Forest, Hood River County, City of Hood River, Oregon Department of Agriculture, Oregon Department of Forestry, Oregon Department of Transportation, Bonneville Power Administration, and the Middle Fork Irrigation District. Each DMA has submitted individual Implementation Plans. An evaluation of each implementation plan is included in Chapter 5. In those cases where individual implementation plans do not exist or are incomplete, these DMAs will be required to prepare and submit individual implementation plans once the TMDL is approved by the Environmental Protection Agency.

CHAPTER 2 – OVERVIEW AND BACKGROUND

2.1 INTRODUCTION

The Middle Columbia-Hood River Basin is in the north-central part of Oregon occupying approximately 1051 square miles. The rivers and creeks in the basin are tributaries to the Columbia River, originating on the eastern slope of the Cascade Range and flowing north from Mt. Hood (elevation 11,235 feet) to the Columbia River (elevation 74 feet). This TMDL will address the western half of the Middle Columbia-Hood River Basin, including five of the nine "Watersheds" or 5th field watersheds (USGS, 1989) in the Subbasin. This portion of the Middle Columbia-Hood River Basin will hereafter be referred to in this TMDL as the "Western Hood Subbasin".



The Western Hood Subbasin encompasses an area of approximately 450 square miles. The major tributaries to the Columbia in the Western Hood Subbasin include Eagle Creek, Herman Creek, Phelps Creek, and the Hood River. **Because water quality impairments, and hence 303(d) listings, have only been observed in the Hood River watershed, this TMDL will primarily focus on that watershed**.

The Western Hood Subbasin supports a wide range of forest, agriculture, urban and recreational activities. With a projected 2000 population of 5,582 (Hood River Chamber of Commerce, 2001), the City of Hood River is largest urban area in the Subbasin. Smaller urban/residential centers are found in the Towns of Parkdale and Odell (both unincorporated) and the City of Cascade Locks (projected 2000 population of 1,174). There are three wastewater treatment plants (WWTPs) with permitted surface water discharges in the Subbasin serving Odell, Parkdale and the Mount Hood Meadows Ski Area. There are also four fruit packing plants with permitted cooling water discharges in the Odell and Parkdale areas. The Subbasin lies entirely within Hood River County.

The Western Hood Subbasin supports bull trout, spring Chinook salmon, summer and winter steelhead, rainbow and cutthroat trout, and lesser numbers of fall Chinook and coho salmon. Hood River fish populations have declined markedly in the last decades. Native Hood River spring Chinook became extinct in the early 1970s. In 1998, steelhead and bull trout were listed as Threatened under the Endangered Species Act.

2.2 TOTAL MAXIMUM DAILY LOADS

2.2.1 What is a Total Maximum Daily Load (TMDL)?

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*. *Beneficial uses* include fisheries, aquatic life, drinking water, recreation and irrigation and others. Specific State and Federal regulations determine if violations have occurred. These include the *Federal Clean Water Act of 1972* and the associated regulations in *40 Code of Federal*

Regulations 130 & 131, the *Oregon Revised Statute* (ORS Chapter 468) and the *Oregon Administrative Rules* (OAR Chapter 340).

The term *water quality limited* is applied to streams and lakes where required treatment processes are being used, but violations of State water quality standards occur. Section 303(d) of the Federal Clean Water Act requires the EPA or delegated states, such as Oregon, to prepare a list of water bodies where these violations occur. The resulting list (the "303(d) list") is a comprehensive catalog of all waterbodies in the state that fail to meet one or more water quality criteria based on available data. With few exceptions, such as in cases where violations are due to natural causes, the State must also establish *a Total Maximum Daily Load* or *TMDL* for any waterbody designated as *water quality limited*. A *TMDL* is a determination of 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. *Wasteload Allocations* are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industries. The *Wasteload 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, such as soils, 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 *Wasteload* and *Load Allocations*.

2.2.2 Elements of a TMDL

The EPA has the authority under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA would need to establish the TMDL themselves within 30 days.

The required elements of a TMDL that must be submitted to EPA include:

1. A description of the geographic area to which the TMDL applies;
2. Specification of the applicable water quality standards;
3. An assessment of the problem, including the extent of deviation of ambient conditions from water quality standards;
4. Evaluation or seasonal variations;
5. Identification of point sources and nonpoint sources;
6. Development of a loading capacity including those based on surrogate measures and including flow assumptions used in developing the TMDL;
7. Development of Waste Load Allocations for point sources and Load Allocations for nonpoint sources;
8. Development of a margin of safety.

2.2.3 TMDLs Addressed in this Report

This report contains a TMDL for the following parameter:

- Temperature

The main text summarizes the eight elements listed above for the temperature TMDL.

2.3 TMDL IMPLEMENTATION

2.3.1 Water Quality Management Plans (WQMPs)

Implementation of TMDLs is critical to the attainment of water quality standards. The support of Designated Management Agencies (DMAs) in implementing TMDLs is essential. In instances where ODEQ has no direct authority for implementation, ODEQ works with DMAs on implementation to ensure attainment of water quality standards.

ODEQ intends to submit a WQMP to EPA concurrently with submission of TMDLs. Both the TMDL and associated WQMP will be submitted by ODEQ to EPA as updates to the State's Water Quality Management Plan pursuant to 40 CFR 130.6.

The following are elements of the WQMPs that will be submitted to EPA:

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

Chapter 5 contains the above elements for DMAs in the Western Hood Subbasin and an evaluation of each DMA's implementation plan.

2.3.2 Implementation and Adaptive Management Issues

The goal of the Clean Water Act and associated Oregon Administrative Rules (OARs) is that water quality standards shall be 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.

TMDLs are numerical loadings that are set to limit pollutant levels such that instream water quality standards are met. ODEQ recognizes that TMDLs are values 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 subbasin 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.

WQMPs 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 beyond the control of humans 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 Western Hood Subbasin TMDL, pollutant surrogates have been defined as alternative targets for meeting the TMDL. The purpose of the surrogates is not to bar or eliminate human access or activity in the subbasin 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 (system potential vegetation, for example) 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 a measurable 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.

2.3.2.1 Adaptive Management

In employing an adaptive management approach to this TMDL and WQMP, ODEQ has the following expectations and intentions:

- Subject to available resources, ODEQ will review and, if necessary, modify TMDLs and WQMPs established for a subbasin 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.

- In conducting this review, ODEQ will evaluate the progress towards achieving the TMDL (and water quality standards) and the success of implementing the WQMP.

- 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 wasteload 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.

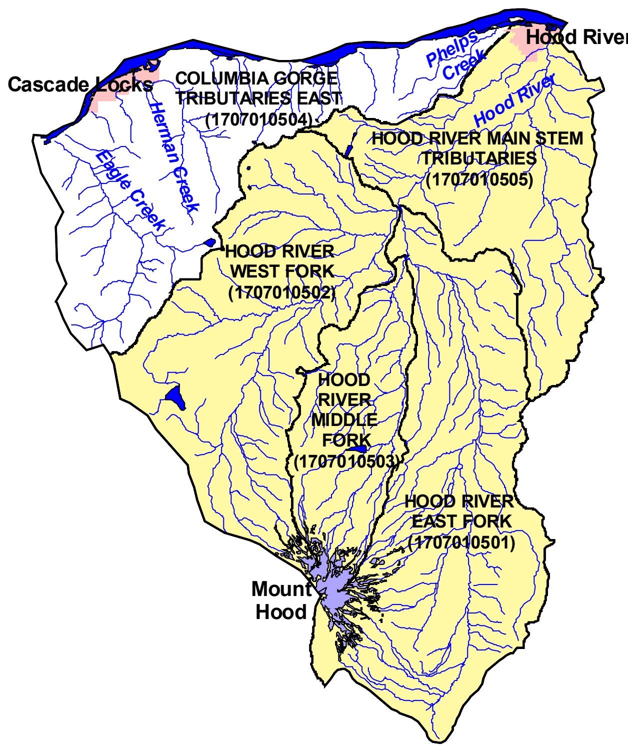
- When ODEQ, in consultation with the management agencies, concludes that all feasible steps have been taken to meet the TMDL and its associated surrogates and attainment of water quality standards, the TMDL, or the associated surrogates is not practicable, it will reopen the TMDL and adjust it as appropriate. ODEQ would also consider reopening the TMDL should new information become available indicating that the TMDL or its associated surrogates should be modified.

2.4 ORGANIZATION OF THIS REPORT

This report is structured to address the required elements of a TMDL for EPA approval. The following chapters summarize the TMDL and provide the detail for the eight required elements of a TMDL.

- Chapter 3 describes the geographic area of the Western Hood Subbasin.
- Chapter 4 summarizes the other seven elements for the temperature TMDL.
- Chapter 5 describes the reasonable assurance of implementation and provides an overview of the Water Quality Management Plan.
- Chapter 6 describes the analytical methodology used in the HeatSource model.

CHAPTER 3 – DESCRIPTION OF THE WESTERN HOOD SUBBASIN



The Western Hood Subbasin encompasses an area of approximately 450 square miles. This area falls within the fifth field HUCs 1707010501, 1707010502, 1707010503, 1707010504, and 1707010505. The major tributaries to the Columbia in the Western Hood Subbasin include Eagle Creek, Herman Creek, Phelps Creek, and the Hood River. **Because water quality impairments, and hence 303(d) listings, have only been observed in the Hood River watershed (highlighted in yellow), this TMDL will primarily focus on that watershed.**

The Hood River is the largest tributary to the Columbia River in the Western Hood Subbasin. The headwaters of the Hood River originate on the eastern slope of the Cascade Range in predominantly conifer forests and flow north from Mt. Hood (elevation 11,235 feet). The Hood River forms from three main tributaries – the East, Middle and West Forks – which converge to form the Hood River mainstem at rivermile 12.3. The Hood River mainstem enters the Columbia River at an elevation of 74 feet above sea level. This confluence occurs at the eastern edge of the City of Hood River, Oregon at rivermile 169 on the Columbia River. The Hood River watershed is approximately 340 square miles. The 5th field HUCs for the four Hood River watersheds are 1707010501 (East Fork Hood River), 1707010502 (West Fork Hood River), 1707010503 (Middle Fork Hood River), and 1707010505 (Hood River Mainstem Tributaries).

The fifth watershed mentioned in this TMDL is the Columbia Gorge Tributaries East (hydrologic unit code 1707010504). This watershed consists of numerous short streams which flow directly into the Columbia River. Elevations range from close to sea level at the Columbia to 5,000 feet in the headwaters of Eagle Creek. The City of Cascade Locks (located near rivermile 149 on the Columbia River) is located near the western edge of this watershed.

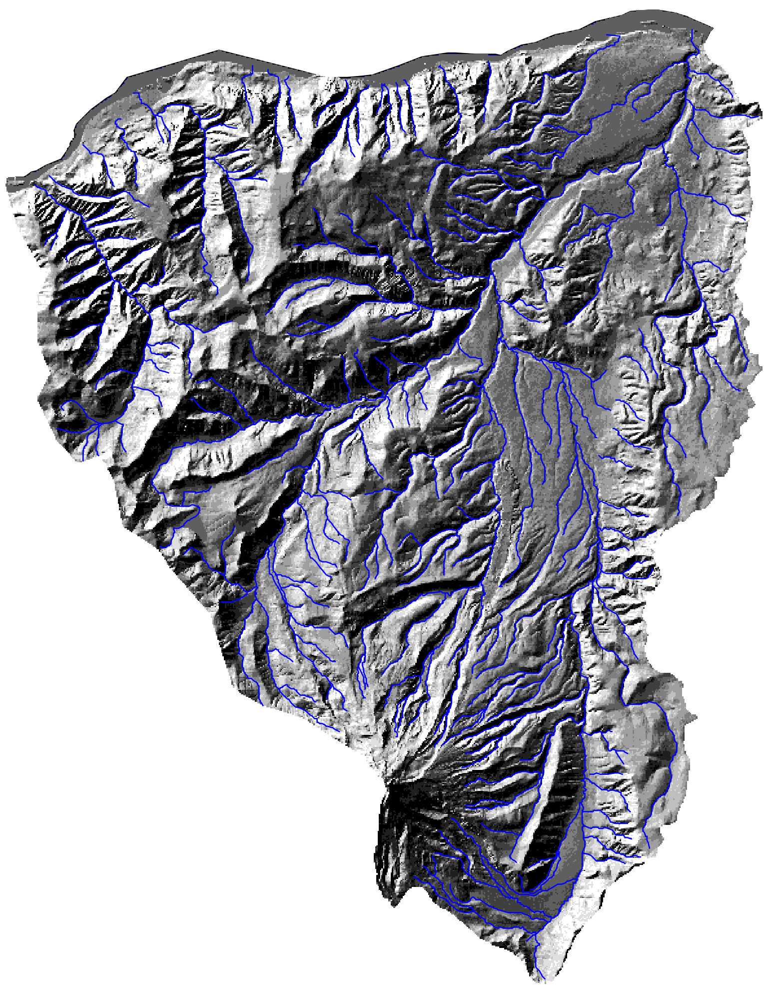
3.1 GEOLOGY

Volcanic lava flows, glaciation and flooding were key forces forming the Columbia Gorge landscape of steep basalt cliffs, waterfalls, talus slopes, and sharply defined ridges. In the Columbia Gorge portion of the Subbasin, landslides are the dominant erosional process in recent history. Alluvial fan deposits at the mouths of the steeper, more constricted creeks where they join the Columbia River suggest the frequent routing of debris torrents down these channels. The lower mile or so of the major creeks have gradients of about 5%, with lower gradient areas in the broad, glaciated headwater valleys.

Debris torrents and landslides, as well as dam-break floods, are also not uncommon in the Hood River watershed. The Hood River is a dynamic, glacially influenced system. Five upper tributaries are fed by glacial sources that drain approximately one third of the total glacial ice on Mt. Hood. During high flow events, large amounts of bedload and sediment are transported in the Middle Fork, East Fork and mainstem of the Hood River, and to a lesser extent, the lower West Fork. Glacial melt increases water turbidity in the form of suspended silt or glacial flour during summer and early fall.

While the mainstem of the Hood River and its West, Middle and East Forks (below rivermile 22.7) have an average channel gradient of less than 2.5%, most stream channels in the watershed have moderate or high gradients and are confined in narrow valleys or between terraces. The headwaters of the Middle and West Forks contain several important low gradient stream reaches. The East Fork Hood River forms a glacial “U-shaped” valley. Most streams are single-thread channels of low sinuosity and have a limited floodplain area. Rock formations are primarily volcanic Columbia River basalt and boulder-rubble substrates dominate most streambeds. Shaded relief topography is depicted in **Figure 1**.

Figure 1. Western Hood Subbasin Shaded Relief Topography

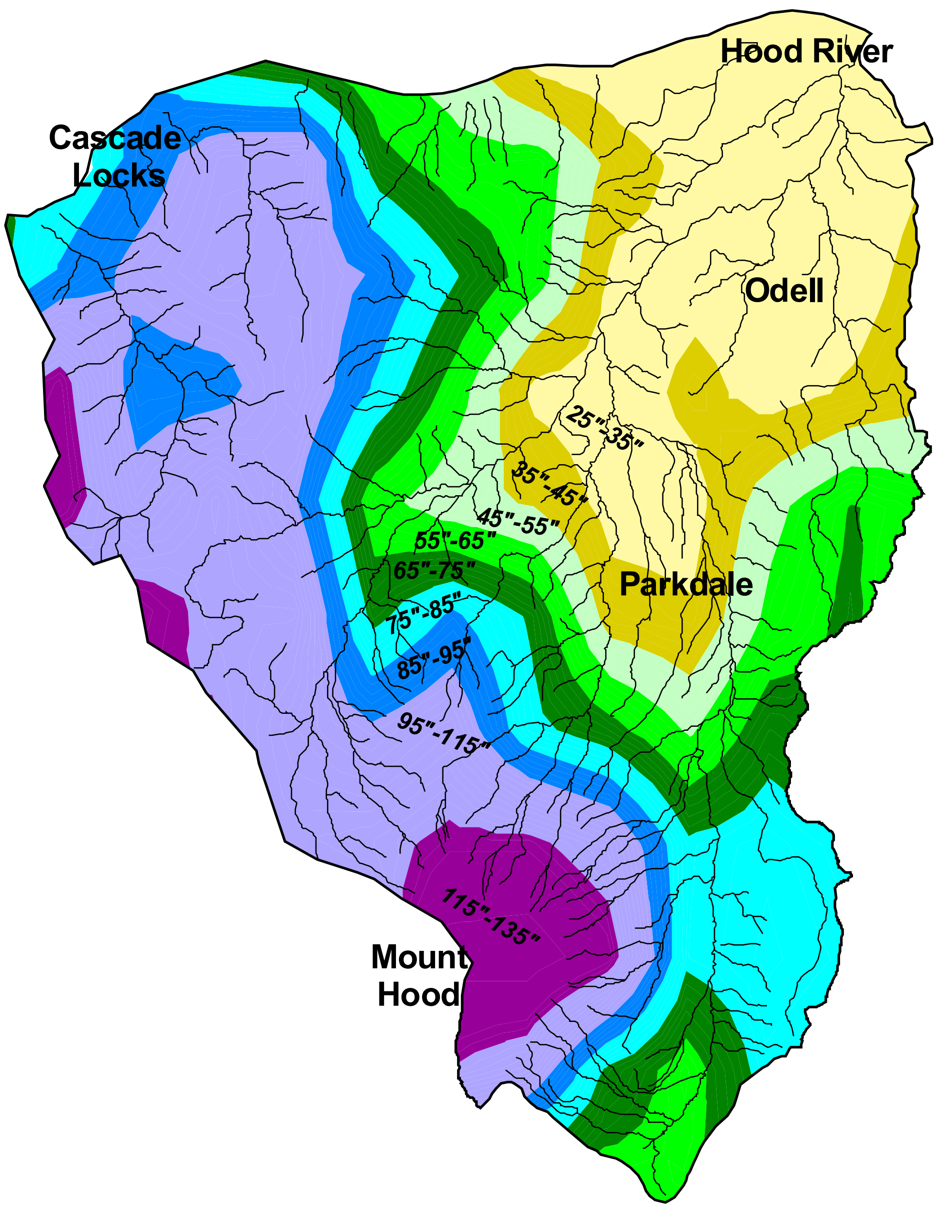


3.2 CLIMATE

Climate varies widely across the Western Hood Subbasin because of its transitional location between weather dominated by wet marine air flow in the west and the semi-arid continental climate of eastern Oregon. Annual precipitation varies from west to east and with elevation, ranging from close to 140 inches along the Cascade crest to less than 30 inches along the east boundary. The majority of the precipitation falls between November and January. Snowfall is heavy at high elevations and can reach 30 feet deep at timberline on Mt. Hood. **Figure 2** displays annual precipitation.

Temperature also varies throughout the Subbasin (Western Regional Climate Center, 2001). Maximum summer temperatures range from 68°F at Government Camp (just outside of the Subbasin boundary on Mt Hood) to 78°F near Cascade Locks at the Bonneville Dam to 81°F in Hood River and Parkdale. Minimum January temperatures range from 23-24°F at Government Camp and Parkdale to 28°F at Hood River and 33°F at Bonneville Dam.

Figure 2. Hood River Subbasin Precipitation
(digital data from Oregon Geospatial Data Clearinghouse)



3.3 LAND USE AND OWNERSHIP

The entire Western Hood River Subbasin is located within Hood River County. The population of the County in 2000 was 20,411 people (U.S. Census Bureau, 2001). The County experienced an annual growth rate of 1.8% between 1990 and 1998 (CGEDA, 2001). The County population is projected to increase by 3,000 to 4,000 people every five years, reaching an estimated 36,483 by the year 2040 (USDA Forest Service, 1996a). The population in the County is dispersed, with almost 70% of County residents living outside of urban growth boundaries. There are four small urban centers located within the County – the cities of Hood River and Cascade Locks and the towns of Odell and Parkdale.

Land ownership is predominantly public in the Western Hood Subbasin, covering more than 70 percent of the total land area. The Mt. Hood National Forest manages 61%, the State of Oregon manages a little under 1% and the County of Hood River manages 11% of the land area, nearly all of which is forested. Private ownership account for approximately 26% of the total land area. Spatial distributions of land ownership are displayed in **Figure 3**.

The entire Hood River watershed is located within the boundary of land ceded to the United States by the seven bands of Wasco- and Sahaptin-speaking Indians whose representatives were signatories to the Treaty with the Tribes of Middle Oregon of June 25, 1855. The Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) is the legal successor in interest to the Indian signatories to the treaty (Hood River Watershed Group, 1999). The tribe's treaty rights include a harvest allocation right to take up to half the harvestable number of each salmon and steelhead run passing the tribe's usual and accustomed fishing places, as well as a right to sufficient water quality and quantity to maintain harvestable run sizes. Because of their rights on the ceded lands in the Hood River basin, the CTWSRO co-manages the fisheries in the basin with the Oregon Department of Fish and Wildlife (ODFW).

Figure 4 shows the spatial distribution of major land use types in the Western Hood Subbasin. Forestry is the predominant land use, accounting for approximately 85% of the Subbasin area. Hood River County owns approximately 30,000 acres of dedicated forest-land and Longview Fibre Company owns approximately 22,000 acres. Timber harvest on these county and private lands are 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, 1994a and 1994b) 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 Subbasin – the Mark O. Hatfield wilderness (approximately 36,000 acres), the Mt. Hood Wilderness (approximately 20,000 acres) and the Badger Creek Wilderness (approximately 360 acres).

Agriculture, primarily fruit production, is the second largest land use in the Subbasin, accounting for a little over 7% of the Subbasin area. All of the agricultural lands are located within the Hood River watershed, mostly on land below 2,000 feet in elevation. Irrigated orchards growing mostly pears and apples make up approximately 15,000 acres, with cherries, peaches, wine grapes and produce grown in smaller amounts. Other agricultural activities include a number of farms raising livestock and a single grazing allotment on the Mt. Hood National Forest. Approximately 2,000 acres of pasture land is irrigated. Agriculture is the leading industry in the Subbasin, followed by tourism and forestry.

Outdoor recreation and tourism have expanded into the second biggest economy in the watershed. The Mt. Hood National Forest, Mt. Hood Meadows Ski Resort and Cooper Spur Ski Area draw visitors to the forested portions of the Subbasin, while the City of Hood River has become an international windsurfing destination. Whitewater kayaking, angling, hiking, camping, backcountry snow sports and mountain biking are increasing watershed uses. A strong link between tourism and land development in the Hood River watershed is noted by historians and continues today (USDA Forest Service, 1996b). Approximately 4% of the Subbasin is considered to be urban or residential.

Figure 3. Land Ownership/Management Spatial Distribution
(digital data from Oregon Geospatial Data Clearinghouse, Hood River County Forestry Dept.)

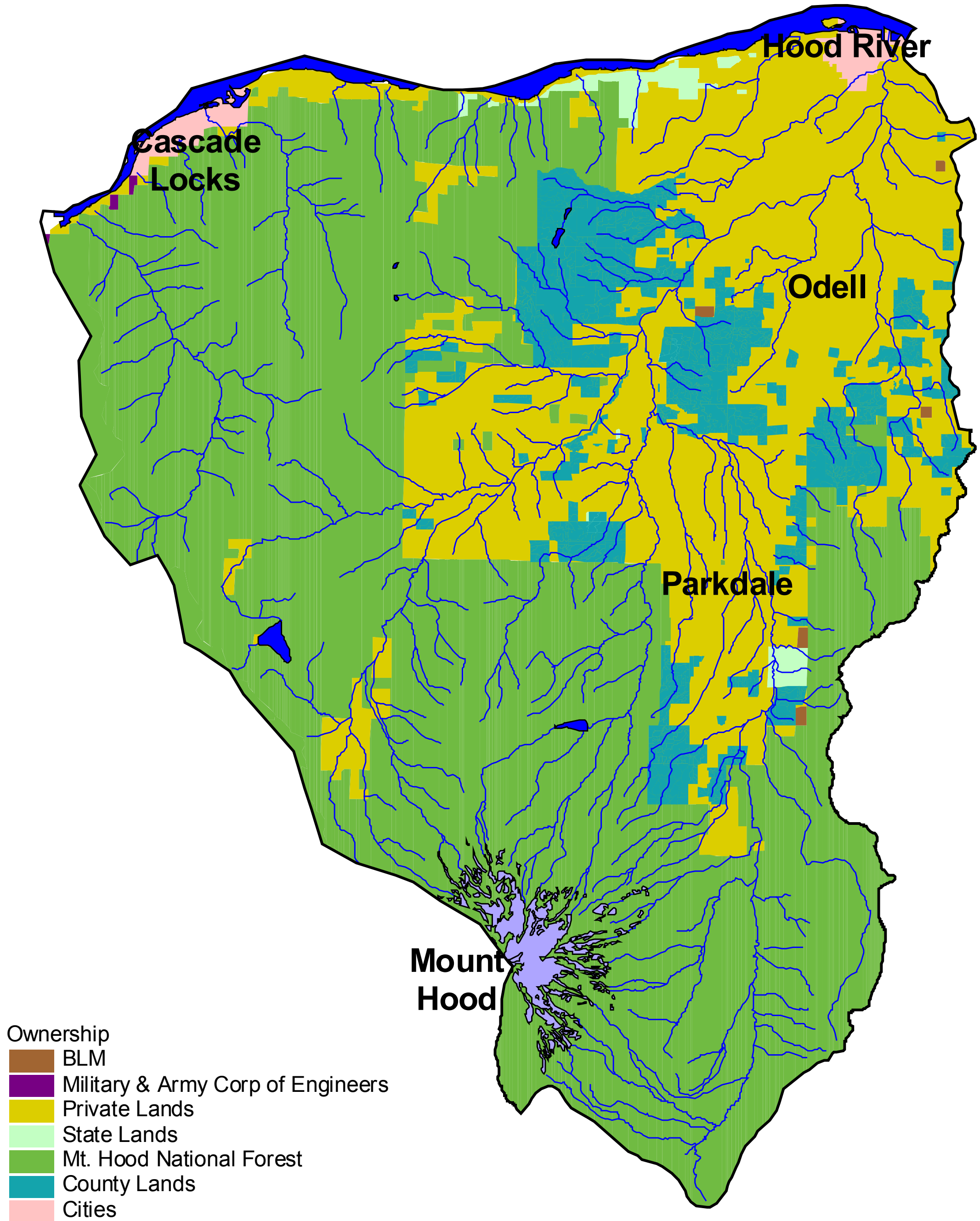
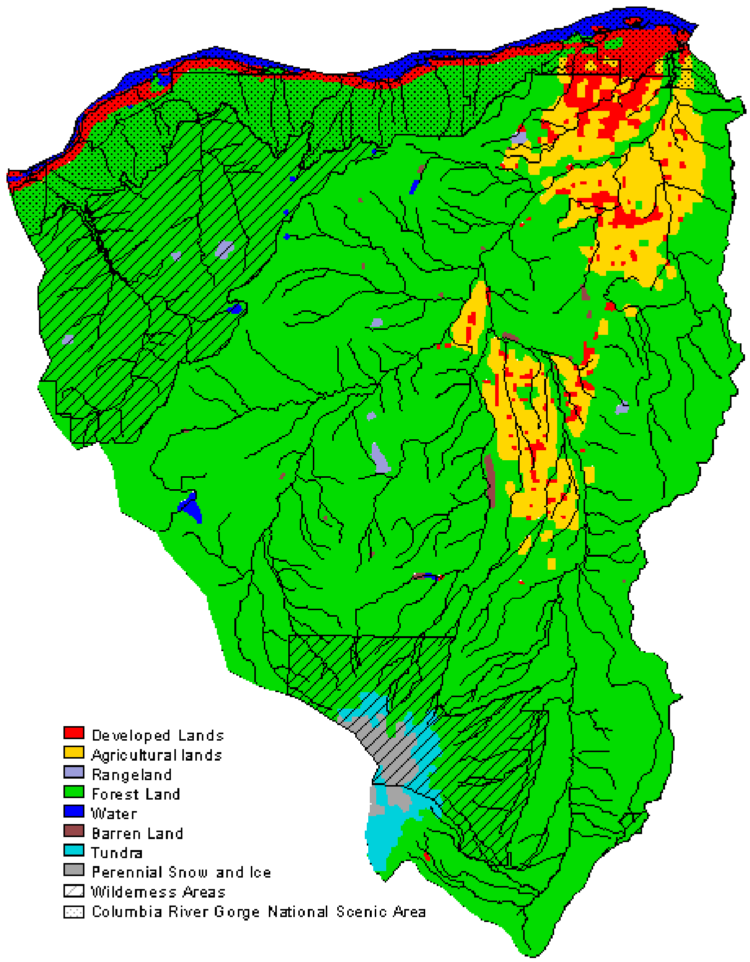
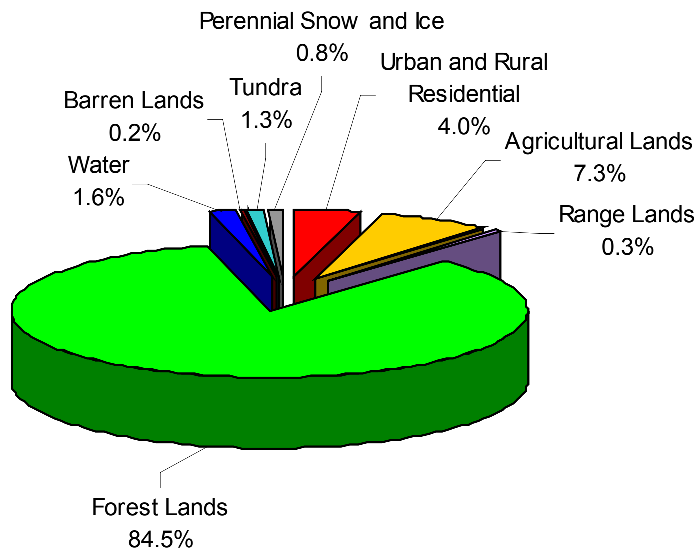


Figure 4. Land Use Spatial Distribution
(digital data from Oregon Geospatial Data Clearinghouse)





3.4 STREAM FLOW CHARACTERISTICS

The natural flow of water in the Hood River watershed is interrupted by irrigation, domestic and municipal withdrawals and diversions for power generation facilities. Irrigation and municipal supply are the principal consumptive uses, while hydropower is the largest single non-consumptive use. The total volume of all legally appropriated water rights for out-of-stream uses is approximately 678,094 acre feet, or 94% of the estimated median natural stream flow at the Hood River mouth (Hood River Watershed Group, 1999). Actual water use at any given time is less than the amount appropriated. However, simultaneous use of consumptive water rights could result in zero instream flow on some streams during critical low flow periods (Oregon Water Policy Review Board, 1985).

There are three primary irrigation districts in the Hood River watershed – Farmers Irrigation District, Middle Fork Irrigation District, and East Fork Irrigation District. The main irrigation season is April 15 to October 1, with peak usage in July. If all lands with irrigation rights were irrigated simultaneously, the maximum allowable diversion would total 409 cfs, an amount equal to 80% of the median natural flow of the Hood River in August (Hood River Watershed Group, 1999).

The single largest diversion and the single largest water right in the Hood River is the Powerdale Hydroelectric Project diversion at Powerdale Dam (**Figure 5**). Up to 500 cfs can be diverted at rivermile 4.5 and returned 3 miles downstream. Under existing minimum flow requirements, between 10% and 74% of the monthly average flow at the Tucker Bridge gauging station is diverted, with a minimum instream flow of 100 cfs required during the months of August-November by PacifiCorp's current license with the Federal Energy Regulatory Commission (FERC). As part of their pending FERC relicensing application, PacfiCorp has agreed to maintain higher instream flows of 250 cfs during May-October (**Figure 6**). Farmers and Middle Fork Irrigation Districts operate five small hydro plants year-round along their irrigation canals and pipelines. Water not used for irrigation after power generation is returned instream at points downstream.

Figure 5. Location of Powerdale Dam and Gauging Stations

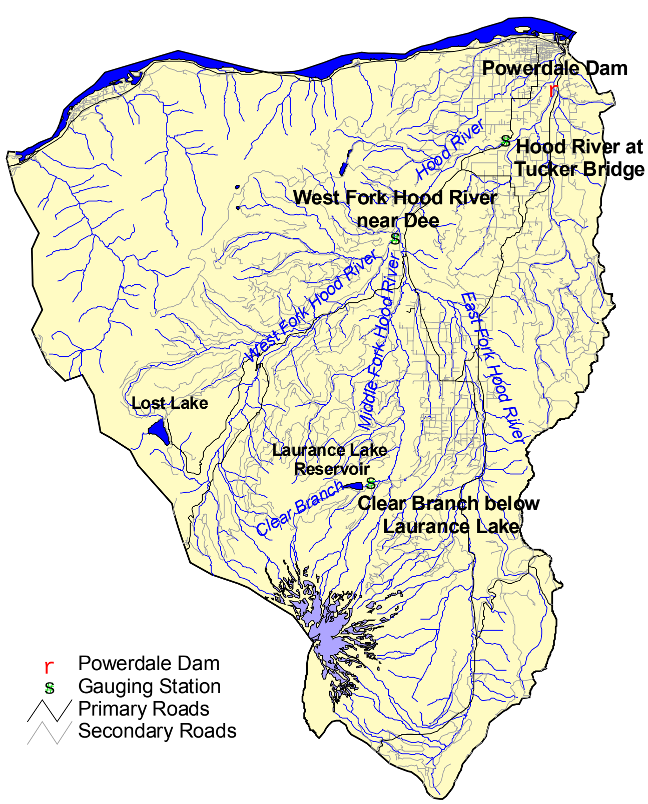
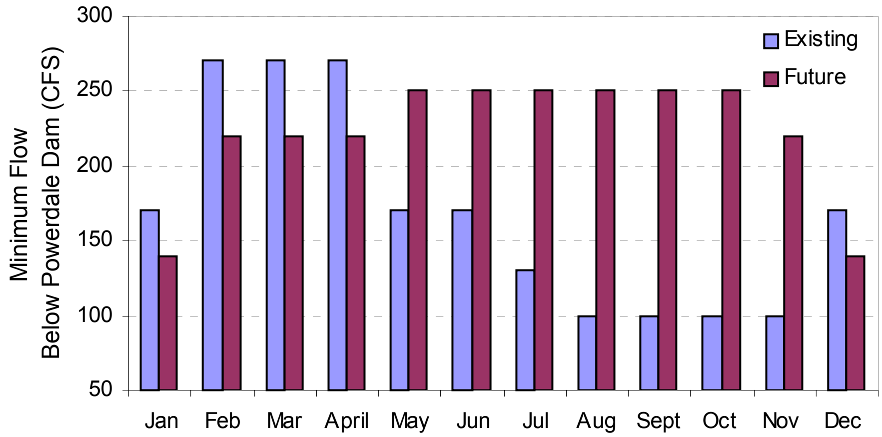


Figure 6. Existing and Future Recommended Minimum Instream Flow Requirements for the Hood River below Powerdale Dam (PacifiCorp, 1999)



Three U.S. Geological Survey (USGS) flow gauging stations have been operated in the Western Hood Subbasin in the last 10 years (**Figure 5**), two of which are still active. The USGS currently operates a station on the Hood River at Tucker Bridge (USGS #14120000), and the Oregon Water Resources Department (OWRD) operates the other active station, located on the West Fork Hood River near Dee (USGS #14118500). The Tucker Bridge station has been operated continuously since 1965, with some records as early as 1897. The West Fork station has been operated since 1932, with OWRD assuming control of the station in 1992. The third USGS station located in the Subbasin was on Clear Branch below Laurance Lake (USGS #14115815). This station was in operation from 1965 to 1995.

Minimum stream flows generally occur during September or October. Many non-glacial streams in the Subbasin have very low summer flows, while tributaries with glacial sources maintain higher summer flows. Approximately 20% of the stream channel length in the Hood River watershed dries up during the summer, with most of these intermittent streams originating at low elevations or on easterly slopes (SWRB, 1965). During low flows, several of the smaller tributaries which drain directly to the Columbia River in the western portion of the Subbasin have subsurface flow near their confluence with the Columbia.

Low flow and high flow 7Q10 statistics were calculated for the three gauging stations[2] (**Table 1**). Monthly flow averages for the Hood River and West Fork Hood River sites are presented in **Figure 7**. Peak flows in the watershed most often occur in December and January and are often associated with rain on snow events. The USGS reports the Hood River flood threshold as 4,500 cfs and 8 feet in stage at Tucker Bridge. The maximum flood of record is 33,200 cfs, which occurred December 22, 1964.

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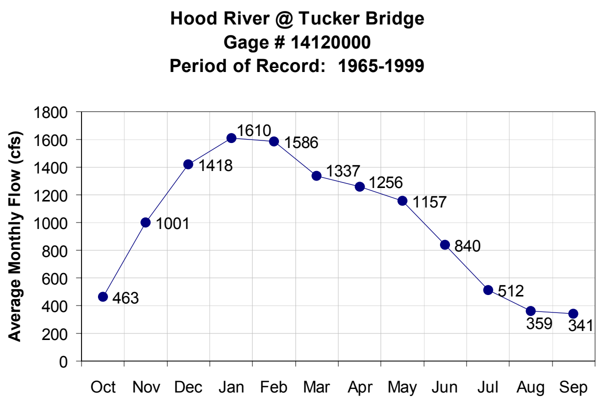
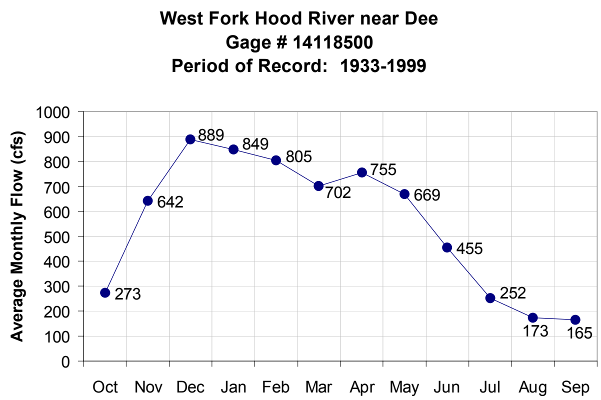
[2] 7Q10 refers to a seven day averaged flow condition that occurs on a ten-year return period. Mathematically, this flow has a 10% probability of occurring every year. A Log Pearson Type III distribution was used to calculate the return period.

Table 1. Log Pearson Type III 7Q10 Flows

Location	Period	Flows Averaged over 7 days with a Return Period of 10 Years	
		7Q10 Low Flow (cfs)	7Q10 High Flow (cfs)
Hood River @ Tucker Bridge	1965-1999	201	7387
West Fork Hood River near Dee	1932-1999	102	4185
Clear Branch below Laurance Lake	1988-1995	3	81

Figure 7. Monthly Flow Averages





CHAPTER 4 – TOTAL MAXIMUM DAILY LOAD FOR STREAM TEMPERATURE

Summary of Temperature TMDL Development and Approach

Water quality standards are developed to protect the most sensitive beneficial uses. The temperature standard is designed to protect cold water fish (salmonids) as the most sensitive beneficial use. Several numeric and narrative trigger conditions invoke the temperature standard. Numeric triggers are based on temperatures that protect various salmonid life stages. Narrative triggers specify conditions that deserve special attention, such as the presence of threatened and endangered cold water species. Dissolved oxygen violations are also a trigger for the temperature standard. The occurrence of one or more of the stream temperature triggers will invoke the standard.

Once invoked, the temperature standard specifies that "*no measurable surface water temperature increase resulting from anthropogenic activities is allowed*" (OAR 340-41-245(2)(b)(A)). The Federal Clean Water Act requires a TMDL be developed for 303(d) listed waterbodies. For all temperature 303(d) listed waterbodies in the Hood River watershed, the standard specifies a condition of no measurable anthropogenic related temperature increases. The temperature TMDL is scaled to the Hood River watershed and includes all surface waters. 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. For example, the Hood River is 303(d) listed for temperature. To address this listing in the TMDL, the Hood River and all major tributaries are included in the TMDL analysis and TMDL targets.

An important step in the TMDL is to examine the anthropogenic contributions to stream heating. The pollutant is heat. Nonpoint source anthropogenic contributions of solar radiation heat loading results from varying levels of decreased stream surface shade throughout the subbasin. 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 which can cause reduced flow instream or through the heating of water in a reservoir. 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 is an estimate of a condition without anthropogenic activities that disturb or remove near stream vegetation.
- System potential is not 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).

The Western Hood Subbasin temperature TMDL allocates heat loading to nonpoint sources (natural background and anthropogenic) and point sources. Allocated conditions are expressed as heat per unit time (kcal per day). Nonpoint and point sources are expected to manage for no measurable surface water temperature increase. The nonpoint source heat allocation is translated to effective shade surrogate measures that linearly translates the nonpoint source solar radiation allocation. Effective shade surrogate measures provide site-specific targets for land managers. Attainment of the surrogate measures ensures compliance with the nonpoint source allocations.

Temperature Standard
"no measurable surface water temperature increase resulting from anthropogenic activities..."

↓

303(d) Listing
Numeric and qualitative triggers invoke the temperature standard.
A TMDL is then developed.

↓

TMDL - Source Assessment

- TMDL scaled to subbasin due to cumulative thermal processes.
- Identify human related sources of stream warming
- Increased solar radiation loading is the primary nonpoint source pollutant
- Near stream vegetation removal/disturbance is the mechanism for decreased stream surface shade and increased solar radiation loading
- Develop system potential as the condition that allows no pollutant loading from anthropogenic activities - establish background condition
- Potential near stream vegetation is that which can reproduce at a site given elevation, soil types, hydrology, and plant biology. Vegetation type/condition is developed and quantified and compared to current vegetation to estimate nonpoint source pollutant loading
- Determine critical periods when the appropriate temperature criteria are likely to be exceeded.
- Quantify nonpoint source heat
- Quantify point source heat

↓

TMDL - Allocations and Surrogate Measures
Targets for Meeting the Temperature Standard

- Nonpoint sources are allocated zero pollutant loading thus meeting the "*no measurable surface water temperature increase resulting from anthropogenic activities...*" specified in the standard.
- Point sources are restricted to thermal discharges that produce no more than a 0.25°F increase over the criteria when the temperature criteria are exceeded within the mixing zone.
- Effective shade surrogate measures are used to help translate the nonpoint source heat loading allocation.
- Meeting the effective shade surrogate measures ensures attainment of nonpoint source heat loading allocations.

Completion of Temperature TMDL

Table 2. Western Hood Subbasin Temperature TMDL Components

Waterbodies	Perennial and/or fish bearing (as identified by ODFW, USFW or NFMS) streams within the 5th field HUCs (hydrologic unit code) 1707010501, 1707010502, 1707010503, 1707010504, 1707010505 (Hood River and its tributaries only).
Pollutant Identification	*Pollutants:* Human caused temperature increases from (1) solar radiation loading and (2) warm water discharge to surface waters.
Target Identification (Applicable Water Quality Standards) ***CWA §303(d)(1)***	OAR 340-41-525(2)(b)(A) No measurable surface water temperature increase resulting from anthropogenic activities is allowed: (i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64°F (17.8°C); (iii) In waters and periods of the year determined by ODEQ to support native salmonid spawning, egg incubation and fry emergence from the egg and from the gravels in a basin which exceeds 55°F (12.8°C); (iv) In waters determined by ODEQ to support or to be necessary to maintain the viability of native Oregon bull trout, when surface water temperatures exceed 50°F (10.0°C); (v) In waters determined by ODEQ to be ecologically significant cold-water refugia; (vi) In stream segments containing federally listed Threatened and Endangered species if the increase will impair the biological integrity of the Threatened and Endangered population. (vii) In Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/l or 10% saturation of the water column or intergravel DO criterion for a given stream reach or Subbasin; (viii) In natural lakes.
Seasonal Variation ***CWA §303(d)(1)***	Peak temperatures occur throughout July and August. Spawning occurs in the Subbasin at different times in different locations.
Existing Sources ***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 ***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 based on the condition that meets the *no measurable surface water temperature increase resulting from anthropogenic activities.* This condition is termed *System Potential* and is achieved when (1) nonpoint source solar radiation loading reflects that produced by riparian vegetation without human disturbance and (2) point source discharges and dams cause no measurable increases in surface waters. *Load Allocations (Nonpoint Sources)*: System potential solar radiation loading. *Load Allocations (Powerdale Hydroelectric Project)*: Maximum allowable heat load based on the 0.25°F allowable temperature increase during spawning periods; 190×10^6 kcal/day during rearing periods. *Load Allocations (Laurance Lake Reservoir)*: Maximum allowable heat load based on the 0.25°F allowable temperature increase. *Waste Load Allocations (NPDES Point Sources)*: Maximum allowable heat load based on the 0.25°F allowable temperature increase in zone of dilution during critical periods.
Surrogate Measures ***40 CFR 130.2(i)***	Translates Nonpoint Source Load Allocations • *Effective Shade targets translate the nonpoint source solar radiation loading capacity.*
Margins of Safety ***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. Explicit Margins of Safety are developed for wasteload allocations and load allocations for the Powerdale Hydroelectric Project and the Laurance Lake Reservoir.
Water Quality Standard Attainment Analysis ***CWA §303(d)(1)***	• Analytical modeling of TMDL loading capacities demonstrates attainment of water quality standards. • The Water Quality Management Plan will consist of Implementation Plans and Facility Operation Plans that contain measures to attain load/wasteload allocations.

4.1 TEMPERATURE POLLUTANT IDENTIFICATION

The pollutants identified for stream temperature pollution are human caused increases in solar radiation loading at the stream surface and warm water discharge to surface waters.

With a few exceptions, such as in cases where violations are due to natural causes, ODEQ must establish a TMDL for any waterbody designated on the 303(d) list as violating water quality standards. A TMDL is the total amount of a pollutant (from all sources) that can enter a specific waterbody without violating water quality standards.

Water temperature change is an expression of heat energy exchange per unit volume:

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

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 and (2) warm water discharges of human origin.

4.2 TEMPERATURE TARGET IDENTIFICATION – CWA §303(D)(1)

The stream temperature TMDL targets protection of salmonids, the most sensitive beneficial use. Oregon's stream temperature standard, which is based on the temperature requirements of salmonids is designed for protection during all salmonid life stages. Several numeric criteria and other triggers for the temperature standard establish factors for designating surface waters as water quality limited. The temperature standard specifies that anthropogenic (i.e. human caused) impacts that cause stream heating should be removed. The TMDL targets this no anthropogenic warming condition. A stream condition that has no anthropogenic-induced warming is considered to be at the system potential.

4.2.1 Salmonid Stream Temperature Requirements

Stream temperatures above 64°F (17.8°C) are considered sub-lethal and can be stressful for cold water fish species, such as salmon and trout.

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). Such warm temperature extremes may never occur in the Western Hood Subbasin.

In some streams in the Western Hood Subbasin, the occurrence of temperatures in the mid-70°F range (mid- to high-20°C range) is occasionally observed. 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** summarizes the modes of cold water fish mortality.

Table 3. Modes of Thermally Induced Cold Water Fish Mortality

(Brett, 1952; Bell, 1986, Hokanson et al., 1977)

Modes of Thermally Induced Fish Mortality	Temperature Range	Time to Death
Instantaneous Lethal Limit – Denaturing of bodily enzyme systems	> 90°F > 32°C	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	70°F - 77°F 21°C - 25°C	Hours to Days
Sub-Lethal Limit – Conditions that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supply and increased competition from warm water tolerant species	64°F - 74°F 20°C - 23°C	Weeks to Months

4.2.2 Sensitive Beneficial Use Identification

Salmonid fish spawning, incubation, fry emergence, and rearing are deemed the most temperature-sensitive beneficial uses within the Western Hood Subbasin.

Beneficial uses and the associated water quality standards are generally applicable basin-wide (i.e. the Middle Columbia-Hood Basin). Some uses require further delineation. At a minimum, uses are considered attainable wherever feasible or wherever attained historically. Numeric and narrative water quality standards are designed to protect the most sensitive beneficial uses. Salmonid spawning and rearing are the most sensitive beneficial uses in the Middle Columbia-Hood Basin. **Figure 8** identifies occurrence of anadromous salmonids and bull trout in the Western Hood Subbasin (ODFW, 2000).

Most of the tributaries to the Columbia River west of the Hood River are blocked by waterfalls within a mile or two of the creek mouth, with the exception of Herman Creek where 5.6 stream miles are accessible to anadromous fish. Cutthroat trout and rainbow trout are the predominant fish species found above these falls, with some anadromous fish and bull trout use observed in the mouths of the creeks (**Figure 8**). Steelhead trout and Chinook salmon are observed in Eagle, Herman, Lindsey, and Viento Creeks. Coho salmon are observed in Herman, Lindsey and Viento Creeks.

