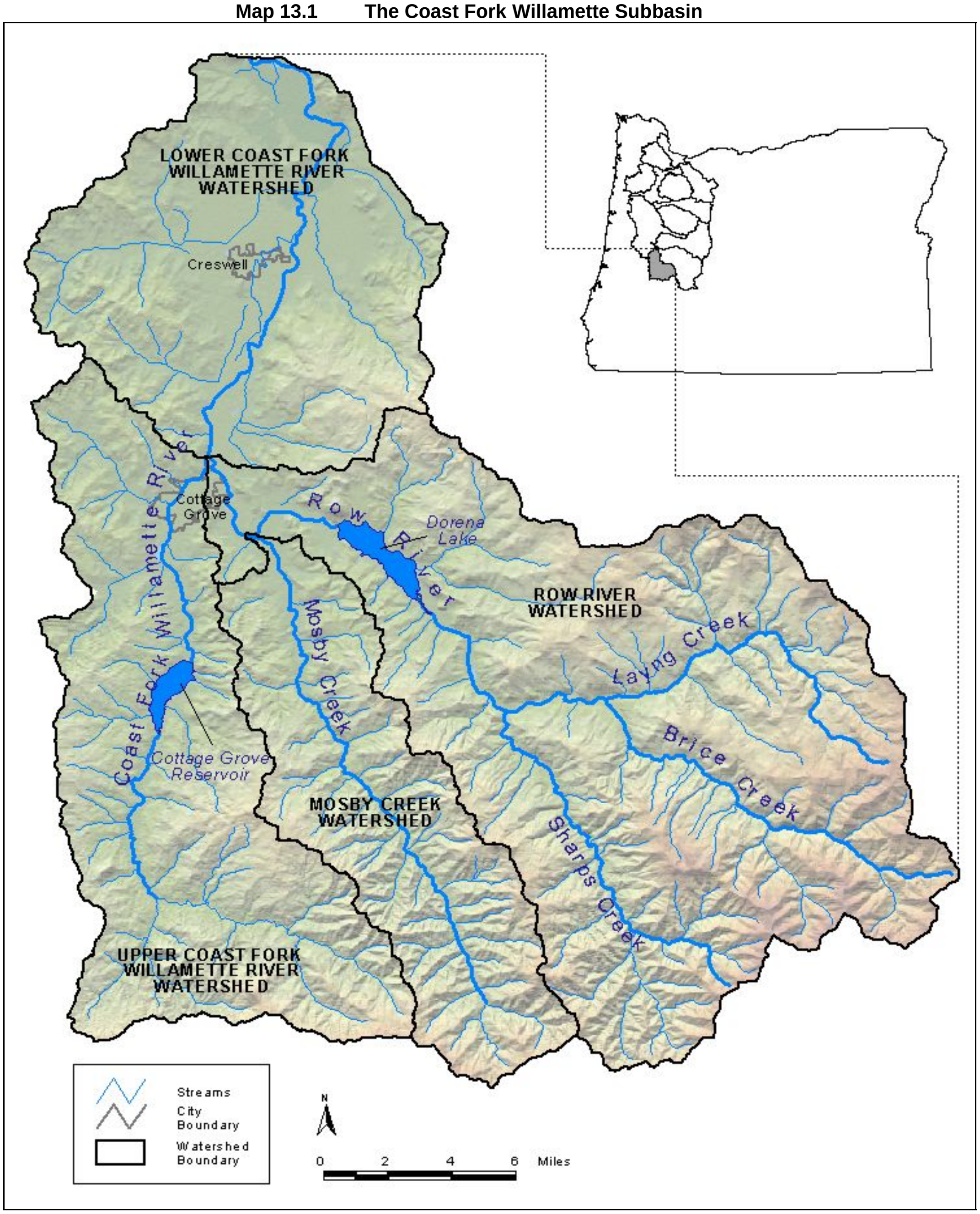
CHAPTER 13: COAST FORK WILLAMETTE SUBBASIN TMDL

WATER QUALITY SUMMARY

Reason for action

The Coast Fork Willamette Subbasin (Map 13.1) has stream segments listed under section 303(d)[1] of the federal Clean Water Act (CWA) that are exceeding water quality criteria for temperature, dissolved oxygen, bacteria, and mercury. Total Maximum Daily Loads (TMDLs) for temperature, bacteria, and mercury are developed based on information for these parameters. Wasteload allocations are developed for individual facilities (point sources) that discharge during the critical period. Load allocations for nonpoint sources are developed for each geomorphic unit and apply to all sectors in the subbasin.