The salmonids present in the Hood River watershed include bull trout, spring and fall Chinook salmon, coho salmon, summer and winter steelhead, rainbow and cutthroat trout, and mountain whitefish. An estimated 100 miles of stream in the Hood River watershed are currently accessible to anadromous fish (**Figure 8**). Bull trout are primarily found in the headwater streams of the Middle Fork Hood River, with the largest population found in Laurance Lake and in Clear Branch above the lake (**Figure 8**). Pacific lamprey are present below Powerdale Dam (river mile 4.5) although none have been documented upstream since the 1960s. Little is known about the status and distribution of sea run cutthroat trout. Hood River fish populations have declined markedly in the last decades. Hood River indigenous spring Chinook are extinct, and steelhead and bull trout were listed as Threatened under the Endangered Species Act in 1998 (listings include the entire Western Hood Subbasin). Coho and fall Chinook are present at run sizes lower than that which likely existed prior to European settlement. A major salmon and steelhead recovery effort – the Hood River Production Program – was initiated in 1991 and is jointly implemented by ODFW and the CTWSRO.

In applying standards and restoration, it is important to know where existing salmonid spawning locations are and where they are potentially attainable. Salmonid spawning and the quality of the spawning grounds are particularly sensitive to water quality and streambed conditions. Under consultation with fish biologists from the Oregon Department of Fish and Wildlife, CTWSRO, Mt. Hood National Forest, and PacifiCorp, ODEQ developed a summary document (September, 2000) identifying the time periods and locations for which the salmonid fish spawning criterion should be applied in the Hood River watershed. This document was submitted to USFWS and NMFS to address State Conservation Measure 4 as required by the Oregon State water quality temperature standard approval process (ODEQ, 2000). **Figure 9** identifies the locations where salmonids are known to spawn and when they spawn in the Hood River watershed; it designates when and where the 55^{o}F salmonid spawning and 50^{o}F bull trout criteria apply in the Hood River watershed. Other sensitive uses (such as drinking water and water contact recreation) are applicable throughout the subbasin. Oregon Administrative Rules (OAR Chapter 340, Division 41, Section 522, Table 8) lists the "Beneficial Uses" occurring within the Middle Columbia-Hood Basin (**Table 4**).

Table 4. Beneficial uses occurring in the Middle Columbia-Hood Basin

(OAR 340 – 41 – 522)

Temperature-Sensitive Beneficial uses are marked in gray

Beneficial Use	***Occurring***	***Beneficial Use***	***Occurring***
Public Domestic Water Supply	✓	Salmonid Fish Spawning (Trout)	✓
Private Domestic Water Supply	✓	Salmonid Fish Rearing (Trout)	✓
Industrial Water Supply	✓	Resident Fish and Aquatic Life	✓
Irrigation	✓	Anadromous Fish Passage	✓
Livestock Watering	✓	Wildlife and Hunting	✓
Boating	✓	Fishing	✓
Hydro Power	✓	Water Contact Recreation	✓
Aesthetic Quality	✓		

Figure 8. Occurrence of Anadromous Salmonids and Bull Trout (data source: ODFW, 2000)

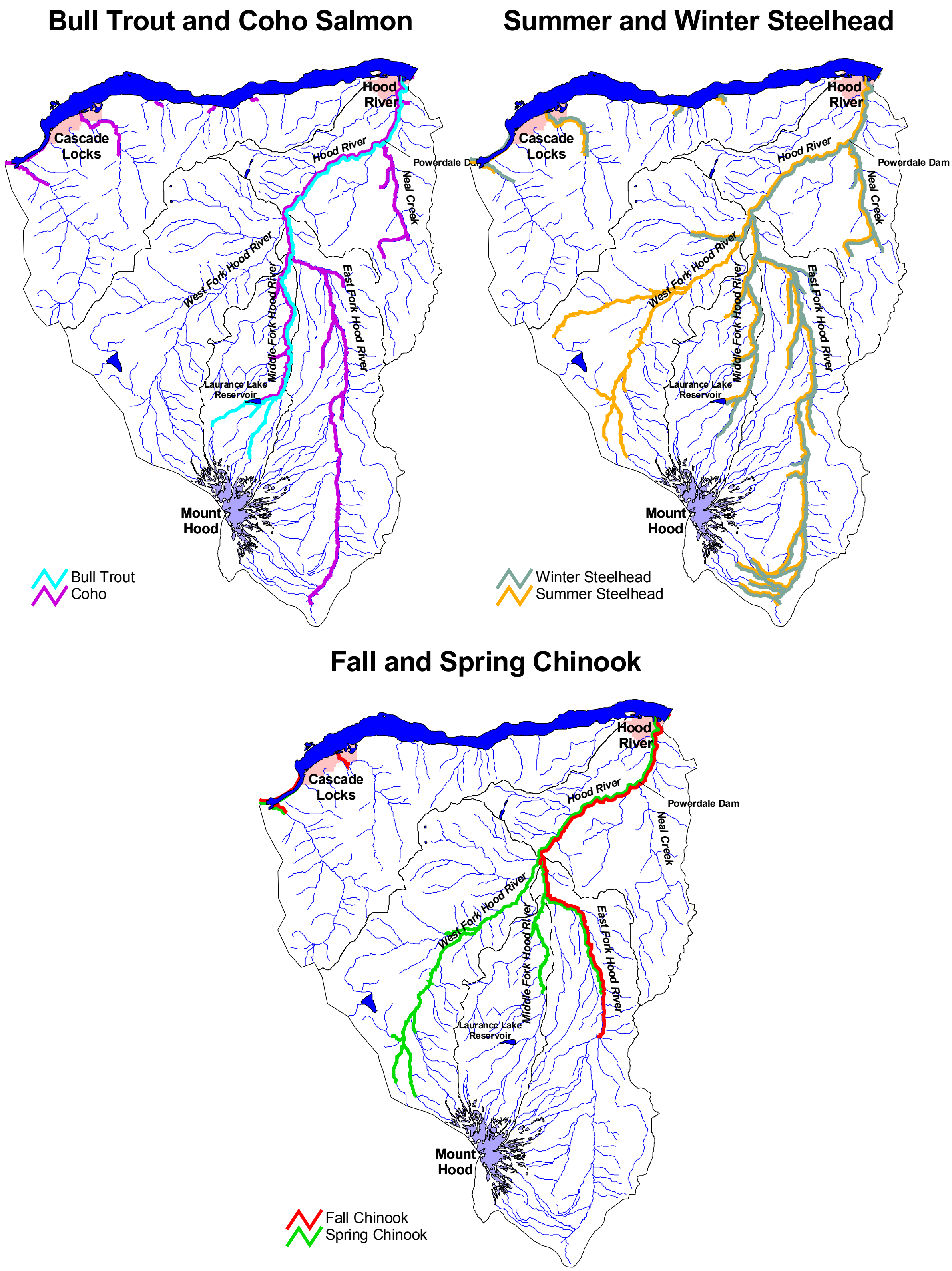
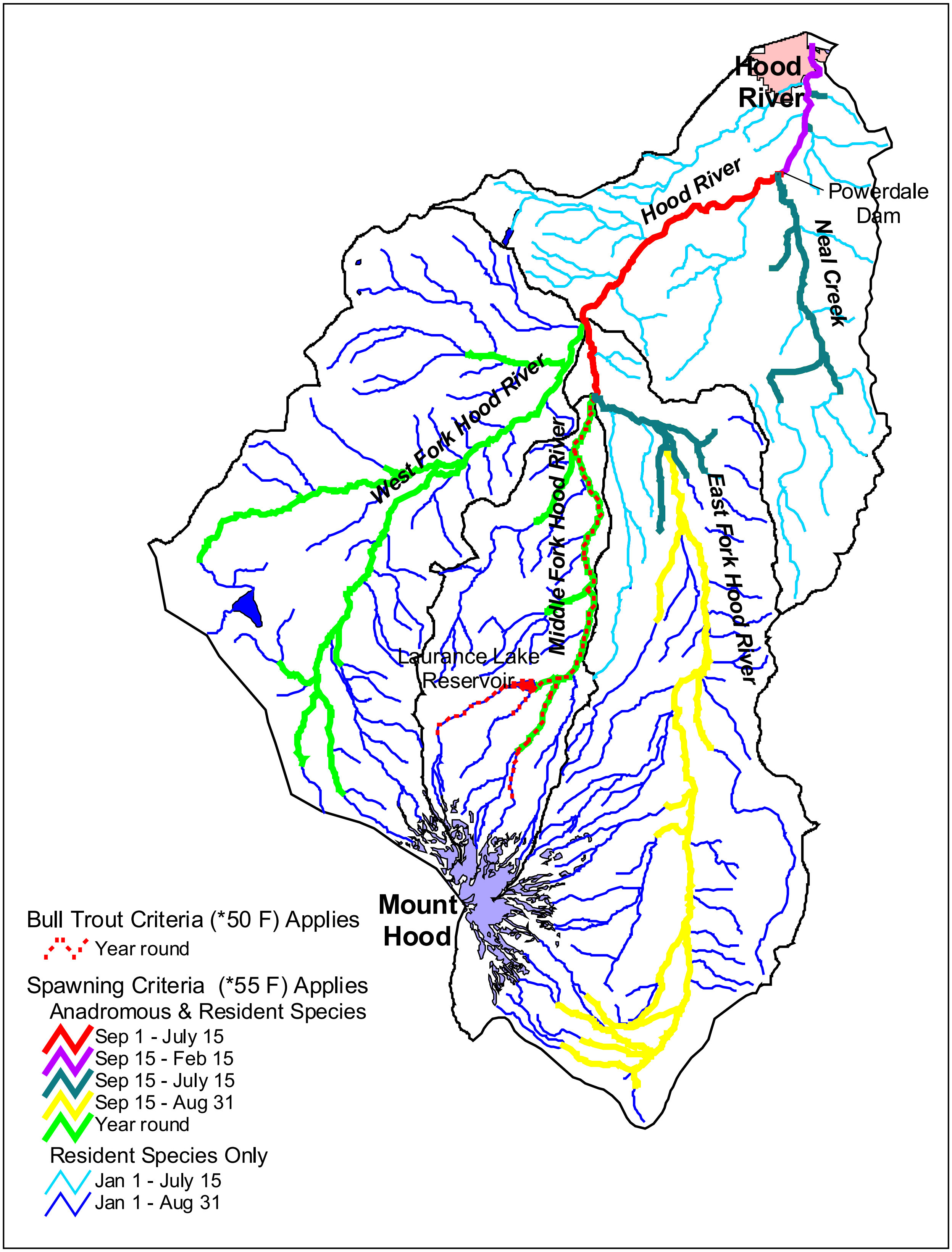


Figure 9. Application of Salmonid Spawning Criteria and Bull Trout Criteria in the Hood River Watershed



4.3 WATER QUALITY STANDARD IDENTIFICATION

A seven-day moving average of daily maximums (7-day statistic) was adopted as the statistical measure of the stream temperature standard. Absolute numeric criteria are deemed action levels and indicators of water quality standard compliance. Unless specifically allowed under a ODEQ-approved surface water temperature management plan as required under OAR 340-041-0026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed in State of Oregon waters determined out of compliance with the temperature standard. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *1992-1994 Water Quality Standards Review Final Issue Papers (ODEQ, 1995)*.

The temperature standard applicable in the Western Hood Subbasin specifies that "no measurable surface water temperature increase resulting from anthropogenic (human induced) activities is allowed".

Middle Columbia-Hood Basin Temperature Standard

OAR 340-41-525(2)(b)(A) To accomplish goals identified in OAR 340-041-120(11), unless specifically allowed under a ODEQ-approved surface water temperature management plan as required under OAR 340-041-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:

(i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64^{o}F (17.8^{o}C);
(ii) In the Columbia River or its associated sloughs and channels from the mouth to rivermile 309 when surface water temperatures exceed 68^{o}F (20.0^{o}C);
(iii) In waters and periods of the year determined by ODEQ to support native salmonid spawning, egg incubation and fry emergence from the egg and from the gravels in a basin which exceeds 55^{o}F (12.8^{o}C);
(iv) In waters determined by ODEQ to support or be necessary to maintain the viability of native Oregon bull trout, when surface water temperatures exceed 50^{o}F (10.0^{o}C);
(v) In waters determined by ODEQ to be ecologically significant cold-water refugia[3];
(vi) In stream segments containing federally listed Threatened and Endangered species if the increase will impair the biological integrity of the Threatened and Endangered population;
(vii) In Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/l or 10% saturation of the water column or intergravel DO criterion for a given stream reach or Subbasin;
(viii) In natural lakes.

4.3.1 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. Seven stream segments (approximately 31 miles) in the Hood River watershed were put on the 1998 303(d) list for exceeding numeric temperature criteria (**Table 5**). Segments were listed based upon either the 64^{o}F rearing criteria or the 50^{o}F bull trout criteria. An evaluation of the 55^{o}F spawning criteria was not conducted for the 1998 303(d) list in the Hood River watershed. Data collected in 1998 (Figure 10) indicates that this criterion is exceeded at certain times of the year and at certain locations. For specific

Seven stream reaches in the Hood River watershed are designated as temperature limited on Oregon's 1998 303(d) list.

[3] Ecologically Significant Cold-Water Refugia exists when all or a portion of a waterbody supports stenotype cold-water species (flora or fauna) not otherwise supported in the Subbasin, and either: (a) maintains cold water temperatures (below numeric criterion) throughout the year relative to other stream segments throughout the Subbasin, or (b) supplies cold water to a receiving stream or downstream reach that supports cold water biota.

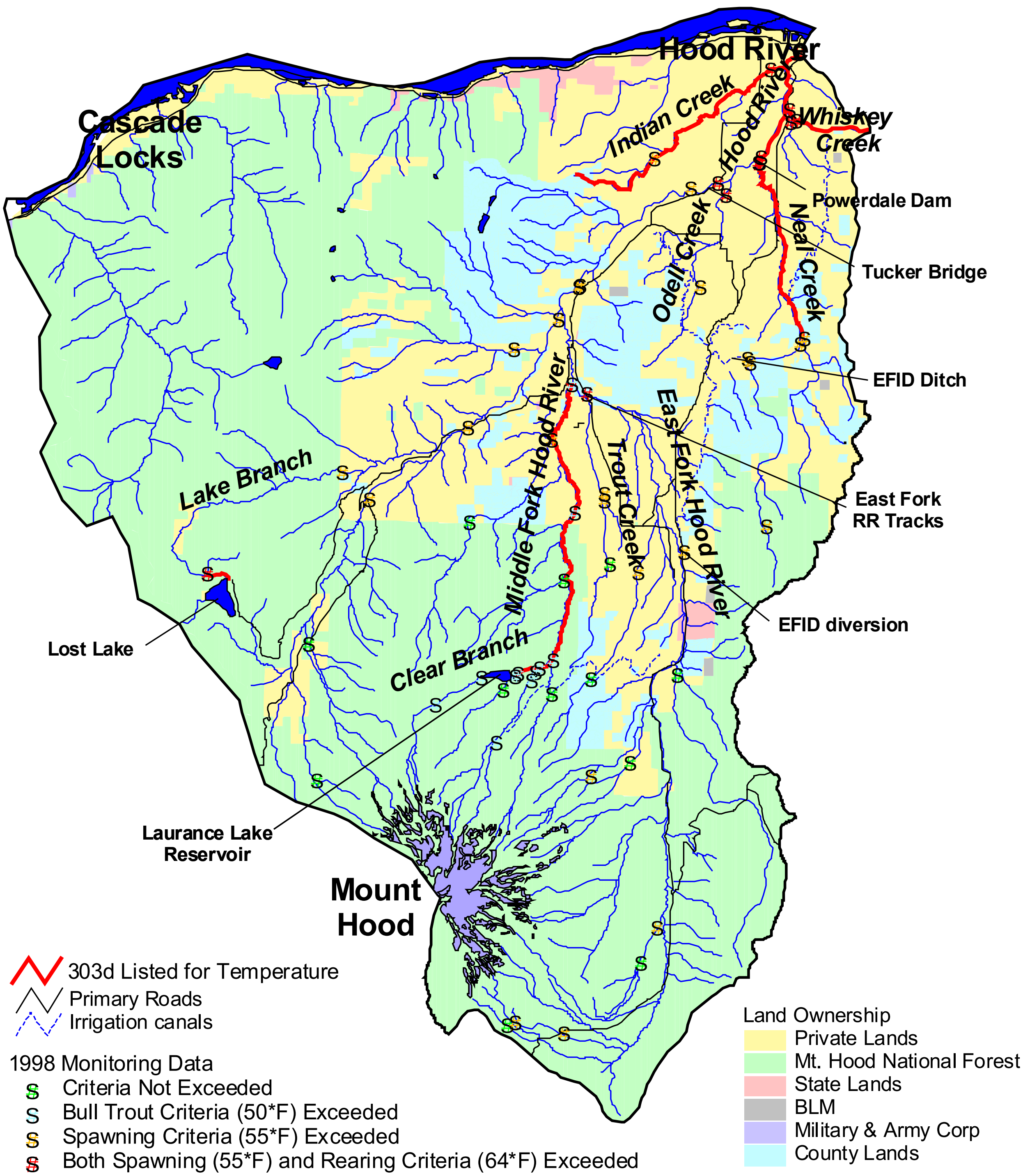
information regarding Oregon's 303(d) listing procedures, and to obtain more information regarding the Western Hood Subbasin's 303(d) listed streams, visit the ODEQ web page at **http://www.deq.state.or.us/**.

During the summer of 1998, temperature monitoring instruments recorded hourly stream temperatures at various locations throughout the Hood River watershed. **Figure 10** displays the 1998 continuous monitoring locations and an assessment of the temperature standard using the 7-day temperature statistic and application of the spawning criteria presented above. Monitoring has shown that water temperatures in the Western Hood Subbasin exceed numeric criteria of the State water quality standard.

Table 5. Western Hood Subbasin Stream Segments on the 1998 303(d) List for Temperature

Stream Name	Stream Segment Listed	Stream Miles	Criteria
Clear Branch	Mouth to Laurence Lake	1.4	Oregon Bull Trout 50^{o}F (10^{o}C)
Hood River	Powerdale Powerhouse to Diversion Dam	3.9	Fish Rearing 64^{o}F (17.8^{o}C)
Hood River, Middle Fork	Mouth to Clear Branch	9.0	Oregon Bull Trout 50^{o}F (10^{o}C)
Indian Creek	Mouth to Headwaters	7.5	Fish Rearing 64^{o}F (17.8^{o}C)
Lake Branch	Rivermile 10 to Lost Lake	1.0	Fish Rearing 64^{o}F (17.8^{o}C)
Neal Creek	Mouth to East/West Fork confluence	6.0	Fish Rearing 64^{o}F (17.8^{o}C)
Whiskey Creek	Mouth to Headwaters	2.5	Fish Rearing 64^{o}F (17.8^{o}C)

Figure 10. Segments on the 1998 303(d) List for Temperature and Continuous Temperature Monitoring Sites (1998) with Standard Assessment Based on 7-Day Temperature Statistic



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

The Hood River mainstem and tributaries experience prolonged warming starting in late spring and extending into the fall. Maximum temperatures typically occur in July and August (**Figures 11-14).** Location of the monitoring sites identified in **Figures 11-14** is shown on **Figure 10**. The TMDL focuses the analysis during early August, 1998 as a critical condition when the 64°F rearing criterion is likely to be exceeded. Exceedance of the 64°F numeric criterion differs at different sites, but typically occurs in portions of July or August. It should also be noted that the Hood River watershed streams are commonly above the 55°F numeric spawning criterion during the period that spans May through October (**Figure 10**).

Figure 11. 1998 Observed Daily Maximum Temperatures in the Hood River above Powerdale Dam

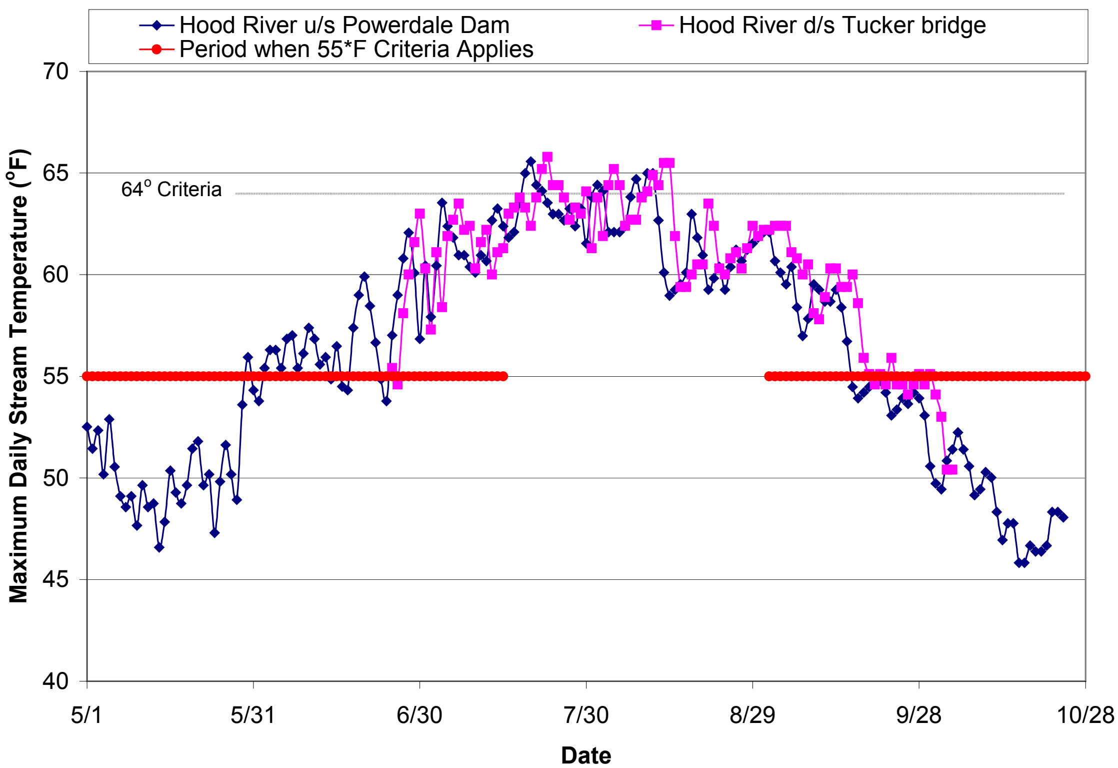


Figure 12. 1998 Observed Daily Maximum Temperatures in the East Fork Hood River

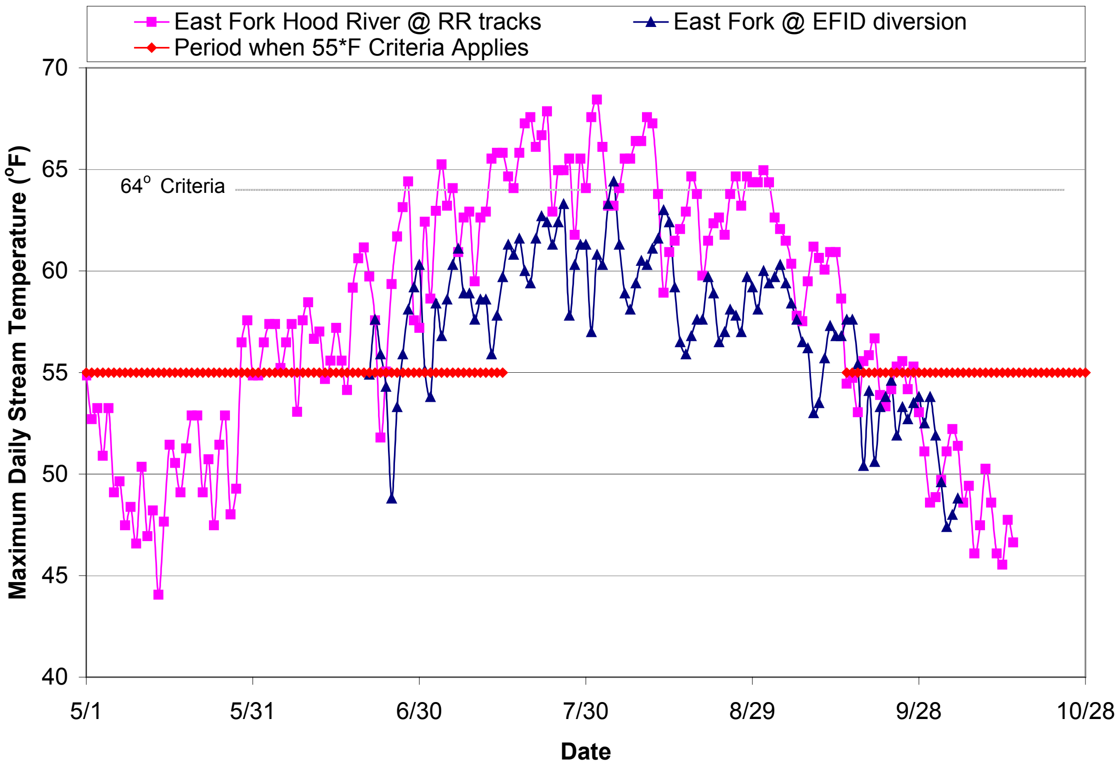


Figure 13. 1998 Observed Daily Maximum Temperatures in Neal Creek

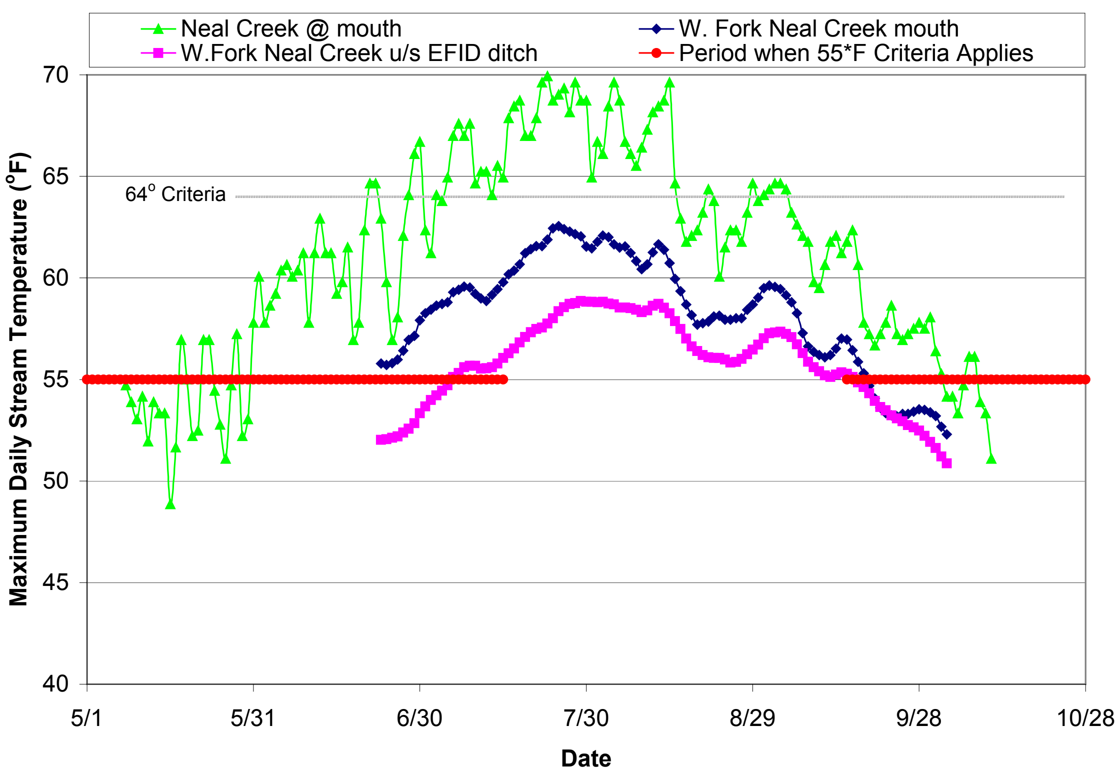
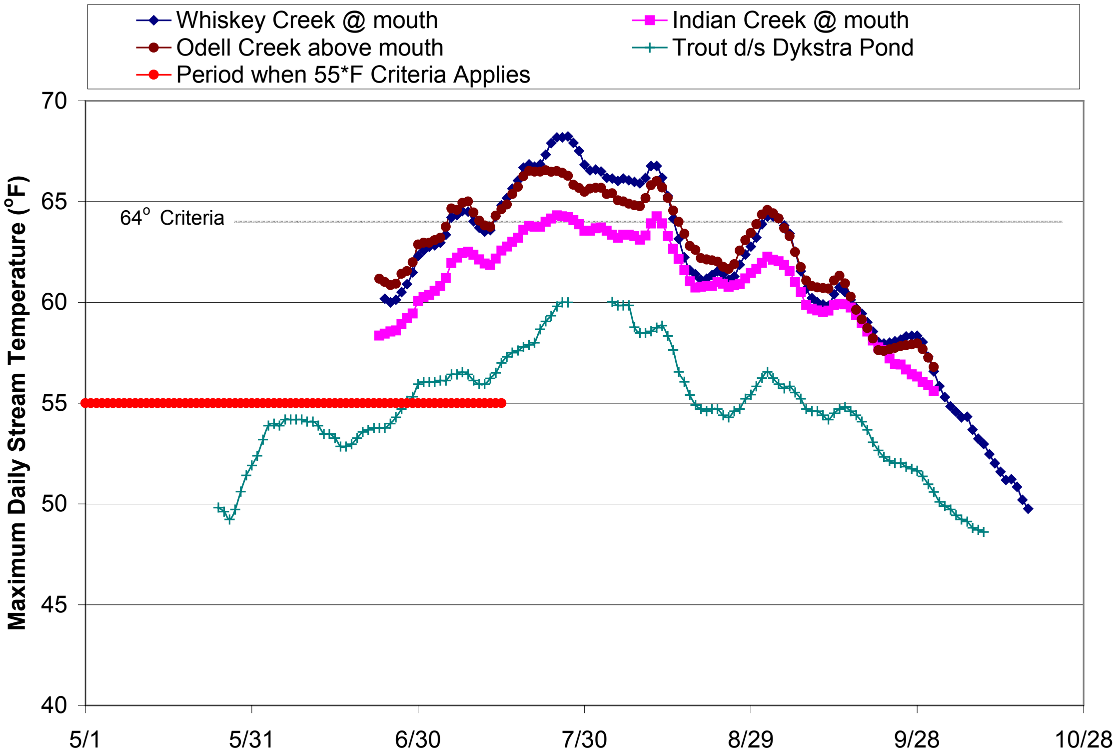


Figure 14. 1998 Observed Daily Maximum Temperatures in Hood River Tributaries



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

4.5.1 Stream Heating Processes – Background Information

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 Western Hood Subbasin 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;
- ✓ Impoundment of water behind dams alters the natural thermal profile of the water downstream of the dam depending on how and when water is released from the dam; and
- ✓ Point source warm water discharge.

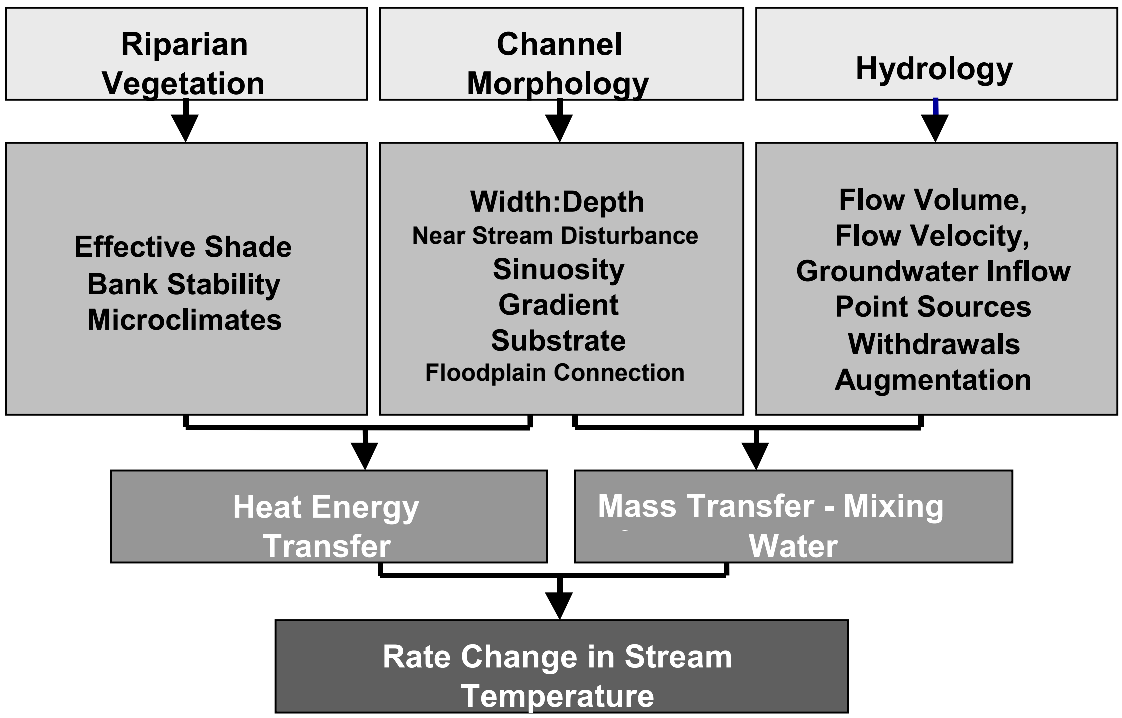
In addition, the following conditions can affect stream temperatures in the Western Hood Subbasin:

- ✓ Reduced summertime base flows from instream withdrawals;
- ✓ Localized channel widening (increased wetted width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation; and
- ✓ Localized near-stream disturbance zone[4] (NSDZ) widening decreases potential shading effectiveness of shade-producing near-stream vegetation.

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

Human activities that contribute to degraded water quality conditions in the Western Hood Subbasin include timber harvest, agriculture activities, road location, rural/urban residential development related riparian disturbances, management of river flows related to dams, and warm water discharges. The relationships between percent effective shade, channel morphology, hydrology and stream temperature are illustrated in **Figure 15**.

Figure 15. Stream Heating Processes in the Western Hood Subbasin



4.5.2 Analytical Methodology

The temperature model utilized by ODEQ to estimate stream network thermodynamics and hydrology is Heat Source (Boyd, 1996). It was developed in 1996 as a Masters Thesis at Oregon State University in the Departments of Bioresource Engineering and Civil Engineering. ODEQ currently supports the Heat Source methodology and computer programming (a more extensive discussion of the analytical framework for the model is provided in **Chapter 6**). The temperature model is designed to analyze and predict stream temperature for one day. This Western Hood Subbasin TMDL is primarily concerned with daily prediction of the diurnal energy flux and resulting temperatures on August 6, 1998.

Stream temperature was simulated for 23.6 miles of the mainstem Hood River and East Fork Hood River together – from the mouth of the Hood River to a point about 2 miles upstream of the East Fork Irrigation District Diversion from the East Fork Hood River. Stream temperature was also simulated for 7.8 miles of Neal Creek – from the mouth to the point where the East Fork Irrigation District ditch enters Neal Creek. Simulations were performed to assess the stream thermal response to: (1) current vs. system potential vegetation; and (2) different flow regimes. The results from the simulations are provided under **Sections 4.5.3.1.4, 4.5.3.2.3,** and **4.5.4.5.1** below**.**

Individual near stream vegetation and flow regime simulations were performed for each stream reach. Results from these single parameter simulations confirm the importance of both riparian vegetation and flow as stream parameters that influence stream heating processes. When both system potential riparian vegetation and flow regime were simulated together, the stream heating was affected to a greater extent.

4.5.3 Nonpoint Sources of Pollution

Elevated summertime stream temperatures attributed to nonpoint sources result from riparian vegetation disturbance (reduced stream-surface shade), reduced base flow, and channel widening (increased stream surface area exposed to solar radiation).

Settlement of the Hood River watershed 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. Beginning around 1880, orchards and strawberry fields began to progress up the valley as the natural landscape pattern of conifer forests and riparian habitat was transformed into pasture and fruit crops. Timber harvest cleared streams and riparian corridors of fallen trees and large woody debris, with riparian areas logged right down to the streambanks. Before 1900, streams began to be diverted into canals and ditches for irrigation. Diversions still occur in a number of streams in the watershed and can result in significant decreases in instream flows and the transferal of water from one watershed into another. 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 and pasture to residential development is occurring, even in riparian areas, which can result in reduced riparian vegetation. The flood plains of many rivers and streams have been affected by the development of transportation corridors. The East Fork Hood River and Neal Creek are among the streams that have been the most severely affected. The confinement of the East Fork Hood River due to construction, reconstruction and maintenance of State Highway 35 is reported as a significant and continuing impact to aquatic habitat. Neal Creek has also been heavily impacted by channelization, confinement and bank stabilization as a result of agricultural practices and road construction. These modifications have caused increased flood scour and channel incision that has separated the creek from its floodplain in many areas.

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 nonpoint sources result from:

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. ***Reduced summertime base flow*** *results from stream withdrawals*
3. ***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.*

4.5.3.1 Riparian Vegetation

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.

4.5.3.1.1 The Dynamics of Shade

Stream surface shade is a function of several landscape and stream geometric relationships. Some of the factors that influence shade are listed in **Table 6**. Geometric relationships important for understanding the mechanics of shade are displayed in **Figure 16**. In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e. a measure of the earth's tilt toward the sun). Geographic position (i.e. latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Riparian height, width and density describe the physical barriers between the stream and sun that can attenuate and scatter incoming solar radiation (i.e. produce shade). The solar position has a vertical component (i.e. altitude) and a horizontal component (i.e. azimuth) that are both functions of time/date (i.e. solar declination) and the earth's rotation (i.e. hour angle). While the interaction of these shade variables may seem complex, the math that describes them is relatively straightforward geometry.

Table 6. Factors that Influence Stream Surface Shade

Description	***Measure***
Season/Time	Date/Time
Stream Characteristics	Aspect, Near-Stream Disturbance Zone Width
Geographic Position	Latitude, Longitude
Vegetative Characteristics	Buffer Height, Buffer Width, Buffer Density
Solar Position	Solar Altitude, Solar Azimuth

Percent effective shade is perhaps the most straightforward stream parameter to monitor and calculate and is easily translated into quantifiable water quality management and geometric relationships that affect stream surface shade recovery objectives. **Figure 17** demonstrates how effective shade is monitored and calculated. Using solar tables or mathematical simulations, the *potential daily solar load* can be quantified. The *measured solar load (current conditions)* at the stream surface can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd, 1996 and Park, 1993).

Figure 16. Geometric Relationships that Affect Stream Surface Shade

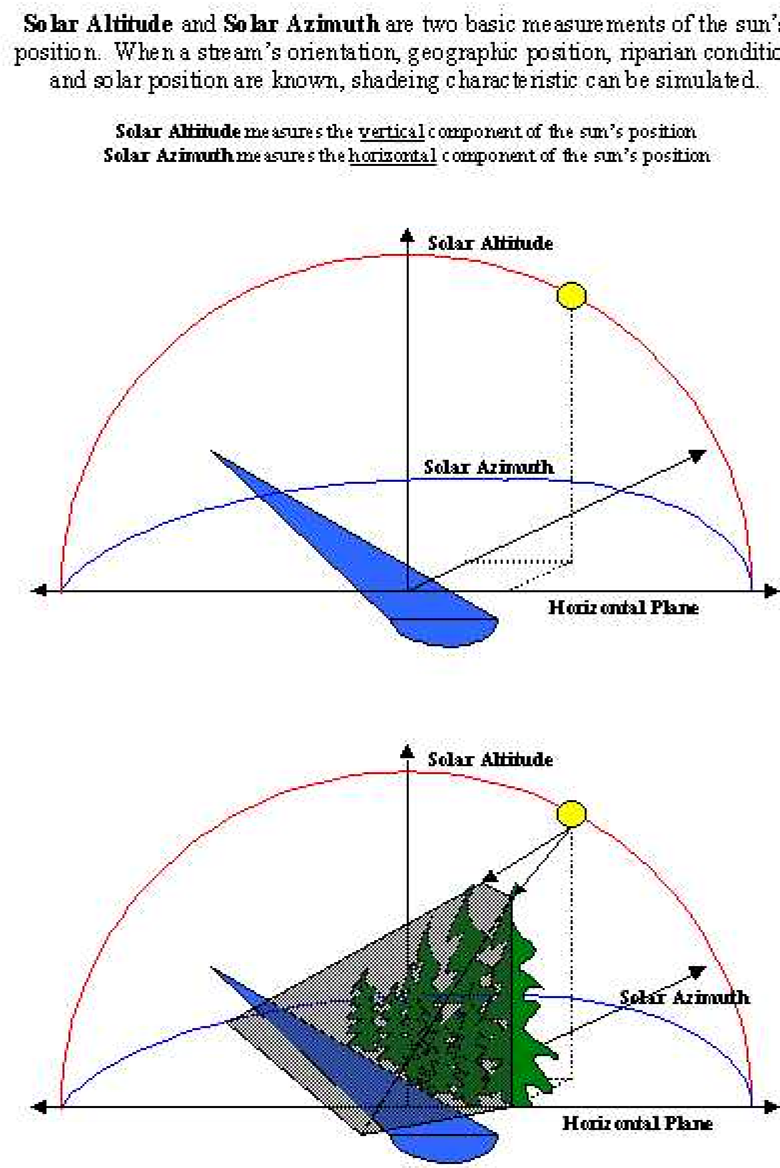
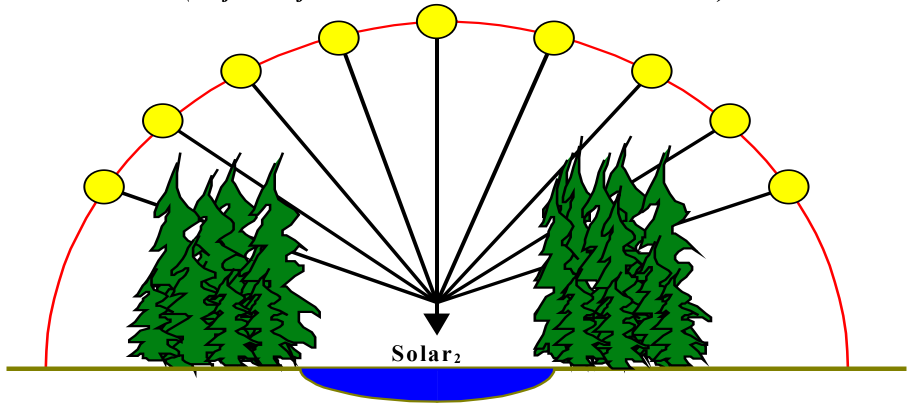


Figure 17. Effective Shade - Defined

$Solar_1$ – Potential Daily Solar Radiation Load
(Adjusted for Solar Altitude and Solar Azimuth)



Effective Shade Defined:

$$\text{Effective Shade} = \frac{(Solar_1 - Solar_2)}{Solar_1}$$

Where,
$Solar_1$: Potential Daily Solar Radiation Load
$Solar_2$: Measured Daily Solar Radiation Load at Stream Surface

4.5.3.1.2 Western Hood Subbasin Vegetation Conditions

In the source assessment for nonpoint sources in the Western Hood Subbasin, riparian vegetation and channel widths were characterized in all watersheds through analysis of a combination of digital orthophoto quads, color aerial photographs, and direct measures in the field. Current conditions were measured directly from one or more of these sources and system potential shade conditions were estimated (modeled) by altering vegetational characteristics and modifying Near-Stream Disturbance Zone widths.

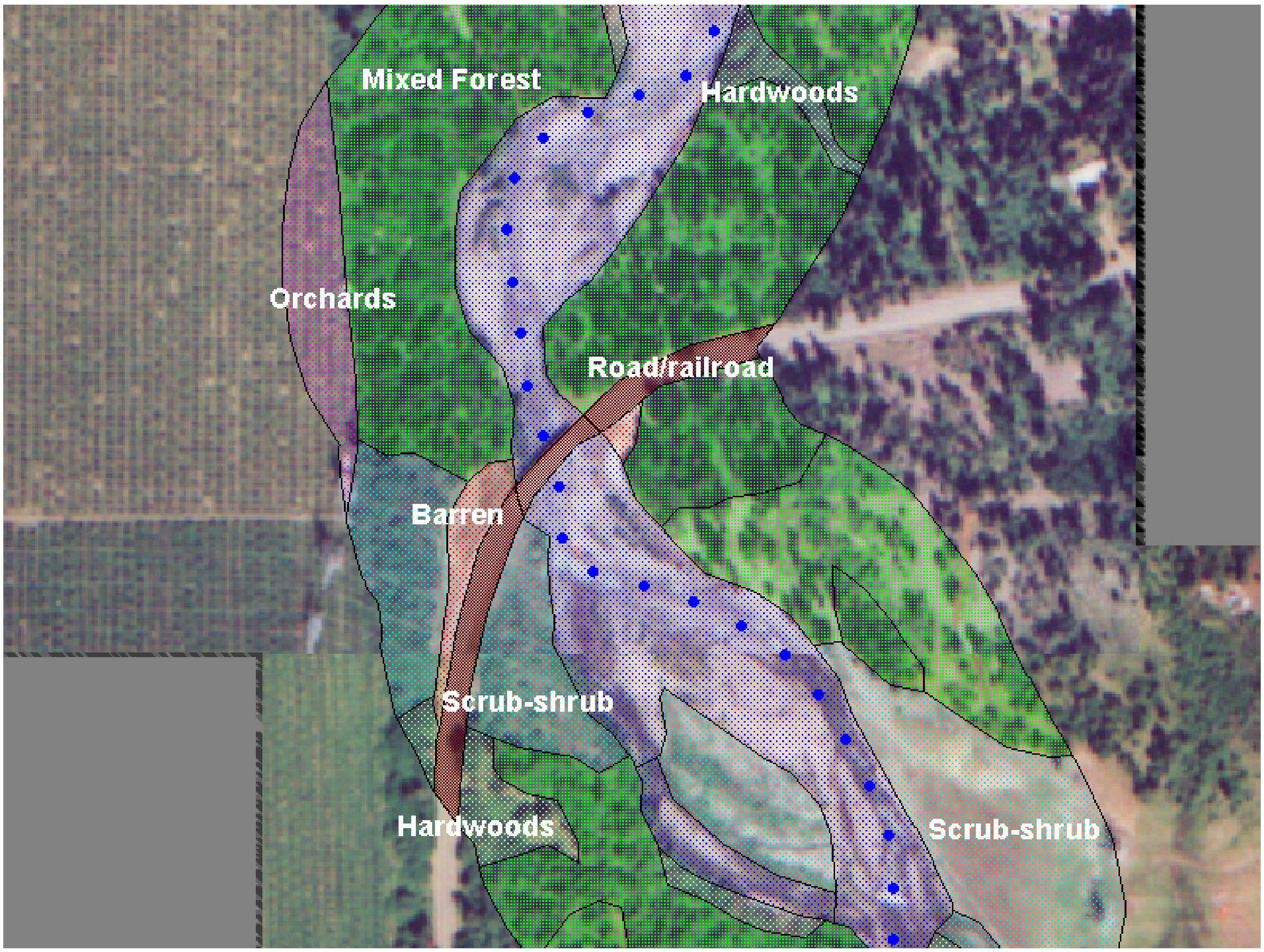
4.5.3.1.2.1 Current Condition

Sampling/Measuring Riparian Vegetation. Current condition riparian vegetation was characterized using digital orthophoto quads (DOQs) and color aerial photos. DOQs were available for the entire subbasin area from 1995. Color aerial photos, from a flight flown in 1999, were available for most of the non-Federal lands in the Hood River watershed. 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. Polygons which appeared to have a limited system potential for natural reasons (such as a lava flow or a steep embankment) were classified as such so they could be analyzed differently under the "Potential Condition" Scenario described below.

Every near-stream vegetation code was quality checked against aerial photographs by ODEQ. Ground level measurements were collected by ODEQ and ODF in 1999 and 2000 throughout the Hood River watershed to assist in vegetation classifications. **Figure 18** displays an example of vegetation and land cover polygons derived from orthophotos and color aerial photographs at 1:3,000.