Map 13.1 The Coast Fork Willamette Subbasin



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

This chapter includes TMDLs for rivers and streams in the Coast Fork Willamette Subbasin. These subbasin rivers and streams are tributary to the Coast Fork Willamette River, upstream of Cottage Grove Reservoir and the Row River upstream of Dorena Reservoir. The temperature analysis for the Coast Fork Willamette, river mile 0 to 31.3 and Row River, river mile 0 to 7.4 below the reservoirs is included in the mainstem Willamette River TMDLs discussed in Chapter 4. The mercury listing for the Coast Fork Willamette River, Cottage Grove Reservoir, and Dorena Lake are addressed in Chapter 3. All other subbasin TMDLs are included in Chapters 5 – 12.

ODEQ established TMDLs for ammonia and nutrients in the Coast Fork Willamette in 1995. These TMDLs were not reviewed or changed as part of this TMDL and thus the allocations established in those TMDLs remain in effect.

Water Quality 303(d) Listed Waterbodies

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

All current 303(d) listings for the subbasin are presented in Table 13.1.

Table 13.1 Name and location of listed Coast Fork Willamette Subbasin waterbodies.

Waterbody Name	Listed River Mile	Parameter	Season	Addressed in TMDL
Brice Creek	0 to 11.2	Temperature	Summer	Yes
Camas Swale Creek	0 to 9.4	Dissolved Oxygen	October 1 - May 31	No
Coast Fork Willamette River	0 to 31.3	Temperature	Summer	Chapter 4
Coast Fork Willamette River	0 to 31.3	Fecal Coliform	Winter/Spring/Fall	Yes
Coast Fork Willamette River	0 to 31.3	Fecal Coliform	Summer	Yes
Coast Fork Willamette River	0 to 31.3	Mercury	Year Around	Chapter 3
Cottage Grove Reservoir/Coast Fork Willamette River	28.5 to 31.3	Mercury	Year Around	Chapter 3
Dorena Lake/Row River	7.4 to 11.3	Mercury	Year Around	Chapter 3
King Creek	0 to 1.6	Temperature	Summer	Yes
Laying Creek	0 to 7.7	Temperature	Summer	Yes
Martin Creek	0 to 3.4	Temperature	Summer	Yes
Mosby Creek	0 to 21.2	Temperature	Summer	Yes
Row River	0 to 7.4	Temperature	Summer	Chapter 4
Row River	11.3 to 20.8	Temperature	Summer	Yes
Sharps Creek	0 to 12.5	Temperature	Summer	Yes

Water Quality Parameters Addressed

The following Coast Fork Willamette Subbasin 303(d) parameters will be addressed in this chapter:

- Temperature
- Bacteria
- Mercury is a parameter of concern throughout the Willamette Basin. A 27% reduction in mercury pollution is needed in the mainstem Willamette to remove fish consumption advisories. Pollutant load allocations are set for each sector but no effluent limits are specified at this time. Sources of mercury in the subbasin will be required to develop mercury reduction plans. Details of the mercury TMDL are included in Chapter 3, the Willamette Basin Mercury TMDL.

Water Quality Parameters Not Addressed

The Willamette Basin TMDL project began in early 2000 and was designed to address the 1998 303(d) listed waterbodies for parameters that exceeded water quality criteria. In 2002 the 303(d) list was updated. Where data were readily available, new parameter listings were addressed in this TMDL. However, there was not sufficient time to collect the additional data and complete the analysis for some of the newly listed parameters. These parameters will be addressed in subsequent TMDL efforts. The parameter that is specifically excluded from this TMDL study is:

- Dissolved Oxygen

The dissolved oxygen (DO) listings for Camas Swale Creek will not be addressed in this TMDL. The listing occurred in 2002, which did not allow sufficient time to collect data needed for TMDL analysis. Until TMDLs for dissolved oxygen are developed, riparian protection and restoration measures developed to address stream temperature concerns in the basin will benefit dissolved oxygen levels. Furthermore, water quality restoration efforts to address mercury and bacteria listings may also benefit other parameters such as dissolved oxygen.