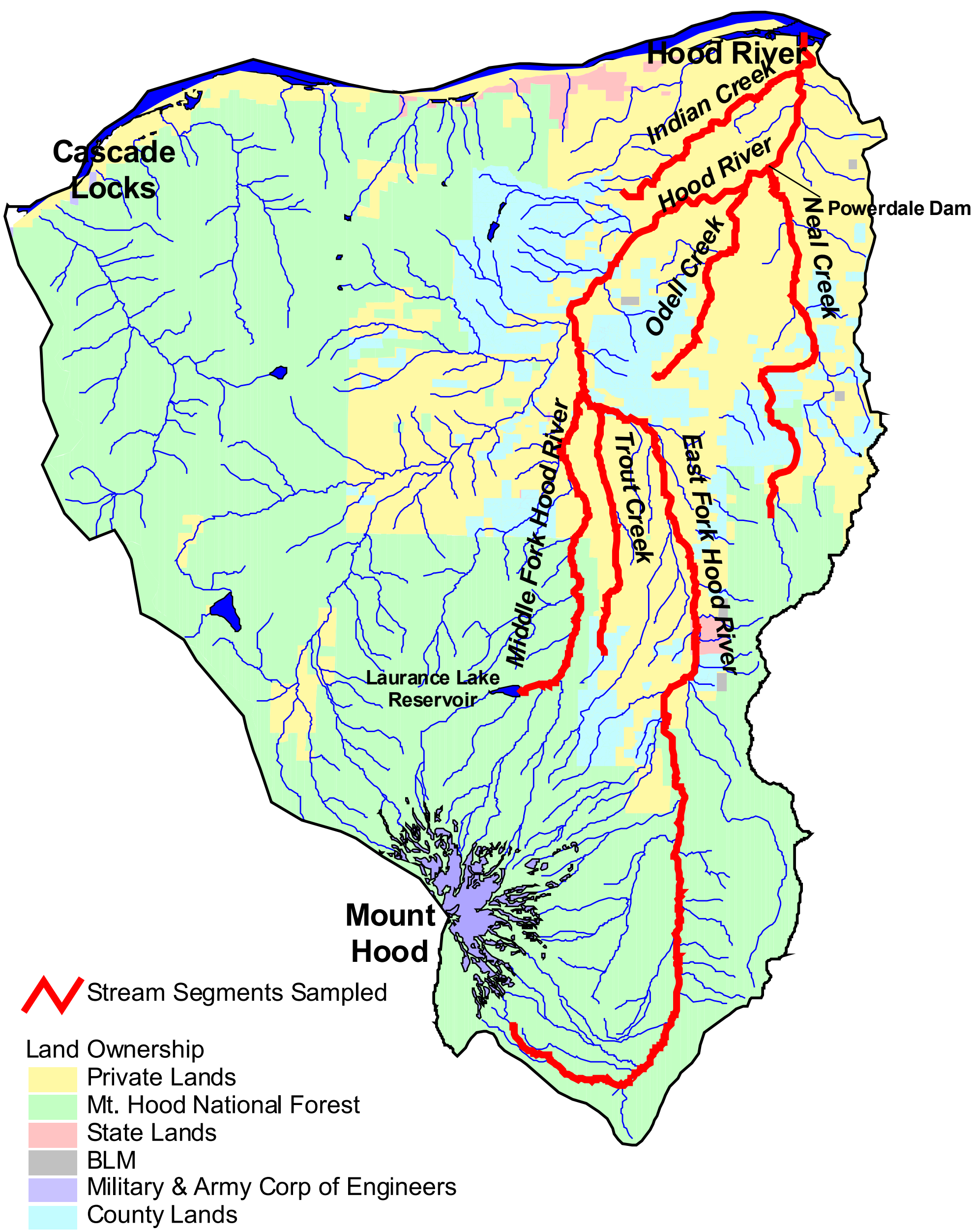
Stream reaches were also digitized from DOQs at less than 1:3,000. These stream data layers were then segmented into data points at a 100-foot interval. These data point layers form the basis for automated sampling performed using Ttools[5]. At every distance node (i.e. every 100 feet) along the stream, 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. Automated near stream vegetation sampling was completed for 82.9 rivermiles in the Hood River (**Figure 19**) watershed including Hood River and East Fork Hood River (42.6 miles), Middle Fork Hood River (10.4 miles), Neal Creek (13.5 miles), Indian Creek (5.6 miles), Odell Creek (5.7 miles) and Trout Creek (5.1 miles).

Figure 18. Hood River Vegetation Mapping from Color Aerial Photograph



[5] 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 19. Streams Analyzed for Riparian Vegetation and Shade



Riparian Vegetation Composition. Near stream vegetation was grouped as one of the following: water or floodplains, cultivated fields or grassed areas, orchards, 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 7**). Existing tree heights were determined by ODEQ using ground level data and the professional expertise of foresters with the Oregon Department of Forestry (Larry Hoffman, Unit Forester and Doug Thiesies, Forest Practices Act Forester) and the Mt. Hood National Forest (Bruce Holmson, Silviculturist). Canopy density is presented as the percentage of ground that is covered by one-story vegetation when viewed from directly above. Mixed forest was the most prevalent land cover type found in the near stream area analyzed and comprised 38.6% of the sampled near stream areas (**Figure 20**).

Current riparian vegetation distribution and height and potential riparian vegetation height are displayed in **Figures 21** through **26** 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 ro USGS river miles).

Table 7. Mean Vegetation Height and Density for Trees in the Hood River Watershed

Near-stream Vegetation Class		Height (ft)	Density (%)
Water & Floodplain	Water & Floodplain	0.0	0%
Cultivated Fields & Grassed Areas	Cultivated Lawns & Fields	0.0	0%
	Grasslands	3.3	75%
Orchards	Young Orchard	6.6	75%
	Mature Orchard	20.0	75%
Mixed Forest	Taller Forest	85.0	25% or 75%
	Shorter Forest	40.0	25% or 75%
Deciduous Forest	Taller Forest	75.1	25% or 75%
	Shorter Forest	34.8	25% or 75%
Conifer Forest	Taller Forest	89.9	25% or 75%
	Shorter Forest	40.0	25% or 75%
Scrub/Shrubs	Scrub/Shrubs	15.1	25% or 75%
Timber Harvest	Recent Clearcut	3.3	75%
	Clearcut - regrowth	15.1	25% or 75%
Developed	Residential	20.0	100% (buildings)
	Industrial or Commercial	29.9	100% (buildings)
	Roads & Railroads	0.0	0%
	Canals or Pipelines	0.0	0%
Barren	Lava flow - barren	0.0	0%
	Lava flow - some tree growth	85.0	25% or 50%
	Barren Lands	0.0	0%

Figure 20. Near Stream Vegetation Distribution Throughout the Hood River Watershed (82.9 River Miles Analyzed)

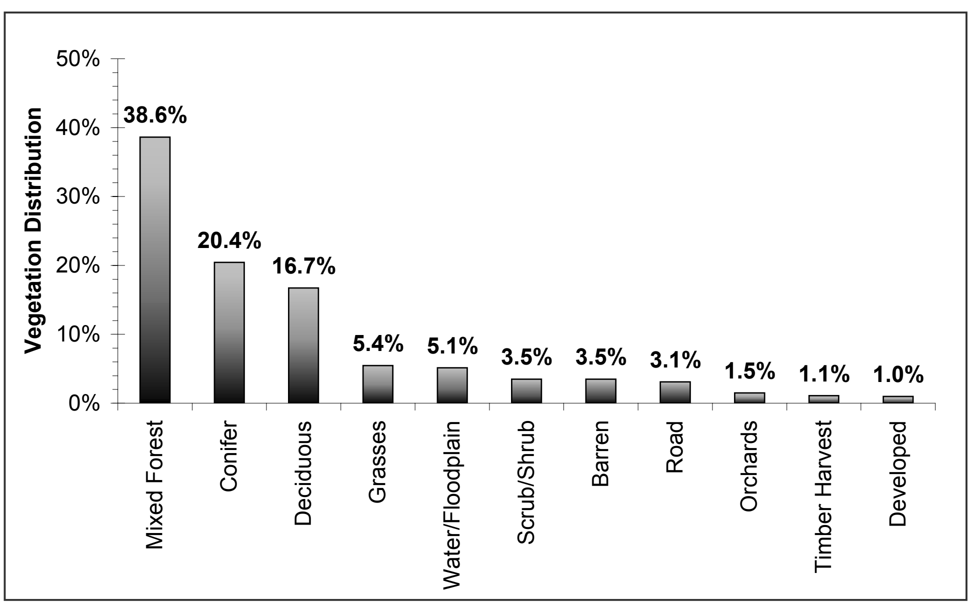
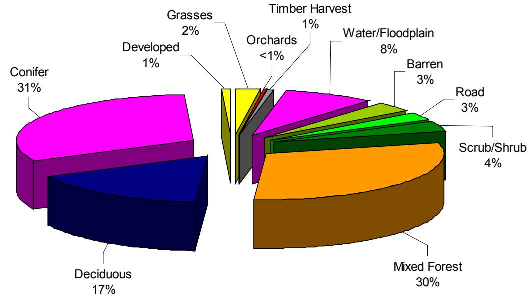
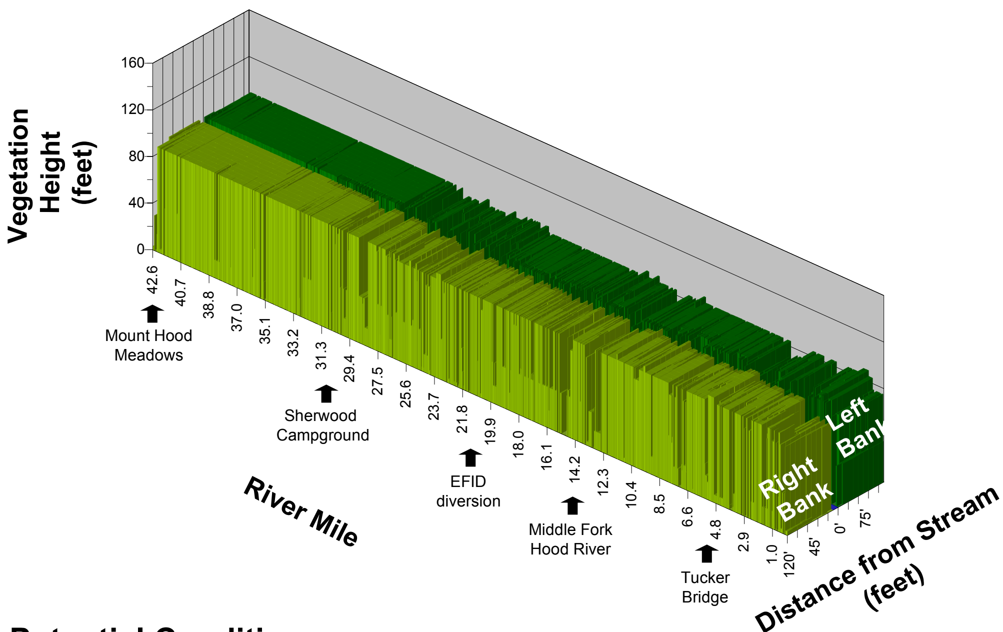


Figure 21. Hood River/East Fork Hood River Near Stream Vegetation Distribution



Current Condition



Potential Condition

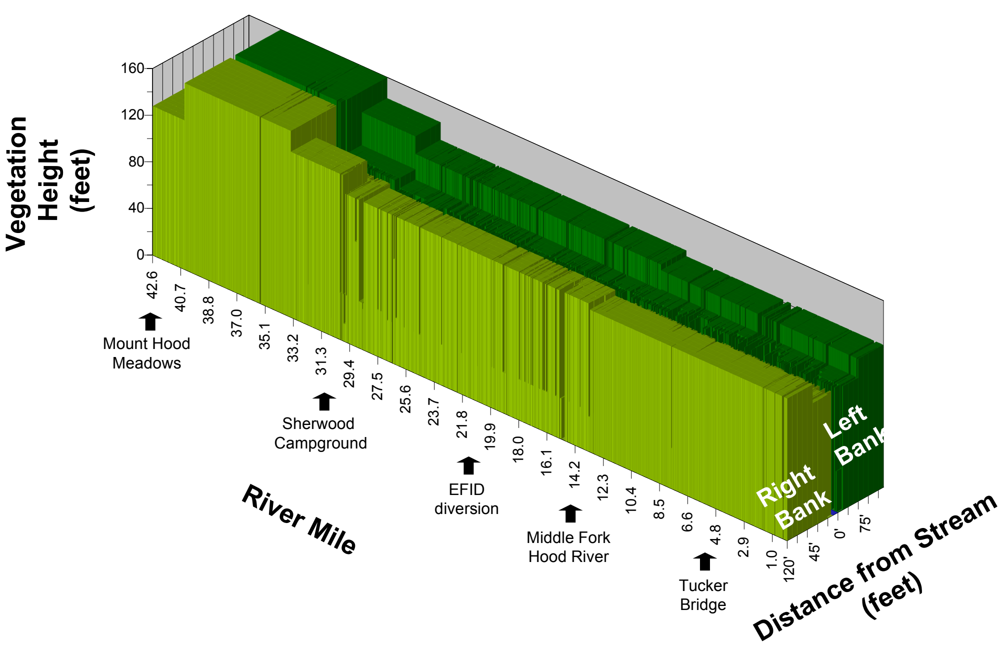
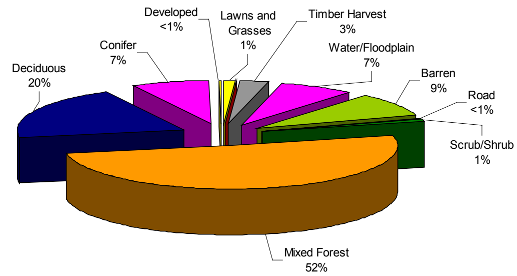
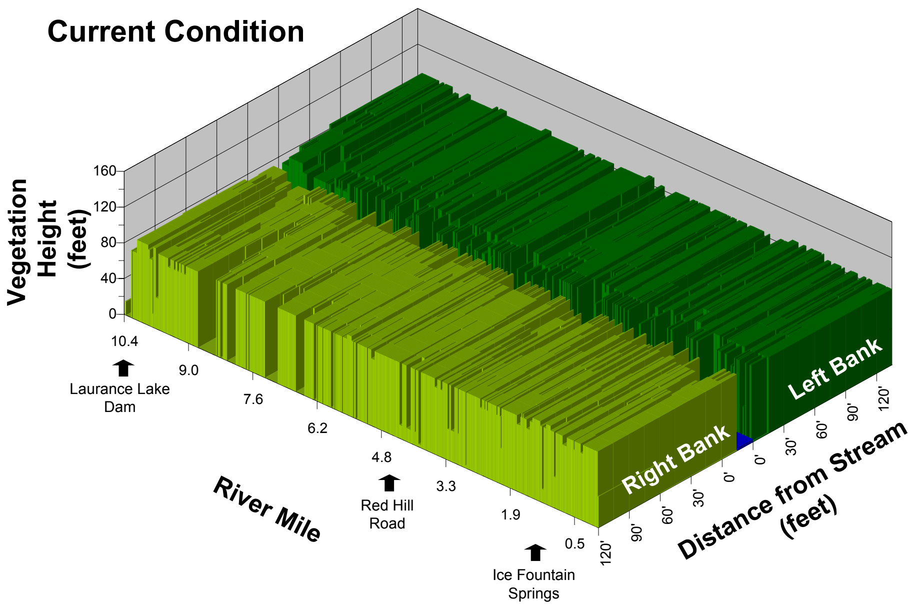


Figure 22. Middle Fork Hood River Near Stream Vegetation Distribution





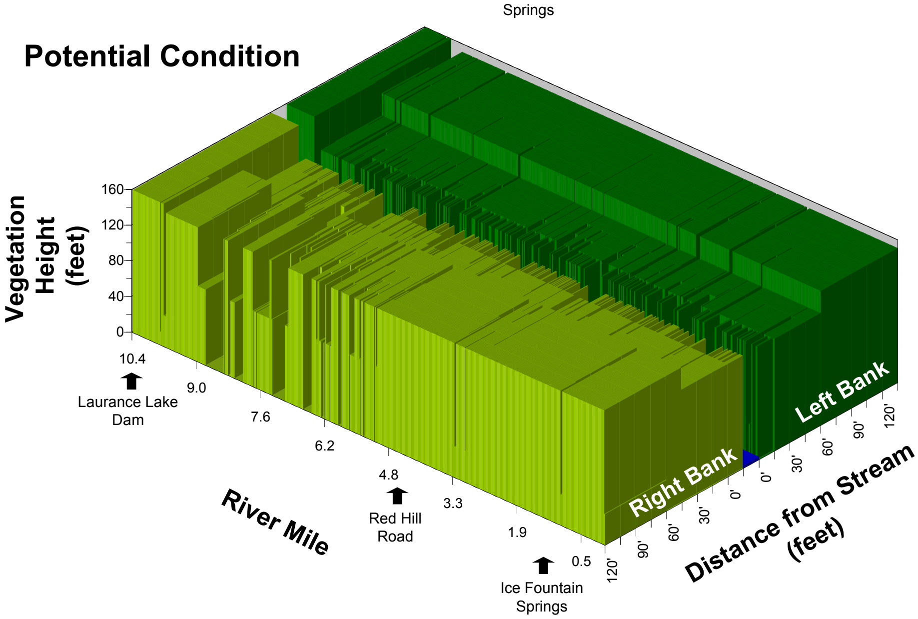
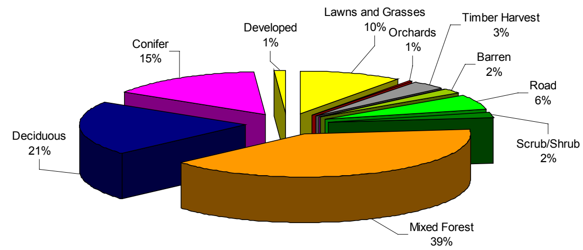
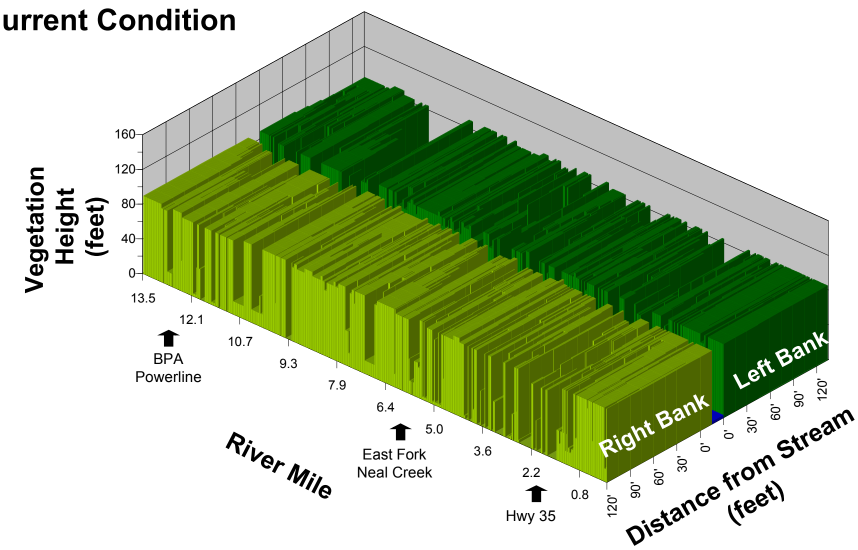


Figure 23. Neal Creek Near Stream Vegetation Distribution



Current Condition



Potential Condition

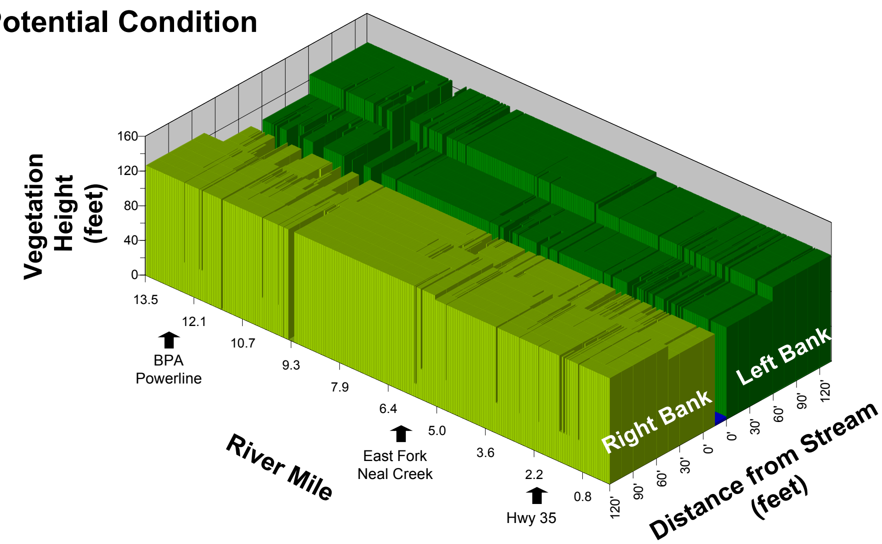
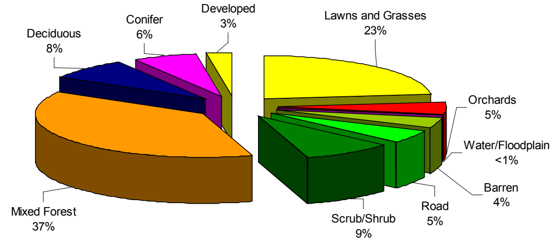
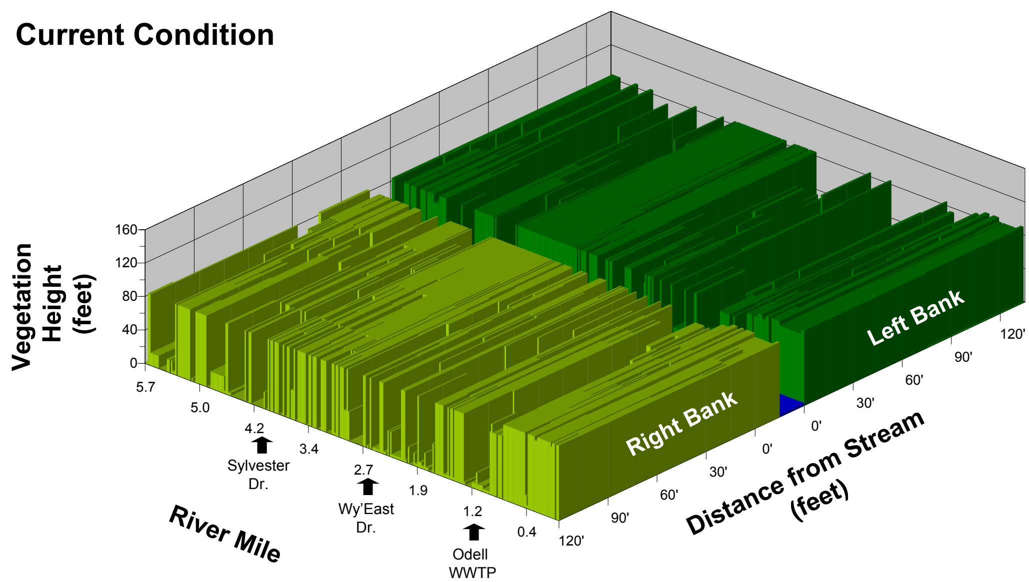


Figure 24. Odell Creek Near Stream Vegetation Distribution



Current Condition



Potential Condition

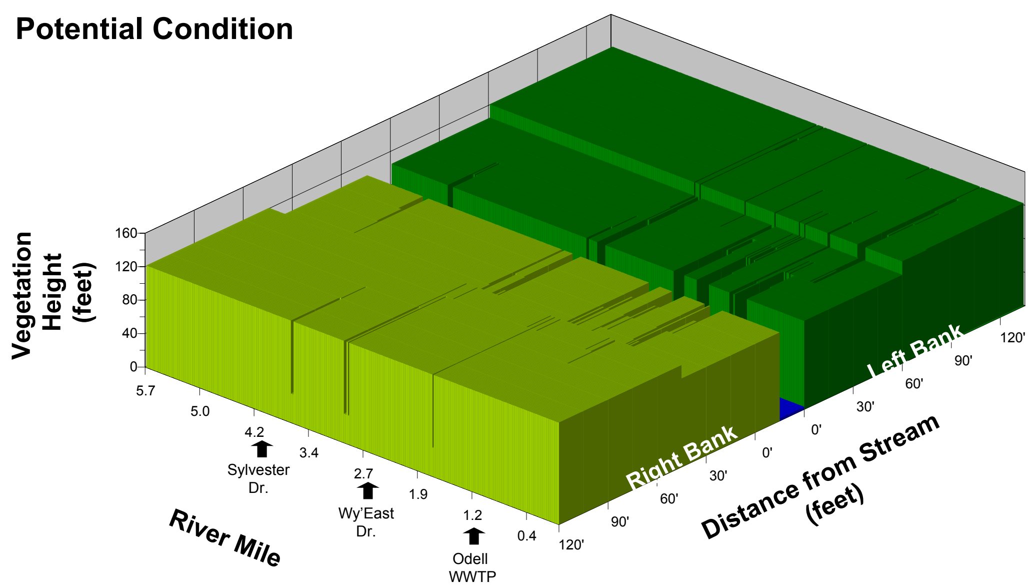
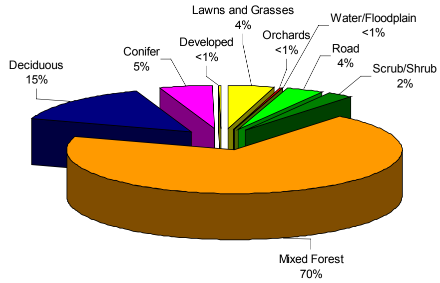
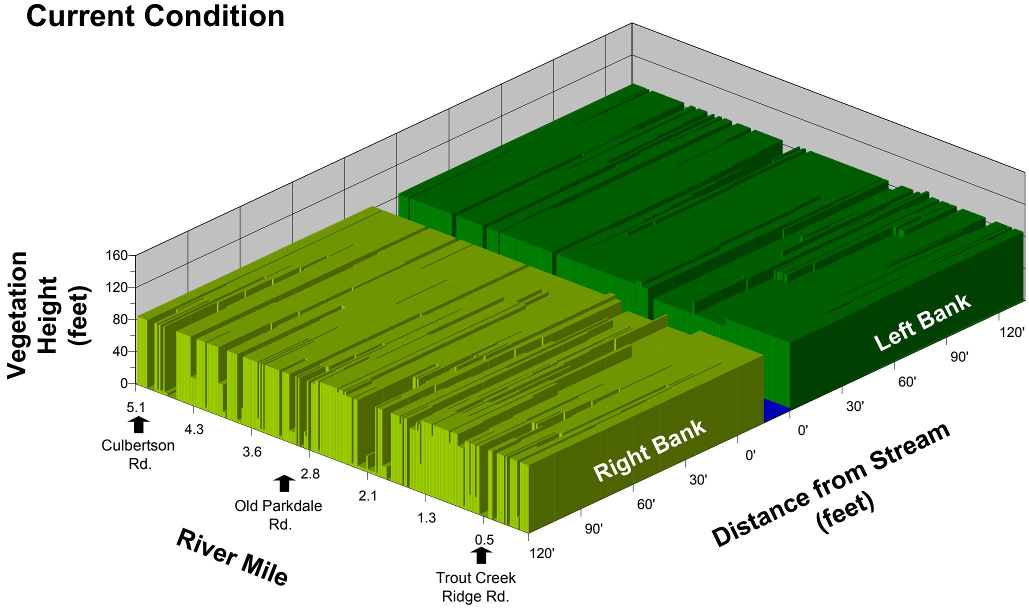


Figure 25. Trout Creek Near Stream Vegetation Distribution





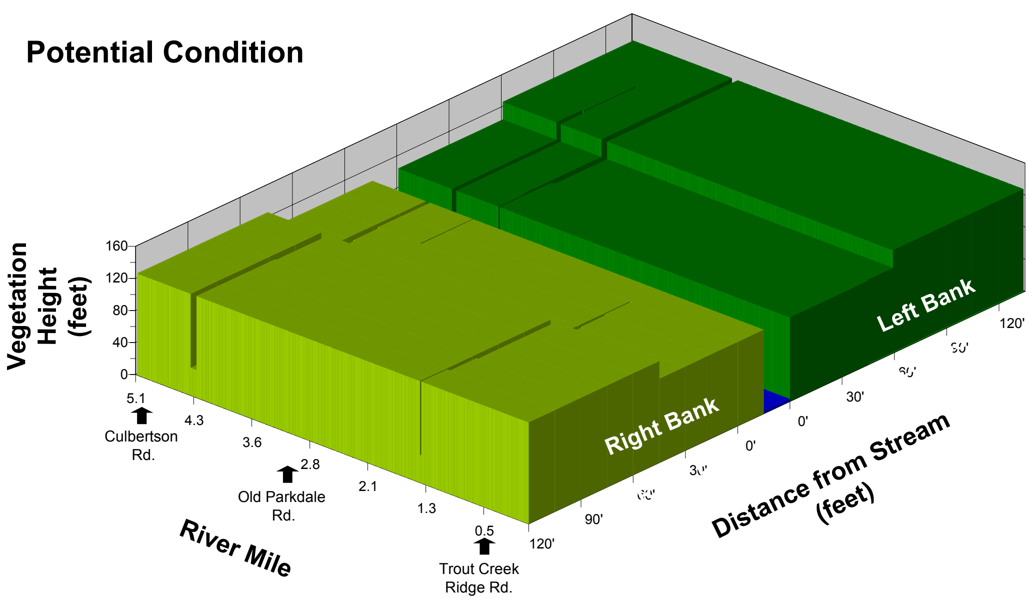
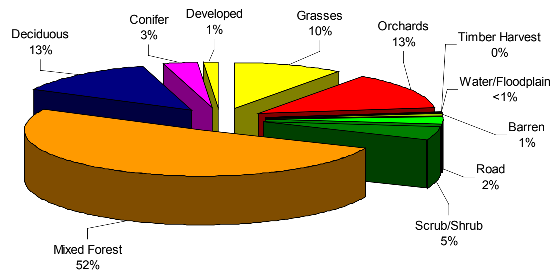
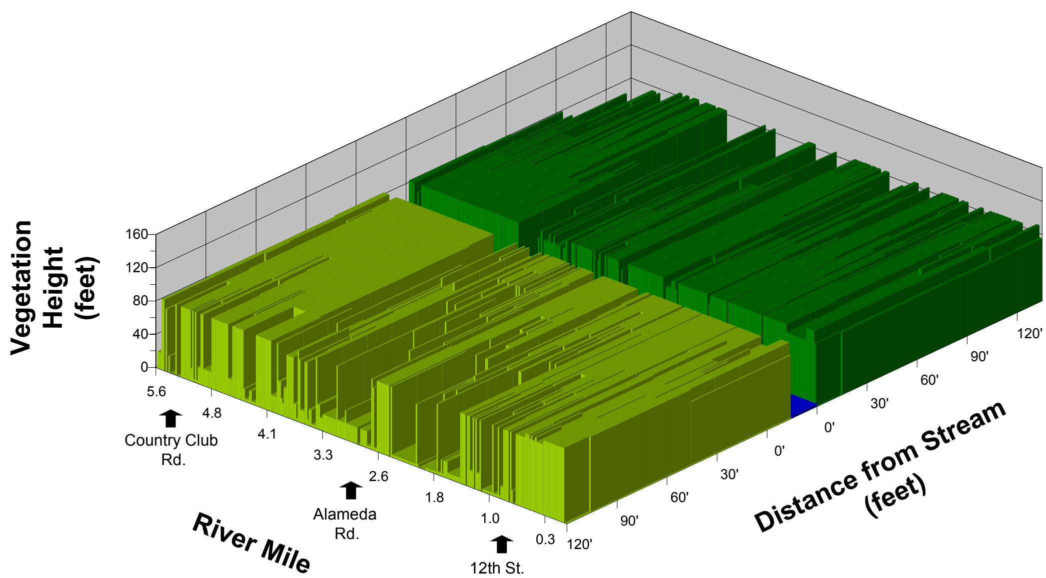


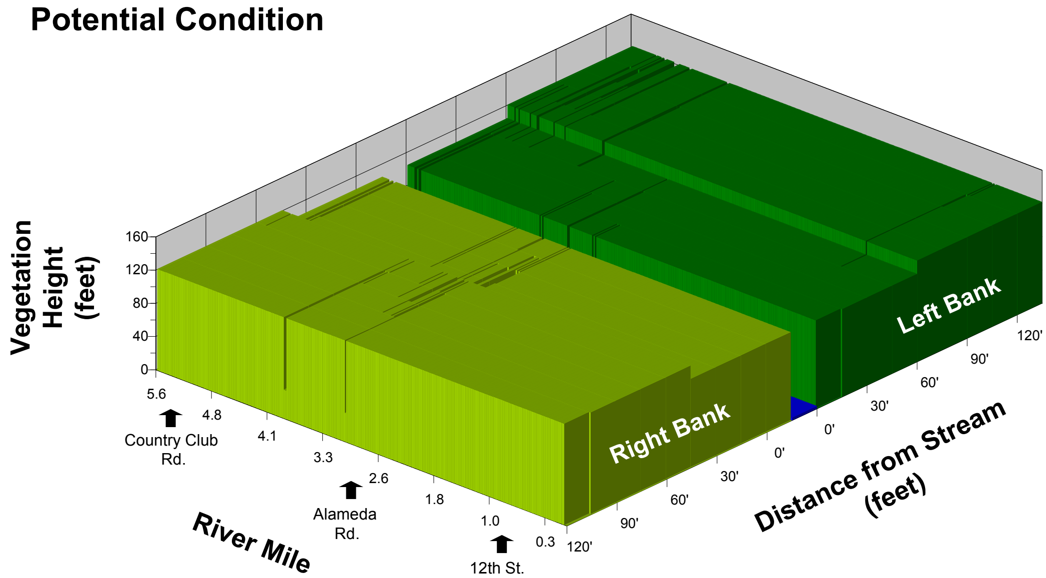
Figure 26. Indian Creek Near Stream Vegetation Distribution



Current Condition



Potential Condition



4.5.3.1.2.2 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 Western Hood Subbasin was developed by the Mt. Hood National Forest (Bruce Holmson, Sliviculturist), the Oregon Department of Forestry (Larry Hoffman, Unit Forester and Doug Thiesies, Forest Practices Act Forester) and ODEQ staff (**Table 8**). Potential vegetation zones were developed based on the Mt. Hood National Forest Plant Associations for Ponderosa Pine (Topik et al., 1988), Douglas Fir (Topik et al.,1988), Western Hemlock (Halverson et al.,1986), Grand Fir (Topik et al., 1988), 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 judgement to include lands off-forest (**Figure 27**).

Automated near stream vegetation sampling was repeated to determine the potential condition for each stream reach, replacing the heights and densities in **Table 7** with those in **Table 8** by potential vegetation zone. All current conditions near stream vegetation classes were replaced with the potential heights with the exception of polygons which had been designated as having limited system potential for natural reasons (such as a lava flow or a steep embankment) or that had been coded as “shorter deciduous forest”. The “shorter deciduous forest” primarily reflected streambank areas dominated by alders. Based on best professional judgement, ODF, ODEQ, and Mount Hood National Forest staff decided that this shorter deciduous component should be included in the potential condition scenario to reflect the continued natural disturbance expected from flooding and fires in the watershed.

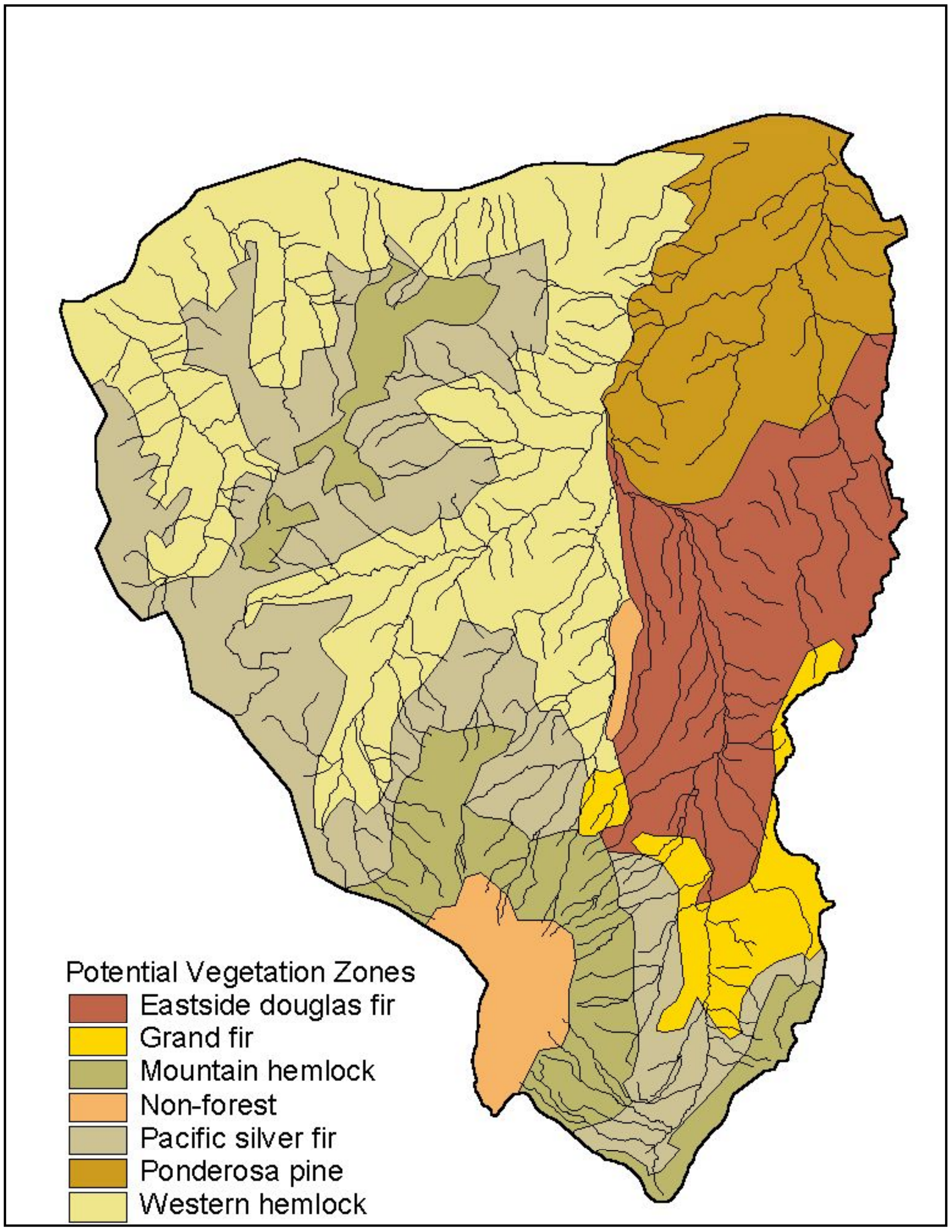
Table 8. Potential Vegetation Zones in the Western Hood Subbasin
(Data gathered from Mt. Hood National Forest Plant Association Guides, personal communications with Larry Hoffman & Doug Thiesies [ODF] and Bruce Holmson [Mt. Hood National Forest], and the Hood River Watershed Assessment [1999])

		Potential Overstory Near Stream Vegetation Characteristics		
Vegetation Zone	**Historic Condition Notes**	**Vegetation**	**Height (feet)**	**Assumed Canopy Density**
Ponderosa Pine		**50 feet closest to stream** Red Alder Cottonwood Oregon White Oak Bigleaf Maple Ponderosa Pine Douglas Fir Grand Fir Western Red Cedar ***Composite Dimension*** *(50% hardwoods/50% conifers)*	 55 100 70 65 130 150 140 140 **106 feet**	**85%**
	Pine-oak forests probably dominated. Today rural residential development, orchards, pastureland, and some urbanization are common. Lower elevation, dryer sites	**Greater than 50 feet from stream** Oregon White Oak Bigleaf Maple Ponderosa Pine Douglas Fir ***Composite Dimension*** *(75% conifer/25% hardwoods)*	 70 65 130 150 **122 feet**	**70%**
Eastside Douglas Fir		**50 feet closest to stream** Red Alder Cottonwood Oregon White Oak Bigleaf Maple Ponderosa Pine Douglas Fir Grand Fir Western Red Cedar ***Composite Dimension*** *(50% hardwoods/50% conifers)*	 55 100 70 65 130 150 140 130 **105 feet**	**85%**
	Lower elevation, dryer sites	**Greater than 50 feet from stream** Oregon White Oak Bigleaf Maple Ponderosa Pine (10%) Douglas Fir (75%) Grand Fir (15%) ***Composite Dimension*** *(75% conifer/25% hardwoods)*	 70 65 130 150 140 **127 feet**	**80%**

Table 8. Potential Vegetation Zones in the Western Hood Subbasin (continued)

	Potential Overstory Near Stream Vegetation Characteristics			
	Historic Condition	**Vegetation**	**Height**	**Assumed Canopy Density**
Western Hemlock	In the lower valley the landscape was a mixture of vegetation types. Oak patches would have been common along with conifers, maples, alder and wetland meadows. Today rural residential development, orchards, pastureland, and some urbanization are common. Lower elevation, wetter sites.	**50 feet closest to stream** Red Alder Cottonwood Bigleaf Maple Western Hemlock Douglas Fir Western Red Cedar Noble Fir Grand Fir ***Composite Dimension*** *(50% hardwoods/50% conifers)*	 80 100 70 190 190 150 170 140 **126 feet**	**85%**
		Greater than 50 feet from stream Bigleaf Maple Western Hemlock Douglas Fir Grand Fir Western Red Cedar Noble Fir ***Composite Dimension*** *(90% conifer/10% hardwoods)*	 70 150 190 140 150 170 **151 feet**	**80%**
Grand Fir	Higher elevation, dryer sites	**30 feet closest to stream** Cottonwood Bigleaf maple Grand Fir Douglas Fir Ponderosa Pine Western Red Cedar ***Composite Dimension*** *(50% hardwoods/50% conifers)*	 100 70 140 170 130 130 **114 feet**	**85%**
		Greater than 30 feet from stream Bigleaf Maple Grand Fir Douglas Fir Ponderosa Pine ***Composite Dimension*** *(90% conifer/10% hardwoods)*	 70 150 170 130 **142 feet**	**80%**
Pacific Silver Fir	3000-5000 feet in elevation, varied precipitation	Pacific Silver Fir Western Hemlock Douglas Fir Western Red Cedar Noble Fir Western White Pine Englemann Spruce ***Composite Dimension***	170 170 180 160 180 150 110 **160 feet**	**80%**
Mountain Hemlock	Cold, upper-elevation sites with deep snowpacks and short growing season. Susceptible to large, high intensity fires (lightning).	Pacific Silver Fir Mountain Hemlock Subalpine Fir Lodgepole Pine Western White Pine ***Composite Dimension***	130 140 120 110 140 **128 feet**	**80%**

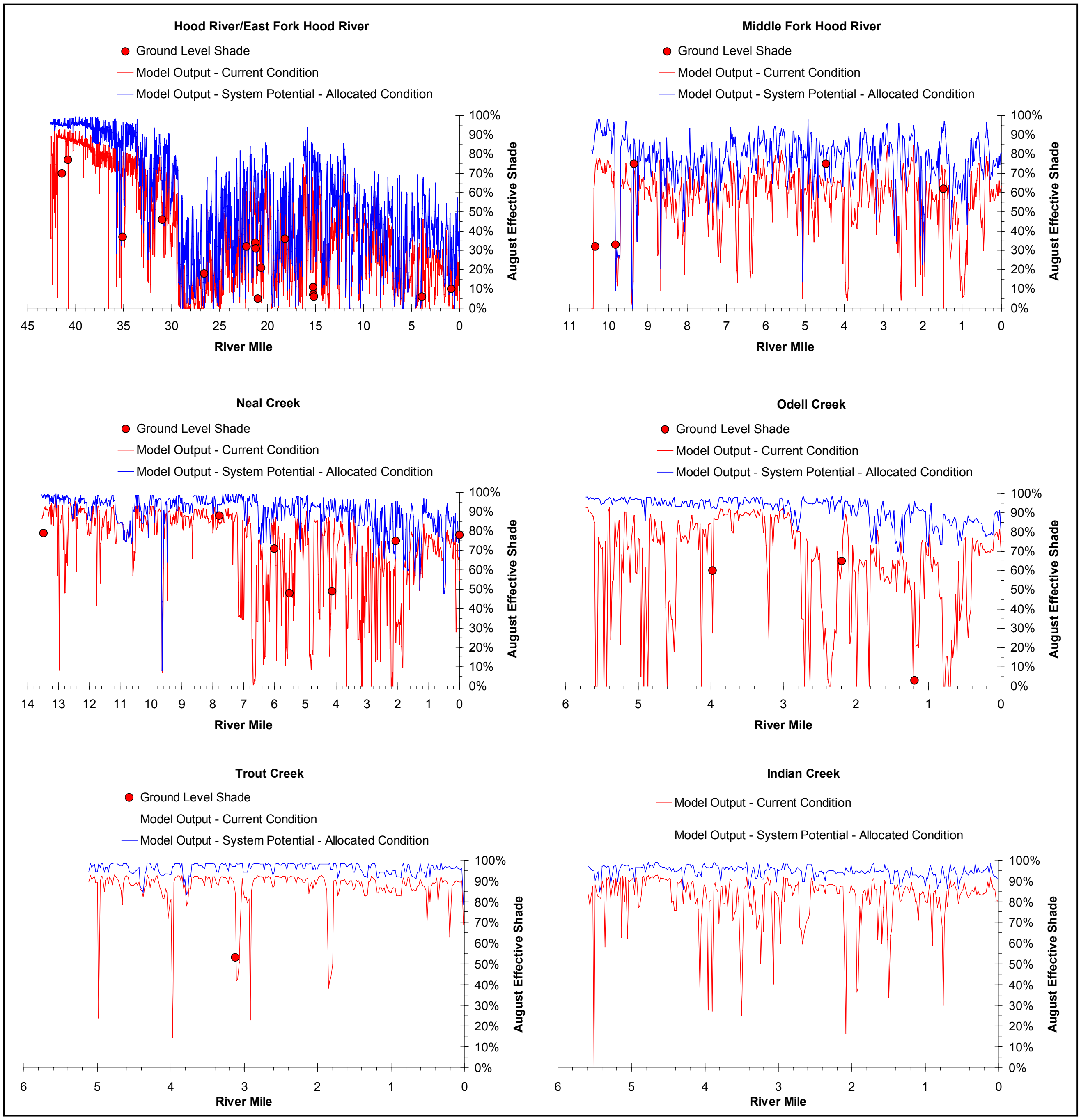
Figure 27. Potential Vegetation Zones, Western Hood Subbasin



4.5.3.1.3 Western Hood Subbasin Shade Conditions

A comparison of effective shade profiles under current conditions and system potential is shown in **Figure 28**. In addition to the simulated conditions, this figure also displays data points where ground level shade measurements (measurements taken to ground-truth model predictions) were taken during the summer of 1998.

Figure 28. Effective Shade Profiles – Current Condition and System Potential



4.5.3.1.4 Western Hood Subbasin 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 6, 1998 was selected as the date representing critical summer conditions to use in running model simulations. Simulations were done for stream reaches where sufficient data had been collected during the first week of August, 1998. These reaches included 23.6 miles of the main stem Hood River and the East Fork Hood River (from the mouth of the Hood River to a point about 2 miles upstream of the East Fork Irrigation District Diversion) and 7.8 miles of Neal Creek (from the mouth to the point where the East Fork Irrigation District (EFID) Ditch enters Neal Creek) (**Figure 29**). Simulations at system potential were performed by increasing stream vegetation to potential height, width and density as described in **Section 4.5.3.1.2.2 Potential Condition**. The results of the simulations are presented in **Figures 30** and **31**. Significant reductions in daily maximum stream temperature resulted from system potential conditions. Diurnal temperature fluctuations were also moderated. Daily minimum stream temperatures were reduced slightly.