Who helped us

Many organizations assisted ODEQ in the development of this TMDL and data from many different sources were considered. ODEQ would like to acknowledge the assistance of the following organizations and agencies:

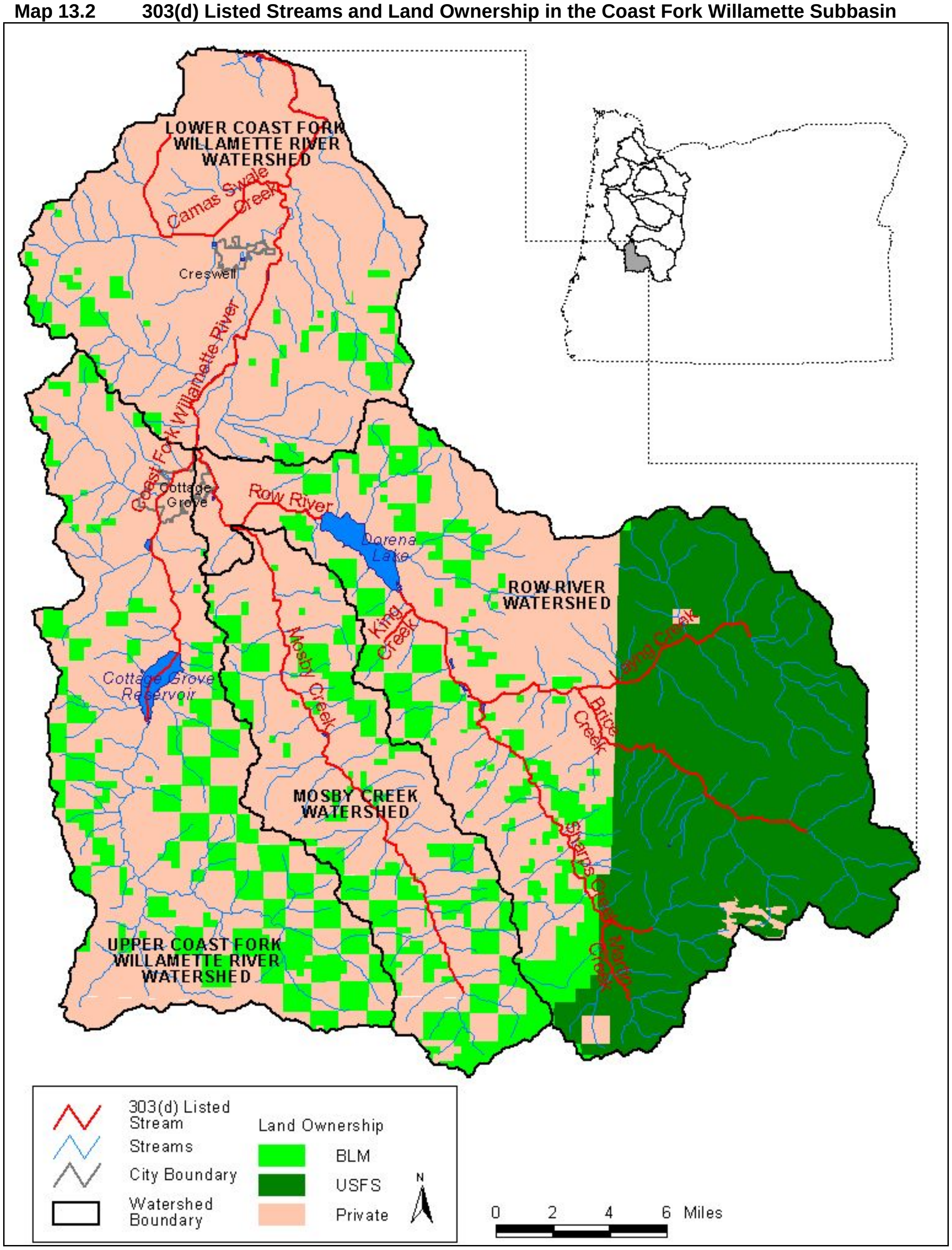
- Coast Fork Willamette Watershed Council
- U.S. Bureau of Land Management (BLM)
- U.S. Forest Service (USFS)
- U.S. Geological Survey, Oregon District (USGS)
- Oregon Water Resources Department (WRD)
- Oregon Department of Fish and Wildlife (ODFW)