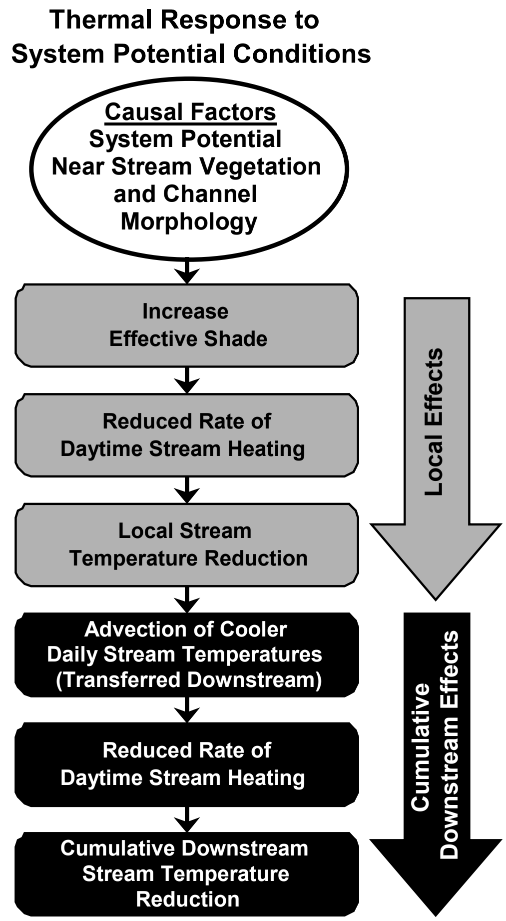


Figure 29. Stream Segments Modeled to Assess Thermal Responses to Changes in Riparian Vegetation and Flow

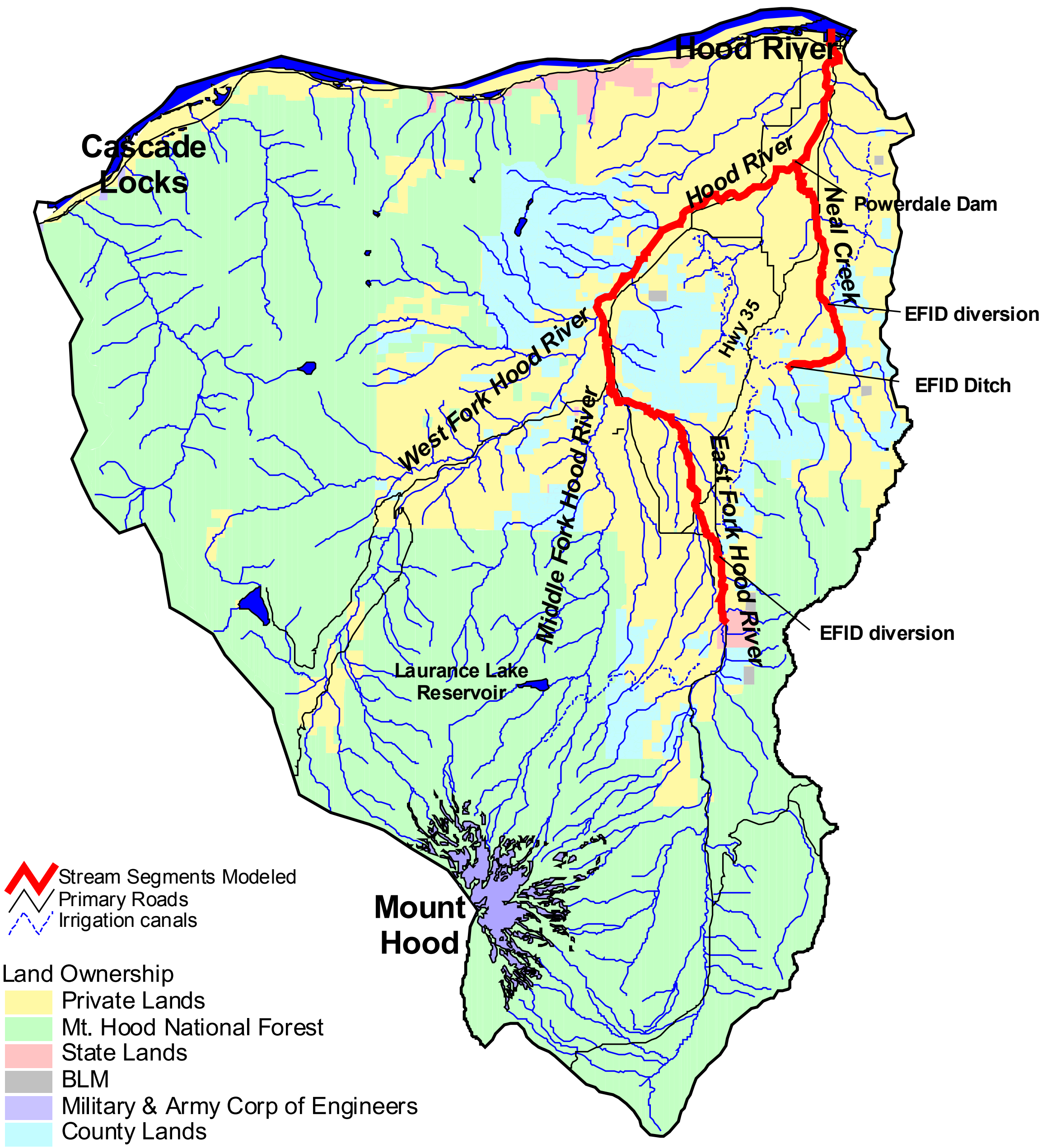


Figure 30. Hood River/East Fork Hood River Diurnal Temperatures: Current Condition Shade and Potential Shade (August 6, 1998)

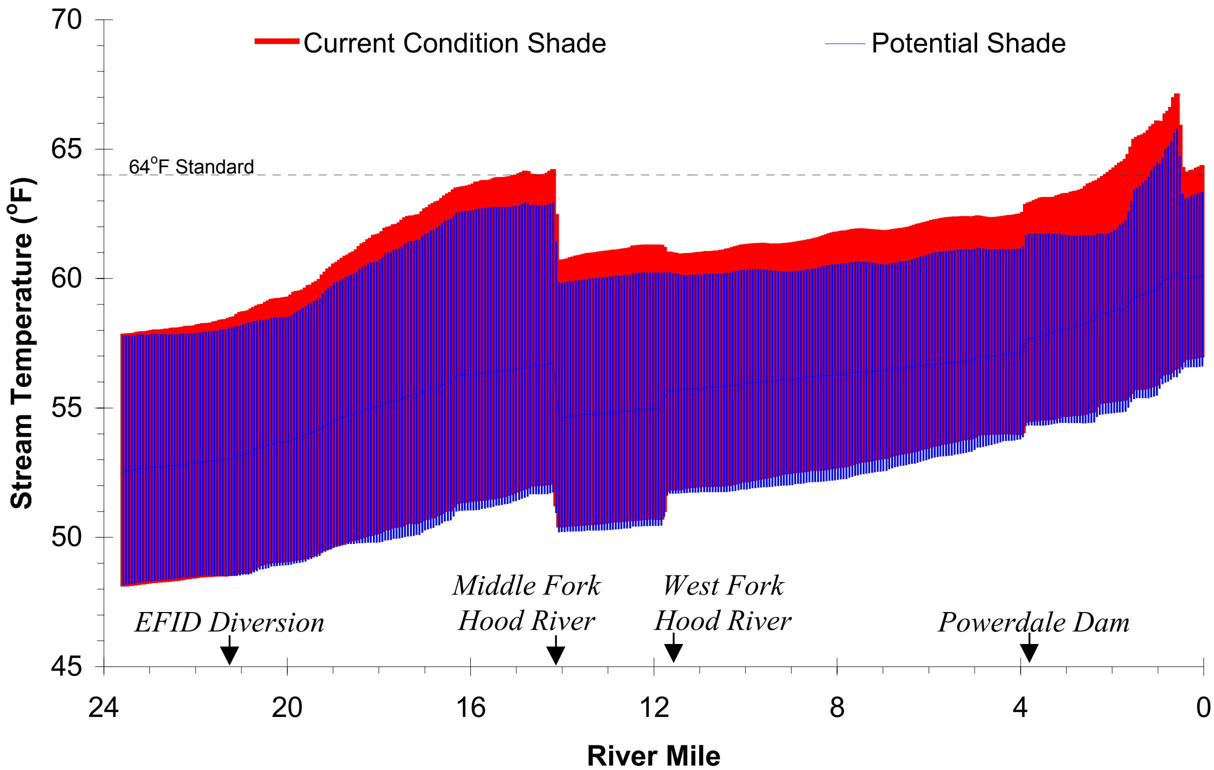
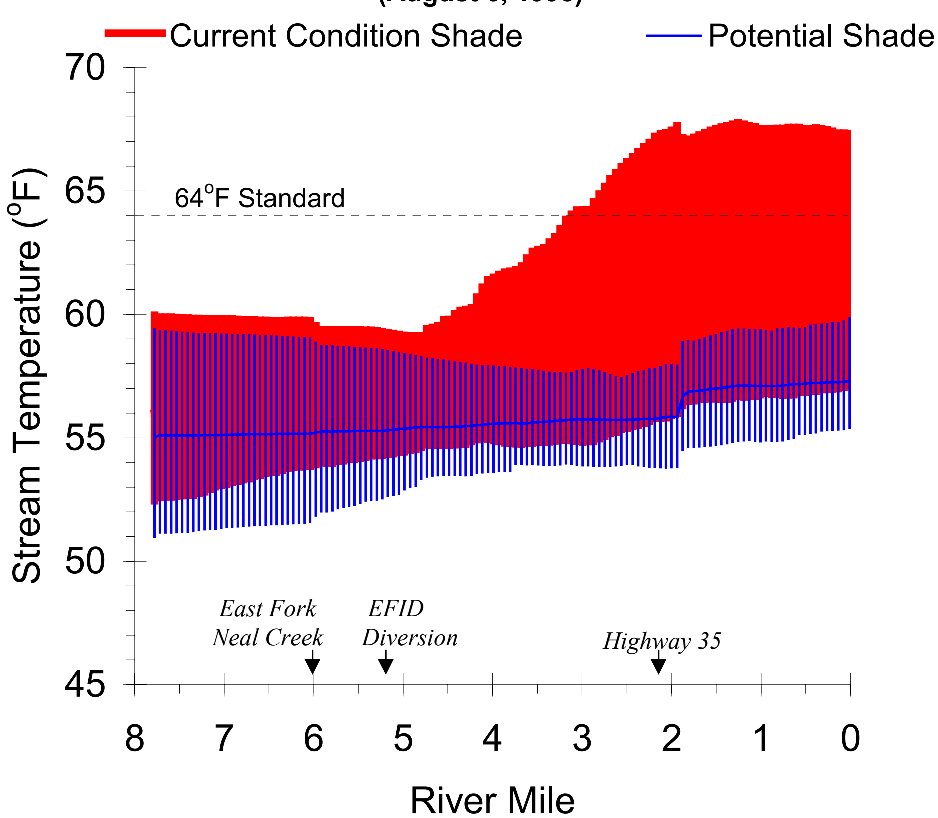


Figure 31. Neal Creek Diurnal Temperatures: Current Condition Shade and Potential Shade (August 6, 1998)



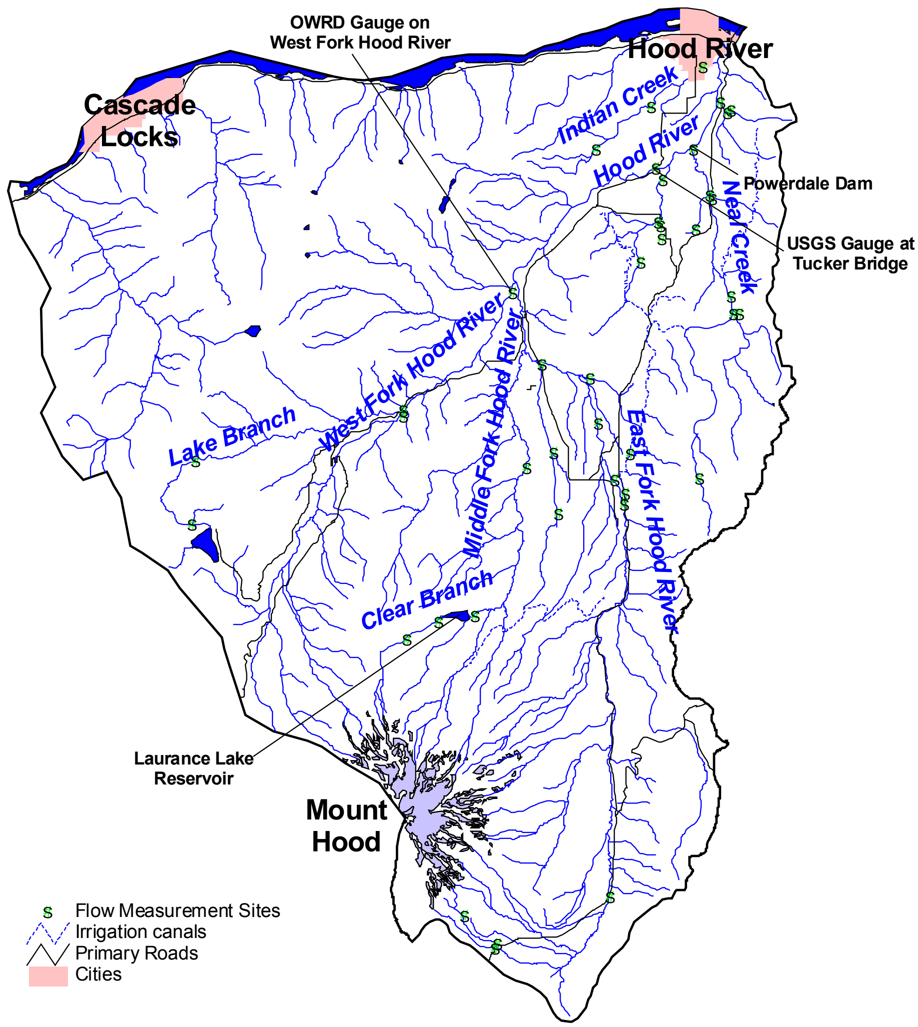
4.5.3.2 Flow

4.5.3.2.1 Western Hood Subbasin Flow Conditions

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 Western Hood Subbasin 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. 7Q10[6] low flows were calculated for the two currently gauged rivers: Hood River at Tucker Bridge - 201 cfs and West Fork Hood River near Dee - 102 cfs.

In addition to the two active gauging stations, stream flow was sampled throughout the Hood River watershed in August, 1998 by ODEQ staff (**Figure 32**).

Figure 32. ODEQ Flow Measurement Sites, August 3-7, 1998



[6] 7Q10 low flow is the average seven day interval with a return period of 10 years. This condition has a 10% probability of occurring during any one year.

Stream flow is used extensively for calculating Manning's equation for stream velocity and average wetted depth.

Manning's Equation,

$$Q = A \cdot V = 1.49 \cdot A \cdot \frac{1}{n} \cdot R_h^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

which can be rearranged to calculate velocity,

$$V = 1.49 \cdot \frac{1}{n} \cdot R_h^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

where,

- Q: Stream flow volume (ft^3/s)
- V: Stream velocity (ft/s)
- A: Wetted cross-sectional area (ft^2)
- R_h: Hydraulic radius (ft)
- S: Stream gradient
- n: Mannings's n

In addition to affecting wetted channel dimensions, stream velocity is used in the hydraulic routing of water downstream. Advection, the movement of water, is the primary means of mass transfer of water in the downstream direction. Travel times are largely a function of stream velocity. Therefore, the effect of stream velocity is considerable in the temperature response of a stream system. Not only does stream velocity help shape the wetted channel (and the surface areas exposed to thermodynamic processes), but exposure times are also largely controlled by the rate of advective transfer of water downstream.

4.5.3.2.2 Groundwater Mixing

Groundwater inflow has a cooling effect on summertime stream temperatures. Subsurface water is insulated from surface heating processes. Groundwater temperatures fluctuate little and are typically cool (45°F to 55°F). Many land use activities that disturb riparian vegetation and associated flood plain areas may affect the surface water connectivity to groundwater sources. Groundwater inflow not only cools summertime stream temperatures, but also augments summertime flows. Reductions or elimination of groundwater inflow will have a compounding warming effect on surface water. The ability of riparian soils to capture, store and slowly release groundwater is largely a function of floodplain/riparian area health.

The effects of groundwater were not analyzed in the Western Hood Subbasin TMDL effort, although it is anticipated that groundwater probably does affect stream thermal conditions in some locations, such as the Middle Fork Hood River. The data required to completely assess the thermal effects of groundwater, such as forward-looking infrared radiometry (FLIR) have not been collected in the Western Hood Subbasin. FLIR, collected via remote sensing, provides the best tool to identify and analyze groundwater and surface stream temperature interactions. ODEQ recommends such data collection for future groundwater/stream analysis.

4.5.3.2.3 Western Hood Subbasin Thermal Response Simulations

To assess the thermal response of stream temperature to changes in flow, simulations were performed using current flow conditions, "natural" flow conditions (no diversions), and several scenarios in between those conditions removing each of the major diversions in the Hood River system. The analysis used estimated average water use in August, 1998. August 6, 1998 was selected as the date representing critical summer conditions to use in running model simulations. Simulations were done for stream reaches where sufficient data had been collected during the first week of August, 1998 and where there was sufficient information to project "natural" flow conditions. These reaches included 23.6 miles of the main stem Hood River and the East Fork Hood River – from the mouth of the Hood River to a point about two miles upstream of the East Fork Irrigation District Diversion. To arrive at the natural flow conditions simulation, all known anthropogenic diversions from the Hood River watershed were removed (**Table 9**).

All simulations are presented in **Figure 33**. Significant reductions in daily maximum and minimum stream temperature resulted from natural flow conditions, as well as from the removal of the East Fork Irrigation

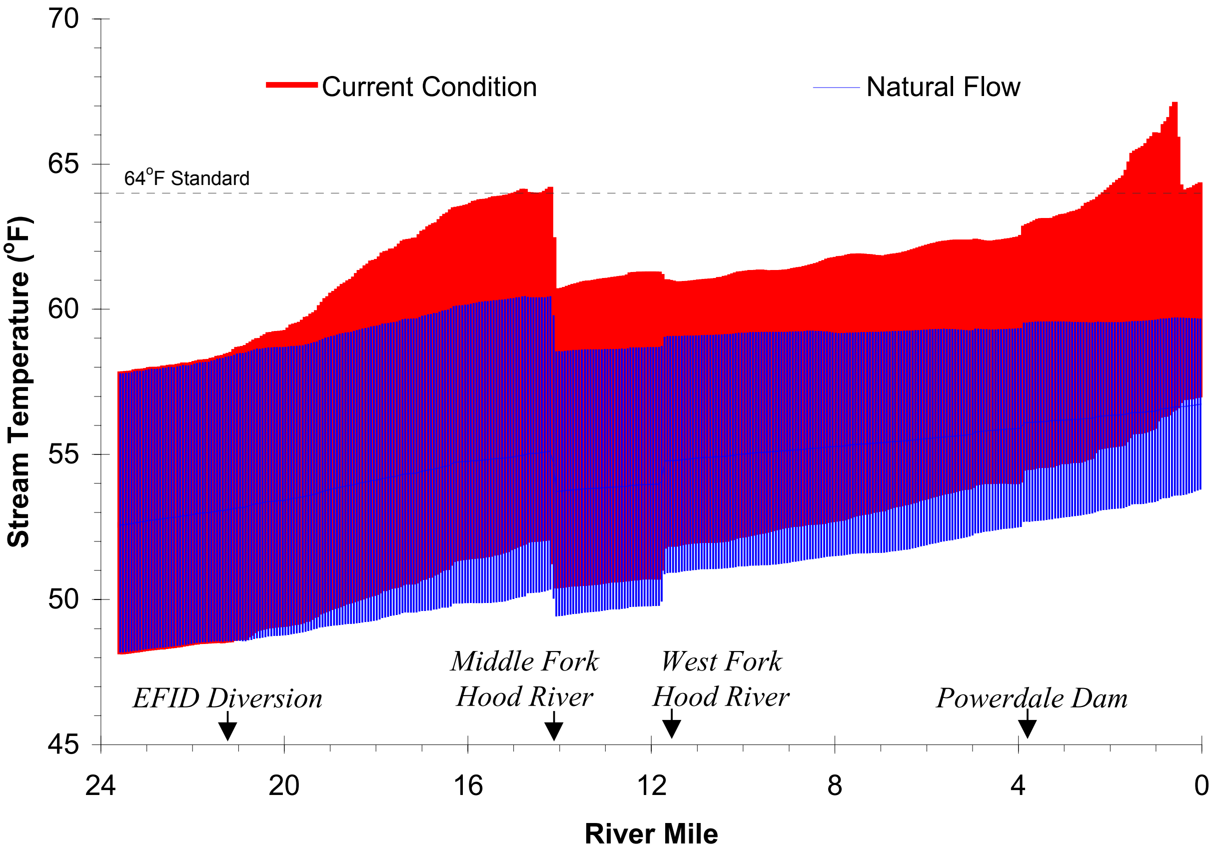
District diversion from the East Fork Hood River. Removal of Powerdale Dam also showed a significant reduction in daily maximum temperatures in the reach of the Hood River below Powerdale Dam.

It should be noted that this analysis of stream flow relative to temperature has been done to demonstrate that improved stream flow can improve stream temperatures. It will not be used, however, as a basis for a requirement in this TMDL that out-of-stream flow diversions be reduced or eliminated. Control or limitations on flow or water rights are outside the authority of a TMDL, with the exception of flows required in the 401 Certification for the Powerdale Hydroelectric Project. These flow simulations do provide, however, a good reason for water users to efficiently use their allocated water so that the amount of diverted water is minimized.

Table 9. Estimated Anthropogenic Diversions in the Hood River Watershed for August, 1998 (Data gathered from the Hood River Watershed Assessment (1999), the Tucker bridge gauge station, personal communication with Tod Hilstad (Farmers Irrigation District), Brian Connors (Middle Fork Irrigation District), John Buckley (East Fork Irrigation District) and Dave Anderson (The Dalles Public Works Department), and from field measurements by ODEQ staff)

Source of Diversion	Organization	Estimated Average Use (cfs)
East Fork Hood River Watershed		
Dog River	City of The Dalles	3
Crystal Springs	Crystal Springs Water District	4
East Fork Hood River	East Fork Irrigation District	141
Evans Creek	Middle Fork Irrigation District	1
Emil Creek	Middle Fork Irrigation District	1
Trout Creek	Middle Fork Irrigation District	2.1
Middle Fork Hood River Watershed		
Laurence Lake	Middle Fork Irrigation District	49
Coe Branch	Middle Fork Irrigation District	19
Eliot Branch	Middle Fork Irrigation District	20
Rogers Creek	Middle Fork Irrigation District	5
Tony Creek	Aldridge Irrigation Company	1
Ice Fountain Springs	Ice Fountain Water District	1
West Fork Hood River Watershed		
Various tributaries, including Green Point Creek	Farmers Irrigation District	25
West Fork Hood River & various tributaries (Camp, Alder, No Name, Deer Creeks)	Dee Irrigation District	13
Cold Springs	City of Hood River	2
Stone Springs	City of Hood River	4
Mainstem Hood River Watershed		
Hood River	Farmers Irrigation District	70
Hood River	PacifiCorp (Powerdale Dam)	405

Figure 33. Hood River/East Fork Hood River Diurnal Temperatures: Current Condition Flow and Projected Conditions with Removal of Diversions (August, 1998)



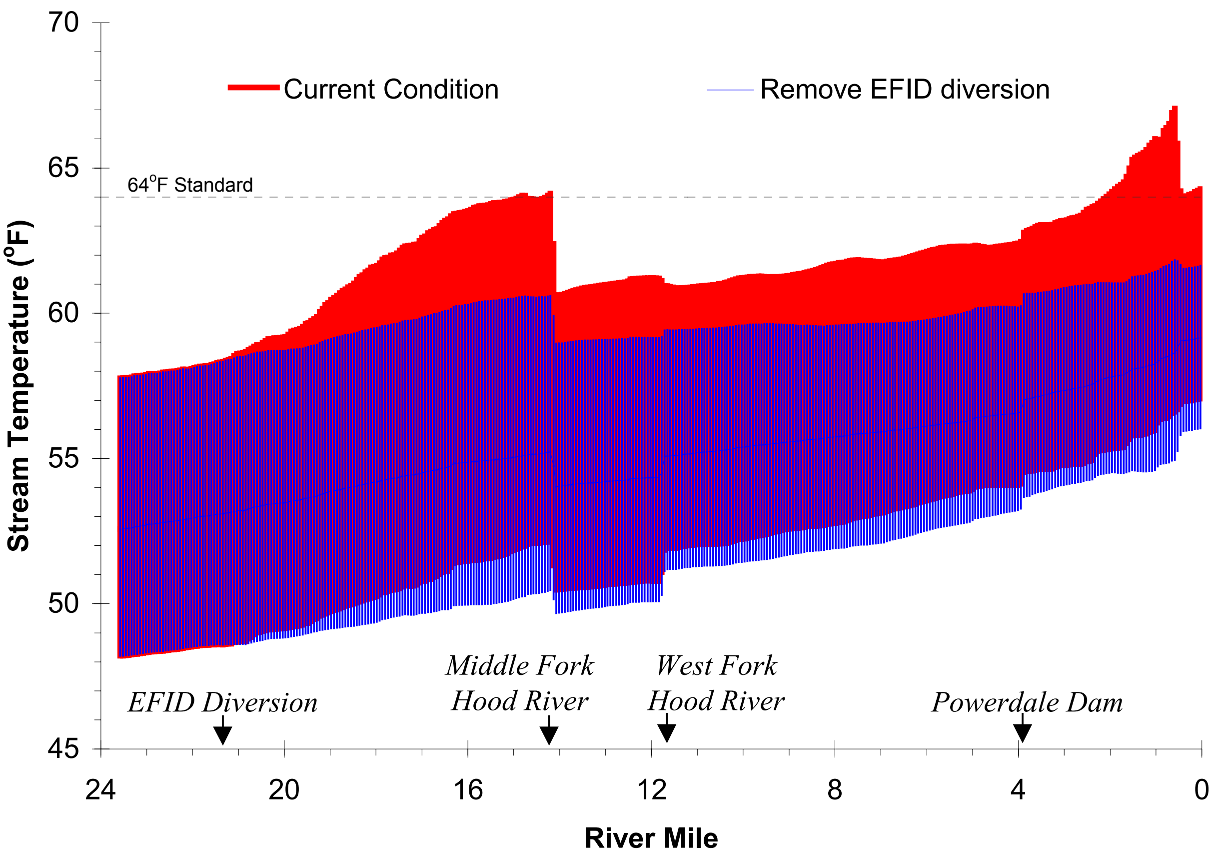
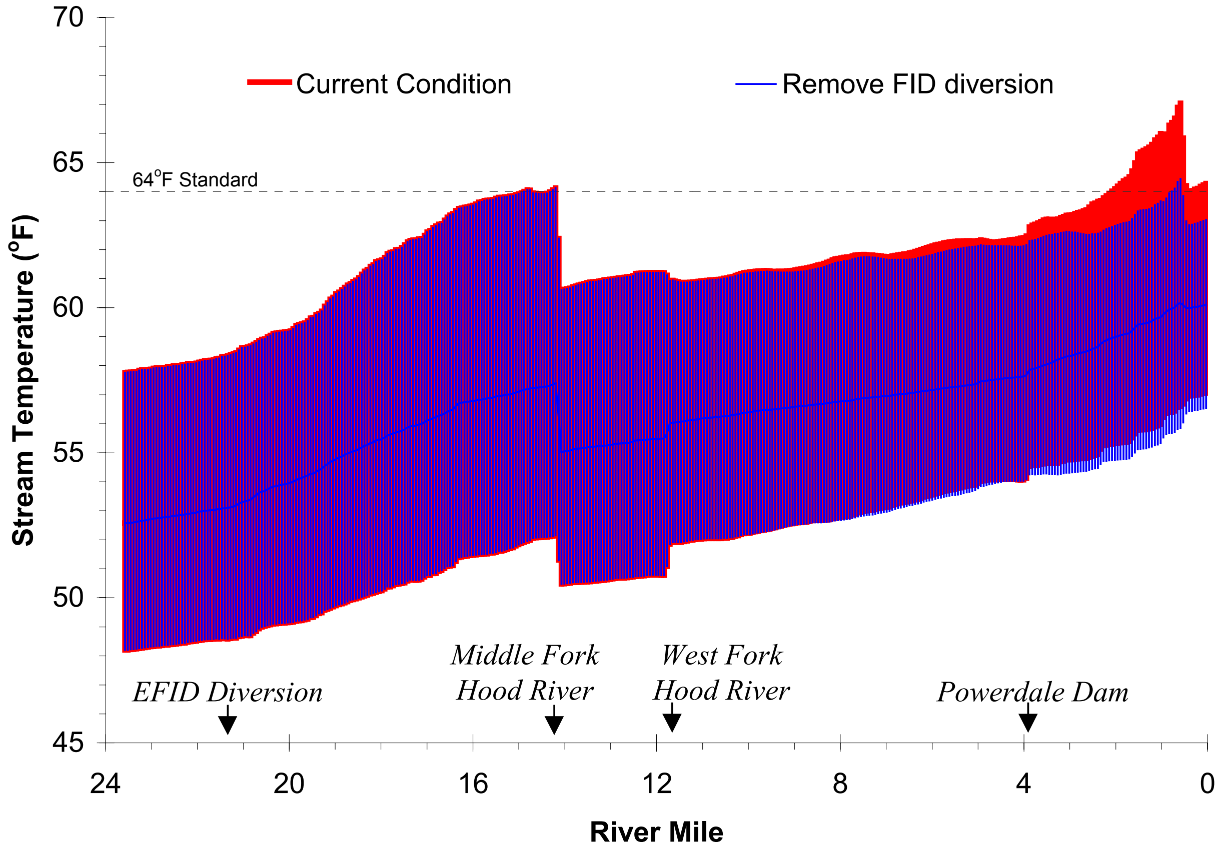
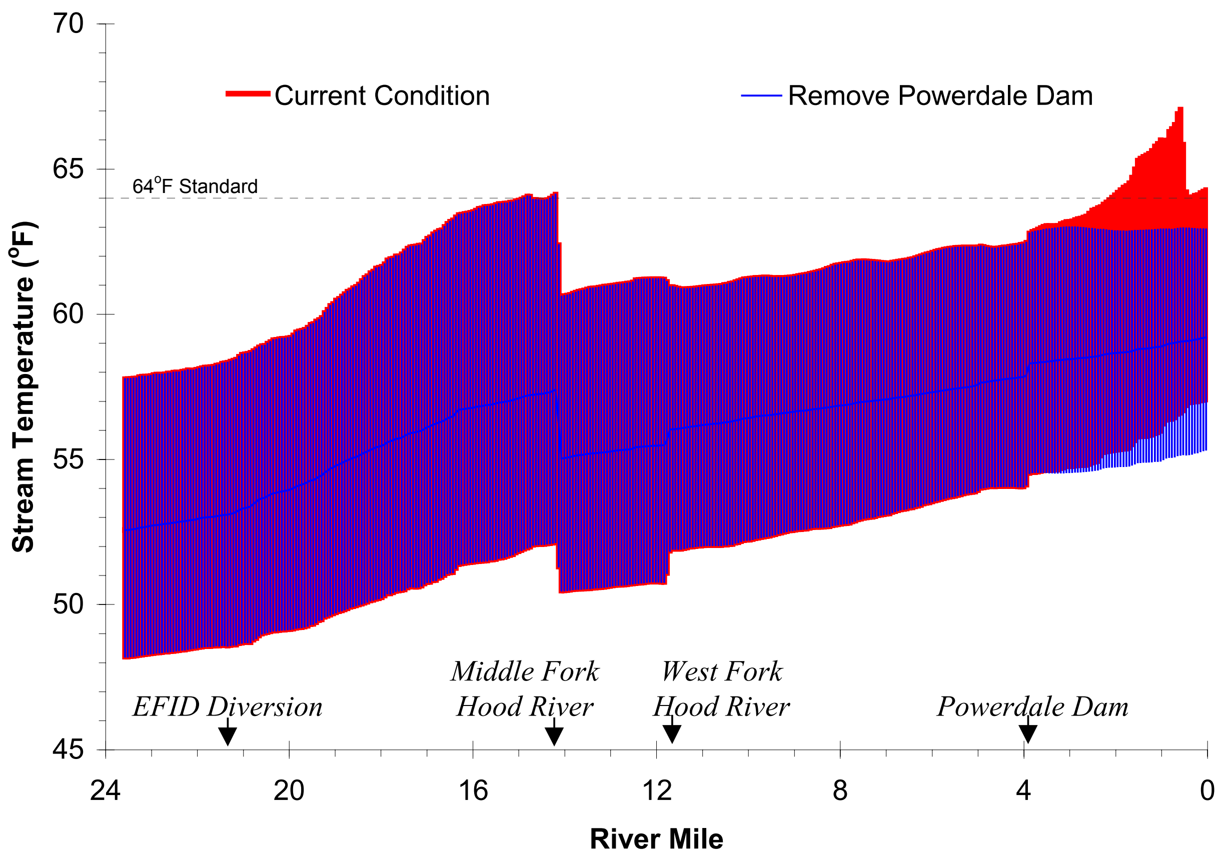


Figure 33. Hood River/East Fork Hood River Diurnal Temperatures: Current Condition Flow and Projected Conditions with Removal of Diversions (continued)





4.5.3.3 Channel Morphology

Changes in channel morphology, namely channel widening, impact stream temperatures. As a stream widens, the surface area exposed to radiant sources and ambient air temperature increases, resulting in increased energy exchange between the stream and its environment (Boyd, 1996). Further, wide channels are likely to have decreased levels of shade due to simple geometric relationships between riparian height and channel width. Conversely, narrow channels are more likely to experience higher levels of shade. An additional benefit 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 on the East Fork Hood River and Hood River, the local stakeholder committee advised ODEQ that changes in channel morphology were not likely to have a significant impact on temperature in the East Fork Hood River or the mainstem Hood River. The committee and ODEQ did feel that it was important to acknowledge the important role that channel morphology can play in regulating stream temperatures, particularly in smaller tributaries, such as Indian Creek, Odell Creek and Neal Creek. A brief discussion of channel morphology is presented here.

4.5.3.3.1 Channel Width

The width to depth ratio is a fundamental measure of channel morphology. High width to depth ratios (greater than 10.0) imply wide shallow channels, while low width to depth ratios (less than 10.0) suggest that the channel is narrow and deep. In terms of reducing stream surface exposure to radiant energy sources, it is generally favorable for stream channels to be narrow and deep (low width to depth ratios).

Channel widening is often related to degraded riparian conditions that allow increased stream bank erosion and sedimentation of the streambed. Both active stream bank erosion and sedimentation correlate strongly to riparian vegetation type and age. Riparian vegetation contributes to rooting strength and flood plain/stream bank roughness that dissipates erosive energies associated with flowing water. Established mature woody riparian vegetation adds the highest rooting strengths and flood plain/stream bank roughness. Annual (grassy) riparian vegetation communities offer less rooting strength and flood plain/stream bank roughness. It is expected that width to depth ratios would be lower (narrower and deeper channels) when established mature woody vegetation is present. Annual (grassy) riparian communities may allow channels to widen and become shallower.

Further, channel morphology, namely wetted width to depth values, are not solely dependent on riparian conditions. Sedimentation can deposit material in the channel and agrade the streambed, reducing channel depth and increasing channel width. Flow events play a major role in shaping the stream channel. Channel modification usually occurs during high flow events. Naturally, land uses that affect the magnitude and timing of high flow events may negatively impact channel width and depth.

Riparian vegetation conditions will affect the resilience of the stream banks/flood plain during periods of sediment introduction and high flow. Linking width to depth ratios to riparian vegetation is fundamental. Disturbance processes may have drastically differing results depending on the ability of riparian vegetation to shape and protect channels. Low width to depth ratios are thus related to riparian vegetation community composition and condition by:

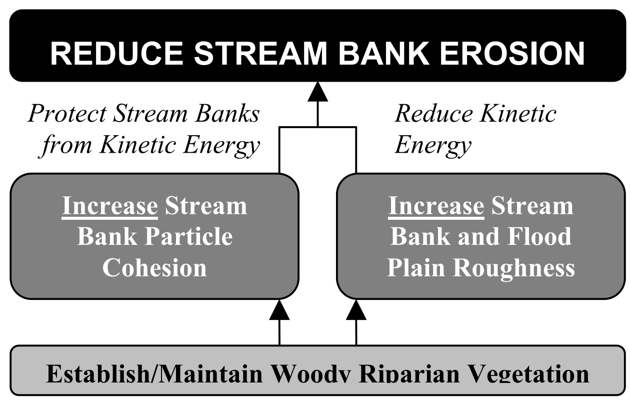
- ✓ ***Building stream banks:*** *Trap suspended sediments, encourage deposition of sediment in the flood plain and reduce incoming sources of sediment.*
- ✓ ***Maintaining stable stream banks:*** *High rooting strength and high stream bank and flood plain roughness prevent stream bank erosion.*
- ✓ ***Reducing flow velocity (erosive kinetic energy):*** *Supplying large woody debris to the active channel, high pool to riffle ratios and adding channel complexity that reduces shear stress exposure to stream bank soil particles.*

4.5.3.3.2 Stream Bank Erosion

Stream bank erosion results from detachment, entrainment and removal of bank material as individual grains or aggregates via fluvial processes. *Stream bank failure* indicates a gravity-related collapse of the stream bank by mass movement. Both *stream bank erosion* and *stream bank failure* result in *stream bank retreat*, which is a net loss of stream bank material and a corresponding widening of the stream channel.

Stream bank stability reflects the condition of riparian vegetation contributing to rooting strength in stream bank soils and flood plain roughness. Riparian vegetation rooting structure serves to strengthen the stream bank and resist the erosive energy exerted on the stream bank during high flow conditions. Flood plain roughness reflects the ability of the flood plain to dissipate erosive flow energy during high flow events that over-top stream banks and inundate the flood plain. Riparian vegetation disturbance often has a compounding effect of increased stream bank erosion, increased kinetic energy exposure, decreased bank rooting strength, loss of soil cohesion and loss of flood plain roughness.

4.5.3.3.3 Stream Bank Protection and Riparian Vegetation



A stream bank erosion recovery process requires the concurrent occurrence of two elements that induce stream bank building: protect stream banks from kinetic energy (bank particle cohesion) and reduce kinetic energy (stream bank/flood plain roughness). High levels of stream bank cohesion tend to protect the stream bank from erosive kinetic energy associated with flowing water. Stream bank erosion reflects looseness of bank soil, rock and organic particles. The opposite condition is cohesion of stream bank soil, rock and organic particles. Vegetation strengthens particle cohesion by increasing rooting strength that helps bind soil and add structure to the stream bank. Different riparian vegetation communities (annual, perennial, deciduous, mixed and conifer dominated) offer a variety of rooting strengths to stream banks. It is a general observation that healthy and intact indigenous riparian vegetation communities will add preferable stream bank cohesion over bare soil and ground conditions.

Physical relationships that relate to decreasing/preventing stream bank erosion can be summarized as:

- ✓ *Rough surfaces decrease local flow velocity,*
- ✓ *Reduced local velocity lowers shear stress acting on the stream bank,*
- ✓ *Lower shear stress acting on the stream bank will be less likely to detach and entrain stream bank particles.*

In an effort to control stream bank erosion processes, the focus is to retain high stream bank and flood plain roughness via riparian vegetation. The species composition and condition of the riparian vegetation determines natural stream bank roughness.

4.5.4 Point Sources and Dams

In the Western Hood Subbasin, both point source discharges and dams can be sources of stream heating. Heat loading from point sources occurs when waters with differing temperatures mix. Heat loading related to dams can occur by two primary mechanisms. Water diverted at a dam can result in a lower flow volume in the stream, which tends to increase stream temperature. Water impounded behind a dam can also impact downstream temperatures depending on the water release scenario utilized at the dam. The temperature standard specifies that when the applicable temperature criteria is exceeded, there shall be no increases in stream temperature due to anthropogenic (human) activities. For point sources, no measurable increase is considered by ODEQ to be 0.25°F or less at the edge of the defined mixing zone. For dams, no measurable increase is considered to be no more than a 0.25°F increase above that which would naturally occur if the dam were not present.

4.5.4.1 NPDES Permits

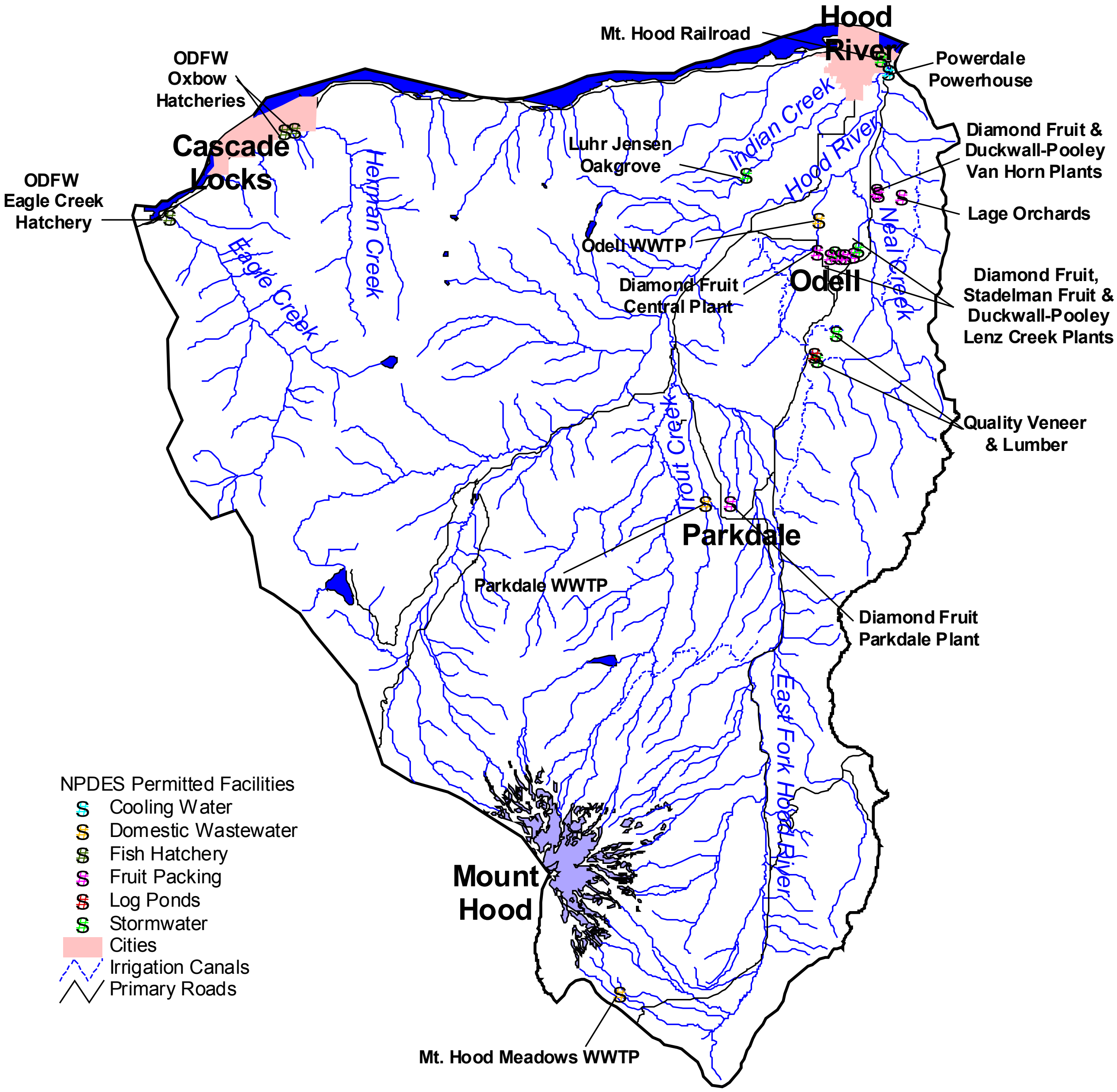
Twenty NPDES permitted discharge points, of which six are for stormwater discharge, are mapped and presented below (**Table 10**, **Figure 34**). These facilities discharge into streams which are either on the 303(d) list or are tributaries to other streams on the list. Discharge temperature data is limited for most of the facilities. There are also two point source discharges to Herman Creek from the Oxbow Fish Hatchery and one to Eagle Creek from the Eagle Creek Fish Hatchery, all operated by the Oregon Department of Fish and Wildlife. Because Herman Creek and Eagle Creek (which are tributaries to the Columbia River) are not included on the 303(d) list, any modifications to these permits will be based on a site specific water quality impact analysis to ensure compliance with appropriate water quality standards.

In addition to the point sources identified above, there are six additional NPDES permits for facilities located within the Western Hood Subbasin which discharge to the Columbia River. These sources are: City of Cascade Locks wastewater treatment, City of Hood River wastewater treatment, City of Hood River stormwater, Hood River Inn cooling water, Luhr Jensen stormwater at Riverside Dr. and Portway facilities. These point sources will be assessed as part of the Columbia River TMDL, slated for completion by the U.S.E.P.A. in 2002.

Table 10. NPDES Permitted Facilities for Wastewater and Stormwater Discharge

Facility Name	Description	Receiving Water	River Mile	Permit Type	Avg. August Flow, 1998 (cfs)	Avg. August Temp., 1998 (^oF)
Mainstem Hood River Watershed						
Mt. Hood Railroad	Stormwater	Hood River	0.5	NPDES	No data	
PacifiCorp – Powerdale Powerhouse	Non-contact cooling water	Hood River	1.0	NPDES	0.0928	59.9
Luhr Jensen – Oakgrove Plant	Stormwater	Indian Creek	6.0	NPDES	No data	
Lage Orchards	Rinse water and cooling water	Neal Creek via ditch	1.6	NPDES	0.00004	80
Diamond Fruit – Van Horn Plant	Rinse water and cooling water	Neal Creek via ditch	1.6	NPDES	No discharge in August	
Duckwall-Pooley Fruit – Van Horn Plant	Non-contact cooling water	Neal Creek via ditch	1.6	NPDES	No data	
Quality Veneer & Lumber – Main Mill	Log ponds, log yard runoff	Neal Creek via irrigation canal	1.8	NPDES	No data	
Quality Veneer & Lumber – Main Mill	Stormwater	Neal Creek via irrigation canal	1.8	NPDES	No data	
Quality Veneer & Lumber – Booth Hill Wood Waste Landfill	Stormwater	Neal Creek via irrigation canal	1.8	NPDES	No data	
Diamond Fruit – Central Plant	Rinse water and cooling water	Lenz Creek	2.1	NPDES	0.1238	56
Diamond Fruit	Stormwater	Lenz Creek	2.0	NPDES	No data	
Duckwall-Pooley Fruit – Odell Plant	Rinse water & cooling water	Lenz Creek	1.8	NPDES	0.3868	68
Stadelman Fruit – Whitney Plant	Fruit wash water	Lenz Creek	1.7	NPDES	0.0031	60.1
Stadelman Fruit – Lenz Plant	Non-contact cooling water	Lenz Creek	1.4	NPDES	.0015	56.5
Quality Veneer & Lumber – Planer Mill	Stormwater	Lenz Creek	1.1	NPDES	No data	
Odell Sanitary District	Domestic wastewater	Odell Creek	1.1	NPDES	0.2907	66.9
Diamond Fruit – Odell Plant	Rinse water and cooling water	McGuire Creek	0.4	NPDES	0.0387	68
East Fork Hood River Watershed						
Parkdale Sanitary District	Domestic wastewater	Trout Creek	3.6	NPDES	0.0542	No data
Diamond Fruit – Parkdale Plant	Rinse water and cooling water	Wishart Creek via ditch	Head waters	NPDES	0.2321	52
Mt. Hood Meadows	Domestic wastewater	East Fork Hood River	27.2	NPDES	0.0046	No data

Figure 34. NPDES Permitted Facilities



4.5.4.2 Powerdale Hydroelectric Project

The portion of the Hood River below Powerdale Dam is partially dewatered in order to divert water into the Powerdale Hydroelectric Project (the Project) operated by PacifiCorp. In February 1998, PacifiCorp applied to the Federal Energy Regulatory Commission (FERC) for a new license to continue operating the Project. As part of the FERC re-licensing process, PacifiCorp also needed to obtain a water quality standards compliance certification statement for the Project from the ODEQ, pursuant to requirements of § 401 in the Federal Clean Water Act and Oregon Administrative Rules Chapter 340, Division 48. Section 401 of the Federal Clean Water Act establishes requirements for State certification of proposed projects or activities that may result in any discharge of pollutants to navigable waters. The Section 401 water quality certification was granted by ODEQ in June, 2000. These certification conditions include requirements that the facility be operated in accordance with established load allocations adopted pursuant to a TMDL. The certification and implementation agreement includes a temperature management plan which provides a process for modifying operation of the facility to meet the temperature TMDL. Within 60 days following approval of this TMDL by EPA, ODEQ will request Pacificorp to submit an operational plan.

Based on monitoring conducted by PacifiCorp in 1995 and 1996, water temperatures at the downstream end of the bypass reach exceeded the 64°F salmonid rearing temperature criterion. These exceedances occurred at the existing required minimum instream flows of 130 cfs in July and 100 cfs in August. PacifiCorp evaluated relationships between flow and water temperature through empirical and model-based studies. Results of these studies indicate that proposed minimum flows of 250 cfs would substantially reduce warming rates within the bypass reach, as well as reduce the 7-day moving average of daily maximum temperatures (7-day statistic) during July and August.