SUBBASIN OVERVIEW

The Coast Fork Willamette Subbasin (Hydrologic Unit Code 17090002) is located in the southern most portion of the Willamette Basin, Map 13.2. The Coast Fork Willamette River flows into the Willamette River at the confluence of the Middle Fork Willamette River. The subbasin's 666 square miles (426,238 acres) include the following four watersheds:

- Lower Coast Fork Willamette River Watershed
- Upper Coast Fork Willamette River Watershed
- Mosby Creek Watershed
- Row River Watershed

Map 13.2 303(d) Listed Streams and Land Ownership in the Coast Fork Willamette Subbasin



The subbasin is located within portions of Lane and Douglas Counties, and includes the cities of Cottage Grove and Creswell. BLM and USFS administer much of the upland area, but most of the land in the subbasin is privately owned. The land use is primarily forestry, with agriculture and urban land uses near the mainstem Coast Fork Willamette River. The Coast Fork Willamette River and the Row River are a source of drinking water for the City of Cottage Grove.

Watershed Descriptions

Row River Watershed

The Row River Watershed is located approximately 20 miles southeast of Eugene and is the principal tributary of the Coast Fork Willamette River. The Row River watershed drains a 375 square mile (239,999 acres) area. The Dorena Dam impounds the river at river mile (RM) 7.5, forming Dorena Reservoir. Dorena Reservoir holds 72,050 acre feet of water and spans 2.7 square miles (1,749 acres) when full. The dam structure was constructed in 1949 with flood control its primary purpose. Several major tributaries flow directly into Row River and include Layng, Brice, Sharps, and Mosby Creeks. Mosby Creek is the only major tributary to flow into Row River below the Dorena Reservoir spillway. Three small communities exist within the watershed boundaries: Disston, Culp Creek, and Dorena with part of the City of Cottage Grove stretching into the western portion of the watershed.

Coast Fork Watershed

The Coast Fork Watershed is located in portions of Lane and Douglas counties. A portion of the city of Cottage Grove is also located within this watershed. The watershed covers 152 square miles (97,420 acres), of which approximately one-third is managed by BLM. Cottage Grove Dam is operated by the U.S. Army Corps of Engineers (USACE) and located on the Coast Fork Willamette River at RM 28. Elevations in the watershed vary from a low of 720 feet above sea level in the city of Cottage Grove to a high of 4,347 feet at Burnt Mountain.

COAST FORK WILLAMETTE TEMPERATURE TMDL

The temperature TMDL for the Coast Fork Willamette Subbasin includes tributaries to the Coast Fork Willamette River and Row River within HUC 17090002. As per Oregon Administrative Rule (OAR) 340-042-0040 required components of a TMDL are listed in Table 13.2.

Table 13.2 Coast Fork Willamette Subbasin Temperature TMDL Components.