Considering recommendations from the agencies (ODFW, USFWS, NMFS, ODEQ) and CTWSRO, PacifiCorp proposed the minimum instream flows shown in **Table 11**. The proposed flows would include the approximately 100-cfs continuous flows of the fish bypass, fish ladder and fish ladder attraction. These flows have been accepted by ODEQ as the minimum instream flows which will be required under the new 401 certification once FERC issues a new license to PacifiCorp for operation of the Project. ODEQ expects that the proposed increases in minimum instream flows from May through November would significantly benefit stream temperature and possibly pH and dissolved oxygen, as well as the resident and anadromous biological community as a whole.

Table 11. Powerdale Project Minimum Instream Flow Proposal

Time Period	Existing	Proposed
January	170 cfs	140 cfs
February	270 cfs	220 cfs
March	270 cfs	220 cfs
April	270 cfs	220 cfs
May	170 cfs	250 cfs
June	170 cfs	250 cfs
July	130 cfs	250 cfs
August	100 cfs	250 cfs
September	100 cfs	250 cfs
October	100 cfs	250 cfs
November	100 cfs	220 cfs
December	170 cfs	140 cfs

4.5.4.3 Laurance Lake Reservoir

Clear Branch of the Middle Fork Hood River is dammed approximately one mile above the confluence with Coe Branch, creating Laurance Lake Reservoir. The reservoir was built in 1968 by the Middle Fork Irrigation District (MFID) for irrigation and has a volume of 3,550 acre-feet (Hood River Watershed Group, 1999). The MIFD is required to maintain a minimum pool volume of 150 acre-feet which would be reserved specifically for fish life use. In addition, the MIFD is required to provide minimum flow releases of 3 cfs from May 15 to August 31, actual stream flow up to 15 cfs from September 1-15, actual stream flow up to 30 cfs from September 16 until the reservoir has filled, and actual stream flow throughout the remainder of the non-irrigation season. These flows can be reduced at the discretion of the fishery management agencies to protect the fisheries, as long as such reduction does not interfere with the primary function of the reservoir (MFID, personal communication).

The largest population of bull trout in the Hood River watershed is found in Clear Branch above the dam and in Laurance Lake itself. Bull trout are also observed in Pinnacle Creek, Compass Creek, and Coe

Branch, Eliot Branch and Clear Branch below Laurance Lake. Bull trout were listed under the Endangered Species Act as a Threatened Species in 1998. The Hood River bull trout population, including juveniles, is believed to number less than 300 and is classified as "at high risk of extinction" by ODFW (Buchanan et al., 1997). As shown in **Figure 10** (page 27), the 50°F criteria is exceeded at some time during the year in the following stream segments where data was collected: Clear Branch at several locations upstream of Laurance Lake, Clear Branch downstream of Laurance Lake, Compass Creek, Coe Branch, and the Middle Fork Hood River.

The collection of temperature data since the mid-1990s indicates that temperatures in Clear Branch below the dam are higher relative to temperatures in Clear Branch above the dam (**Figure 35-37**) during some times of year. These increases occur during fall spawning periods (mid August-November), as well as during other life stage periods. Water is passed below the dam using a bottom withdrawal. Because the bottom waters in the reservoir are cold during early-mid summer (after the lake has stratified), the water temperatures below the lake during this time of year are sometimes colder than waters above the lake (**Figure 35-37**). During the spring and late summer/early fall, however, temperatures are warmer below the lake. It is hypothesized that the warmer waters observed below the lake in the spring are due to surface spilling which occurs when the lake is full. By the late summer and fall, it is hypothesized that the cooler waters of the hypolimnion in the lake have been depleted and the water released from the lake during this time is now being pulled from the warmer metalimnion. Although data has not been collected during the winter, concerns have been raised (Mick Jennings, personal communication) that temperatures below the dam remain elevated in the winter during egg incubation. If true, elevated winter temperatures could negatively affect bull trout egg survival, even though temperatures are below the numeric criterion of 50°F.

Figure 35. Maximum Daily Temperatures in Clear Branch and Middle Fork Hood River, 1998 (Data provided by Middle Fork Irrigation District and Mount Hood National Forest)

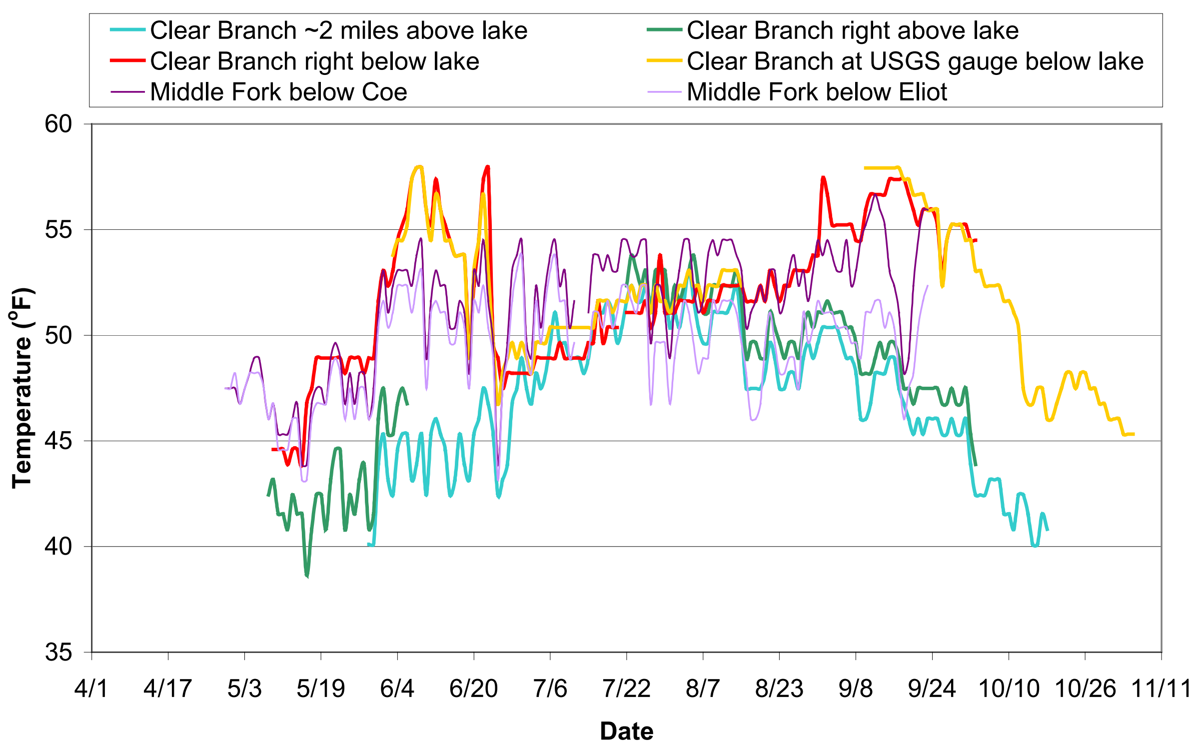


Figure 36. Maximum Daily Temperatures in Clear Branch and Middle Fork Hood River, 1999 (Data provided by Middle Fork Irrigation District and Mount Hood National Forest)

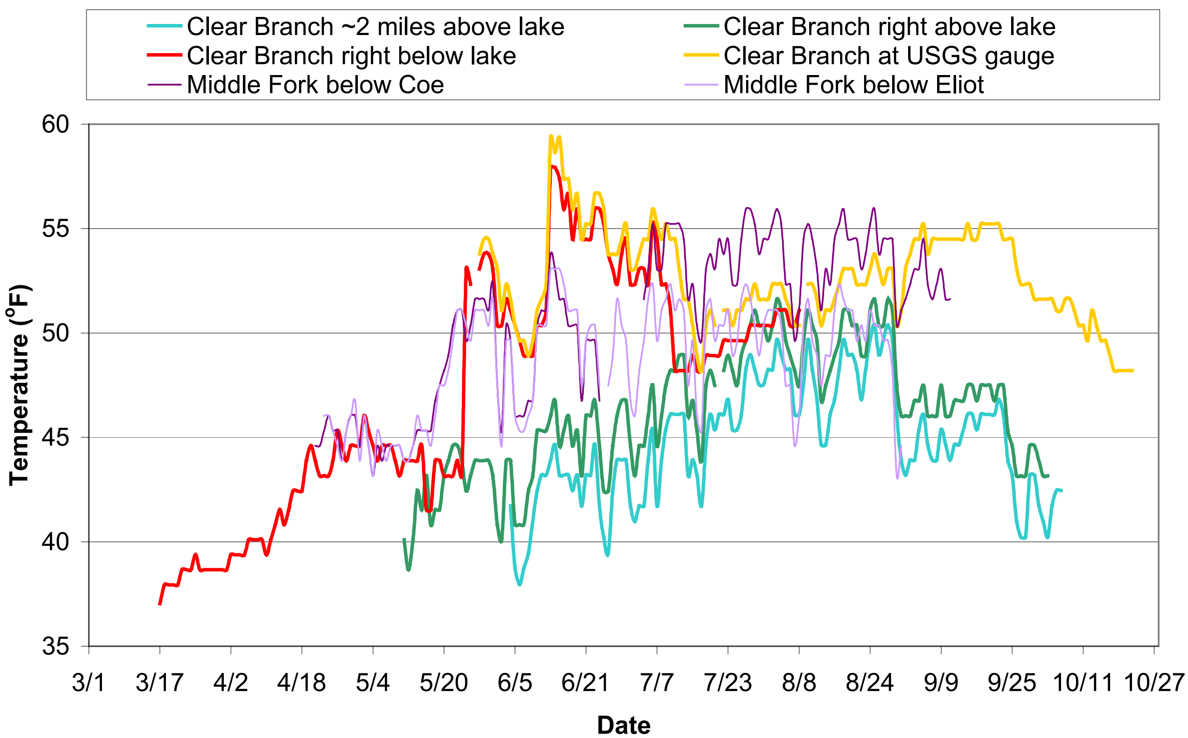
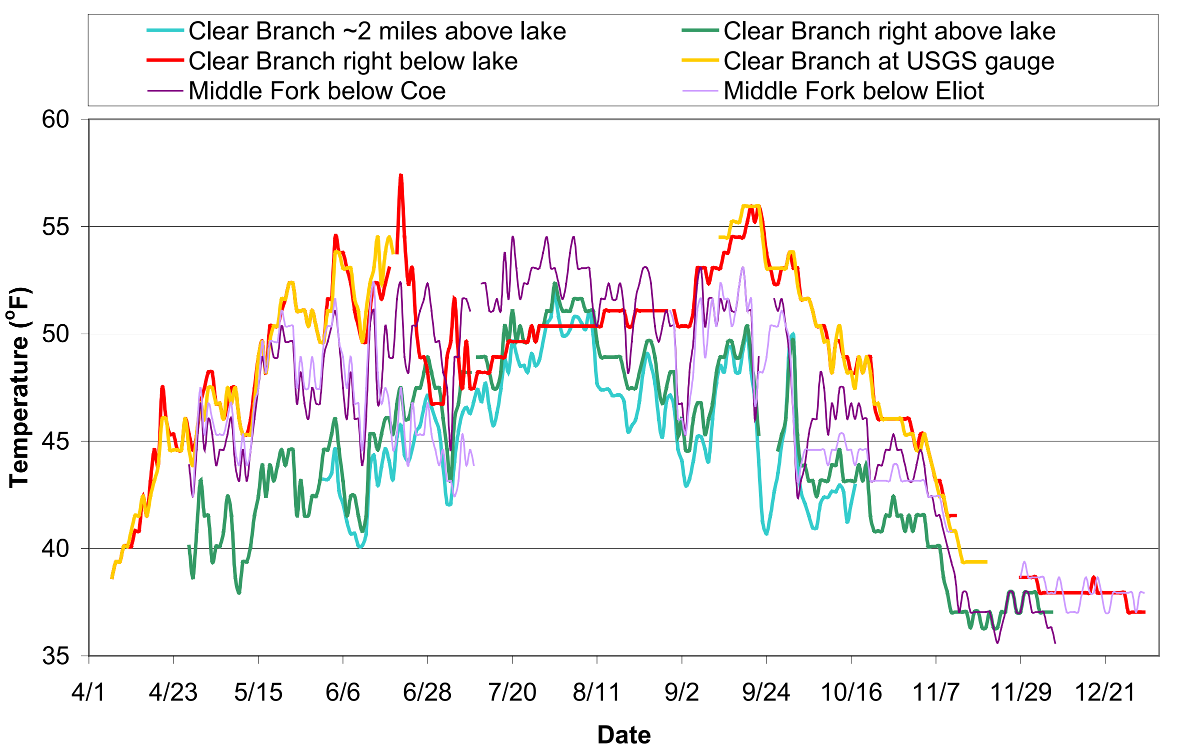


Figure 37. Maximum Daily Temperatures in Clear Branch and Middle Fork Hood River, 2000 (Data provided by Middle Fork Irrigation District and Mount Hood National Forest)



4.5.4.4 Critical Period

The critical temperature period is the period when stream temperatures exceed numeric and/or narrative criteria.

The critical temperature period spans May through September when evaluating both the 55°F and 64°F criteria.

The critical temperature period spans the entire year when considering that temperature increases in Clear Branch below Laurance Lake may impair the biological integrity of a Threatened and Endangered population of bull trout.

The determination of loading capacity and load allocations is dependent on the available assimilative capacity of the receiving water during critical temperature periods. In determining the critical period for the point sources, Powerdale Dam and Laurance Lake Reservoir, ODEQ evaluated the salmonid spawning and rearing periods defined in Conservation Measure 4 (ODEQ, 2000) for each of the affected streams (**Figure 9**, page 24). Based upon a review of available data, ODEQ then determined the likely time periods when the appropriate temperature criteria (64°F, 55°F, or 50°F) were likely to be exceeded. The periods of salmonid spawning and rearing, applicability of the bull trout criterion, and the critical periods are defined in **Table 12**.

The determination of the critical period for Laurance Reservoir is based on an evaluation of two portions of the Middle Columbia-Hood Basin Temperature Standard: "… no measurable surface water temperature increase resulting from anthropogenic activities is allowed: (iv) in waters determined by ODEQ to support or be necessary to maintain the viability of native Oregon bull trout when surface water temperatures exceed 50°F (10°C); and (vi) in stream segments containing federally listed Threatened and Endangered species if the increase will impair the biological integrity of the Threatened and Endangered population". Because concerns have been raised by local fish biologists about increased temperatures below the dam possibly impairing the biological integrity of the bull trout population below the dam year-round, the critical period for Clear Branch below Laurance Reservoir has been defined by ODEQ at this point in time as occurring year-round.

Table 12. Critical Periods for Salmonid Spawning and Rearing in Relation to Point Sources and Dams

Stream	Bull Trout Criterion (50°F) Applies	Critical Period Data for stream			
		Spawning (55°C)		Rearing (64°C)	
		Period	Critical Period	Period	Critical Period
PacifiCorp Cooling Water and Hydroelectric Project					
Hood River below Powerdale Dam	No	9/15-2/15	9/15-9/30	2/16-9/14	7/1-8/15
Odell Wastewater Treatment Plant					
Hood River above Powerdale Dam	No	9/01-7/15	5/01-7/15 9/01-9/30	7/16-8/31	7/16-8/15
Odell Creek	No	1/01-7/15	5/01-7/15	7/16-12/31	7/16-9/14
Odell Fruit Packing Plants					
Hood River above Powerdale Dam	No	9/01-7/15	5/01-7/15 9/01-9/30	7/16-8/31	7/16-8/15
Neal Creek	No	9/15-7/15	5/01-7/15 9/15-9/30	7/16-9/14	7/16-9/14
Lenz Creek	No	9/15-7/15	5/01-7/15 9/15-9/30	7/16-9/14	7/16-9/14
Diamond Odell Fruit Packing Plant					
Odell Creek	No	1/01-7/15	5/01-7/15	7/16-12/31	7/16-9/14
McGuire Creek	No	1/01-7/15	5/01-7/15	7/16-12/31	7/16-9/14
Diamond Parkdale Fruit Packing Plant					
East Fork Hood River d/s Emil Creek	No	9/15-7/15	6/01-7/15 9/15-9/30	7/16-9/14	7/16-9/14
Emil Creek	No	9/15-7/15	6/15-7/15	7/16-9/14	----
Parkdale Wastewater Treatment Plant					
East Fork Hood River d/s Emil Creek	No	9/15-7/15	6/01-7/15 9/15-9/30	7/16-9/14	7/16-9/14
Trout Creek	No	1/01-7/15	6/15-7/15	7/16-12/31	----
Mount Hood Meadows Wastewater Treatment Plant					
East Fork u/s Emil Creek	No	9/15-8/31	6/15-8/31 9/15-9/30	9/1-9/15	---
East Fork u/s Sahalie Falls	No	1/01-8/31	7/15-9/15	9/1-12/31	---
Laurance Lake Reservoir					
Clear Branch below Laurance Lake	Yes	8/15-2/28	Year-round	3/1-8/14	Year-round

4.5.4.5 Western Hood Subbasin Thermal Response Simulations

Thermal response simulations were only performed for the Powerdale Hydroelectric Project. Insufficient data was collected to perform thermal response simulations for the NPDES point sources or for Laurance Lake Reservoir during the critical periods.

4.5.4.5.1 Powerdale Hydroelectric Project

In determination of the heat load that would be allowed for the Powerdale Hydroelectric Project diversion, ODEQ simulated the conditions in the Hood River below the Powerdale Dam in early August, which represents a worst case condition for stream temperature during the rearing period (February 16 – September 14). This reach was simulated with all but 250 cubic feet per second (cfs) being diverted from the diversion reach (as conditioned in the Section 401 certification for this hydroelectric facility) and with no water being diverted (i.e. no power being generated). Simulations were performed both with current riparian vegetation conditions and when the riparian conditions were at system potential.

Under current riparian conditions, these simulations indicate that, with 250 cfs maintained instream below Powerdale Dam, the salmonid rearing criteria of 64^{o}F should not be exceeded in early August (**Figure 38**). This standard is exceeded under the current flow conditions where PacifiCorp is required to maintain only 100 cfs in the Hood River in early August.

Simulations were also performed to compare Hood River temperature conditions with 250 cfs maintained below the dam with those if the dam were removed. System potential vegetation was assumed in both scenarios. Based on flow measurements taken by ODEQ field staff and at the Tucker Bridge gauge, it was estimated that the “dam removal” scenario would represent approximately 500 cfs in the Hood River in early August. The results of these simulations indicate that the maintenance of 250 cfs instream below Powerdale Dam does not cause a measurable increase (>0.25^{o}F) in the maximum daily temperature at the bottom of the bypass reach in comparison with instream temperatures if the dam were removed (**Figures 39** and **40)**. The maximum daily temperature under both flow scenarios was 61.7^{o}F. When looking at simulated diurnal patterns at a location 33 meters upstream from the bottom of the bypass reach, it becomes apparent that the dam still does cause the Hood River to heat up more in the diversion reach than would occur under natural conditions during most of the day (**Figure 39**). The maximum increase occurred at 14:00 and represented a 1.9^{o} F increase above that which would occur if no water were being diverted. The average increase for the entire 24-hour period was 0.56^{o} F. It should be noted, in addition, that the figures indicate that at system potential vegetation and with 250 cfs in the diversion reach, the salmonid rearing criteria of 64^{o} F is not exceeded.

Simulations were only done for the rearing period. The determination of spawning time periods and locations for application of the 55^{o}F state temperature criterion was not identified for the Hood River watershed until September, 2000 to address State Conservation Measure 4 (ODEQ, 2000). Because of this late determination, insufficient flow data was collected during the salmonid spawning period to enable simulations to be performed. ODEQ believes that attainment of the 55^{o}F criterion is adequately addressed in this TMDL in the development of load allocations through making conservative assumptions about thermal conditions and assigning a “no measurable increase” load to point sources and the Powerdale Project during the spawning period (see discussion below in **Section 4.6.2.2 Loading Capacity: Powerdale Hydroelectric Project**).

Figure 38. Hood River/East Fork Hood River Diurnal Temperatures: Affects of Two Flow Scenarios With Current Riparian Vegetation (August 6, 1998)

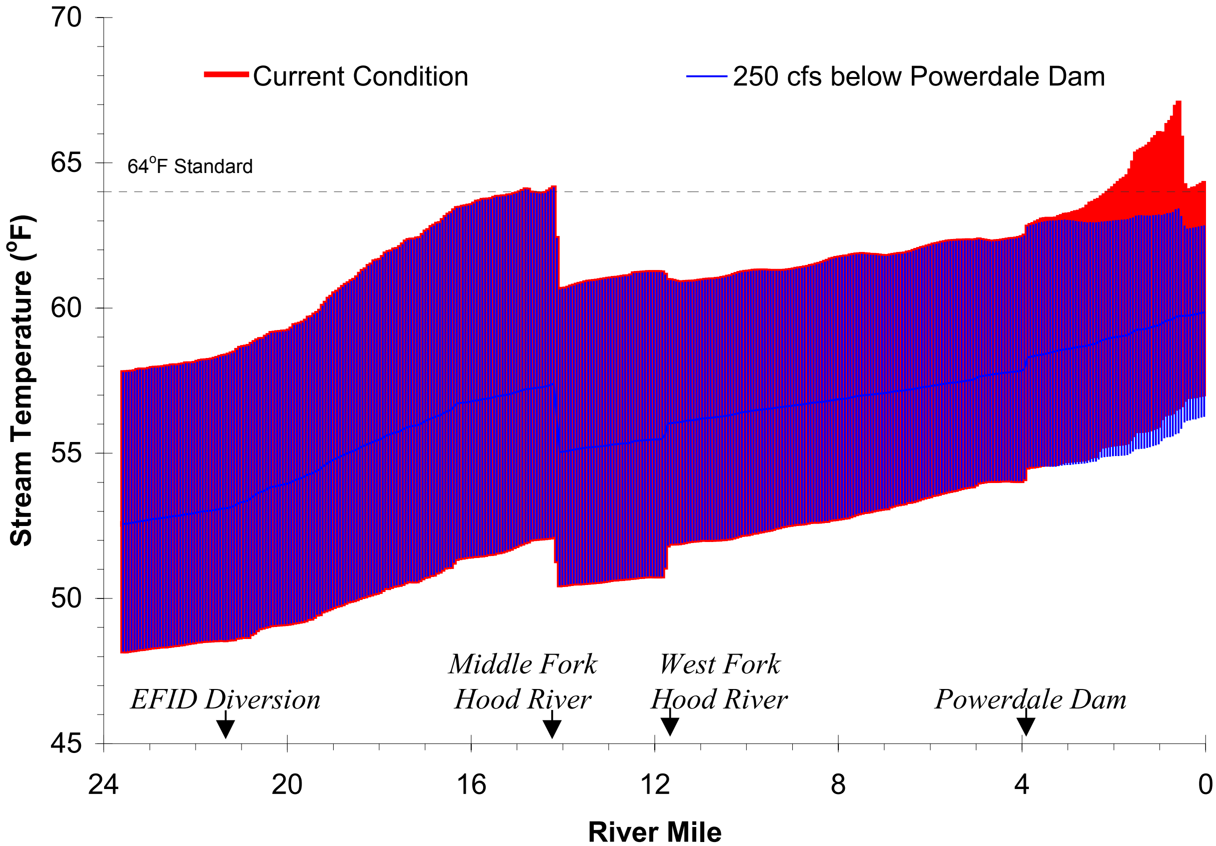


Figure 39. Modeled Diel Temperature Fluctuations at the Bottom of the PacifiCorp Bypass Reach on August 6, 1998

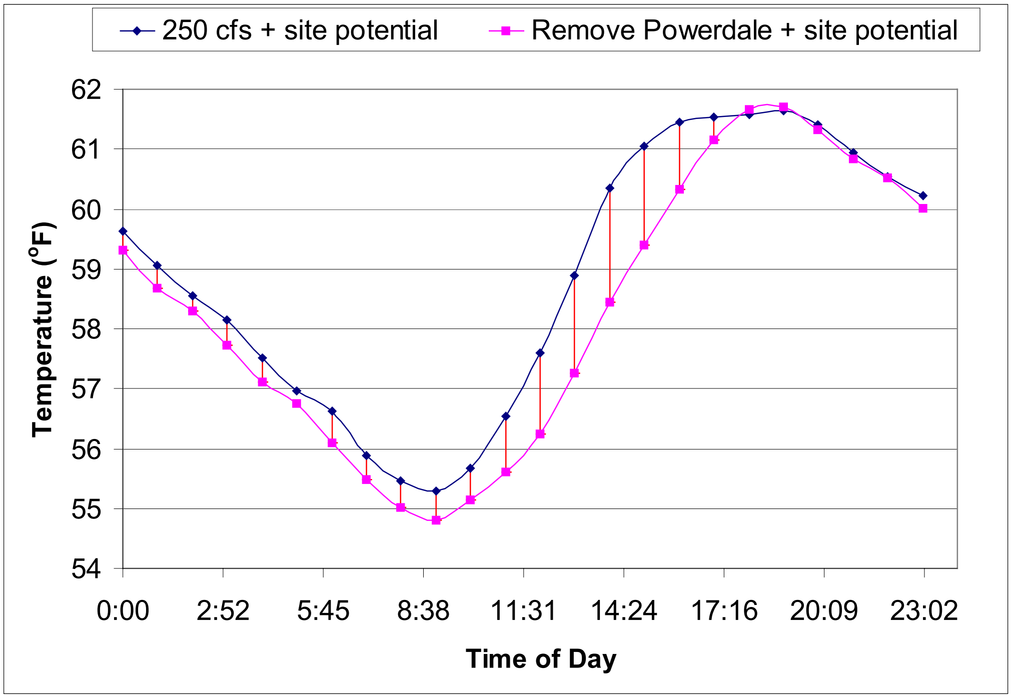
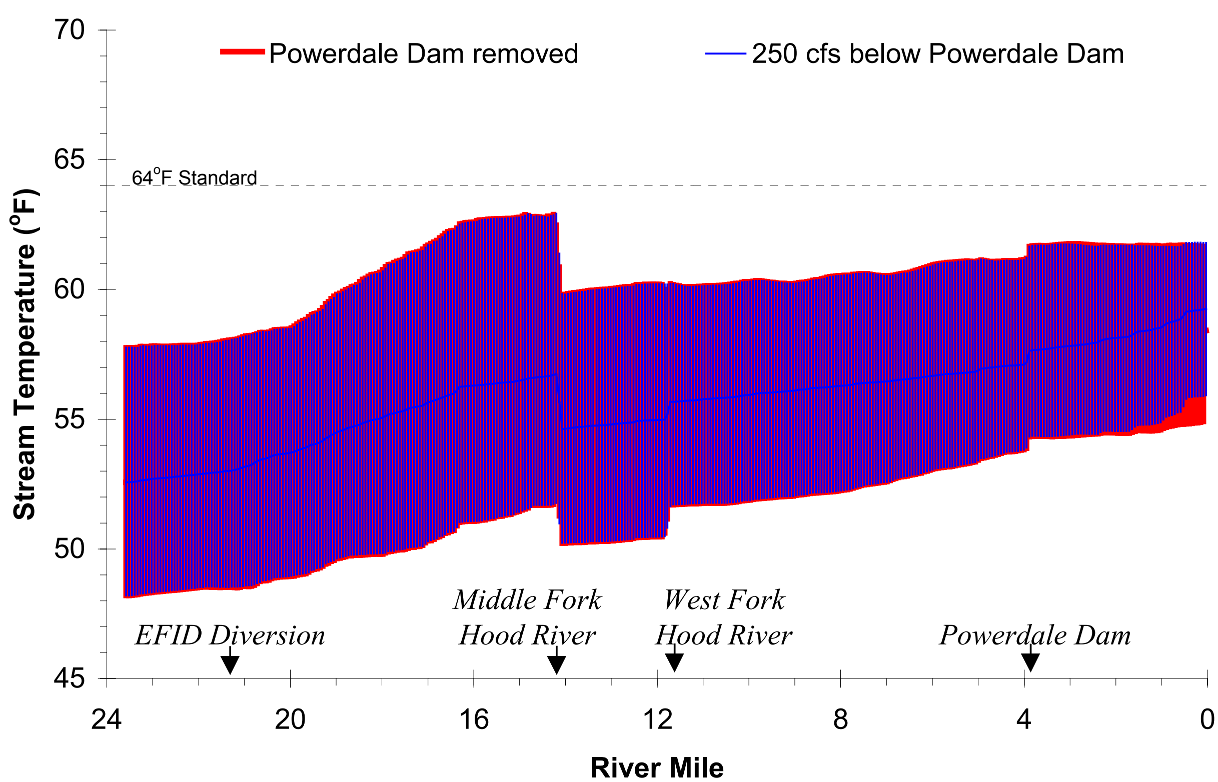


Figure 40. Hood River/East Fork Hood River Diurnal Temperatures: Affects of Two Flow Scenarios With System Potential Vegetation (August 6, 1998)



4.6 LOADING CAPACITY – 40 CFR 130.2(F)

*The Water Quality Standard mandates a **Loading Capacity** based on the condition that meets the **no measurable surface water temperature increase resulting from anthropogenic activities when surface water temperature criteria are exceeded.***

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)). The water quality standard states that ***no measurable surface water temperature increase resulting from anthropogenic activities*** is allowed in the Western Hood Subbasin when surface water temperature criteria are exceeded. The pollutants are human increases in solar radiation loading (nonpoint sources) and heat loading from warm water discharge (point sources) and from flow diversion or impoundment at a dam.

The loading capacity is dependent on the available assimilative capacity of the receiving water. For nonpoint sources, the loading capacity is the amount of background solar radiation that reaches the stream when the stream is at system potential conditions in terms of riparian vegetation and channel morphology. For rivers whose system potential temperatures are at or above the temperature standard for a given period, there is no available assimilative capacity. The loading capacity is consumed by non-anthropogenic sources. This means that, for point sources or dams, the discharge of anthropogenic heat pollution would not be allowed to increase the concentration of that pollutant outside of an appropriate mixing zone or above that which would naturally occur.

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 water body and still obtain water quality standards.

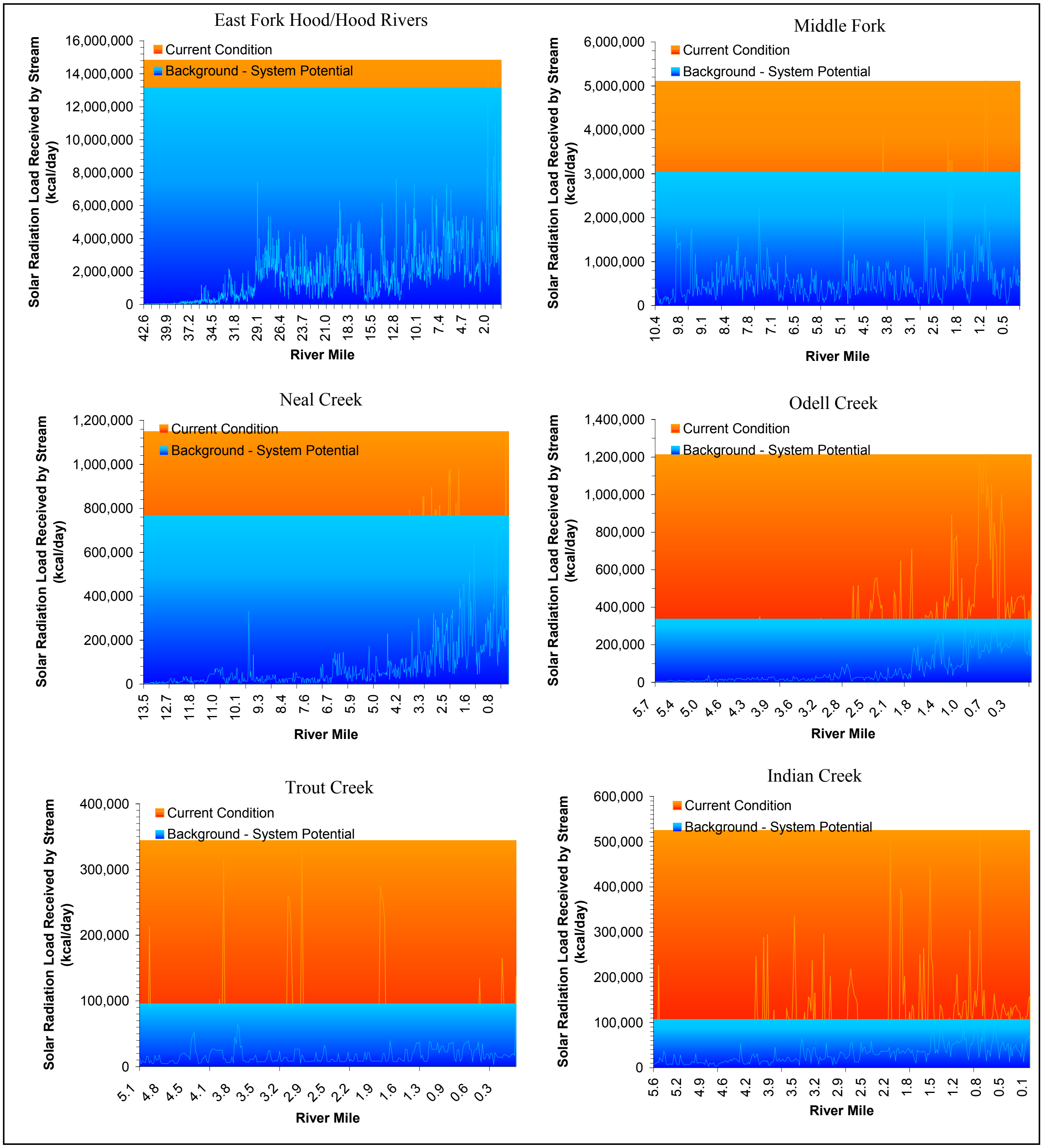
4.6.1 Nonpoint Sources

Based on simulations performed on the Hood River, East Fork Hood River, and Neal Creek and on data collected during the spawning period in 1998, it is unlikely that the 55°F criterion will be achieved in these reaches during the spawning period even under system potential vegetation conditions. This is a conservative assumption. Although temperatures may be below the criteria in upper parts of the watersheds, loading in these areas will typically result in failure to meet the criteria in the lower reaches of the Hood River. Since there is no additional loading that can be obtained by control or management measures, there is no available capacity for anthropogenic sources of heat. This applies to all streams in the subbasin above Powerdale Dam because they are all tributaries to the Hood River.

There is also no assimilative capacity to distribute to tributaries to the Hood River below Powerdale Dam (Whiskey Creek, Cedar Creek and Indian Creek). In these tributaries, the spawning time of year and the 55°F standard extend until July 15th. Based on simulations performed on Neal Creek and field temperature data collected during 1998, it is unlikely that the 55°F criteria will be achieved in these tributaries even under system potential conditions. This is a conservative assumption.

Solar radiation loading was calculated using system potential riparian vegetation at current channel and stream aspect conditions. Current and system potential solar loading for the East Fork Hood/Hood Rivers, Middle Fork Hood River, Neal Creek, Odell Creek, Trout Creek and Indian Creek are presented in **Figure 41**. Solar radiation loading is presented for every 100 meters of modeled stream length. As can be seen in **Figure 41**, solar radiation loading at system potential (loading capacity) is generally less than levels currently observed, although the difference varies by stream and stream reach. Because the TMDL targets achieving system potential vegetation, the TMDL applies year-round for nonpoint sources. It is not possible to achieve system potential conditions only during the critical periods since changes made to riparian vegetation and channel morphology will occur year-round.

Figure 41. Solar Radiation Loading – Current Condition and Background System Potential Condition



4.6.2 Point Sources and Dams

4.6.2.1 NPDES Permits

Point source discharges are permitted for sources on the Hood River, East Fork Hood River, Odell Creek, Trout Creek, McGuire Creek, Wishart Creek and Lenz Creek as long as they do not cause a measurable increase (>0.25^{o}F) in stream temperature above the criteria outside of the mixing zone when the temperature criteria is exceeded in the stream. During 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 (see **Chapter 5.13.1 NPDES Permits** for a further discussion of the establishment of permit limits). The critical spawning and rearing periods for each stream reach were outlined in **Table 12** (page 68). Future point sources will also only be allowed to discharge to surface waters in the Western Hood Subbasin if it can be demonstrated that they will not cause a measurable increase (>0.25^{o}F) in stream temperature criteria outside of the mixing zone.

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

$$WLA_{PS} = (\Delta T \times (Q_R + Q_s)/4)/1.1$$

Where WLA_{PS} = the point source waste load allocation
ΔT = no measurable increase equal to 0.25^{o} F
Q_R = receiving stream flow
Q_S = point source flow

1.1 is a factor of safety (i.e. 10%) that is applied as required by the Clean Water Act

The above equation is derived as follows from a conventional mass balance equation:

$$(Q_R \times T_R) + (Q_s \times T_S) = (Q_R + Q_s) \times (T_R + \Delta T)$$

$$\cancel{Q_R T_R} + Q_s T_S = \cancel{Q_R T_R} + Q_s T_R + \Delta T(Q_R + Q_s)$$

$$\Delta T(Q_R + Q_s) = Q_s (T_S - T_R)$$

Both sides of the equation represent the heat load discharged to the stream. If ΔT is set at 0.25^{o} F, then this is the maximum allowable heat load which could be allowed and be considered not measurable. The equation is divided by 4 because ODEQ intends to allow a source to use no more than ¼ of the stream for mixing. Permit writers, when calculating actual permit limits, should allow either ¼ of the stream flow or the dilution provided at the edge of the mixing zone whichever is less.

ODEQ chose a safety factor of 1.1, in part, because a factor of safety is required by federal rule. ODEQ believes that an explicit safety factor of a 10% buffer is approvable and is a reasonable figure. In addition to this explicit safety factor and as later stated in **Section 4.9 Margins of Safet**y, there are also implicit, conservative measures built into the TMDL that provide additional factors of safety.

Table 13 is a list of the thermal point sources that discharge within the Hood River subbasin and calculated waste load allocations. ODEQ calculated waste load allocations only for those facilities with thermal wastewater discharges. ODEQ did not develop waste load allocations for the six stormwater permitted facilities because they are not considered to have a thermal discharge. ODEQ did not develop a waste load allocation for the Quality Veneer & Lumber log pond discharge because no discharge is permitted between May 1 and October 31 under the limitations of their current 400-J general permit.

In development of the waste load allocations for most of the facilities, the receiving stream flow was estimated from data collected by ODEQ during August 3-7, 1998 at the closest location shown on **Figure 32** (page 53) and are indicated with an asterisk. ODEQ did not have flow data for the receiving streams for most of the point sources at the point of discharge because generally the receiving streams are minor tributaries of the Hood River and have no flow gauges. Discharge flows are those specified as flow limitations in the source's current discharge permit.

Table 13. Calculated Waste Load Allocations for NPDES Permitted Point Sources in the Hood River Watershed

Source Name	Permitted Flow gal per day (gpd)	Receiving Stream	Stream Flow cfs	Waste Load Allocation kcals per day
Pacificorp - Cooling Water	50000	Hood River	250	19.31×10^6
Lage Orchards	50000	Neal Creek	10*	0.78×10^6
Diamond Fruit - Van Horn	120000	Neal Creek	10*	0.79×10^6
Duckwall Pooley - Van Horn	500000	Neal Creek	10*	0.78×10^6
Diamond Fruit – Central	90000	Lenz Creek	1*	0.11×10^6
Duckwall Pooley – Odell	250000	Lenz Creek	1*	0.08×10^6
Stadelman – Whitney	3000	Lenz Creek	1*	0.08×10^6
Stadelman – Lenz	1500	Lenz Creek	1*	0.14×10^6
Odell Sanitary District	500000	Odell Creek	10*	0.78×10^6
Diamond Fruit – Odell	30000	McGuire Ck	4*	0.32×10^6
Parkdale Sanitary District	100000	Trout Creek	1*	0.10×10^6
Diamond Fruit – Parkdale	220000	Wishart Ck	1*	0.08×10^6
Mt. Hood Meadows	18700	East Fork Hood River	5*	0.45×10^6
Total				23.78×10^6

* Stream flow estimated from data collected by ODEQ during August 3-7, 1998.

4.6.2.2 Powerdale Hydroelectric Project

The equation for determination of the load allocation for the Powerdale Project and Laurance Lake Reservoir is derived from the following general equation:

$$\text{Load (kcal/day)} = [(\Delta T) \times (Q_R) \times (86400 \text{ sec/day}) \times (62.4\#\text{water/ft}_3)]/(SF \times 3.968 \text{BTU/kcal})$$

ΔT = change in temperature
Q_R = flow in the river (cfs)
SF = Safety factor

4.6.2.2.1 Rearing Period

The equation for calculating the heat load allocation during the rearing period (February 16 through September 14) is provided below. The change in temperature (0.56°F) is the average daily temperature increase in the bypass reach with 250 cfs instream as compared to full river flow with no diversion (**Section 4.5.4.5.1 Powerdale Hydroelectric Project**). Because the diversion reach is not expected to be water quality limited during the rearing period when system potential vegetation is achieved, no factor of safety was included in setting this load allocation.

$$\text{Load} = [(0.56^{o}\text{ F})\text{x}(250 \text{ ft}^3\text{/sec})\text{x}(86400\text{sec/day})\text{x } (62.4\#\text{water/ ft}^3\text{ }]/(3.968\text{BTU/kcal})$$

Powerdale Project load allocation =190 x 10^6 kcal/day

4.6.2.2.2 Spawning Period

Temperature data collected in the diversion reach indicates that the spawning temperature criterion of 55^o F is likely exceeded in some years after September 15 when the spawning criterion applies. The duration of this exceedance will vary from year to year and will depend upon a number of factors including stream flow and weather conditions. Load allocations for the Project during the spawning period will be based on the river temperature just above the Powerdale Powerhouse at the bottom of the bypass reach. When the river temperature just above the Powerhouse is 55^o F or less, the load allocation will be 190 x 10^6 kcal/day which is the same as the load allocation during the rearing period. ODEQ believes this is achievable and conservative because the solar energy that heats the diversion reach during the spawning period will be substantially less with shorter days and a lower sun angle than during the August period when the river was modeled.

When the river temperature just above the Powerhouse is greater than 55^o F, the allowable load will be based upon no measurable increase (< 0.25^o F). Note that this increase would be above and beyond that which would otherwise occur if no water were being diverted. It must be recognized that the temperature of the river will increase in the diversion reach even if no water is being diverted. Powerdale's load would be the difference between the actual bypass reach warming under condition of diversion less the natural warming under conditions of no diversion. When Powerdale is limited to no measurable increase, the facility may need to reduce the amount of water it diverts from the river. By leaving more water in the river, the facility essentially is being allowed a larger load allocation. [This may seem counter-intuitive. If Powerdale's impact is viewed, however, as if it were an actual point source discharging heated water, one can easily see that added river flow would allow a higher discharge while still staying within a 0.25 ^{o}F increase.] The allocated waste load for Powerdale can be represented by this equation:

$$\text{Heat Load Allocation} = \text{Flow X } \Delta T$$

$$\Delta T = \text{allowable increase in temperature.}$$

If the flow is allowed to increase, then, obviously, the load allocation also will increase assuming that ΔT remains constant. For this reason, the Department believes it is reasonable for the temperature management plan to allow a flow-based load allocation which may allow the facility to continue to produce power albeit at a lower capacity and by allowing more flow in the diversion reach. Calculated loads are in **Table 14** and are based upon the following equation:

$$\text{Load (kcal/day)} = [(0.25^o\text{F}) \times (Q_R) \times (86400\text{sec/day}) \times 62.4\text{\#water/ft}^3]/(1.1 \times 3.968\text{BTU/kcal})$$

$$Q_R = \text{flow in the river (cfs)}$$

A safety factor (SF) of 1.1 (i.e. 10%) was included in this calculation because it is during a condition when the waterbody is potentially water quality limited for temperature. **Table 14** summarizes the load allocations for the Powerdale Hydroelectric Project.

Table 14. Summary of Calculated Load Allocations for the Powerdale Hydroelectric Project

During Rearing Period and Spawning Period when River Temperature at Powerhouse is <55^oF	During Spawning Period when River Temperature at Powerhouse is > 55^o F	
Load Allocation kcal/day	River Flow below Diversion Dam (cfs)	Load Allocation kcal/day
190 X 10^6	250-300	77.2 x 10^6
	300-400	92.6 x 10^6
	400-500	123 x 10^6
	500-1000	154 x 10^6

In calculating the load allocations during the spawning period, ODEQ used the lower river flow value of the range. In addition, ODEQ assumed that there is no significant temperature increase in the diversion channel itself. In establishing operational parameters in the Powerdale temperature management plan, one may both extrapolate or interpolate from the flow ranges of the table provided the intent of the equation used to calculate the waste load allocations is maintained.

In addition, compliance will not be determined by the overall increase in temperature between the diversion dam and the powerhouse. Compliance will be based upon operational parameters established in the temperature management plan. These operational parameters will be determined from the Heat Source stream temperature model (or other appropriate model) which can determine the temperature increase due exclusively to the operation of Powerdale.

4.6.2.2.3 Operational Plan

ODEQ granted a Section 401 WQ Standards Certification for the Powerdale Facility in June, 2000. Associated with the certification, Pacificorp and ODEQ entered into a 401 implementation agreement to provide additional assurance that water quality standards would be met with the operation of the facility. The certification and agreement includes a temperature management plan which provides a process for modifying operation of the facility to meet the temperature TMDL. Within 60 days following approval of this TMDL by EPA, ODEQ will request Pacificorp to submit an operational plan. The operational plan will address how Pacificorp will adjust its operation of the facility to limit its temperature impacts to less than 0.25 ^{o} F when spawning criteria is both applicable and exceeded. It will also identify a schedule for the collection of any additional data needed to determine compliance with the 55^{o}F spawning criterion. Based upon the operational plan, the Department will modify the temperature management plan in accordance with the 401 certification and implementation agreement to incorporate load allocations as prescribed in this TMDL.

4.6.2.3 Laurance Lake Reservoir

Temperature data collected in Clear Branch indicate that instream temperatures below Laurance Lake are warmer than instream temperatures above Laurance Lake for some portions of the year. Because concerns have been raised about increased temperatures below the dam possibly impairing the biological integrity of the bull trout population below the dam year-round, including during winter egg incubation, the critical period for Clear Branch below Laurance Reservoir has been defined by ODEQ as occurring year-round.

As with the Powerdale project, the allowable load for the Laurance Lake Reservoir will be based upon no measurable increase (0.25^{o}F). Note that this increase would be above and beyond that which would otherwise occur in this reach of Clear Branch if the reservoir did not exist. It must be recognized that the temperature of the Clear Branch would likely increase downstream even if the reservoir did not exist.

ODEQ believes that the load allocation for Laurance Lake Reservoir should vary depending on the flow in Clear Branch. If the flow is allowed to increase, then the load allocation also will increase assuming that the change in temperature remains constant. (Note: although the load allocation is flow-based, ODEQ does not believe that increasing flow through the reservoir will achieve the allocation. It is more likely that the reservoir will need to be refitted with a selective withdrawal system. A selective withdrawal system would draw water out of the reservoir from different levels such that the temperature of the water leaving the reservoir would be more comparable to the temperature regime of the river without the reservoir.) Calculated loads are shown in **Table 15**. The load allocations established in **Table 15** are based upon the following equation:

$$\text{Load, kcal/day} = [(0.25^{o}F) \times (Q_R) \times (86400 sec/day) \times 62.4\#water/ft^3]/(SF \times 3.968 BTU/kcal)$$

Q_R = flow in Clear Branch above the reservoir in cfs
SF = a factor of safety equal to 1.1

A safety factor (SF) of 1.1 was included in this calculation because it is during a condition when the waterbody is potentially water quality limited for temperature. In calculating the load allocations, the Department used the lower river flow value for each range presented in **Table 15**.

Table 15. Calculated Load Allocation for Laurance Lake Reservoir

Flow in Clear Branch above Reservoir cfs	Load Allocation kcal/day
0-10	0.31×10^6
10-20	3.09×10^6
20-30	6.18×10^6
30-40	9.26×10^6
40-50	12.4×10^6
50-60	15.4×10^6
60-70	18.5×10^6
70-80	21.6×10^6
80-90	24.7×10^6
90-100	27.8×10^6

4.6.2.3.1 Operational Plan

Within 60 days following approval of this TMDL by EPA, ODEQ will request MFID to enter into a Mutual Agreement and Order (MAO) with ODEQ that will include a schedule for developing and implementing a reservoir water quality management plan to control stream temperature impacts of Laurance Lake consistent with its established load allocation. The schedule would likely include provisions for collection of additional temperature data, creation of a model to simulate temperature management strategies, development of a proposed plan to control temperature, and implementation of a ODEQ-approved operational plan. This operational plan will be considered a temperature management plan as specified by Oregon Administrative Rule (OAR) 340-41-026(3).