Waterbodies **OAR 340-042-0040(4)(a)**	Perennial and/or fish bearing, as identified in OAR 340-041- 0340; Figures 340A & 340B, streams in the Coast Fork Willamette Subbasin, HUCs 170900201, 170900202, 170900203, and 170900204.
Pollutant Identification **OAR 340-042-0040(4)(b)**	*Pollutants:* Human caused temperature increases from (1) solar radiation loading and (2) warm water discharge to surface waters
Beneficial Uses **OAR 340-042-0040(4)(c)**	Salmonid fish spawning and rearing, anadromous fish passage, resident fish and aquatic life are the most sensitive beneficial uses in the Coast Fork Willamette Subbasin.
Target Criteria Identification **OAR 340-042-0040(4)(c)** ***CWA §303(d)(1)*** **OAR 340-041-0028(8)** **OAR 340-041-0028(4)(a)** **OAR 340-041-0028(4)(b)** **OAR 340-041-0028(4)(c)** ***OAR* 340-041-0028(8)** **OAR 340-041 0028(12)(b)(B)**	OAR 340-041-0028 provides numeric and narrative temperature criteria. Maps and tables provided in OAR 340-041-0101 to 0340 specify where and when the criteria apply. 12.0°C during times and at locations of bull trout spawning and juvenile rearing use. 13.0°C during times and at locations of salmon and steelhead spawning. 16.0°C during times and at locations of core cold water habitat identification. 18.0°C during times and at locations of salmon and trout rearing and migration. Natural Conditions Criteria: Where the department determines that the natural thermal potential temperature of all or a portion of a water body exceeds the biologically-based criteria in section 4 the natural thermal potential temperatures supersede the biologically-based criteria and are deemed the applicable criteria for that water body. Maps and tables provided in OAR 340-041-0101 to 0340 specify where and when the criteria apply. Following a temperature TMDL or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.
Existing Sources **OAR 340-042-0040(4)(f)** ***CWA §303(d)(1)***	Nonpoint source solar loading due to a lack of riparian vegetation from forestry, agriculture, rural residential, and urban activities. Point source discharge of warm water to surface water.
Seasonal Variation **OAR 340-042-0040(4)(j)** ***CWA §303(d)(1)***	Peak temperatures typically occur in mid-July through mid-August and often exceed the salmon and trout rearing and migration criterion. Temperatures are much cooler late summer through late spring but occasionally exceed the spawning criterion.
TMDL **Loading Capacity and Allocations** **OAR 340-042-0040(4)(d)** **OAR 340-042-0040(4)(e)** **OAR 340-042-0040(4)(g)** **OAR 340-042-0040(4)(h)** ***40 CFR 130.2(f)*** ***40 CFR 130.2(g)*** ***40 CFR 130.2(h)***	*Loading Capacity:* OAR 340-041-0028 (12)(b)(B) states that no more than a 0.3°C increase in stream temperature above the applicable biological criteria or the natural condition criteria as a result of human activities is allowable. This condition is achieved when the cumulative effect of all point and nonpoint sources results in no greater than a 0.3 oC (0.5 oF) increase at the point of maximum impact. Loading capacity is the heat load that corresponds to the applicable numeric criteria plus the small increase in temperature of 0.3°C provided with the human use allowance. *Excess Load:* The difference between the actual pollutant load and the loading capacity of the waterbody. In these temperature TMDLs excess load is the difference between heat loads that meet applicable temperature criteria plus the human use allowance and current heat loads from background, nonpoint source and point source loads. *Wasteload Allocations (NPDES Point Sources):* Allowable heat load based on achieving no greater than a 0.3oC temperature increase at the point of maximum impact. This is achieved by limiting stream temperature increases from individual point sources to 0.075ºC. This may also be expressed as a limitation of 0.3ºC increase in 25% of the 7Q10 stream flow. Where multiple point sources discharge to a single receiving stream the accumulated heat increase for point sources is limited to 0.2˚C. *Load Allocations (Nonpoint Sources):* Background solar radiation loading based on system potential vegetation near the stream. An additional heat load equal to 0.05°C temperature increase at the point of maximum impact is available but is not explicitly allocated to individual sources. • Mosby Creek background solar radiation loading based on system potential vegetation is $2.79x10^8$ kcal/day. • An additional heat load equal to 0.05°C temperature increase at the point of maximum impact is available but is not explicitly allocated to individual sources.

Surrogate Measures **OAR 340-042-0040(5)(b)** ***40 CFR 130.2(i)***	*Translates Nonpoint Source Load Allocations* Effective shade targets translate riparian vegetation objectives into the nonpoint source solar radiation loading capacity. These targets are based on vegetation communities appropriate for each geomorphic unit in the subbasin.
Margins of Safety **OAR 340-042-0040(4)(i)** ***CWA §303(d)(1)***	*Margins of Safety* are demonstrated in critical condition assumptions for point source load calculations and are inherent in the methodology for determining nonpoint source loads.
Reserve Capacity **OAR 340-042-0040(4)(k)**	Allocation for increases in pollutant loads for future growth from new or expanded sources. Reserve capacity will be a percentage of the 0.3˚C human use allowance (HUA). The HUA will be divided among various sources. When point sources are present reserve capacity will be 0.05˚C, 17% of the HUA. Where there are no point sources in a subbasin, or less than the allowed 0.2˚C is used by point source discharges, the remainder is allocated to reserve capacity.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan (WQMP) provides the framework of management strategies to attain and maintain water quality standards. The WQMP is designed to complement the detailed plans and analyses provided in specific implementation plans. See Chapter 14.
Standards Attainment & Reasonable Assurance **OAR 340-042-0040(4)(l)(e) & (j)**	Implementation of pollutant load reductions and limitations in the point source and non point source sectors will result in water quality standards attainment. Standards Attainment and Reasonable Assurance are addressed in the WQMP, Chapter 14.

Waterbodies Listed for Temperature

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

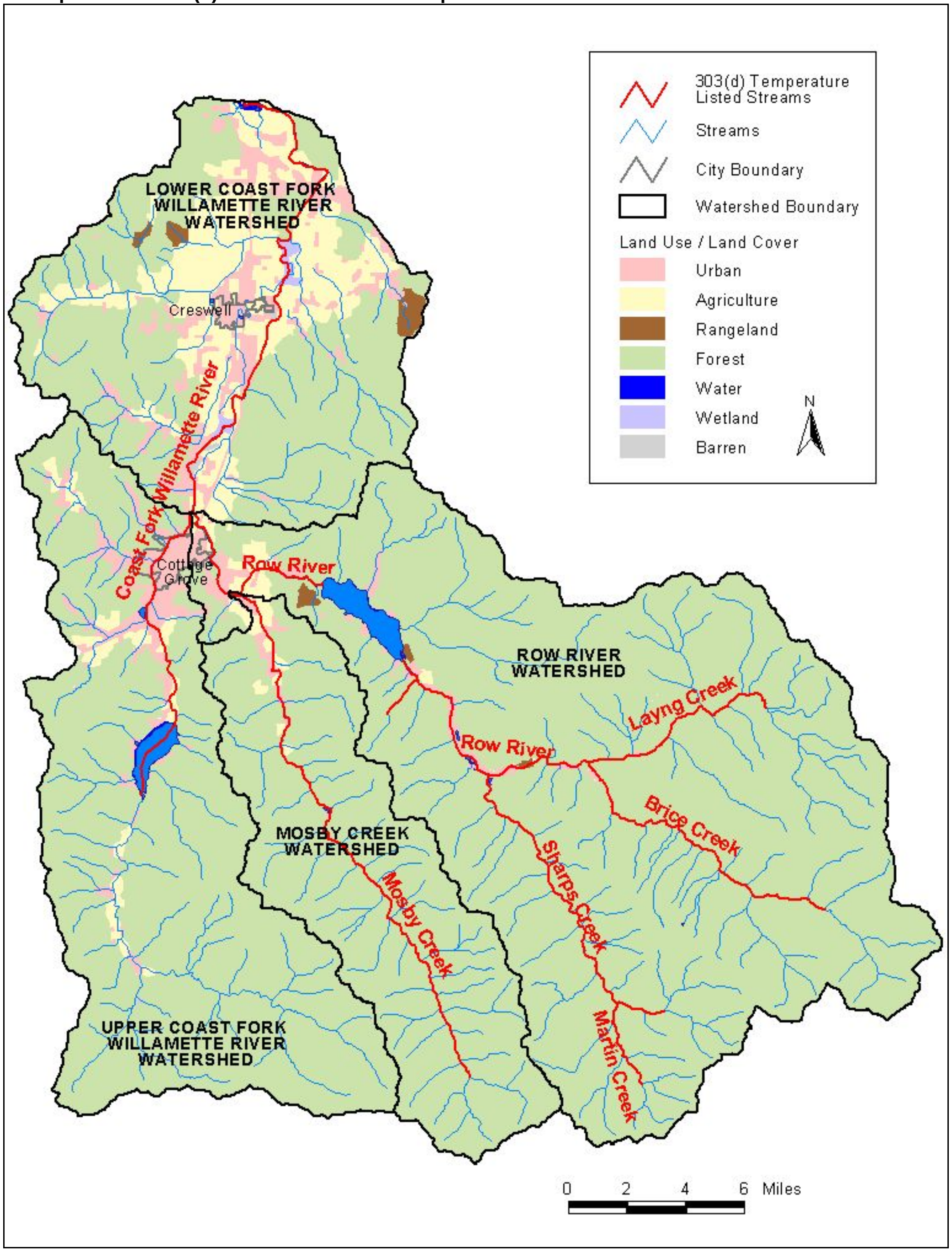
The Coast Fork Willamette Subbasin has seven stream segments on the 303(d) list for exceeding the summer rearing criteria. Brice Creek, King Creek, Layng Creek, Martin Creek, Mosby Creek, Row River upstream of Dorena Reservoir, and Sharps Creek exceeded numeric criteria to protect salmon and trout rearing (Table 13.3 and Map 13.3). The Coast Fork Willamette River downstream of Cottage Grove Reservoir and the Row River downstream of Dorena Reservoir are listed year round for exceeding rearing and spawning temperature criteria. Both of these river reaches are addressed in Chapter 4 of this document.