It should be noted that if, during the collection and evaluation of instream temperature data, it is determined that the critical period does not occur year-round in Clear Branch, then the load allocation (and temperature management plan) for Laurance Lake Reservoir may be amended. Such a determination will be made by ODEQ in conjunction with local fish biologists from ODFW, CTWSRO, the Mount Hood National Forest, and the U.S. Fish and Wildlife Service.

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

Loading capacity will be available for allocation where surface water temperatures throughout a given stream or river and all reaches downstream decrease below the standard by an amount sufficient to accommodate either point source or nonpoint source influences.

Load Allocations are portions of the loading capacity divided between natural, human and future nonpoint pollutant sources. **Table 16** lists load allocations (i.e. distributions of the loading capacity) according to land-use and location in the watershed. Each DMA's portion of the WQMP (**Chapter 5**) will address only the lands and activities within each identified stream segment to the extent of the DMA's authority. A *Waste Load Allocation* (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria.

Above Powerdale Dam, the loading capacity of the system is all allocated to natural sources since, even at system potential conditions, temperatures in the watershed will still exceed the 55°F standard in Hood River during the spawning time of year. No assimilative capacity exists for nonpoint sources. This requires that heat from nonpoint sources reduce temperature inputs to reach system potential conditions.

The means of achieving these conditions is through restoration and protection of riparian vegetation, increasing instream flows, and narrowing of stream channel widths. Point source surface water discharges into the Hood River watershed receiving waters and Laurance Lake Reservoir water releases are allowed no measurable increase (defined as 0.25^{o}F) above the applicable criteria during the critical periods (see **Section 5.13.1 NPDES Permits** for a further discussion of the determination of permit limits). **Table 17** lists specific waste load allocations (i.e. distributions of the loading capacity) for each point source, the Powerdale Hydroelectric project and for Laurance Reservoir.

Below Powerdale Dam, there is some assimilative capacity to distribute in the Hood River during the rearing time of year. This in part is because of the shortened period of spawning below the dam (September 15 to February 15 as compared to September 1 to July 15 above the dam). During the spawning time of year, there is only assimilative capacity to distribute when stream temperatures are below the spawning criteria of 55^{o}F (**Tables 16** and **17**). There is no assimilative capacity to distribute on tributaries to the Hood River below Powerdale Dam. In these tributaries, the spawning time of year extends later into the summer with the 55^{o}F criteria applying until July 15th. Based on simulations performed on Neal Creek and on field temperature data collected during 1998, it is unlikely that the 55^{o}F criteria will be achieved in these tributaries even under system potential conditions. This is a conservative assumption.

Table 16. Temperature Load Allocation Summary

Source	Loading Allocation
Natural	100% - (Waste Load Allocations for NPDES Discharges, Load Allocations for Powerdale Project or Laurance Reservoir)
Agriculture	0%
Forestry	0%
Urban	0%
Future Sources	0%

Table 17. Point Source Waste Load Allocations for NPDES Discharges and Load Allocations for Powerdale Project and Laurance Lake Reservoir

Subtable A: NPDES Point Source Waste Load Allocations

Source Name	Permitted Flow gal per day (gpd)	Receiving Stream	Stream Flow cfs	Waste Load Allocation Allowable Point Source Heat Load kcals/day
Pacificorp - Cooling Water	50000	Hood River	250	19.31x10^{6}
Lage Orchards	50000	Neal Creek	10*	0.78 x10^{6}
Diamond Fruit - Van Horn	120000	Neal Creek	10*	0.79 x10^{6}
Duckwall Pooley - Van Horn	500000	Neal Creek	10*	0.78 x10^{6}
Diamond Fruit – Central	90000	Lenz Creek	1*	0.11 x10^{6}
Duckwall Pooley – Odell	250000	Lenz Creek	1*	0.08 x10^{6}
Stadelman – Whitney	3000	Lenz Creek	1*	0.08 x10^{6}
Stadelman – Lenz	1500	Lenz Creek	1*	0.14 x10^{6}
Odell Sanitary District	500000	Odell Creek	10*	0.78 x10^{6}
Diamond Fruit – Odell	30000	McGuire Ck	4*	0.32 x10^{6}
Parkdale Sanitary District	100000	Trout Creek	1*	0.10 x10^{6}
Diamond Fruit – Parkdale	220000	Wishart Ck	1*	0.08 x10^{6}
Mt. Hood Meadows	18700	East Fork Hood River	5*	0.45 x10^{6}
Total				23.78 x10^{6}

Subtable B: Powerdale Hydroelectric Project Load Allocations

September 15-February 15 (Critical Period for Spawning)			February 16-September 14 (Critical Period for Rearing)
River Temperatures at Powerhouse <55^{o}F	River Temperatures at Powerhouse >55^{o}F		
Load Allocation (kcal/day)	River Flow Below Diversion Dam (cfs)	**Load Allocation** (kcal/day)	**Load Allocation** (kcal/day)
190 X 10^{6}	250-300	77.2 x 10^{6}	190 X 10^{6}
	300-400	92.6 x 10^{6}	
	400-500	123 x 10^{6}	
	500-1000	154 x 10^{6}	

Subtable C: Laurance Reservoir Load Allocations

Flow in Clear Branch above Reservoir cfs	Load Allocation kcal/day
0-10	0.31 x 10^{6}
10-20	3.09 x 10^{6}
20-30	6.18 x 10^{6}
30-40	9.26 x 10^{6}
40-50	12.4 x 10^{6}
50-60	15.4 x 10^{6}
60-70	18.5 x 10^{6}
70-80	21.6 x 10^{6}
80-90	24.7 x 10^{6}
90-100	27.8 x 10^{6}

* Stream flow estimated from data collected by ODEQ during August 3-7, 1998.

4.8 SURROGATE MEASURES – 40 CFR 130.2(I)

The Western Hood Subbasin 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)].

The *Report of Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program"* (FACA Report, July 1998) offers a discussion on the use of surrogate measures for TMDL development. The FACA Report indicates:

> *"When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not. The criterion must be designed to meet water quality standards, including the waterbody's designated uses. The use of BPJ does not imply lack of rigor; it should make use of the "best" scientific information available, and should be conducted by "professionals." When BPJ is used, care should be taken to document all assumptions, and BPJ-based decisions should be clearly explained to the public at the earliest possible stage.*
>
> *If they are used, surrogate environmental indicators should be clearly related to the water quality standard that the TMDL is designed to achieve. Use of a surrogate environmental parameter should require additional post-implementation verification that attainment of the surrogate parameter results in elimination of the impairment. If not, a procedure should be in place to modify the surrogate parameter or to select a different or additional surrogate parameter and to impose additional remedial measures to eliminate the impairment."*

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.

4.8.1 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 42** to **47** display the percent effective shade values that correspond to the loading capacities throughout the Hood River watershed (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 42. East Fork Hood River/Hood River Effective Shade Surrogate Measure for Nonpoint Sources

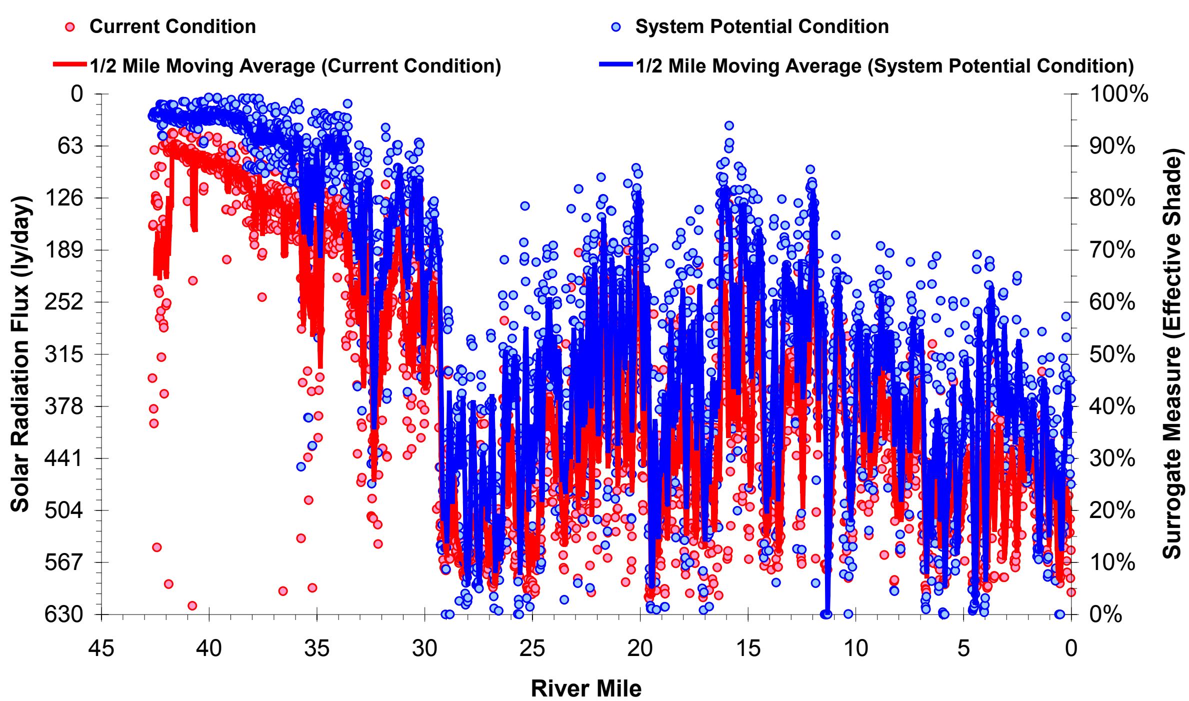


Figure 43. Middle Fork Hood River Effective Shade Surrogate Measure for Nonpoint Sources

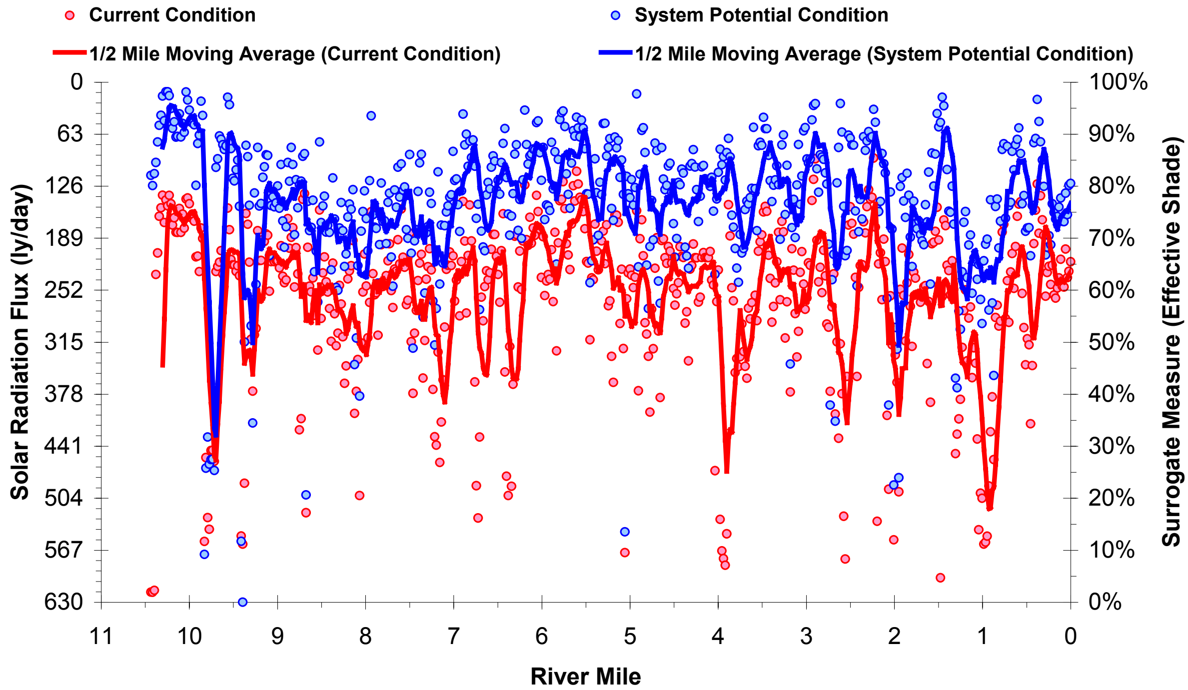


Figure 44. Neal Creek Effective Shade Surrogate Measure for Nonpoint Sources

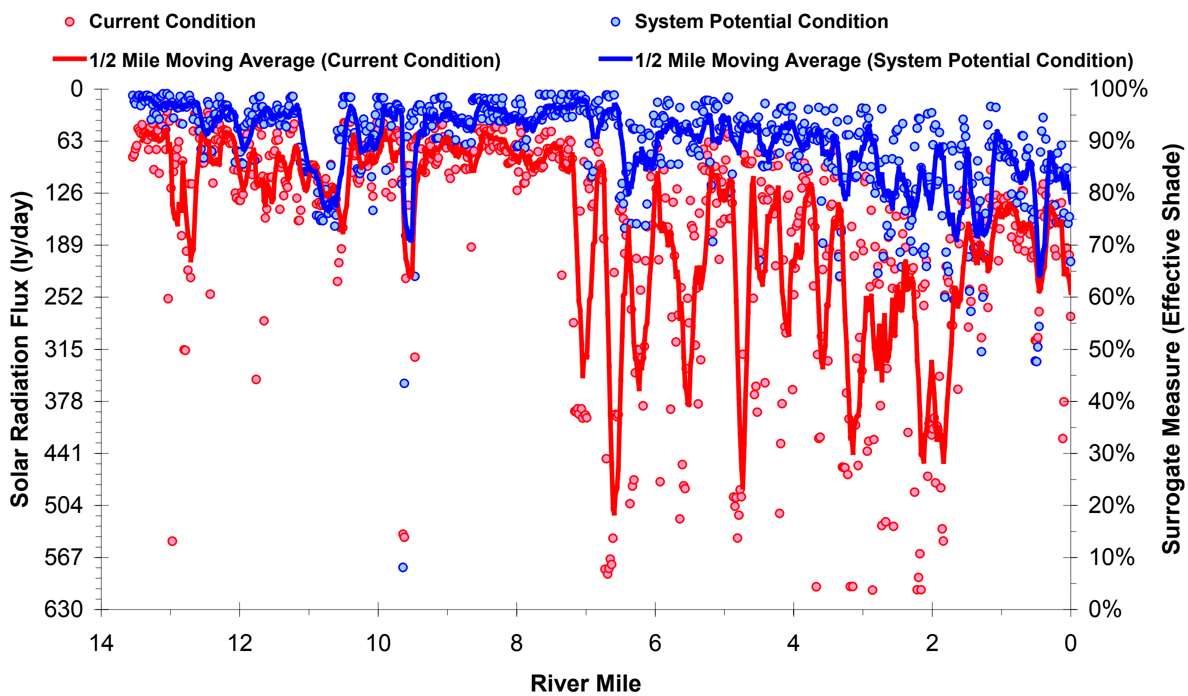


Figure 45. Odell Creek Effective Shade Surrogate Measure for Nonpoint Sources

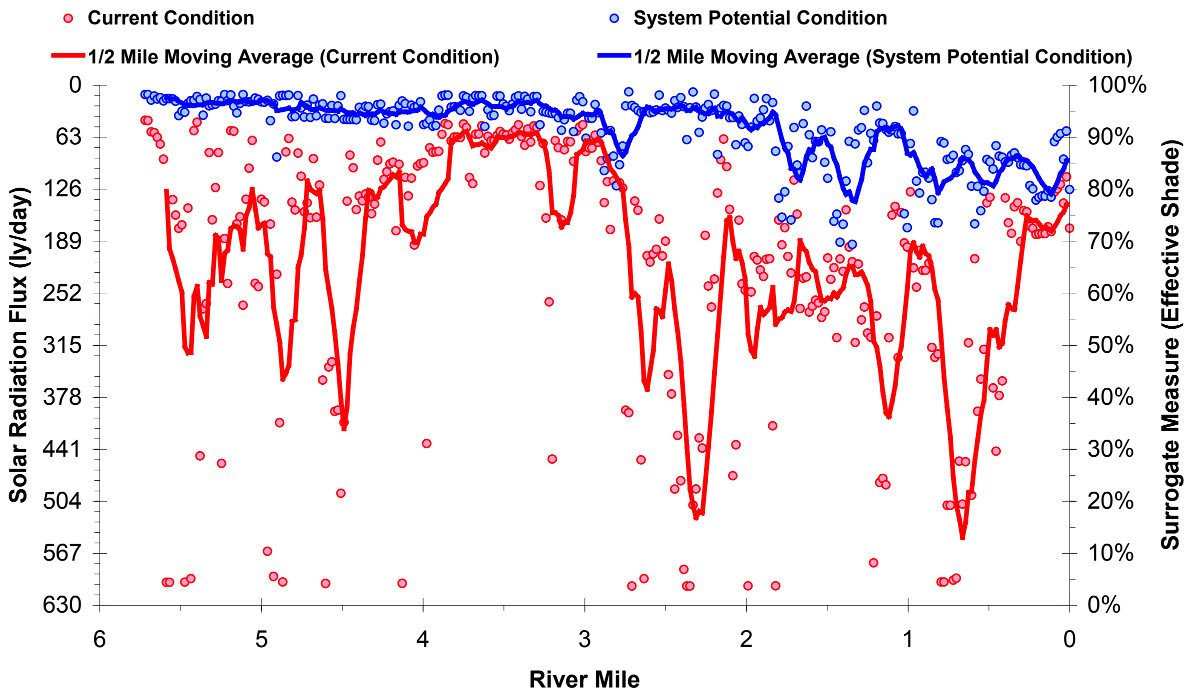


Figure 46. Trout Creek Effective Shade Surrogate Measure for Nonpoint Sources

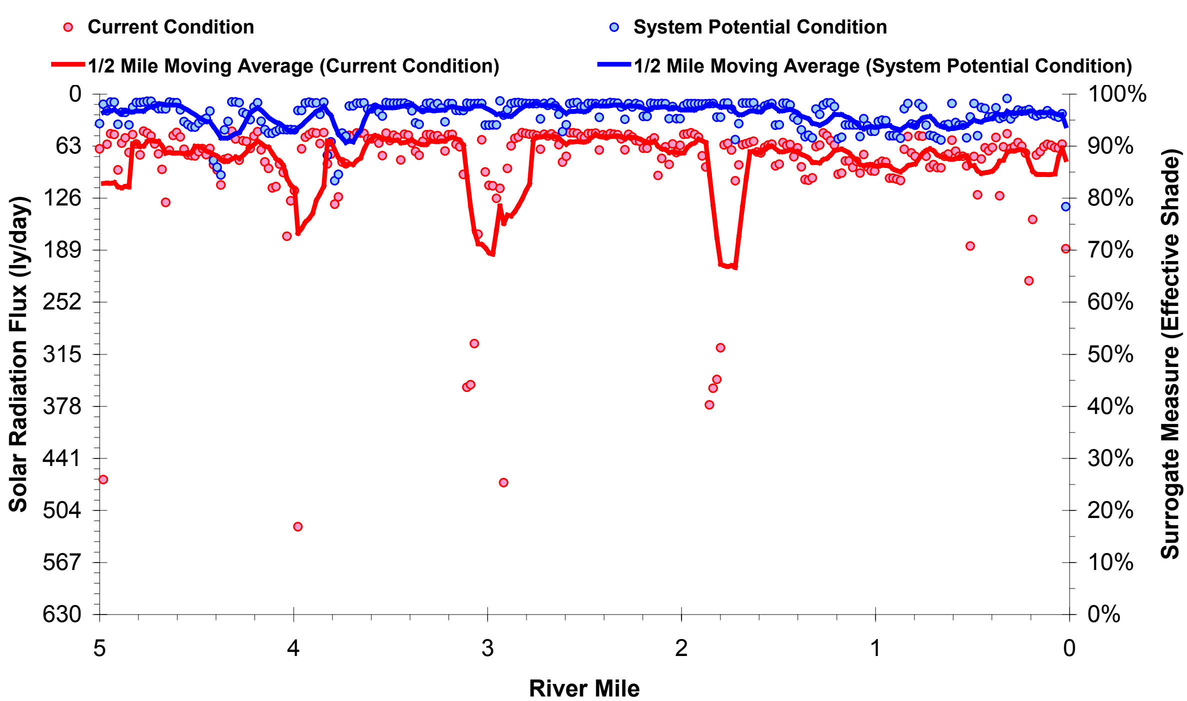
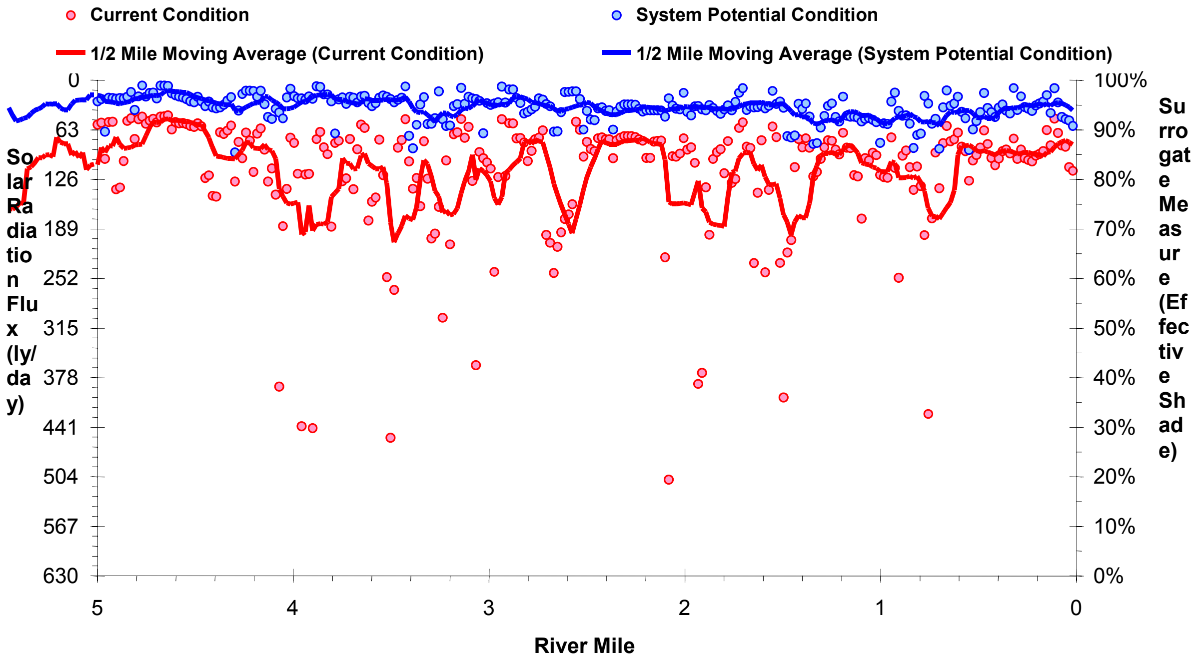


Figure 47. Indian Creek Effective Shade Surrogate Measure for Nonpoint Sources



4.8.2 Effective Shade Curves - Surrogate Measures

Where effective shade levels are not specified in **Figures 42** to **47**, effective shade for the appropriate vegetation zone (described in **Table 8** [pages 46-47] and **Figure 27** [page 48]) and near stream disturbance zone width are provide in **Figures 48** to **53**.

Figure 48. Effective Shade Curve – Ponderosa Pine Potential Vegetation Zone

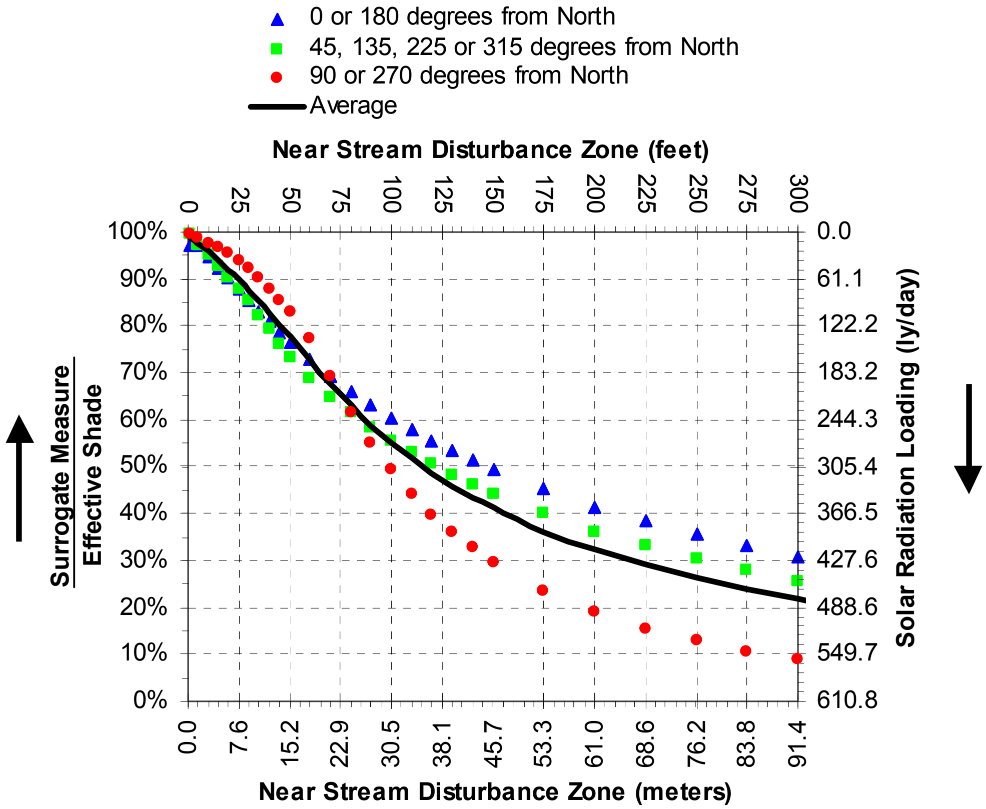


Figure 49. Effective Shade Curve – Eastside Douglas Fir Potential Vegetation Zone

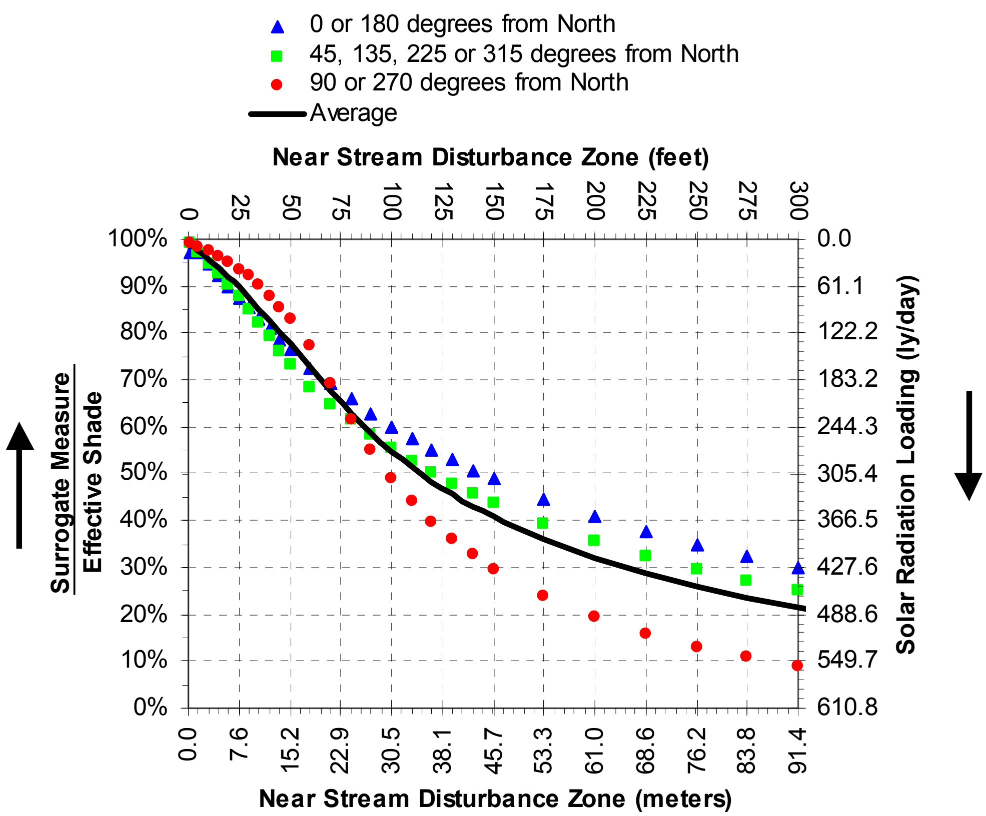


Figure 50. Effective Shade Curve – Western Hemlock Potential Vegetation Zone

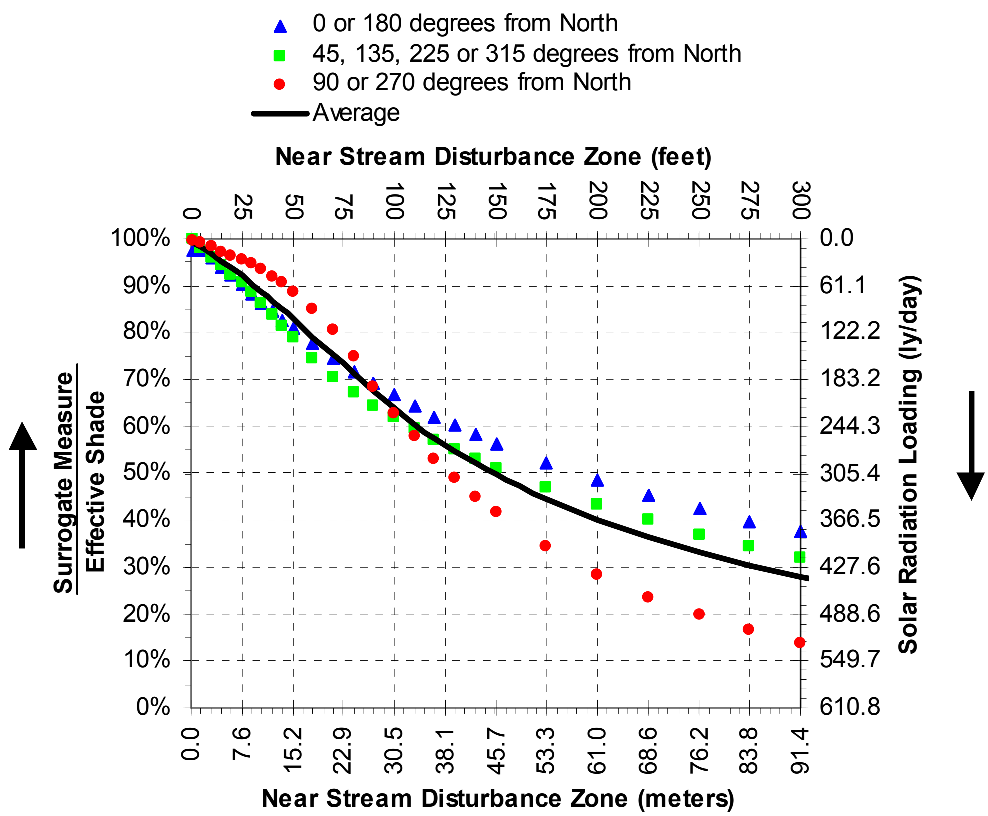


Figure 51. Effective Shade Curve – Grand Fir Potential Vegetation Zone

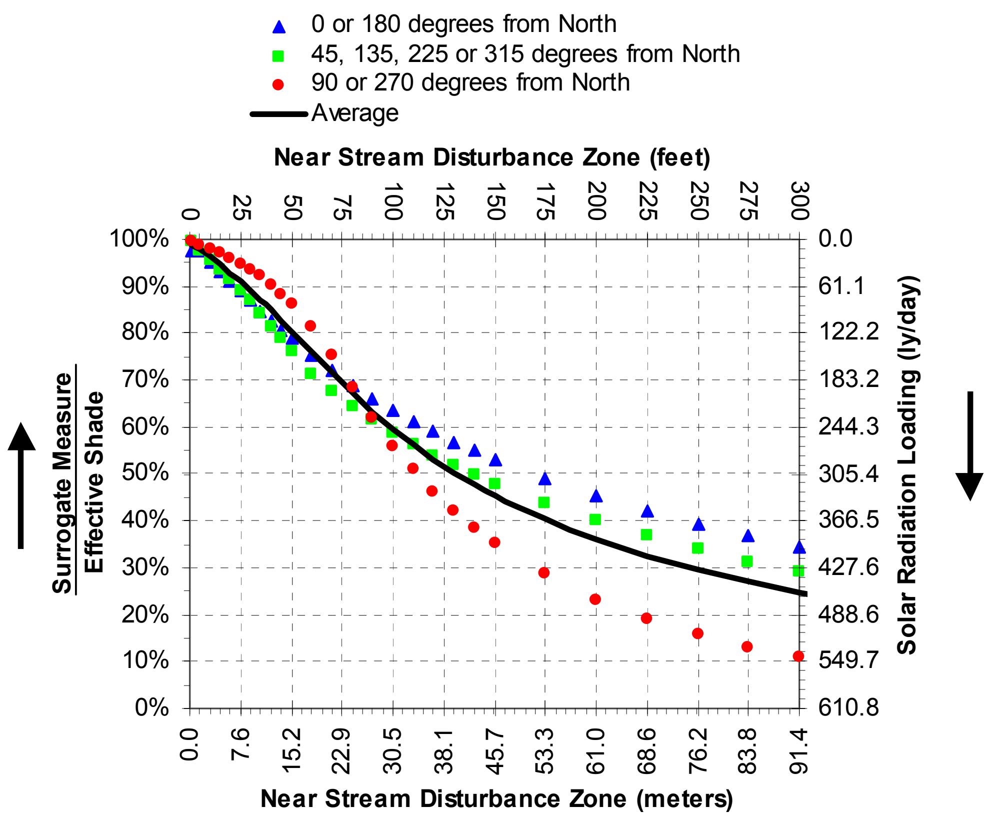


Figure 52. Effective Shade Curve – Pacific Silver Fir Potential Vegetation Zone

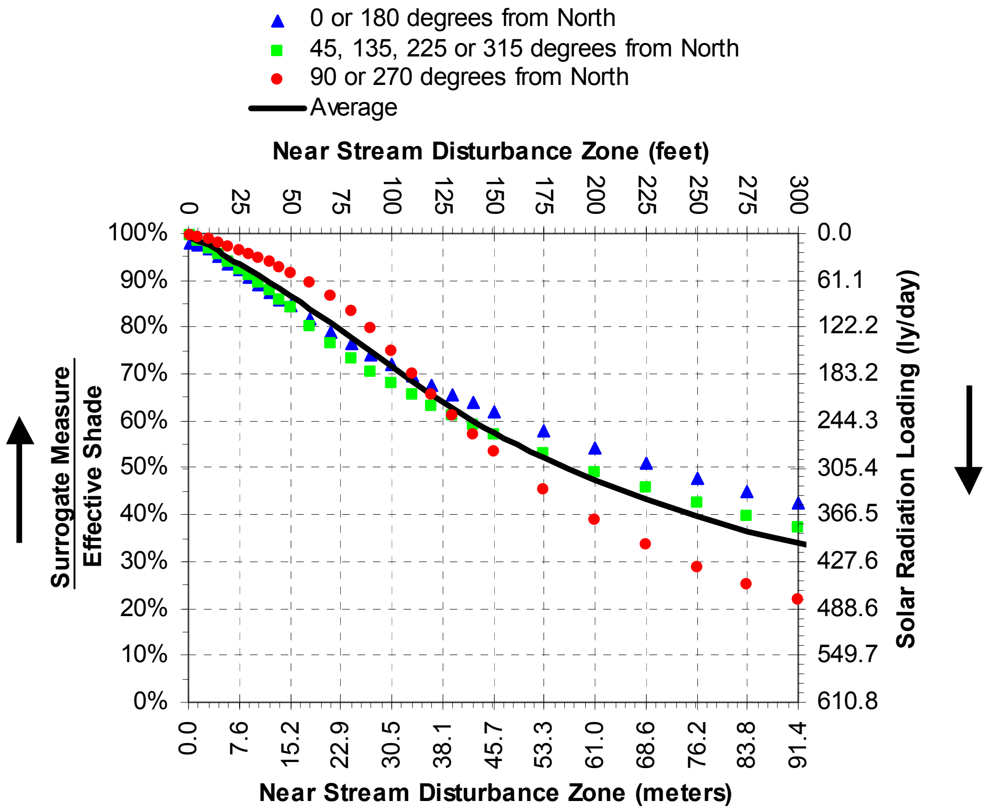
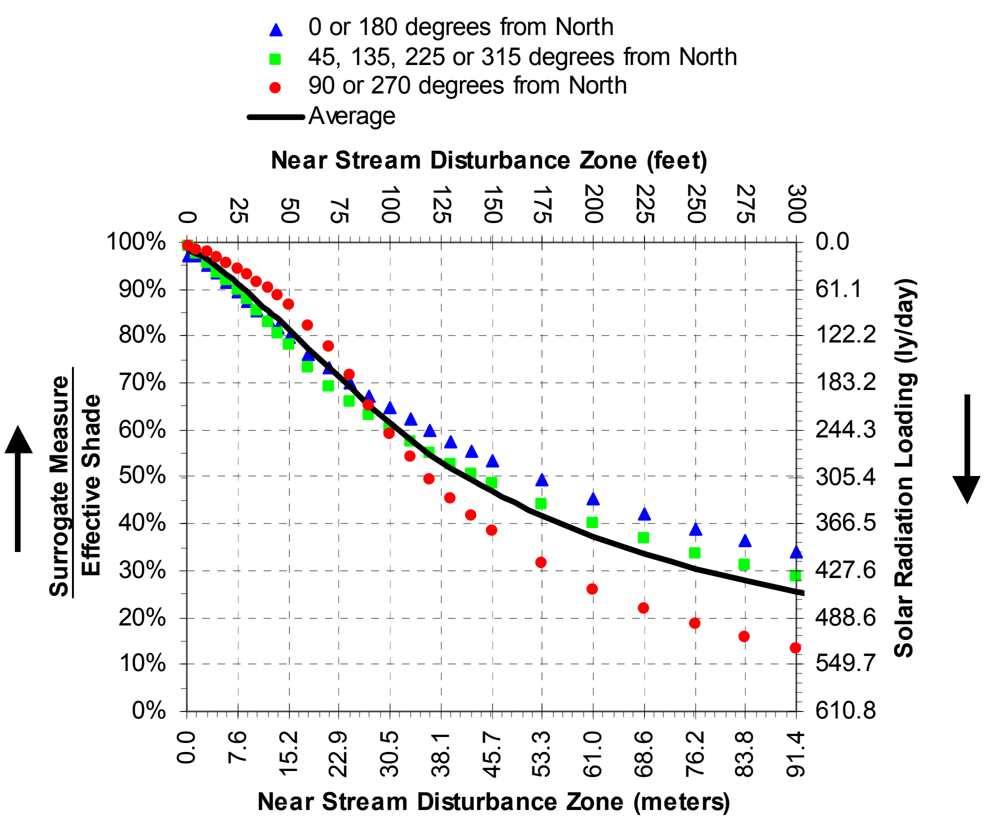


Figure 53. Effective Shade Curve – Mountain Hemlock Potential Vegetation Zone



4.9 MARGINS OF SAFETY – 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 18** 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, represents 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 18. 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.

4.9.1 Explicit Margins of Safety

For point source waste load allocations and load allocations for the Powerdale Hydroelectric Project and Laurance Lake reservoir, ODEQ has applied a safety factor of 10 percent during the critical periods when temperature criteria would be exceeded. Waste load allocations were calculated so that there would be no more than a 0.25°F increase in the zone of dilution. Load allocations for the dams were calculated so that there would be no more than a 0.25°F increase above that which would naturally occur if the dam were not present. These loads and waste loads were then reduced by dividing the calculated load by 1.1.

Because nonpoint sources have been given a zero allocation, an explicit safety factor is irrelevant. Dividing a zero allocation by 1.1 still produces zero. The implicit MOS for nonpoint sources is described below in **Section 4.9.2 Implicit Margins of Safety**.

4.9.2 Implicit Margins of Safety

Description of the MOS for the Western Hood Subbasin 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.

Calculating a numeric MOS is not easily performed with the methodology presented in this document. In fact, the basis for the loading capacities and load allocations is the definition of system potential conditions. It is illogical to presume that anything more than system potential riparian conditions are possible, feasible or reasonable for load allocations.

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

Simulations were performed to calculate the temperatures that result with the allocated measures that form the basis for the factors that represent the system potential condition with ***no measurable surface water temperature increase resulting from anthropogenic activities***. The resulting simulated temperatures represent attainment of system potential, and therefore, attainment of the temperature standard.

A total of 31.3 river miles in the Hood River, East Fork Hood River, and Neal Creek were analyzed and simulated during the critical period (August 6, 1998). **Figure 54** compares the current maximum daily temperatures with those that result with the system at allocated conditions. For the East Fork Hood and Hood River, the allocated conditions result from system potential conditions and 250 cfs instream below Powerdale Dam. The 250 cfs is required as part of PacifiCorps's Section 401 Certification. For Neal Creek, the allocated conditions result from system potential conditions. **Figures 55** and **56** depict the diurnal temperatures under current and allocated conditions.

The temperature TMDL and the temperature water quality standards are achieved when (1) nonpoint source solar radiation loading is representative of a riparain vegetation condition without human distrubance and (2) point source discharges cause no measurable temperature increases in surface waters.

*Stream temperatures (displayed in **Figures 47 and 48**) that result from the system potential conditions represent attainment of the temperature standard (**no measurable surface water temperature increase resulting from anthropogenic activities).***

Generally speaking, the East Fork Hood River, Hood River and Neal Creek currently experience critical condition maximum daily temperatures in the low- to mid-60°F range. Under the allocated system potential condition, maximum daily temperatures shifted to the mid-50°F to low-60°F range. In 1998, 16.7% of the analyzed stream reaches had critical condition maximum daily temperatures greater than 64°F. Under the system potential, 0% of these reaches would experience maximum daily temperatures greater than 64°F.

Simulations were only done for the rearing period. The determination of spawning time periods and locations for application of the 55°F state temperature criterion was not identified for the Hood River watershed until September, 2000 to address State Conservation Measure 4 (ODEQ, 2000). Because of this late determination, insufficient flow data was collected during the salmonid spawning period to enable simulations to be performed. Attainment of the 55°F criterion is addressed in this TMDL in the development of load allocations through making conservative assumptions about thermal conditions and assigning a “no measurable increase” load to point sources, the Powerdale Hydroelectric Project, and Laurance Lake Reservoir during the spawning period.

Figure 54. Distributions of Daily Maximum Temperatures for Current Conditions and the Allocated Condition (August 6, 1998)

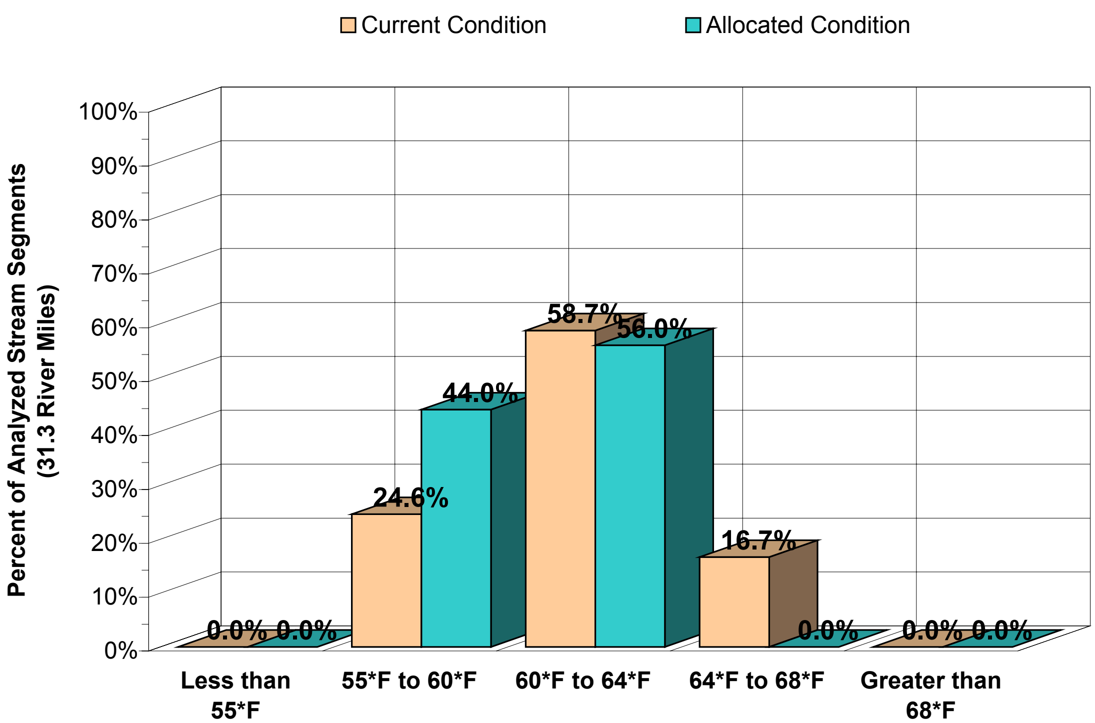


Figure 55. Hood River/East Fork Hood River Diurnal Temperatures – Current Condition and Allocated Condition

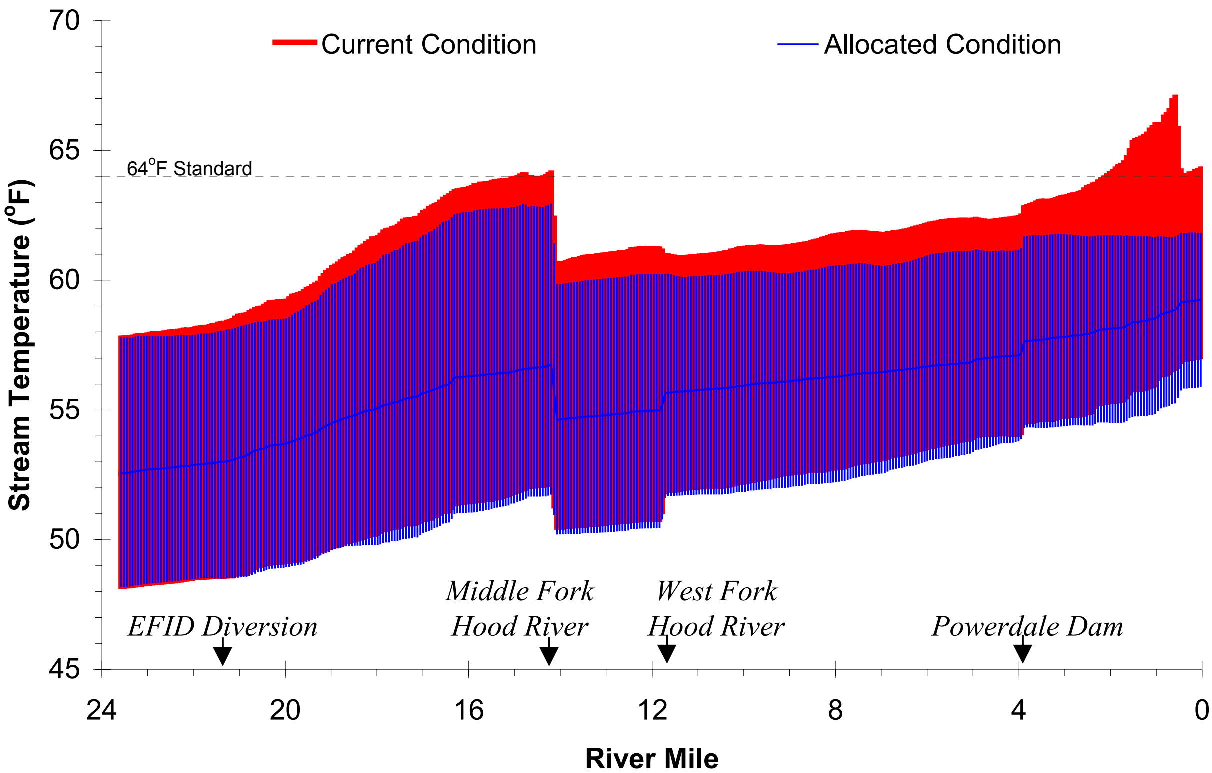
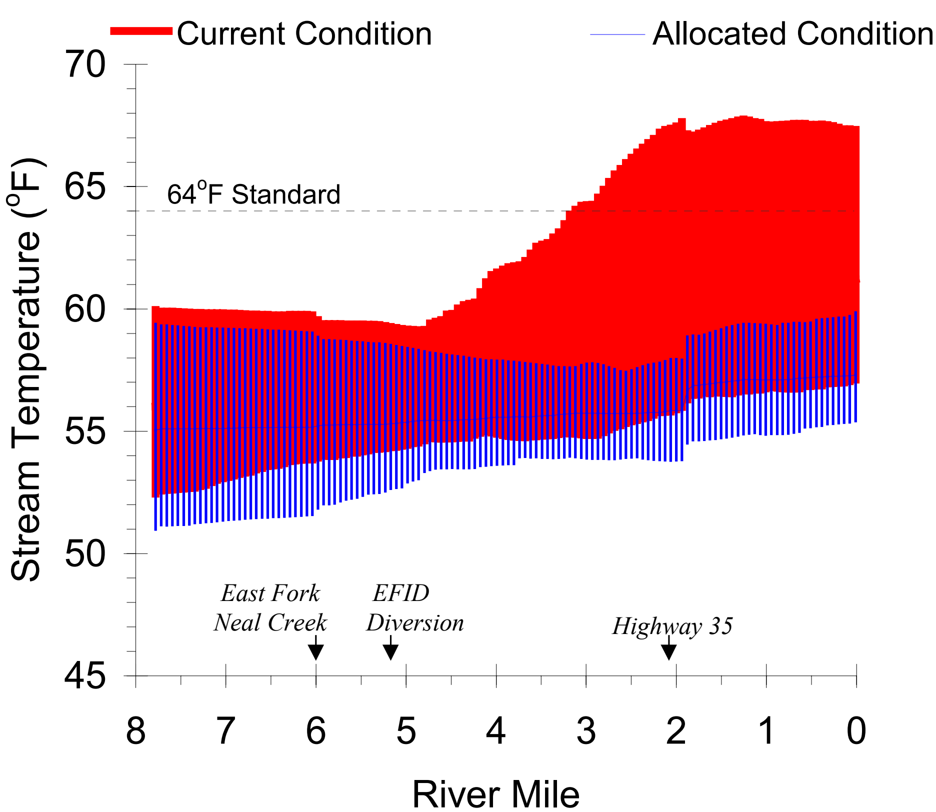


Figure 56. Neal Creek Diurnal Temperatures – Current Condition and Allocated Condition

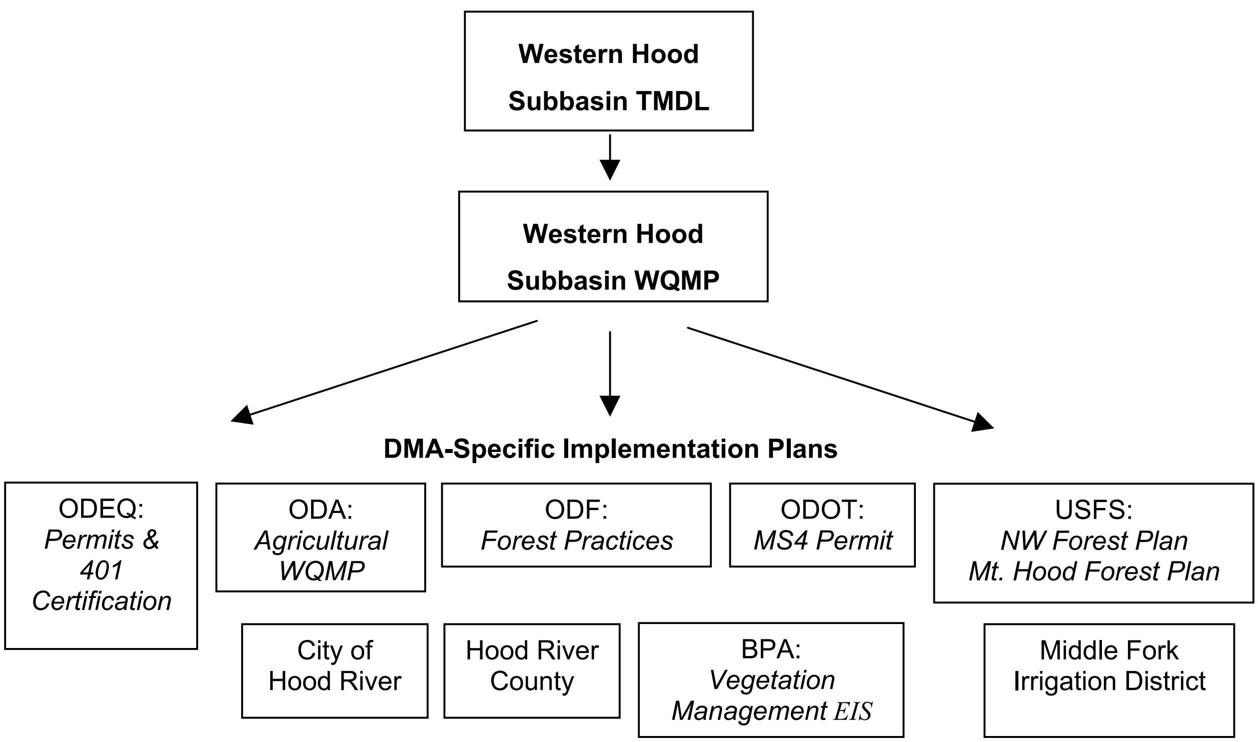


CHAPTER 5 – WATER QUALITY MANAGEMENT PLAN

5.1 INTRODUCTION

This document is intended to describe strategies for how the Western Hood Subbasin Total Maximum Daily Load (TMDL) will be implemented and, ultimately, achieved. 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 subbasin'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 Western Hood Subbasin TMDL. Appended to this document are DMA-specific Implementation Plans which describe each DMA's existing or planned efforts to implement their portion of the TMDL. This relationship is presented schematically in **Figure 57**, below.

Figure 57. TMDL/WQMP/Implementation Plan Schematic



At the time this WQMP was written, some of the DMAs named in the Western Hood Subbasin TMDL had submitted individual Implementation Plans. In some cases, ODEQ has judged a plan as fulfilling the minimum requirements for an individual implementation plan. Others have been judged incomplete and will need to be revised. Other DMAs have not prepared or submitted any implementation plan at all. In those cases where individual implementation plans do not exist or are incomplete, following approval of the TMDL by USEPA, these DMAs will be required to prepare and submit individual implementation plans. An evaluation of ODEQ's review of individual implementation plans is provided in **Section 5.13 Implementation Plans**.

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 document is the first iteration of the Water Quality Management Plan (WQMP) for the Western Hood Subbasin TMDL. As explained in "Element 6" of this document, 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. Currently, the DMAs have proposed timelines (following final TMDL approval) to develop full Implementation Plans. 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". In short, this document is a starting point and foundation for the WQMP elements being developed by ODEQ and Western Hood Subbasin DMAs.

5.1.1 Adaptive Management

The goal of the Clean Water Act and associated Oregon Administrative Rules (OARs) is that water quality standards shall be 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.

TMDLs are numerical loadings that are set to limit pollutant levels such that instream water quality standards are met. ODEQ recognizes that TMDLs are values 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 for this reason that the TMDL has been established with a margin of safety.

WQMPs 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. **Figure 58** is a graphical representation of this adaptive management concept.

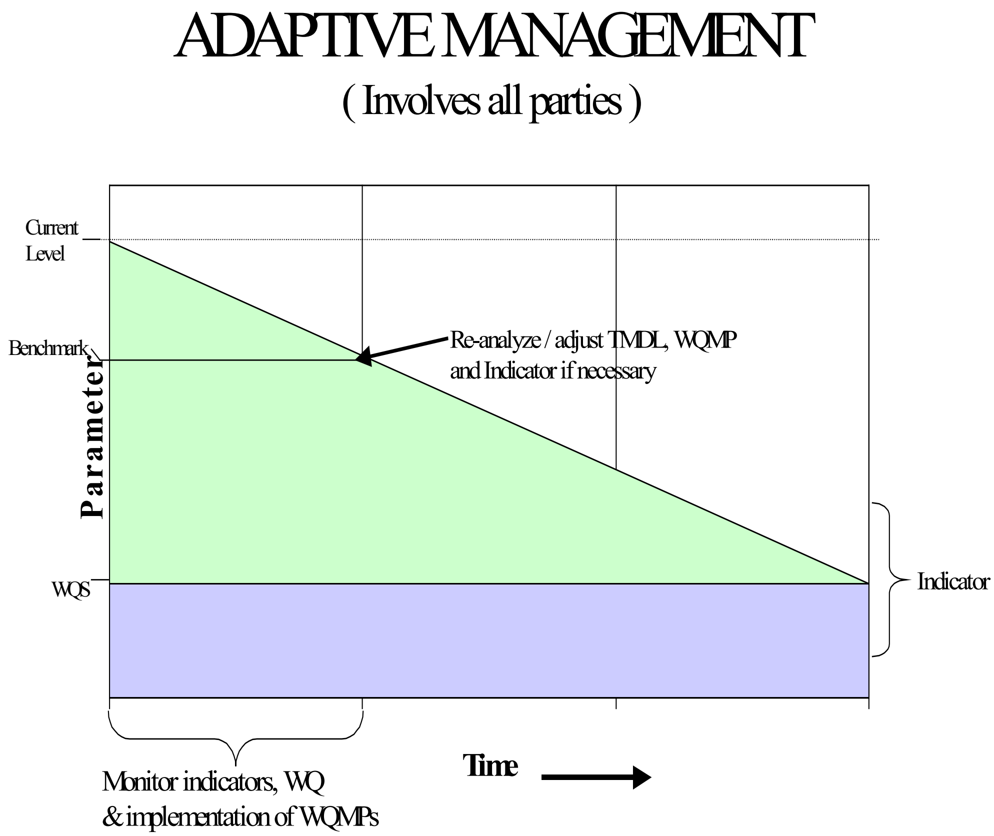
ODEQ also recognizes that, despite the best and most sincere efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated surrogates. Such events could be, but are not limited to, floods, fire, insect infestations, and drought.

In the Western Hood Subbasin TMDL, pollutant surrogates have been defined as alternative targets for meeting the TMDL. The purpose of the surrogates 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 (system potential vegetation, for example) 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 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 58. Adaptive Management



The implementation of 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.

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. For instance, a permit applicant may be able to demonstrate that a proposed thermal discharge would not have a measurable detrimental impact on projected stream temperatures when site temperature is achieved. Alternatively, in the case where a TMDL is set based upon attainment of a specific pollutant concentration, a source may be permitted to discharge at that concentration and still be considered as meeting a zero allocation.

In employing an adaptive management approach to the TMDL and the WQMP, ODEQ has the following expectations and intentions:

- Subject to available resources, on a five-year basis, ODEQ intends to 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.
- ODEQ expects that each DMA will also monitor and document its progress in implementing the provisions of its Implementation Plan. This information will be provided to ODEQ for its use in reviewing the TMDL.
- As implementation of the WQMP and the associated Implementation Plans proceeds, ODEQ expects that DMAs will develop benchmarks for attainment of TMDL surrogates, which can then be used to measure progress.
- Where implementation of the Implementation Plans or effectiveness of management techniques are found to be inadequate, ODEQ expects management agencies to revise the components of their Implementation Plan to address these deficiencies.
- When ODEQ, in consultation with the DMAs, 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 revise it as appropriate. ODEQ would also consider reopening the TMDL should new information become available indicating that the TMDL or its associated surrogates should be modified.

5.2 TMDL WATER QUALITY MANAGEMENT PLAN GUIDANCE

In February 2000, ODEQ entered into a Memorandum of Agreement (MOA) with the U.S. Environmental Protection Agency (EPA) that describes the basic elements needed in a TMDL Water Quality Management Plan (WQMP). That MOA was endorsed by the Courts in a Consent Order signed by United States District Judge Michael R. Hogan in July 2000. These elements, as outlined below, will serve as the 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 Western Hood Subbasin WQMP is organized around these plan elements and is intended to fulfill the requirement for a management plan contained in OAR 340-041-485.

5.3 CONDITION ASSESSMENT AND PROBLEM DESCRIPTION

The Condition Assessment and Problem Description are provided above in **Chapter 3 Description of the Western Hood Subbasin** and **Chapter 4 Total Maximum Daily Load for Stream Temperature**.

5.4 GOALS AND OBJECTIVES

The overall goal of the TMDL Water Quality Management Plan (WQMP) is to achieve compliance with water quality standards for each of the 303(d) listed parameters and streams in the Hood River watershed. Specifically the WQMP combines a description of all Designated Responsible Participants (or Designated Management Agencies (DMA)) plans that are or will be in place to address the load and wasteload 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. As discussed above, this plan is preliminary in nature and is designed to be adaptive as more information and knowledge is gained regarding the pollutants, allocations, management measures, and other related areas.

The expectation of all DMAs are to:

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

5.5 IDENTIFICATION OF RESPONSIBLE PARTICIPANTS

The purpose of this element is to identify the organizations responsible for the implementation of the plan and to list the major responsibilities of each organization. What follows is a simple list of those organizations and responsibilities. This is not intended to be an exhaustive list of every participant that bears some responsibility for improving water quality in the Hood 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 or working within the subbasin. We are all contributors to the existing quality of streams in the Hood River watershed and we all must be participants in the efforts to improve the river. In addition to the organizations listed below, ODEQ also evaluated the Bureau of Land Management and the Confederated Tribes of the Warm Springs Reservation of Oregon. Both of these land management entities own land in Hood River County. However, upon review of the location of their parcels, we determined that either their land did not drain into the Hood River watershed (but rather drained to the Columbia) or their land did not have frontage on waters of the state.

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

- NPDES Permitting[7] and Enforcement
- WPCF Permitting and Enforcement
- Section 401 Certification
- Technical Assistance
- Financial Assistance

OREGON DEPARTMENT OF AGRICULTURE

- Agricultural Water Quality Management Plan Development Implementation & Enforcement
- CAFO Permitting and Enforcement
- Technical Assistance
- Revise Agricultural WQMAP
- Rules under Senate Bill (SB) 1010 to clearly address TMDL and Load Allocations as necessary
- Riparian area management

OREGON DEPARTMENT OF FORESTRY

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

OREGON DEPARTMENT OF TRANSPORTATION

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

FEDERAL LAND MANAGEMENT AGENCIES (FOREST SERVICE)

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

CITY OF HOOD RIVER

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

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

HOOD RIVER 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

BONNEVILLE POWER ADMINISTRATION

- Riparian area management

MIDDLE FORK IRRIGATION DISTRICT

- Flow management

Table 19, below, shows stream segments in the Hood River watershed which exceed the state's temperature criteria along with the responsible DMAs. Data for this table was compiled from the 1998 303(d) list and from the results of stream temperature monitoring conducted in 1998. 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 all points upstream of the exceedance.

Table 19. Geographic Coverage of Designated Management Agencies in the Hood River Watershed

Stream	Criteria Exceeded	Included on 1998 303(d) List	Designated Management Agencies
East Fork Hood River Watershed			
Evans Creek	Fish Spawning (55°F)		ODF, HR, MHNF, ODA
Hood River – East Fork	Fish Rearing (64°F) and Fish Spawning (55°F)		MHNF, HR, ODF, BPA, ODA, ODOT
Meadows Creek	Fish Spawning (55°F)		MHNF, HR, ODOT
Robinhood Creek	Fish Spawning (55°F)		MHNF, HR
Tilly Jane Creek	Fish Spawning (55°F)		MHNF, HR
Trout Creek	Fish Spawning (55°F)		HR, ODF, ODA, BPA, ODOT
Middle Fork Hood River Watershed			
Clear Branch	Bull Trout (50°F) and Fish Spawning (55°F)	yes	MHNF, HR, MFID
Coe Branch	Bull Trout (50°F) and Fish Spawning (55°F)		MHNF, HR
Compass Creek	Bull Trout (50°F)		MHNF, HR
Hood River – Middle Fork	Bull Trout (50°F) and Fish Spawning (55°F)	yes	MHNF, ODF, HR, ODA, BPA, MFID
Tony Creek	Fish Spawning (55°F)		MHNF, ODF, HR, BPA
West Fork Hood River Watershed			
Green Point Creek	Fish Spawning (55°F)		MHNF, ODF, HR,
Hood River – West Fork	Fish Spawning (55°F)		MHNF, ODF, HR, BPA, ODA
Lake Branch	Fish Spawning (55°F)		MHNF, ODF, HR
Lake Branch (rivermile 10 to Lost Lake)	Fish Rearing (64°F) and Fish Spawning (55°F)	yes	MHNF, ODF, HR
Mainstem Hood River Watershed			
Hood River	Fish Rearing (64°F) and Fish Spawning (55°F)	yes	ODF, HR, CHR, ODA, ODOT, CHR,
Indian Creek	Fish Rearing (64°F) and Fish Spawning (55°F)	yes	CHR, HR, ODF, ODA
Neal Creek	Fish Rearing (64°F) and Fish Spawning (55°F)	yes	ODF, HR, ODA, ODOT
Neal Creek – East Fork	Fish Spawning (55°F)		MHNF, ODF, HR, BPA,
Neal Creek – West Fork	Fish Spawning (55°F)		MHNF, ODF, HR, ODA, PA
Odell Creek	Fish Rearing (64°F) and Fish Spawning (55°F)		ODF, HR, ODA, ODOT
Spring Creek	Fish Rearing (64°F) and Fish Spawning (55°F)		ODF, HR, ODA
Whiskey Creek	Fish Rearing (64°F) and Fish Spawning (55°F)	yes	ODF, HR, ODA, ODOT

BPA=Bonneville Power Administration CHR=City of Hood River HR=Hood River County MHNF=Mt. Hood National Forest ODA=Oregon Dept. of Agriculture ODF=Oregon Dept. of Forestry ODOT=Oregon Department of Transportation MFID=Middle Fork Irrigation District

5.6 PROPOSED MANAGEMENT MEASURES

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.

Oregon Administrative Rules (OAR) contain specific language regarding temperature management plans. In particular, the language reads (in part):

OAR 340-041-0026 - Policies and Guidelines Generally Applicable to All Basins

(3) (a) (D) Effective July 1, 1996, in any waterbody identified by the Department as exceeding the relevant numeric temperature criteria specified for each individual water quality management basin identified in … OAR-340-041-0445, … and designated as water quality limited under Section 303(d) of the Clean Water Act, the following requirements shall apply to appropriate watersheds or stream segments in accordance with priorities established by the Department. The Department may determine that a plan is not necessary for a particular stream segment or segments within a water-quality limited basin based on the contribution of the segment(s) to the temperature problem:

(i) Anthropogenic sources are required to develop and implement a surface water temperature management plan which describes the best management practices, measures, and/or control technologies which will be used to reverse the warming trend of the basin, watershed, or stream segment identified as water quality limited for temperature;

(ii) Sources shall continue to maintain and improve, if necessary, the surface water temperature management plan in order to maintain the cooling trend until the numeric criterion is achieved or until the Department, in consultation with the Designated Management Agencies (DMAs), has determined that all feasible steps have been taken to meet the criterion and that the designated beneficial uses are not being adversely impacted. In this latter situation, the temperature achieved after all feasible steps have been taken will be the temperature criterion for the surface waters covered by the applicable management plan. The determination that all feasible steps have been taken will be based on, but not limited to, a site-specific balance of the following criteria: protection of beneficial uses; appropriateness to local conditions; use of best treatment technologies or management practices or measures; and cost of compliance;

(iii) Once the numeric criterion is achieved or the Department has determined that all feasible steps have been taken, sources shall continue to implement the practices or measures described in the surface water temperature management plan in order to continually achieve the temperature criterion;

(iv) For point sources, the surface water temperature management plan will be part of their National Pollutant Discharge Elimination System Permit (NPDES);

(v) For nonpoint sources, the surface water temperature management plan will be developed by designated management agencies (DMAs) which will identify the appropriate BMPs or measures;

(vi) A source (including but not limited to permitted point sources, individual landowners and land managers) in compliance with the Department or DMA (as appropriate) approved surface water temperature management plan shall not be deemed to be causing or contributing to a violation of the numeric criterion if the surface water temperature exceeds the criterion;

As the development of the WQMP and the associated DMA-specific Implementation Plans progresses, these rules will provide guidance for both point and nonpoint sources.

The management measures to meet the Load and Waste Load Allocations may differ depending on the source of the pollutant. Given below is a categorization of the sources and a description of the management measures being proposed for each source category.

5.6.1 Sewage Treatment and Fruit Packing Plants

The Waste Load Allocations given to the three sewage treatment plants (Odell, Parkdale and Mount Hood Meadows) and the four fruit packing plants (Diamond, Duckwall-Pooley, Stadelman, and Lage Orchards) will be implemented through actions relative to their National Pollutant Discharge Elimination System (NPDES) permits. These permits will either include numeric effluent limits or provisions to develop and implement management plans, which ever is appropriate.

In the case of three fish hatchery/rearing facilities discharging to Herman Creek and Eagle Creek, Waste Load Allocations have not been assigned because both creeks discharge directly to the Columbia River and neither are listed on Oregon's current 303d list. The permits for these sources, however, will be evaluated during permit renewal to ensure that the discharges not violate any applicable water quality standards.

5.6.2 General NPDES Permitted Sources

All general NPDES permits will be reviewed and, if necessary, modified to ensure compliance with allocations. If necessary sources on general permits may be converted to individual permits.

5.6.3 Section 401 Certification

The Section 401 Certification and Implementation Agreement issued on June 9, 2000 details the certification conditions under which the Powerdale Hydroelectric Project will be operated to comply with the load allocations established under this TMDL.

5.6.4 Other Sources

For discharges from sources other than the sewage treatment and fruit packing plants, and those permitted under general NPDES permits or Section 401 Certification, ODEQ has assembled an initial listing of management categories. This listing, given in **Table 20** below, is designed to be used by the DMAs as guidance for selecting management measures to be included in their Implementation Plans. Each DMA will be responsible for examining the categories in **Table 20** to determine if the source and/or management measure is applicable within their jurisdiction. This listing is not comprehensive and other sources and management measures will most likely be added by the DMAs where appropriate. For each source or measures deemed applicable a listing of the frequency and extent of application should also be provided. In addition, each of the DMAs is responsible for source assessment and identification, which may result in additional categories. It is crucial that management measures be directly linked with their effectiveness at reducing pollutant loading contributions.

Table 20. Management Categories and Related Management Measures for Controlling Instream Temperatures

Management Measure/Source Category		
Public Awareness/Education		X
General Outreach		
Targeted Outreach		
New Development and Construction		
Planning Procedures		X
Permitting/Design		X
Education and Outreach		X
Construction Control Activities		X
Procedures/Measures		
Inspection/Enforcement		
Post-Construction Control Activities		X
Procedures/Measures		
Inspection/Enforcement		
Storm Drain System Construction		
Erosion Control		X
Existing Development		
Storm Drain System		
Streets & Roads		
Street Sweeping		
Maintenance Activities		X
Septic Systems		
Procedures/Measures		
Inspection/Enforcement		
Erosion Control		X
Parking Lots		X
Commercial and Industrial Facilities		X
Source Control		
Fertilizers		
Pet Waste		
Other		
Flow management		X
Illicit Connections and Illegal Dumping		
Residential		
Commercial and Industrial		X
Riparian Area Management		
Revegetation		X
Streambank Stabilization		
Public/Governmental Facilities		
Parks		
Public Waterbodies (Ponds, etc.)		X
Municipal Corporation Yard O&M		X
Other Public Buildings and Facilities		X
Forest Practices		
Riparian Area Management		X
Roads/Culverts		X
Erosion Control		X

Table 20. Management Categories and Related Management Measures for Controlling Instream Temperatures (continued)

Management Measure/Source Category		
Agricultural Practices		
Riparian Area Management		X
Erosion Control		X
Animal Waste		
CAFOs		
Other		
Nutrient Management		
Planning and Assessment		X
Source Assessment/Identification		X
Source Control Planning		X
Monitoring and Evaluation		X
BMP Monitoring and Evaluation		X
Instream Monitoring		X
BMP Implementation Monitoring		X
Transportation		X
Road Construction, Maintenance and Repair		X

5.7 TIMELINE FOR IMPLEMENTATION

The purpose of this element of the WQMP is to demonstrate a strategy 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.

The DMA-specific Implementation Plans are designed to reduce pollutant loads from sources to meet TMDLs, associated loads and water quality standards. ODEQ recognizes that where implementation involves significant habitat restoration or reforestation, water quality standards may not be met for decades. In addition, ODEQ recognizes that technology for controlling nonpoint source pollution is, in some cases, in the development stages and will likely take one or more iterations to develop effective techniques.

In the Western Hood Subbasin TMDL, pollutant surrogates have been defined as alternative targets for meeting the TMDL. The purpose of the surrogates is not to bar or eliminate human access or activity in the subbasin or its riparian areas. It is the expectation, however, that the Implementation Plans will address how human activities will be managed to achieve the surrogates. It is also recognized that full attainment of pollutant surrogates (system potential vegetation) 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.

ODEQ intends to regularly review progress of the Implementation Plans. The plans, this overall WQMP, and the TMDLs are part of an adaptive management process. Modifications to the WQMP and the Implementation Plans are expected to occur on an annual or more frequent basis. Review of the TMDLs are expected to occur approximately five years after the final approval of the

TMDLs, or whenever deemed necessary by ODEQ. **Table 21**, below, gives the timeline for activities related to the WQMP and associated DMA Implementation Plans.

Table 21. Water Quality Management Plan Timeline

Activity	2002		2003		2004		2005		2006		2007	
ODEQ Establish MAOs with NPDES Permitted Sources and MFID	■	■										
Permitted Sources and MFID Collect Flow and Temperature Data	■	■	■	■								
ODEQ Incorporate WLAs into Permits					■	■						
ODEQ Renew/Modify Permits for ODFW Hatcheries Near Cascade Locks to Incorporate WQ-Based Limits	■	■	■									
ODEQ Review of General Permits to Ensure WLA-Based Limits are Included	■	■	■									
Development and Submittal of Implementation Plan by MFID					■	■						
Development and Submittal of Operational Plan by PacifiCorp	■											
PacifiCorp Implementation of Operational Plan		■	■	■	■	■	■	■	■	■	■	■
Development and Submittal of Implementation and Monitoring Plans by Other DMAs	■	■	■									
DMA Implementation of Plans	■	■	■	■	■	■	■	■	■	■	■	■
DMA Submittal of Annual Reports	Sept. 30 of Each Year											

5.8 REASONABLE ASSURANCE

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.

5.8.1 Point Sources and Dams

Reasonable assurance that implementation of the point source waste load allocations will occur will be addressed through the issuance or revision of NPDES and WPCF permits. Reasonable assurance that implementation of the Powerdale Hydroelectric Project load allocation will occur will be addressed through the Section 401 certification. The Middle Fork Irrigation District will be treated as a nonpoint source DMA and reasonable assurance of implementation will be addressed through the development of their implementation plan.

5.8.1.1 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 Pollutant Discharge Elimination System (NPDES) permits for surface water discharge; and Water Pollution Control Facilities (WPCF) permits for onsite (land) disposal. 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. The WPCF permit is unique to the State of Oregon. 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 Waste Load Allocations (WLAs) will be incorporated into NPDES permits when permits are renewed by ODEQ, typically within 1 year after the EPA approves the TMDL. It is likely each point source will be given a reasonable time to upgrade, if necessary, to meet its new permit limits. A schedule for meeting the requirements will be incorporated into the permit. Adherence to permit conditions is required by State and Federal Law and ODEQ has the responsibility to ensure compliance.

The NPDES permits for the three sewage treatment plants, Odell Sanitary District, Parkdale Sanitary District, and Mount Hood Meadows, will be revised to include the WLAs. In conducting the work on this TMDL, ODEQ did not have sufficient resources to collect much data on the smaller tributaries into which the permitted sources discharge. Because the WLAs are dependent upon the flow and temperature of both the receiving stream and the effluent of each source, the permits will be revised after each source obtains necessary information for its effluent and receiving stream. The schedule for developing this information and for developing individual plans to meet the WLAs will first be established in a Mutual Agreement and Order (MAO). The NPDES permits for the four fruit packing companies with wasteload allocations, Diamond Fruit, Duckwall-Pooley, Stadelman, and Lage Orchards, will be revised to address the WLAs in the same fashion as the sewage treatment plants.

Guidance for establishing permit limits pursuant to the WLAs established in this TMDL are provided in **Section 5.13.1 NPDES Permits**.

All general NPDES permits within the subbasin will also be revised to address the appropriate WLAs. The state fish hatcheries near Cascade Locks discharge to streams that are not listed as water quality limited. 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.

NPDES permits for facilities which discharge to the Columbia River will not be addressed in this TMDL. WLAs for these facilities will be developed through the Columbia River TMDL process, which is slated for completion by the U.S.E.P.A. in 2002. These facilities include the sewage treatment plants for the cities of Cascade Locks and Hood River, a cooling water discharge for the Hood River Inn, and various stormwater discharges.

5.8.1.2 Powerdale Hydroelectric Project

In February 1998, PacifiCorp applied to the Federal Energy Regulatory Commission (FERC) for a new license to continue operating the Project. As part of the FERC re-licensing process, PacifiCorp also needed to obtain a water quality standards compliance certification statement for the Project from the ODEQ, pursuant to requirements of § 401 in the Federal Clean Water Act and Oregon Administrative Rules Chapter 340, Division 48. Section 401 of the Federal Clean Water Act establishes requirements for State certification of proposed projects or activities that may result in any discharge of pollutants to navigable waters. The Section 401 water quality certification was granted by ODEQ in June, 2000. These certification conditions include requirements that the facility be operated in accordance with established load allocations adopted pursuant to a TMDL.

5.8.2 Nonpoint Sources

Responsible participants for implementing DMA specific water quality management plans for urban and rural sources were identified in **Section 5.5** of this WQMP. Upon approval of the Western Hood Subbasin TMDL, it is ODEQ's expectation that identified, responsible participants will develop, submit to ODEQ, and implement individual water quality 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 5.7** 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 for example.
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 issuance of Department or Commission Orders and other enforcement mechanisms.

5.8.2.1 Forestry

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.

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. How water quality parameters are affected, as established through the TMDL process, as well as other monitoring data, will be an important part of the body of information used in determining the adequacy of the FPA.

As the DMA for water quality management on non-federal forestlands, the ODF is also 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. The purpose of the MOU is also to guide coordination between the ODF and ODEQ regarding water quality limited streams on the 303d list. An evaluation of rule adequacy will be conducted (also referred to as a "sufficiency analysis") through a water quality parameter by parameter analysis. This statewide demonstration of forest practices rule effectiveness in the protection of water quality will address the following specific parameters and will be conducted in the following order[8]:

1) Temperature (draft report completed in Fall, 2000)
2) Sediment and turbidity (estimated draft report target completion date Fall, 2001)
3) Aquatic habitat modification (estimated date Spring, 2002)
4) Bio-criteria (estimated date Fall, 2002)
5) Other parameters (estimated date Spring, 2003)

These sufficiency analyses will be reviewed by peers and other interested parties prior to final release. The analyses will be designed to provide background information and assessments of BMP effectiveness in meeting water quality standards. Once the sufficiency analyses are completed, they 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. See **Section 5.13.3** for a more detailed description of the non-federal forest lands portion of the WQMP.

Currently ODF and DEQ 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 Western Hood Subbasin. 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 TMDL. The draft versions of the statewide FPA sufficiency analyses for the various water quality parameters will be completed as noted above. The proposed Western Hood TMDL will be completed in December, 2001. Data from an ODF/ODEQ shade study was collected over the summer of 1999 and a final report will be completed in the summer of 2001, and information from the forest practices ad hoc committee advisory process is currently available. Information from these efforts, along with other relevant information provided by the ODEQ, will be considered in reaching a determination on whether the existing FPA BMPs meet water quality standards within the Western Hood Subbasin.

Section 5.13.3 further describes the way in which the BMPs in the FPA fulfill the forestry component of this TMDL.

5.8.2.2 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.

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[8] The estimated completion dates listed here differ from those dates listed in the MOU. Due to unforeseen circumstances the ODEQ and ODF have agreed to revise the dates.

The ODA drafted an AWQMP for the Hood River Basin with the assistance of a Local Advisory Committee (LAC) in 2000. The plan was adopted in February, 2001. Recognizing 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 revise the current AWQMP in 2003. 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 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 Western Hood Subbasin TMDL.

Section 5.13.4 summarizes ODA's plans for addressing existing and future TMDLs.

5.8.2.3 Transportation

The Oregon Department of Transportation (ODOT) has been issued an NPDES MS4 waste 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 Total Maximum Daily Load (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.

Section 5.13.5 summarizes ODOT's plans for addressing existing and future TMDLs.

5.8.2.4 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 superceded 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.

Section 5.13.6 further evaluates the Federal management plans as implementation plans for this TMDL.

5.8.2.5 Urban and Rural Sources

Responsible participants for implementing DMA specific implementation plans for urban and rural sources were identified in **Section 5.5** of this WQMP. Upon approval of the Western Hood Subbasin TMDL, it is ODEQ's expectation that identified, responsible participants will develop, submit to ODEQ, and implement individual water quality 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 5.7** of this WQMP.

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 issuance of Department or Commission Orders and other enforcement mechanisms.

Sections 5.13.7 – 5.13.10 summarize the implementation plans for the City of Hood River, Hood River County, Bonneville Power Administration, and the Middle Fork Irrigation District.

5.8.3 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 Western Hood Subbasin. 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 Western Hood Subbasin. 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, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

Field staff from the administrative agencies provide technical assistance and advice to individual landowners, watershed councils, local governments, and organizations interested in enhancing the subbasin. 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), and the Wildlife Habitat Incentive Program (WHIP).

5.9 MONITORING AND EVALUATION

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 and to use as we evaluate progress as described under Adaptive Management in **Section 2.3 TMDL Implementation**.

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 Western Hood Subbasin TMDL WQMP. There has been a significant temperature monitoring program implemented within the subbasin over the past ten years, with increased organization participation since 1997. This has been a joint effort between the ODEQ, the Hood River Watershed Group, the Mt. Hood National Forest, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Middle Fork Irrigation District, and Farmers Irrigation District. It is expected that this program will continue and that the information generated by each of the agencies/entities gathering data in the Western Hood Subbasin 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. If progress is not occurring then the appropriate management agency will be contacted with a request for action.

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.

5.10 PUBLIC INVOLVEMENT

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 and permit applications, future Western Hood Subbasin 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.

5.11 COSTS AND FUNDING

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 subbasin 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 Western Hood Subbasin.

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.

5.12 CITATION TO LEGAL AUTHORITIES

5.12.1 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.

5.12.2 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.

5.12.3 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.

5.12.4 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.

5.12.5 Oregon Administrative Rules

The following Oregon Administrative Rules provide numeric and narrative criteria for parameters of concern in the Western Hood Subbasin:

TMDL Parameter: Temperature
Applicable Rules: OAR 340-41-525(2)(b)(A)
OAR 340-41-026(3)(a)(D)
OAR 340-41-006(54) and (55)

5.12.6 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 340-041-0026, OAR 629-635-110, and OAR 340-041-0120.

5.12.7 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.

5.12.8 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.

5.13 IMPLEMENTATION PLANS

5.13.1 NPDES Permits

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 these permit limits, the following should be considered:

1. Permit limits must be set so that there is no measurable increase over the applicable temperature criterion, not actual background. This document recommends that staff use the equation displayed below as the basis for setting limits.
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 the intent of no measurable increase over the applicable temperature criterion.

3. The applicable temperature criterion and subsequent effluent limits apply during the critical periods as established above in **Section 4.5.4.4 Critical Period** of this TMDL. 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. Refer to OAR 340-41-120(11) and 340-41-525(1).
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 a measurable 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 no measurable increase provided that the criteria is not exceeded either in the receiving stream or any water body down stream. For proposed increased thermal discharges above current discharge levels, such increase must be subjected to an antidegradation and Threatened and Endangered Species analysis regardless of whether or not criteria will be exceeded.
6. In determining no measurable increase, 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. In addition, the permit writer should provide a safety factor of 1.1.
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 be protective of the environment and be compliant with the WLAs.

The following equation would be the basis for setting flow-based temperature limitations:

$$T_{eff} = 64+((1+((Q_{River}/4)/((SF \times Q_{Eff})/0.646)))/4)$$

Where: T_{eff} = 7 day average daily maximum temperature of the point source's effluent.
Q_{River} = receiving stream flow in cubic feet per second (cfs),
Q_{Eff} = point source effluent flow, in million gallons per day (MGD).
SF = safety factor of 1.10

Note: 64^o F is used in the equation for river temperature when salmonid rearing criteria applies. When spawning criteria applies, 55^o F is used.

The derivation of this equation is shown below. The attentive reader will note three variations from the above equation. First, the river flow is divided by 4. This is because the proposed TMDL does not propose to allow more than ¼ of the receiving stream to be used for dilution. In implementing the WLAs, the point source will be allowed either ¼ of the stream for dilution or that dilution provided in the regulatory mixing zone as defined in the permit for the point source, which ever is most stringent. Second, the effluent flow is divided by 0.646 in order to convert MGD to cubic feet per second (cfs) and achieve consistent units. Finally, effluent flow has been multiplied by a safety factor of 1.1 as a safety factor to provided added insurance that water quality standards will not be violated.

$$(Q_{River} \times T_{River}) + (Q_{Eff} \times T_{Eff}) = (Q_{River} + Q_{Eff}) \times (T_{River} + ¼)$$

$$\cancel{Q_R T_R} + Q_E T_E = \cancel{Q_R T_R} + Q_E T_R + Q_R/4 + Q_E/4$$

$$Q_E T_E = Q_E T_R + (Q_R+Q_E)/4$$

$$T_E = T_R + (Q_R + Q_E)/4 Q_E$$

$$T_E = T_R + (1 + Q_R/Q_E)/4$$

$$T_E = T_R + (1 + (Q_R/4)^*/Q_E)/4$$

* $Q_R/4$ refers to the mixing zone allowance of ¼ of the stream for dilution

$$T_E = T_R + (1 + (Q_R/4)/(SFxQ_E)^*)/4$$

* $SFxQ_E$ incorporates the safety factor of 1.1

$$T_E = T_R + (1 + (Q_R/4)/((SFxQ_E)/0.646^*))/4$$

* 0.646 incorporates the conversion factor for going from mgd to cfs

In addition to the equation, this TMDL has also represented maximum allowable effluent temperatures in **Table 22**. It should be noted that permit temperature limitations should not allow a discharge temperature above 77°F because this is the incipient lethal limit which is not allowed inside a mixing zone pursuant to Oregon Administrative Rule (OAR) 340-41-0525(4)(b)(A)(i).

The temperatures set forth in **Table 22** are calculated on the low end of both the river flow range and the high end of the discharge flow range so the numbers are conservative. This TMDL, however, does not contemplate the insertion of the Waste Load Allocation table into individual permits. Inclusion of the table would likely be too complicated as a regulatory tool. Instead, **Table 22** and the equation upon which it is based should be used as a framework to set the limits.

5.13.2 Section 401 Certification

The Section 401 Certification and Implementation Agreement issued on June 9, 2000 details the certification conditions under which the Powerdale Hydroelectric Project will be operated to comply with the load allocations established under this TMDL.

Table 22. Maximum Allowable 7 Day Average of Daily Maximum Effluent Temperatures for Hood River Dischargers

Subtable A: When Stream 7 Day Average Maximum Daily Temperature Exceeds 64^o F:						
River Flow Range cfs	Discharge Flow MGD					
	0.01 <0.099	0.10 <0.199	0.20 < 0.499	0.50 <0.99	1.00 < 1.99	2.00 < 2.99
0.10 < 0.99	64.29^{o}F	64.27	64.26	64.25	64.25	64.25
1.0 < 1.99	64.62	64.43	64.32	64.29	64.27	64.26
2.00 < 4.99	64.99	64.62	64.40	64.32	64.29	64.27
5.0 < 9.99	66.10	65.17	64.62	64.44	64.34	64.31
10.0 < 19.99	67.96	66.09	64.99	64.62	64.43	64.37
20.0 < 39.9	71.67	67.94	65.72	64.99	64.62	64.50
40.0 < 59.9	77.00	71.63	67.19	65.73	64.99	64.74
60.0 < 99.9	77.00	75.32	68.66	66.47	65.36	64.99
100 <199	77.00	77.00	71.61	67.96	66.09	65.48
200 <299	77.00	77.00	77.00	71.67	67.94	66.71
Subtable B: When Stream 7 Day Average Maximum Daily Temperature is less than 63^o F but exceeds 55^o F and salmonid spawning criteria applies:						
River Flow Range cfs	Discharge Flow MGD					
	0.01 <0.099	0.10 <0.199	0.20 < 0.499	0.50 <0.99	1.00 < 1.99	2.00 < 2.99
0.10 < 0.99	55.29^{o}F	55.27	55.26	55.25	55.25	55.25
1.0 < 1.99	55.62	55.43	55.32	55.29	55.27	55.26
2.00 < 4.99	55.99	55.62	55.40	55.32	55.29	55.27
5.0 < 9.99	57.10	56.17	55.62	55.44	55.34	55.31
10.0 < 19.99	58.96	57.09	55.99	55.62	55.43	55.37
20.0 < 39.9	62.67	58.94	56.72	55.99	55.62	55.50
40.0 < 59.9	70.08	62.63	58.19	56.73	55.99	55.74
60.0 < 99.9	77.00	66.32	59.66	57.47	56.36	55.99
100 <199	77.00	73.69	62.61	58.96	57.09	56.48
200 <299	77.00	77.00	69.96	62.67	58.94	57.71

5.13.3 Oregon Department of Forestry (Non-Federal Forest Lands)

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.

Currently, several streams within the Hood River watershed exceed the WQS's for temperature. The water quality impairment(s) in the Hood River watershed clearly do not result solely from current forestry activities. The proposed Hood River watershed TMDL demonstrates that urban and agriculture areas contribute significantly to water quality impairment within the subbasin. It is also important to note that historic forest practices such as splash dam activities 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.

As described below, ODF and DEQ 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. The information in the TMDL, as well as other monitoring data, will be an important part of the body of information used in determining the adequacy of the FPA.

Forest practices on non-federal land in Oregon are regulated under the FPA and implemented through administrative rules that are administered by the Oregon Department of Forestry (ODF). The Oregon Board of Forestry (BOF), in consultation with the Environmental Quality Commission (EQC), establish BMPs and other rules to ensure that, to the extent practicable, NPS pollution resulting from forest operations does not impair the attainment of water quality standards. With respect to the temperature standard, surface water temperature management plans are required according to OAR 340-041-0026 when temperature criteria are exceeded and the waterbody is designated as water-quality limited under Section 303(d) of the Clean Water Act. In the case of state and private forestlands, OAR 340-041-0120 identifies the FPA rules as the surface water management plan for forestry activities

ODF and DEQ 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.

ORS 527.765 Best management practices to maintain water quality.

(1) The State Board of Forestry shall establish best management practices and other rules applying to forest practices as necessary to insure that to the maximum extent practicable nonpoint source discharges of pollutants resulting from forest operations on forestlands do not impair the achievement and maintenance of water quality standards established by the Environmental Quality Commission for the waters of the state. Such best management practices shall consist of forest practices rules adopted to prevent or reduce pollution of waters of the state. Factors to be considered by the board in establishing best management practices shall include, where applicable, but not be limited to:
   (a) Beneficial uses of waters potentially impacted;
   (b) The effects of past forest practices on beneficial uses of water;
   (c) Appropriate practices employed by other forest managers;
   (d) Technical, economic and institutional feasibility; and
   (e) Natural variations in geomorphology and hydrology.

ORS 527.770 Good faith compliance with best management practices not violation of water quality standards; subsequent enforcement of standards.

A forest operator conducting, or in good faith proposing to conduct, operations in accordance with best management practices currently in effect shall not be considered in violation of any water quality standards. When the State Board of Forestry adopts new best management practices and other rules applying to forest operations, such rules shall apply to all current or proposed forest operations upon their effective dates.

There are currently extensive statutes and administrative rules that regulate forest management activities in the Western Hood Subbasin, which address the key water quality issues of stream temperatures, riparian aquatic functions, and sediment dynamics. The following is a list of specific administrative rules describing the purpose and goals of the FPA towards the achievement and maintenance of water quality standards established by the EQC.

OAR 629-635-100 - Water Protection Rules; Purpose and Goals

(3) The purpose of the water protection rules is to protect, maintain and, where appropriate, improve the functions and values of streams, lakes, wetlands, and riparian management areas. These functions and values include water quality, hydrologic functions, the growing and harvesting of trees, and fish and wildlife resources.

(4) The water protection rules include general vegetation retention prescriptions for streams, lakes and wetlands that apply where current vegetation conditions within the riparian management area have or are likely to develop characteristics of mature forest stands in a "timely manner." Landowners are encouraged to manage stands within riparian management areas in order to grow trees in excess of what must be retained so that the excess may be harvested.

(5) The water protection rules also include alternative vegetation retention prescriptions for streams to allow incentives for operators to actively manage vegetation where existing vegetation conditions are not likely to develop characteristics of mature conifer forest stands in a "timely manner."

(6) OARs 629-640-400 and 629-645-020 allow an operator to propose site-specific prescriptions for sites where specific evaluation of vegetation within a riparian management area and/or the condition of the water of the state is used to identify the appropriate practices for achieving the vegetation and protection goals.

(7) The overall goal of the water protection rules is to provide resource protection during operations adjacent to and within streams, lakes, wetlands and riparian management areas so that, while continuing to grow and harvest trees, the protection goals for fish, wildlife, and water quality are met.

(a) The protection goal for water quality (as prescribed in ORS 527.765) is to ensure through the described forest practices that, to the maximum extent practicable, nonpoint source discharges of pollutants resulting from forest operations do not impair the achievement and maintenance of the water quality standards.

(b) The protection goal for fish is to establish and retain vegetation consistent with the vegetation retention objectives described in OAR 629-640-000 (streams), OAR 629-645-000 (significant wetlands), and OAR 629-650-000 (lakes) that will maintain water quality and provide aquatic habitat components and functions such as shade, large woody debris, and nutrients.

OAR 629-640-000 - Vegetation Retention Goals for Streams; Desired Future Conditions

(1) The purpose of this rule is to describe how the vegetation retention measures for streams were determined, their purpose and how the measures are implemented. The vegetation retention requirements for streams described in OAR 629-640-100 through OAR 629-640-400 are designed to produced desired future conditions for the wide range of stand types, channel conditions, and disturbance regimes that exist throughout forestlands in Oregon.

(2) The desired future condition for streamside areas along fish use streams is to grow and retain vegetation so that, over time, average conditions across the landscape become similar to those of mature streamside stands. Oregon has a tremendous diversity of forest tree species growing along waters of the state and the age of mature streamside stands varies by species. Mature streamside stands are often dominated by conifer trees. For many conifer stands, mature stands occur between 80 and 200 years of stand age. Hardwood stands and some conifer stands may become mature at

an earlier age. Mature stands provide ample shade over the channel, an abundance of large woody debris in the channel, channel-influencing root masses along the edge of the high water level, snags, and regular inputs of nutrients through litter fall.

(3) The rule standards for desired future conditions for fish use streams were developed by estimating the conifer basal area for average unmanaged mature streamside stands (at age 120) for each geographic region. This was done by using normal conifer yield tables for the average upland stand in the geographic region, and then adjusting the basal area for the effects of riparian influences on stocking, growth and mortality or by using available streamside stand data for mature stands.

(4) The desired future condition for streamside areas that do not have fish use is to have sufficient streamside vegetation to support the functions and processes that are important to downstream fish use waters and domestic water use and to supplement wildlife habitat across the landscape. Such functions and processes include: maintenance of cool water temperature and other water quality parameters; influences on sediment production and bank stability; additions of nutrients and large conifer organic debris; and provision of snags, cover, and trees for wildlife.

(5) The rule standards for desired future conditions for streams that do not have fish use were developed in a manner similar to fish use streams. In calculating the rule standards, other factors used in developing the desired future condition for large streams without fish use and all medium and small streams included the effects of trees regenerated in the riparian management area during the next rotation and desired levels of instream large woody debris.

(6) For streamside areas where the native tree community would be conifer dominated stands, mature streamside conditions are achieved by retaining a sufficient amount of conifers next to large and medium sized fish use streams at the time of harvest, so that halfway through the next rotation or period between harvest entries, the conifer basal area and density is similar to mature unmanaged conifer stands. In calculating the rule standards, a rotation age of 50 years was assumed for even-aged management and a period between entries of 25 years was assumed for uneven-aged management. The long-term maintenance of streamside conifer stands is likely to require incentives to landowners to manage streamside areas so that conifer reforestation occurs to replace older conifers over time.

(7) Conifer basal area and density targets to produce mature stand conditions over time are outlined in the general vegetation retention prescriptions. In order to ensure compliance with state water quality standards, these rules include requirements to retain all trees within 20 feet and understory vegetation within 10 feet of the high water level of specified channels to provide shade.

(8) For streamside areas where the native tree community would be hardwood dominated stands, mature streamside conditions are achieved by retaining sufficient hardwood trees. As early successional species, the long-term maintenance of hardwood streamside stands will in some cases require managed harvest using site specific vegetation retention prescriptions so that reforestation occurs to replace older trees. In order to ensure compliance with state water quality standards, these rules include requirements in the general vegetation retention prescription to retain all trees within 20 feet and understory vegetation within 10 feet of the high water level of specified channels to provide shade.

(9) In many cases the desired future condition for streams can be achieved by applying the general vegetation retention prescriptions, as described in OAR 629-640-100 and OAR 629-640-200. In other cases, the existing streamside vegetation may be incapable of developing into the future desired conditions in a "timely manner." In this case, the operator can apply an alternative vegetation retention prescription described in OAR 629-640-300 or develop a site specific vegetation retention prescription described in OAR 629-640-400. For the purposes of the water protection rules, "in a timely manner" means that the trees within the riparian management area will meet or exceed the applicable basal area target or vegetation retention goal during the period of the next harvest entry that would be normal for the site. This will be 50 years for many sites.

(10) Where the native tree community would be conifer dominant stands, but due to historical events the stand has become dominated by hardwoods, in particular, red alder, disturbance is allowed to produce conditions suitable for the re-establishment of conifer. In this and other situations where the

existing streamside vegetation is incapable of developing characteristics of a mature streamside stand in a "timely manner," the desired action is to manipulate the streamside area and woody debris levels at the time of harvest (through an alternative vegetation retention prescription or site specific vegetation retention prescription) to attain such characteristics more quickly.

The Water Protection Rules are an important component of the rules that are designed to achieve and maintain water quality standards. The rules identify seven geographic regions and distinguishes between streams, lakes, and wetlands. The rules further distinguish each stream by size and type. Stream size is distinguished as small, medium, or large, based on average annual flow. Stream type is distinguished as fish use, domestic use, or neither.

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 23**). 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 23. 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 clearcut 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.

In terms of sediment issues specific to forest roads, there are BMPs within the FPA specifically designed to regulate road design, construction and maintenance. The bulk of the BMPs are directed at minimizing sediment delivery to channels. The primary goals of the road rules are to: (1) protect the water quality of streams, lakes, and wetlands; (2) protect fish and wildlife habitat; and (3) protect forest productivity.

The Board of Forestry revised several BMPs related to road design when the new Water Protection Rules were adopted in the fall of 1994. Significant changes made to the road construction rules include the following:

- The requirement for operators not to locate roads in riparian management areas, flood plains, or wetlands unless all alternative locations would result in greater resource damage.
- The requirement for operators to design stream crossings to both minimize fill size and minimize excavation of slopes near the channel. A mandatory written plan is required for stream crossing fills over 15 feet deep.

- The requirement to design stream crossing structures for the 50-year flow with no ponding, rather than the 25-year storm with no specification of allowable ponding.
- The requirement that stream crossing structures be passable by juvenile fish as well as adult fish.
- The requirement that fish must be able to access side channels.
- The requirement that stream structures constructed under these rules must be maintained for fish passage.

In determining the location of a new road, operators are required to avoid steep slopes, slides and areas next to channels or in wetlands to the extent possible. Existing roads should be used when possible, and stream crossings should be used only when essential. The design of the road grade must vary to fit the local terrain and the road width must be minimized. The operator must also follow specific guidelines for stream-crossing structures (listed above). Cross-drainage structures must be designed to divert water away from channels so that runoff intercepted by the road is dispersed onto the hillslope before reaching a channel. The specific method used is up to the operator, but the end result should be the dispersal of water running off of the road and the filtering of fine sediment before the water reaches waters of the state.

Construction and maintenance activities should be done during low water periods and when soils are relatively dry. Excavated materials must be placed where there is minimal risk of those materials entering waters of the state, and erodible surfaces must be stabilized. Landings must be built away from streams, wetlands and steep slopes.

Road maintenance is required on all active and inactive roads. Regardless of when a road was constructed, if the road has been used as part of an active operation after 1972, it is subject to all maintenance requirements within the current rules. Culverts must be kept open, and surface road drainage and adequate filtering of fine sediment must be maintained. If the road surface becomes unstable or if there is a significant risk of sediment running off of the road surface and entering the stream, road activity must be halted and the erodible area must be stabilized. Abandoned roads constructed prior to 1972 and not used for forest management since that time are not subject to Forest Practices regulatory authority.

All roads in use since 1972 must either be maintained or vacated by the operator. Vacated roads must be effectively barricaded and self-maintaining, in terms of diverting water away from streams and off of the former road surface, where erosion will remain unlikely. Methods for vacating roads include pulling stream-crossing fills, pulling steep side cast fills, and cross ditching. It is up to the landowner to choose between vacating a road and maintaining a road. If a road is not vacated, the operator is required to maintain the road under the current rules whether it is active or inactive, however they are not required to bring the design up to current standards outside of the normal maintenance and repair schedule.

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 and other projects will have final reports available in the spring of 2000, 2001 and beyond.

Voluntary measures are currently being implemented across the state under the Oregon Plan for Salmon and Watersheds (OPSW) to address water quality protection. These measures are designed to supplement the conifer stocking within riparian areas, increase large wood inputs to streams, and provide for additional shade. This is accomplished during harvest operations by (1) placing appropriate sized large wood within streams that meet parameters of gradient, width and existing wood in the channel; and (2) relocating in-unit leave trees in priority areas[9] to maximize their benefit to salmonids while recognizing operational constraints, other wildlife needs, and specific landowner concerns.

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[9] The Executive Order replaced the concept of “core areas” with “priority areas”. See (1)(f) of the Executive Order (p.5).

The measures include the following:

ODF 8S: Riparian Conifer Restoration

Forest practice rules have been developed to allow and provide incentives for the restoration of conifer forests along hardwood-dominated RMAs where conifers historically were present. This process enables sites capable of growing conifers to contribute conifer LWD in a timelier manner. This process will be modified to require an additional review process before the implementation of conifer restoration within core areas.

ODF 19S: Additional Conifer Retention along Fish-Bearing Streams in Core Areas

This measure retains more conifers in RMAs by limiting harvest activities to 25 percent of the conifer basal area above the standard target. This measure is only applied to RMAs containing a conifer basal area that is greater than the standard target.

ODF 20S: Limited RMA for Small Type N Streams in Core Areas

This measure provides limited 20 foot RMAs along all perennial or intermittent small Type N streams for the purpose of retaining snags and downed wood.

ODF 21S: Active Placement of Large Wood during Forest Operations

This measure provides a more aggressive and comprehensive program for placing large wood in streams currently deficient of large wood. Placement of large wood is accomplished following existing ODF/ODFW placement guidelines and determining the need for large wood placement is based upon a site-specific stream survey.

ODF 22S: 25 Percent In-unit Leave Tree Placement and Additional Voluntary Retention

This measure has one non-voluntary component and two voluntary components:

1) The State Forester, under statutory authority, will direct operators to place 25 percent of in-unit leave trees in or adjacent to riparian management areas on Type F and D streams.
2) The operator voluntarily locates the additional 75 percent in-unit leave trees along Type N, D or F streams, and
3) The State Forester requests the conifer component be increased to 75 percent from 50 percent.

ODF 61S: Analysis of "Rack" Concept for Debris Flows

OFIC members will conduct surveys to determine the feasibility and value of retaining trees along small type N streams with a high probability of debris flow in a "rack" just above the confluence with a Type F stream. The rack would extend from the RMA along the Type F stream up the Type N stream some distance for the purpose of retaining trees that have a high likelihood of delivery to the Type F stream.

ODF 62S: Voluntary No-Harvest Riparian Management Areas

Establishes a system to report and track, on a site-specific basis, when landowners voluntarily take the opportunity to retain no-harvest RMAs.

The voluntary management measures are implemented within priority areas. Several of the measures utilize in-unit leave trees and are applied in a “menu” approach to the extent in-unit leave trees are available to maximize their value to the restoration of salmonid habitat. The choice of menu measures is at the discretion of the landowner, but one or more of the measures is selected.

The measures can be described as either active restoration measures, or passive restoration measures that provide long-term large wood recruitment. Voluntary measures ODF 8S and 21S are active restoration activities. ODF 8S restores hardwood-dominated riparian areas back to a conifer-dominated condition, where appropriate, using a site-specific plan. Site-specific plans require additional consultation with the ODFW to minimize potential damage to the resource. They often result in conditions that are more protective of the resources than would occur without the site-specific plan. ODF 21S addresses large wood placement if stream surveys determine there is a need. Measures ODF 19S, 20S, 22S, and 62S provide future large wood recruitment through additional riparian protection. This additional protection is accomplished by retaining in-unit leave trees, snags, and downed wood within and along RMAs, and by changing the ratio of in-unit leave trees to 75 percent conifer.

The following application priority has been developed for OPSW voluntary measures for harvest units containing more than one stream type. The list establishes the general priority for placement of in-unit leave trees.

1) Small and medium Type F streams.
2) Non-fish bearing streams (Type D or Type N), especially small low-order headwater stream channels, that may affect downstream water temperatures and the supply of large wood in priority area streams.
3) Streams identified as having a water temperature problem in the ODEQ 303(d) list of water quality limited waterbodies, or as evidenced by other available water temperature data; especially reaches where the additional trees would increase the level of aquatic shade.
4) Potentially unstable slopes where slope failure could deliver large wood.
5) Large Type F streams, especially where low gradient, wide floodplains exist with multiple, braided meandering channels.
6) Significant wetlands and stream-associated wetlands, especially estuaries and beaver pond complexes, associated with a salmon core area stream.

The Oregon Plan also has voluntary measures addressing sediment issues related to forest roads. Many forest roads built prior to the development of the FPA or prior to the current BMPs continue to pose increased risk to fish habitat. Industrial forest landowners and state forest lands are currently implementing the Road Hazard Identification and Risk Reduction Project, measures ODF 1S and ODF 2S, to identify risks to salmon from roads and address those risks. The purposes of this project are:

1. Implement a systematic process to identify road-related risks to salmon and steelhead recovery.
2. Establish priorities for problem solution.
3. Implement actions to reduce road related risks.

The Road Hazard Identification and Risk Reduction Project is a major element of the Oregon Plan. The two major field elements of this project are (1) the surveying of roads using the Forest Road Hazard Inventory Protocol, and (2) the repairing of problem sites identified through the protocol. Road repairs conducted as a result of this project include improving fish passage, reducing washout potential, reducing landslide potential, and reducing the delivery of surface erosion to streams.

Roads assessed by this project include all roads on Oregon Forest Industry Council member forestland, plus some other industrial and non-industrial forestland, regardless of when they were constructed. Industrial forest landowners have estimated spending approximately $13 million a year, or $130 million over the next 10 years, on this project for the coastal ESUs alone. However, the effort is not limited to nor bound by this funding estimate. Funding for the implementation for this measure within the other ESUs will be reflective of road problems found.

Under ODF 2S, the State Forest Lands program has spent over $2.5 million during the last biennium (1997-1999) for the restoration of roads, replacement of culverts and other stream crossing structures damaged by the 1996 storm. State Forest Lands are also proposing to spend an additional $2.5 million dollars in each of the next two biennia to improve roads, including stream crossing structures. This effort will upgrade approximately 130 miles of road in each biennium.

In addition to ODF 1S & 2S, there are additional measures under the Oregon Plan that address road management concerns:

ODF 16S - Evaluation of the Adequacy of Fish Passage Criteria: Establish that the criteria and guidelines used for the design of stream crossing structures pass fish as intended under the goal.

ODF 34S - Improve Fish Passage BMPs on Stream Crossing Structures: Ensure that all new stream crossing structures on forestland installed or replaced after the fall of 1994 will pass both adult and juvenile fish upstream and down stream.

Adaptive Management Process

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.

In January of 1999 the Governor of Oregon signed Executive Order no. EO 99-01 that directed the Oregon Board of Forestry, with the assistance of an advisory committee, to determine to what extent changes to forest practices are needed to meet state water quality standards and protect and restore salmonids. The committee was directed to consider both regulatory and non-regulatory approaches to water quality protection. To carry out this charge, an ad hoc advisory committee developed four separate issue papers on the following topics:

- Fish passage restoration and water classification
- Forest roads
- Riparian functions
- Landslides

The committee represents diverse interests, including environmental, industrial, non-industrial, county, and public advocates. In addition to ODF technical staff, the ODEQ and ODFW have technical staff participating in the process. The committee expects to make recommendations to the Board of Forestry in early 2000. The Board will then consider the recommendations in determining whether revisions to the FPA and additional voluntary approaches are necessary consistent with ORS 527.710.

As the designated management agency (DMA) for water quality management on nonfederal forestlands, the ODF is also 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 and resulting Water Quality Management Plan (WQMP). The purpose of the MOU is also to guide coordination between the ODF and ODEQ regarding water quality limited streams on the 303d list. An evaluation of rule adequacy will be conducted (also referred to as a "sufficiency analysis") through a water quality parameter by parameter analysis. This statewide demonstration of forest practices rule effectiveness in the protection of water quality will address the following specific parameters and will be conducted in the following order[10]:

1) Temperature (draft report completed in Fall, 2000)
2) Sediment and turbidity (estimated draft report target completion date Fall, 2001)
3) Aquatic habitat modification (estimated date Spring, 2002)
4) Bio-criteria (estimated date Fall, 2002)
5) Other parameters (estimated date Spring, 2003)

These sufficiency analyses will be reviewed by peers and other interested parties prior to final release. The analyses will be designed to provide background information and assessments of BMP effectiveness in meeting water quality standards. Once the sufficiency analyses are completed, they 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.

[10] The estimated completion dates listed here differ from those dates listed in the MOU. Due to unforeseen circumstances the ODEQ and ODF have agreed to revise the dates.

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. This information will also be considered in making the FPA sufficiency determination. ODF and ODEQ will share their understanding of whether water quality impairment is due to current forest practices or the long-term legacy of historic forest management practices and/or other practices. The two agencies will then work together and use their determinations to figure out which condition exists (a, b, c, or d in the MOU). The MOU describes the appropriate response depending on which condition exists.

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 Western Hood Subbasin. This situation most closely resembles the scenario described under condition c of the ODF/DEQ 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 proposed Western Hood Subbasin TMDL will be completed in December, 2001. Data from the ODF/ODEQ shade study will be collected over the summer of 1999 and a final report will be completed in the summer of 2001, and information from the forest practices ad hoc committee advisory process is currently available. Information from these efforts, along with other relevant information provided by the ODEQ, will be considered in reaching a determination on whether the existing FPA BMPs meet water quality standards within the Western Hood Subbasin.

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.

5.13.4 Department of Agriculture

In November 1999, the Hood River Local Advisory Committee (LAC) was convened by ODA to develop the Hood River Agricultural Water Quality Management Area Plan (Area Plan). They were assisted by the Hood River Soil and Water Conservation District (SWCD). LAC members represented the interests of local landowners (orchardists, livestock growers, and small-acreage farmers), Hood River Growers-Shippers Association, fruit packing houses and agricultural businesses, irrigation districts, Hood River Watershed Group, fish biologists, Hood River County Board of Commissioners, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Hood River SWCD.

The Area Plan applies specifically to agricultural activities on all agricultural, rural, and forest lands within the Hood River Agricultural Water Quality Management Area that are not owned by the federal government or are Tribal Trust Lands. 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 Area Plan was adopted by the Department of Agriculture on March 2, 2001, prior to completion of the Western Hood Subbasin TMDL. 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 Hood River Area Plan will serve as the implementation plan for agriculture in the Western Hood Subbasin. 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.

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 streamflows, 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 *recommende*d, not *required*.

As specified under the MOA between ODA and ODEQ (1998), ODA and the Hood River LAC will revise the Area Plan every two years. In this review the adopted rules will need to be quantitatively evaluated in terms of the load allocations and surrogates in this TMDL and in terms of whether the rules provide a reasonable assurance that the TMDL loads will be attained.

5.13.5 Department of Transportation

The Oregon Department of Transportation (ODOT) plan addresses the requirements of a Total Maximum Daily Load (TMDL) allocation for pollutants associated with the ODOT system. This statewide approach for an ODOT TMDL watershed management plan would address specific pollutants, but not specific watersheds. Instead, this plan would demonstrate how ODOT incorporates water quality into project development, construction, and operations and maintenance of the state and federal transportation system, thereby meeting the elements of the National Pollutant Discharge Elimination System (NPDES) program, and the TMDL requirements.

ODOT has partnered with ODEQ in the development of several watershed management plans. By presenting a single, statewide, management plan, ODOT:

- 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 TMDL 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 can only be 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 anadramous 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.

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 effect 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.

Requirements of a TMDL Implementation Plan
Designated Management Agencies appointed by ODEQ are required to develop a watershed management plan once the TMDL for the watershed is defined. EPA and ODEQ have listed the following requirements as essential elements of a watershed TMDL Implementation plan:

1) Proposed management measures tied to attainment of the TMDL. This will include a list of sources by category or sub-category of activity;
2) Timeline for implementation, including a schedule for revising permits, and a schedule for completion of measurable milestones (including appropriate incremental, measurable water quality targets and milestones for implementing control actions);
3) Timeline for attainment of water quality standards, including an explanation of how implementation is expected to result in the attainment of water quality standards;
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 parties responsible for monitoring, and a plan and schedule for revision of the TMDL and/or implementation plan;
7) Public involvement;
8) Maintenance of effort over time;
9) Discussion of cost and funding;
10) Citation to legal authorities under which the implementation will be conducted.

ODEQ will address these requirements as follows:

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 employees. 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.

The Oregon Transportation Commission and the Oregon State Legislature approve the ODOT budget.

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.

5.13.6 Federal Forest Lands

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 superceded 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. The Mt. Hood National Forest has also developed two Watershed Analyses: West Fork of Hood River Watershed Analysis (1996a) and East Fork Hood River and Middle Fork Hood River Watershed Analyses (1996b).

In its review of these management plans, ODEQ believes that they meet the requirements of a TMDL management plan (**Section 5.8.2 Reasonable Assurance – Nonpoint Sources**). 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.

- Fish-bearing streams – 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.

- Permanently flowing nonfish-bearing streams – 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.

- Lakes and natural ponds – 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.

- Constructed ponds and reservoirs and wetlands greater than one acre – 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.

- Seasonally flowing or intermittent streams, wetlands less than one acre and unstable and potentially unstable areas – 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 *West Fork of the Hood 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. Since portions of the West Fork watershed are prone to mass wasting, Riparian Reserve widths often increased significantly, particularly in the upper Lake Branch and West Fork subwatersheds. Site potential tree heights identified for the Green Point, Lake Branch and West Fork subwatersheds are consistent with the system potential tree heights identified for the "Western Hemlock" zone in this TMDL (**Table 8**, pages 46 and 47).

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 both of the watershed analyses developed for the Hood River Watershed (USDA Forest Service 1996a and 1996b).

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.

5.13.7 City of Hood River

The city of Hood River's Comprehensive Plan (1983) was submitted by the City of Hood River to be reviewed as an implementation plan. Because the Plan was developed prior to the completion of this TMDL, it does not specifically address the ten elements described in **Section 5.8.2 Reasonable Assurance – Nonpoint Sources**.

Goal 5 of the Plan references the City's goal "*to conserve open space and protect natural, historic, and scenic resources*". The City then lists several Policies to support this goal which also appear to be supportive of the maintenance of system potential riparian communities. These Policies include:

5. The riparian habitat along the Hood River and Indian Creek floodplains will be protected and preserved, both as fish and wildlife habitat, and as an open space resource.
9. A major consideration in land conservation and development decisions shall be the carrying capacity of the air, land, and water resources.
14. Wherever possible, areas of standing trees and shrubs will remain connected, particularly along natural drainage courses.

An Implementation Strategy is also listed under Goal 5 which supports the surrogates defined in this TMDL:

4. Natural vegetation shall be preserved for a minimum of 50 feet on either side along the Hood River, Indian Creek, and where applicable, the Columbia River.

Similarly, under Goal 6 (Air, Water, and Land Resources Quality) several Water Policies and Water Implementation Strategies are listed which state that the "State water quality laws will be followed" and that "The City of Hood River shall support and assist in the enforcement of state water quality laws".

While the policies and implementation strategies described above refer to the importance of protecting riparian communities, ODEQ believes that the Comprehensive Plan does not adequately address the requirements of an implementation plan for the TMDL. As such, the City of Hood River will be requested to submit an implementation plan to ODEQ within one year of the approval of this TMDL by the U.S. EPA. The implementation plan will need to address the ten elements outlined in **Section 5.8.2 Reasonable Assurance – Nonpoint Sources**.

5.13.8 Hood River County

The Hood River County Zoning Ordinance (1984) was submitted by Hood River County to be reviewed for its adequacy in addressing TMDL load allocations and surrogate measures. Because the Zoning Ordinance was developed prior to the completion of this TMDL, it does not specifically address the ten elements described in **Section 5.8.2 Reasonable Assurance – Nonpoint Sources**. The Director of the Hood River County Planning and Community Development Office also indicated that Hood River County still needs to complete the Goal 5 tasks associated with the protection of riparian areas.

The current Hood River County Zoning Ordinance appears to provide a modicum of riparian protection, although the protection is primarily focused on providing stream setbacks for new building construction. An example of the language used to provide for these setbacks is excerpted below from the "Site Development Standards" Section under Article 5 – Forest Zone:

C. Setback from streams: New buildings shall be set back 100 feet from ordinary high water line except for those uses in conjunction with a water related or water dependent use. Exceptions to this requirement shall be allowed when affirmative findings through documentation are made and submitted to the Planning Director to satisfy the following: (1) the proposal would provide better protection, maintenance and retention of riparian vegetation than would occur by observance of the setback requirement; (2) the protection, maintenance and retention of riparian vegetation are not applicable to the proposal. If a conflict is noted among setback requirements, the more restrictive will be used.

While the Zoning Ordinance refers to the importance of providing building setbacks from streams, ODEQ believes that it does not adequately address the requirements of an implementation plan for the TMDL. As such, Hood River County will be requested to submit an implementation plan to ODEQ within one year of the approval of this TMDL by the U.S. EPA. The implementation plan will need to address the ten elements outlined in **Section 5.8.2 Reasonable Assurance – Nonpoint Sources**.

5.13.9 Bonneville Power Administration

BPA does not have an implementation plan developed specifically to meet the Load Allocations as identified in this TMDL. BPA's riparian vegetation management is addressed in the Bonneville Power Administration Transmission System Vegetation Management Program Final Environmental Impact Statement (ODE/EIS-0285) published in May, 2000. The EIS can be accessed on the BPA website at *http://www.efw.bpa.gov*. BPA submitted this EIS to ODEQ to be reviewed as their implementation plan.

BPA is required by law (National Electrical Safety Code [NESC], 1997) to manage vegetation in their right-of-way corridors such that: the vegetation does not interfere with workers while maintaining, upgrading or repairing transmission lines; and the vegetation must not create a safety hazard. If vegetation is too close to a transmission line, electricity can "arc over" and can create a fire or injure or kill anyone. The NESC requires BPA to remove any trees or other vegetation that is a hazard to the power system or that could become a hazard to the power system (BPA, 2000). In general, BPA limits tree growth in rights-of-way to 3 meters (10 feet) (BPA, 2000).

Although providing system potential riparian shade (as identified in this TMDL) is not specifically addressed in the EIS, it appears that BPA plans to promote the growth of riparian vegetation as much as possible. In the EIS, BPA considered three sets of alternatives that could be combined to provide an overall right-of-way management program. The alternatives selected were: (1) Promotion of Low-growing Plant Communities (Right-of-way Management Approach); (2) Manual, Mechanical, Biological, Herbicide - *spot, localized, broadcast + aerial application* (Right-of-way Methods Package); and (3) Any Vegetation (Right-of-way Vegetation Selection).

The Right-of-Way Management Approach selected (Promotion of Low-growing Plant Communties) seeks to promote the establishment of low-growing plant communities on the right-or-way to "out-compete" trees and tall-growing brush. This would be accomplished by protecting low-growing plants from disturbance during maintenance and from competing tall-growing vegetation, so that low-growers can establish and propagate (BPA, 2000). Under the mitigation measures described in the sections on "Water Resources" (Chapter 3, Site-specific Planning Steps) and "Water" (Chapter 6, Environmental Consequences), BPA lists "leave vegetation intact, where possible” as a measure to help protect water resources (BPA, 2000). In Chapter 6 reducing shading and increasing water temperatures is described as a general impact of vegetation management. BPA also identifies that the likely impacts of rights-of-way on stream temperatures are minimal because the rights-or-way are linear - usually less than 100 meters (about 300 feet) of any stream is typically affected.

ODEQ recognizes that the EIS submitted by BPA does not address all of the items typically required of a DMA (**Section 5.8.2 Reasonable Assurance - Nonpoint Sources**), such as providing a reasonable assurance that load allocations will be met. In fact, the obligations of the TMDL to provide system potential shade run counter to the obligations of the NESC to ensure that the transmission lines do not create a safety hazard. Because the right-of-way corridors typically impact only a short reach of any given stream (less than 100 meters), ODEQ believes the riparian protection provided in the BPA EIS, although less than system potential, will not significantly adversely affect water quality attainment of standards. Further, ODEQ believes that, in this case, strict adherence to the Load Allocations (system potential shade) is subservient to the needs of public safety.

Recognizing the safety restraints that limit BPA’s ability to allow system potential vegetation to mature, ODEQ still encourages BPA to comply with the practices to protect riparian vegetation as described in the EIS and to promote the growth of healthy riparian communities as much as possible. ODEQ is aware of situations in the past where BPA appeared to have clear-cut all trees and shrubs growing in a riparian corridor. Such actions do not promote the maintenance of riparian shade nor do they meet the underlying tenor of the EIS which recognizes the importance of protecting natural communities where possible.

5.13.10 Middle Fork Irrigation District

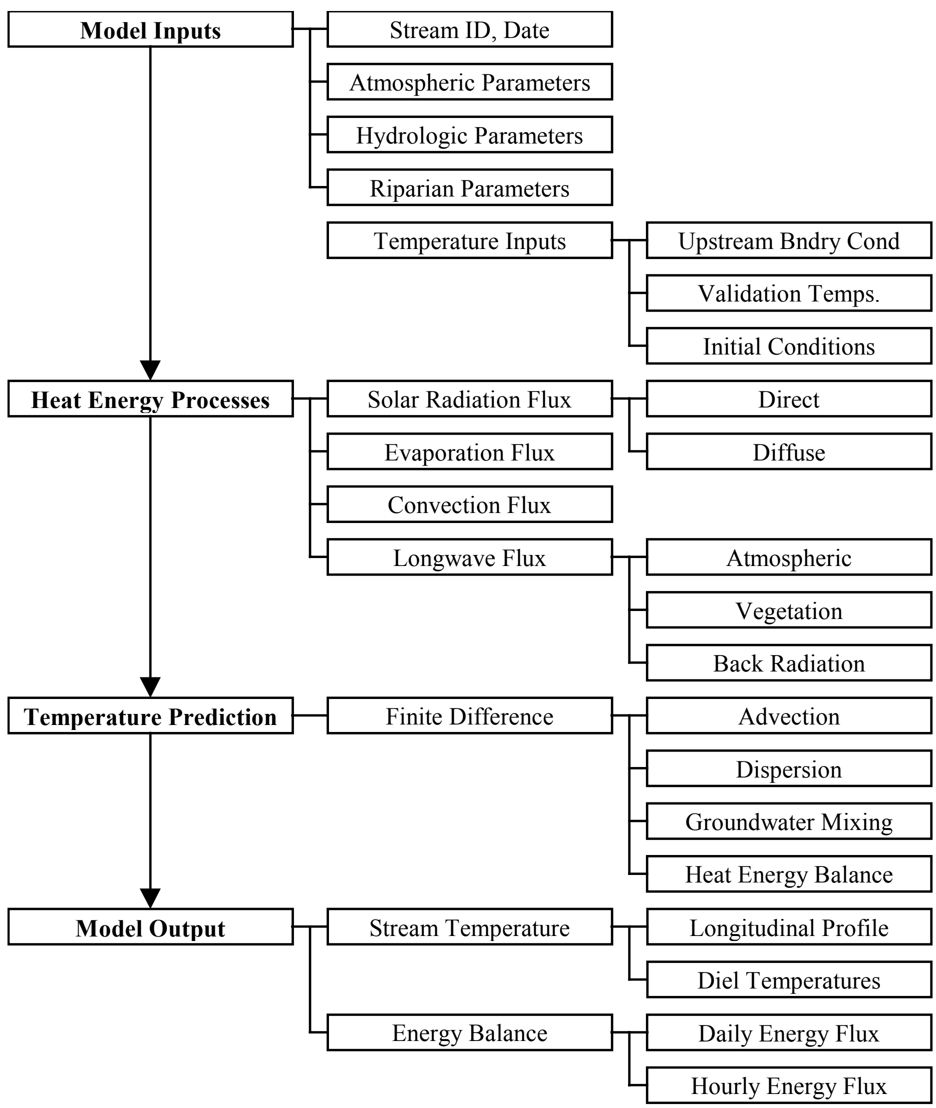
Within 60 days following approval of this TMDL by U.S. E.P.A., ODEQ will request MFID to enter into a Mutual Agreement and Order (MAO) with ODEQ that will include a schedule for developing and implementing a reservoir water quality management plan to control stream temperature impacts of Laurance Lake consistent with its established load allocation. The schedule would likely include provisions for collection of additional temperature data, creation of a model to simulate temperature management strategies, development of a proposed plan to control temperature, and implementation of a ODEQ-approved operational plan. This operational plan will be considered a temperature management plan as specified by Oregon Administrative Rule (OAR) 340-41-026(3).

CHAPTER 6 - ANALYTICAL FRAMEWORK

6.1 CONCEPTUAL MODEL

At any particular instant of time, a defined stream reach is capable of sustaining a particular water column temperature. Stream temperature change that results within a defined reach is explained rather simply. The temperature of a parcel of water traversing a stream/river reach enters the reach with a given temperature. If that temperature is greater than the energy balance is capable of supporting, the temperature will decrease. If that temperature is less than energy balance is capable of supporting, the temperature will increase. Stream temperature change within a defined reach, is induced by the energy balance between the parcel of water and the surrounding environment and transport of the parcel through the reach. The temperature model utilized by ODEQ to estimate stream network thermodynamics and hydrology is Heat Source (Boyd, 1996). It was developed in 1996 as a Masters Thesis at Oregon State University in the Departments of Bioresource Engineering and Civil Engineering. DEQ currently supports the Heat Source methodology and computer programming. The general progression of the model is outlined in the model flow chart, **Figure 59**.

Figure 59. Temperature Model Flow Chart



It takes time for the water parcel to traverse the longitudinal distance of the defined reach, during which the energy processes drive stream temperature change. At any particular instant of time, water that enters the upstream portion of the reach is never exactly the temperature that is supported by the defined reach. And, as the water is transferred downstream, heat energy and hydraulic processes that are variable with time and space interact with the water parcel and induce water temperature change. The described modeling scenario is a simplification; however, understanding the basic processes in which stream temperatures change occurs over the course of a defined reach and period of time is essential.

6.2 GOVERNING EQUATIONS

6.2.1 Heat Energy Processes

Water temperature change is a function of the total heat energy transfer in a discrete volume and may be described in terms of energy per unit volume. It follows that large volume streams are less responsive to temperature change, and conversely, low flow streams will exhibit greater temperature sensitivity.

Equation 1. Heat Energy per Unit Volume,

$$\Delta T_w = \frac{\Delta Heat \quad Energy}{Volume}$$

Water has a relatively high heat capacity ($c_w = 10^3$ cal kg^{-1} K^{-1}) (Satterlund and Adams 1992). Conceptually, water is a heat sink. Heat energy that is gained by the stream is retained and only slowly slowly released back to the surrounding environment, represented by the cooling flux ($\Phi_{cooling}$). Heating periods occur when the net energy flux (Φ_{total}) is positive: ($\Phi_{heating} > \Phi_{cooling}$).

Equation 2. Heat Energy Continuity,

$$\Phi_{total} = \Phi_{heating} - \Phi_{cooling}$$

In general, the net energy flux experienced by all stream/river systems follows two cycles: a seasonal cycle and a diurnal cycle. In the Pacific Northwest, the seasonal net energy cycle experiences a maximum positive flux during summer months (July and August), while the minimum seasonal flux occurs in winter months (December and January). The diurnal net energy cycle experiences a daily maximum flux that occurs at or near the sun's zenith angle, while the daily minimum flux often occurs during the late night or the early morning. It should be noted, however, that meteorological conditions are variable. Cloud cover and precipitation significantly alter the energy relationship between the stream and its environment.

The net heat energy flux (Φ_{total}) consists of several individual thermodynamic energy flux components, namely: solar radiation (Φ_{solar}), long-wave radiation ($\Phi_{longwave}$), conduction ($\Phi_{conduction}$), groundwater exchange ($\Phi_{groundwater}$) and evaporation ($\Phi_{evaporation}$).

Equation 3. Net Heat Energy Continuity,

$$\Phi_{total} = \Phi_{solar} + \Phi_{longwave} + \Phi_{convection} + \Phi_{evaporation} + \Phi_{streambed} + \Phi_{groundwater}$$

Stream temperature is an expression of heat energy per unit volume, which in turn is an indication of the rate of heat exchange between a stream and its environment. The heat transfer processes that control stream temperature include solar radiation, longwave radiation, convection, evaporation and bed conduction (Wunderlich, 1972; Jobson and Keefer, 1979; Beschta and Weatherred, 1984; Sinokrot and

Stefan, 1993; Boyd, 1996). With the exception of solar radiation, which only delivers heat energy, these processes are capable of both introducing and removing heat from a stream. **Figure 60** displays heat energy processes that solely control heat energy transfer to and from a stream.

When a stream surface is exposed to midday solar radiation, large quantities of heat will be delivered to the stream system (Brown 1969, Beschta et al. 1987). Some of the incoming solar radiation will reflect off the stream surface, depending on the elevation of the sun. All solar radiation outside the visible spectrum (0.36μ to 0.76μ) is absorbed in the first meter below the stream surface and only visible light penetrates to greater depths (Wunderlich, 1972). Sellers (1965) reported that 50% of solar energy passing through the stream surface is absorbed in the first 10 cm of the water column. Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al., 1982; Brown, 1983; Beschta et al., 1987). The principal source of heat energy delivered to the water column is solar energy striking the stream surface directly (Brown 1970). Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. The ability of riparian vegetation to shade the stream throughout the day depends on vegetation height, width, density and position relative to the stream, as well as stream aspect.

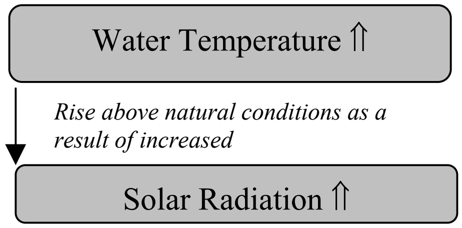
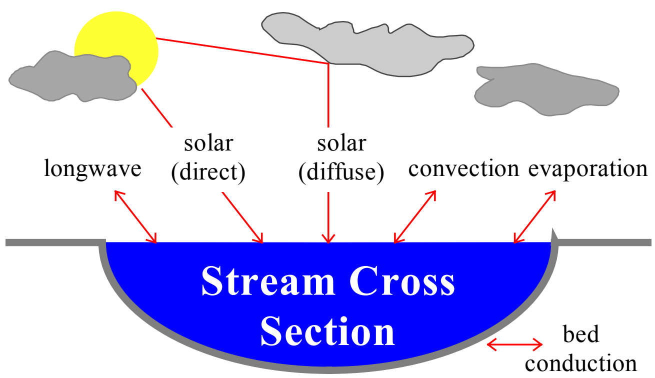


Figure 60. Heat Energy Processes



Both the atmosphere and vegetation along stream banks emit longwave radiation that can heat the stream surface. Water is nearly opaque to longwave radiation and complete absorption of all wavelengths greater than 1.2μ occurs in the first 5 cm below the surface (Wunderlich, 1972). Longwave radiation has a cooling influence when emitted from the stream surface. The net transfer of heat via longwave radiation usually balances so that the amount of heat entering is similar to the rate of heat leaving the stream (Beschta and Weatherred, 1984; Boyd, 1996).

Evaporation occurs in response to internal energy of the stream (molecular motion) that randomly expels water molecules into the overlying air mass. Evaporation is the most effective method of dissipating heat from water (Parker and Krenkel, 1969). As stream temperatures increase, so does the rate of evaporation. Air movement (wind) and low vapor pressures increase the rate of evaporation and accelerate stream cooling (Harbeck and Meyers, 1970).

Convection transfers heat between the stream and the air via molecular and turbulent conduction (Beschta and Weatherred, 1984). Heat is transferred in the direction of warmer to cooler. Air can have a warming influence on the stream when the stream is cooler. The opposite is also true. The amount of convective heat transfer between the stream and air is low (Parker and Krenkel, 1969; Brown, 1983). Nevertheless, this should not be interpretted to mean that air temperatures do not affect stream temperature.

Depending on streambed composition, shallow streams (less than 20 cm) may allow solar radiation to warm the streambed (Brown, 1969). Large cobble (> 25 cm diameter) dominated streambeds in shallow streams may store and conduct heat as long as the bed is warmer than the stream. Bed conduction may cause maximum stream temperatures to occur later in the day, possibly into the evening hours. Conduction may also occur between groundwater, tributary, or point source inputs and the stream. The rate of conduction between two volumes of water depends upon 1) their relative volumes and 2) the temperatures of each water volume.

The instantaneous heat transfer rate experienced by the stream is the summation of the individual processes:

$$\Phi_{Total} = \Phi_{Solar} + \Phi_{Longwave} + \Phi_{Evaporation} + \Phi_{Convection} + \Phi_{Conduction}.$$

Solar Radiation (Φ_{Solar}) is a function of the solar angle, solar azimuth, atmosphere, topography, location and riparian vegetation. Simulation is based on methodologies developed by Ibqal (1983) and Beschta and Weatherred (1984). *Longwave Radiation* ($\Phi_{Longwave}$) is derived by the Stefan-Boltzmann Law and is a function of the emissivity of the body, the Stefan-Boltzmann constant and the temperature of the body (Wunderlich, 1972). *Evaporation* ($\Phi_{Evaporation}$) relies on a Dalton-type equation that utilizes an exchange coefficient, the latent heat of vaporization, wind speed, saturation vapor pressure and vapor pressure (Wunderlich, 1972). *Convection* ($\Phi_{Convection}$) is a function of the Bowen Ratio and terms include atmospheric pressure, and water and air temperatures. *Bed Conduction* ($\Phi_{Conduction}$) simulates the theoretical relationship ($\Phi_{Conduction} = K \cdot dT_b / dz$), where calculations are a function of thermal conductivity of the bed (K) and the temperature gradient of the bed (dT_b/dz) (Sinokrot and Stefan, 1993). Bed conduction is solved with empirical equations developed by Beschta and Weatherred (1984).

The ultimate source of heat energy is solar radiation both diffuse and direct. Secondary sources of heat energy include long-wave radiation, from the atmosphere and streamside vegetation, streambed conduction and in some cases, groundwater exchange at the water-stream bed interface. Several processes dissipate heat energy at the air-water interface, namely: evaporation, convection and back radiation. Heat energy is acquired by the stream system when the flux of heat energy entering the stream is greater than the flux of heat energy leaving. The net energy flux provides the rate at which energy is gained or lost per unit area and is represented as the instantaneous summation of all heat energy components.

6.2.2 Non-Uniform Heat Energy Transfer Equation

The rate change in stream temperature is driven by the heat energy flux (Φ_i). It is easily shown that a defined volume of water will attain a predictable rate change in temperature, providing an accurate prediction of the heat energy flux. The rate change in stream temperature (T) is calculated as shown in **Equation 4**.

Equation 4. Rate Change in Temperature Caused by Heat Energy Thermodynamics,

$$\frac{\partial T}{\partial t} = \left(\frac{Ax_i \cdot \Phi_i}{\rho \cdot c_p \cdot V_i} \right),$$

Which reduces to,

$$\frac{\partial T}{\partial t} = \left(\frac{\Phi_i}{\rho \cdot c_p \cdot D_i} \right).$$

Where,

Ax_i:	cross-sectional area (m^2)
C_p:	specific heat of water (cal $kg^{-1} \cdot {}^oC^{-1}$)
D_i:	average stream depth (m)
t:	time (s)
T:	Temperature (^oC)
V_i:	volume (m^3)
Φ_i:	total heat energy flux (cal $m^{-2} \cdot s^{-1}$)
ρ:	density of water (kg/m^3)

Advection (U_x) redistributes heat energy in the positive longitudinal direction. No heat energy is lost or gained by the system during advection, and instead, heat energy is transferred downstream as a function of flow velocity. In the case where flow is uniform, the rate change in temperature due to advection is expressed in the first order partial differential equation below.

Equation 5. Rate Change in Temperature Caused by Advection,

$$\frac{\partial T}{\partial t} = -U_x \cdot \frac{\partial T}{\partial x}$$

Dispersion processes occur in both the upstream and downstream direction along the longitudinal axis. Heat energy contained in the system is conserved throughout dispersion, and similar to advection, heat energy is simply moved throughout the system. The rate change in temperature due to dispersion is expressed in the second order partial differential equation below.

Equation 6. Rate Change in Temperature Caused by Dispersion,

$$\frac{\partial T}{\partial t} = D_L \cdot \frac{\partial^2 T}{\partial x^2}$$

The dispersion coefficient (D_L) may be calculated by stream dimensions, roughness and flow. In streams that exhibit high flow velocities and low longitudinal temperature gradients, it may be assumed that the system is advection dominated and the dispersion coefficient may be set to zero (Sinokrot and Stefan 1993). In the event that dispersion effects are considered significant, the appropriate value for the dispersion coefficient can be estimated with a practical approach developed and employed in the QUAL 2e model (Brown and Barnwell 1987). An advantage to this approach is that each parameter is easily measured, or in the case of Manning's coefficient (n) and the dispersion constant (K_d), estimated.

Equation 7. Physical Dispersion Coefficient,

$$D_L = C \cdot K_d \cdot n \cdot U_x \cdot D^{\frac{5}{6}}$$

Where,

C:	Unit conversion
	C = 3.82 for English units
	C = 1.00 for Metric units
D:	Average stream depth (m)
D_L:	Dispersion coefficient (m^2/s)
K_d:	Dispersion constant
n:	Manning's coefficient
U_x:	Average flow velocity (m/s)

The simultaneous non-uniform one-dimensional transfer of heat energy is the summation of the rate change in temperature due to heat energy thermodynamics, advection and dispersion. Given that the stream is subject to steady flow conditions and is well mixed, transverse temperature gradients are negligible (Sinokrot and Stefan 1993). An assumption of non-uniform flow implies that cross-sectional area and flow velocity vary with respect to longitudinal position. The following second ordered parabolic partial differential equation describes the rate change in temperature for non-uniform flow.

Equation 8. Non-Uniform One-dimensional Heat Energy Transfer,

$$\frac{\partial T}{\partial t} = -U_x \cdot \frac{\partial T}{\partial x} + D_L \cdot \frac{\partial^2 T}{\partial x^2} + \frac{\Phi}{c_p \cdot \rho \cdot D_i}$$

$$\text{Steady Flow: } \frac{\partial U_x}{\partial t} = 0$$

$$\text{Non-Uniform Flow: } \frac{\partial U_x}{\partial x} \neq 0$$

The solution to the *one-dimensional heat energy transfer equation* is essentially the summation of thermodynamic heat energy exchange between the stream system and the surrounding environment and physical processes that redistribute heat energy within the stream system. It is important to note that all heat energy introduced into the stream is conserved, with the net heat energy value reflected as stream temperature magnitude. Further, heat energy is transient within the stream system, due to longitudinal transfer of heat energy (i.e., advection and dispersion). The net heat energy flux (Φ) is calculated at every distance step and time step based on physical and empirical formulations developed for each significant energy component. The dispersion coefficient (D_L) is assumed to equal zero.

6.2.3 Boundary Conditions and Initial Values

The temperatures at the upstream boundary (i_o) for all time steps (t_o ,t_1,..., t_{M-1}, t_M) are supplied by the upstream temperature inputs. The downstream boundary temperature at longitudinal position i_{n+1} is assumed to equal that of i_n with respect to time t. Initial values of the temperatures at each distance node (i_o ,i_1,..., i_{N-1}, i_N) occurring at the starting time (t_o) can be input by the model user or assumed to equal the boundary condition at time t_o.

6.2.4 Spatial and Temporal Scale

The lengths of the defined reaches are 100 feet. The temperature model is designed to analyze and predict stream temperature for one day and is primarily concerned with daily prediction of the diurnal energy flux and resulting temperatures on August 6, 1998. Prediction time steps are limited by stability considerations for the finite difference solution method.

6.3 INPUT PARAMETERS

Data collected during this TMDL effort has allowed the development of temperature simulation methodology that is both spatially continuous and spans full day lengths (diurnal). Detailed spatial data sets have been developed for the following parameters:

- ✓ River and Tributary Digital Mapping at 1:5,000 scale
- ✓ Riparian Vegetation Species, Size and Density Digital Mapping at 1:3,000 scale
- ✓ West, East and South Topographic Shade Angles calculations at 1:5,000 scale
- ✓ Stream Elevation and Gradient at 1:5,000 scale,
- ✓ Hydrology Developed from Field Data - Spatially Continuous Flow, Wetted Width, Velocity and Depth Profiles.

All input data is longitudinally referenced in the model allowing spatial and/or continuous inputs to apply to certain zones or specific river segments.

6.3.1 Spatial Input Parameters

Longitudinal Distance (meters): Defines the modeled reaches for which spatial input parameters reference. Model reaches are 100 feet each, are derived from DOQ 1:5000 river layer digitized from Digital Orthophoto Quarter Quads (DOQs) and geo-referenced color aerial photographs, and are measured in the downstream direction.

Elevation (meters): Sampled for each model reach either from Digital Raster Graphic (DRG) or Digital Elevation Model (DEM).

Gradient (%): Is the difference between the upstream and downstream elevations divided by the reach length.

Bedrock (%): The percent of streambed material that has a diameter of 25 cm or greater. Values are derived from stream survey data or assumed where data is limited.

Aspect (decimal degrees from North): Calculated for each reach break and represents the direction of stream flow.

Flow Volume (cubic meters per second): Measured by ODEQ with standard USGS protocols with interpolation between flow measurement sites, while taking into account known water withdrawals and inputs.

Flow Velocity (meters per second): Derived from Manning's equation and Leopold power functions calibrated to measured flow velocity data.

Wetted Width (meters): Derived from Manning's equation and Leopold power functions calibrated to measured wetted width data.

Average Depth (meters): Derived from Manning's equation and Leopold power functions calibrated to measured average depth data. Calculated based on assuming rectangular channel.

Near-Stream Disturbance Zone Width (meters): Based upon ODEQ field measurements and aerial photograph interpretation.

Channel Incision (meters): Depth of the active channel below riparian terrace or floodplain. Based on ODEQ field measurements.

Riparian Height (meters): Determined from the professional expertise of foresters with ODF and the Mt. Hood National Forest and from ODEQ field observations.

Canopy Density (%): Determined from the professional expertise of foresters with ODF and the Mt. Hood National Forest, from ODEQ field observations and from aerial photograph interpretation.

Riparian Overhang (meters): Distance of riparian vegetation intrusion over Near-Stream Disturbance Zone. Based on ODEQ field observations.

Topographic Shade Angle (decimal degrees): The angle made between the stream surface and the highest topographic features to the west, east and south as calculated from DEM at each stream reach.

6.3.2 Continuous Input Parameters

Wind Speed (meters per second): Hourly values measured at the U.S. Bureau of Reclamation (BOR) Agrimet Station in Hood River.

Relative Humidity (%): Hourly values measured at the BOR Agrimet Station in Hood River.

Air Temperature (^{o}C): Hourly values measured at the BOR Agrimet Station in Hood River.

Stream Temperature (^{o}C): Hourly values measured by ODEQ, Mt. Hood National Forest, Hood River Watershed Group, Middle Fork Irrigation District, Farmer’s Irrigation District, and the Confederated Tribes of the Warm Springs reservation of Oregon.

Tributary Temperature (^{o}C): Hourly values measured by ODEQ, Mt. Hood National Forest, Hood River Watershed Group, Middle Fork Irrigation District, Farmer’s Irrigation District, and the Confederated Tribes of the Warm Springs reservation of Oregon.

Tributary/Flow Volume (cubic meters per second): Measured flow volumes for all major tributaries.

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