Stream segments were included on the 303(d) list based on the temperature criteria in place at the time the list was revised. Listings in 1998 and 2002 were based on a temperature criterion of 17.8°C (64°F) for salmonid migration and rearing, Table 13.3. However, new temperature criteria were adopted by the Environmental Quality Commission in December 2003 and approved by USEPA in March 2004. The new temperature criterion for salmon and trout rearing and migration is 18.0°C (64.4°F). A review of the temperature data for the streams listed in the Coast Fork Willamette Subbasin indicates that these streams exceed the recently adopted numeric criterion.

Table 13.3 Coast Fork Willamette Subbasin 303(d) Temperature Listed Stream Segments

Waterbody Name	Listed River Mile	Parameter	Criteria	Season
Brice Creek	0 to 11.2	Temperature	Rearing: 17.8ºC	Summer
King Creek	0 to 1.6	Temperature	Rearing: 17.8ºC	Summer
Layng Creek	0 to 7.7	Temperature	Rearing: 17.8ºC	Summer
Martin Creek	0 to 3.4	Temperature	Rearing: 17.8ºC	Summer
Mosby Creek	0 to 21.2	Temperature	Rearing: 17.8ºC	Summer
Row River	11.3 to 20.8	Temperature	Rearing: 17.8ºC	Summer
Sharps Creek	0 to 12.5	Temperature	Rearing: 17.8ºC	Summer

Map 13.3 303(d) Listed Streams for Temperature in the Coast Fork Willamette Subbasin



Pollutant Identification

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

ODEQ must establish a TMDL for any waterbody designated on the 303(d) list as exceeding water quality criteria. Although temperature criteria are designed to protect beneficial uses from excessive water temperature, the pollutant of concern is heat energy. Water temperature change is an expression of heat energy exchange per unit of volume:

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

Stream temperatures are affected by natural and human caused sources of heating. Disturbance processes such as wildfire, flood, and insect infestation influence the presence, height and density of riparian vegetation which in turn determines the amount of solar radiation reaching the stream. Such processes are recognized and incorporated as a natural condition in the TMDL. This temperature TMDL does address stream heating caused by human activities that affect characteristics of riparian vegetation in addition to point sources that discharge heat directly into surface waters in the Coast Fork Willamette Subbasin.

Beneficial Use Identification

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

Numeric and narrative water quality criteria are applied to protect the most sensitive beneficial uses. The most sensitive beneficial uses to temperature in the Coast Fork Willamette Subbasin are:

- Resident fish and aquatic life
- Salmonid spawning, rearing and migration
- Anadromous fish passage

At a minimum, beneficial uses are considered attainable wherever feasible or wherever attained historically.

Salmonid Stream Temperature Requirements

This temperature TMDL is focused on the protection of cold water salmonids, specifically steelhead and salmon. In general, there are three levels of thermally induced fish mortality. If stream temperatures become greater than 32 °C (>90°F), fish die almost instantly due to denaturing of critical enzyme systems in their bodies (Hogan, 1970). This level is termed *instantaneous lethal limit.* The second level is termed *incipient lethal limit* and can cause fish mortality in hours to days when stream temperatures are in the 21°C to 25°C (70°F to 77°F) range. The time period to death depends on the acclimation and life-stage of the fish. The cause of death is from the breakdown of physiological regulation, such as respiration and circulation, which are vital to fish health (Heath and Hughes, 1973). The third level is the most common and widespread cause of thermally induced fish mortality, termed *indirect or sub-lethal limit* and can occur weeks to months after the onset of elevated stream temperatures of 17.8°C to 23°C (64°F to 74°F). The cause of death is from interactive effects such as: decreased or lack of metabolic energy for feeding, growth, and reproductive behavior; increased exposure to pathogens (viruses, bacteria and fungus); decreased food supply because the macroinvertebrate populations are also impaired by high stream temperature; and increased competition from warm water tolerant species. Table 13.4 summarizes the modes of cold water fish mortality.

Table 13.4 Thermally Induced Cold Water Fish Mortality Modes (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	> 32°C (> 90°F)	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	21°C - 25°C (70°F - 77°F)	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	17.8°C - 23°C (64°F - 74°F)	Weeks to Months

Target Criteria Identification

OAR 340-041-0028(4)(c), OAR 340-041-0028(4)(d),OAR 340-041-0028(9) CWA 303(d)(1)

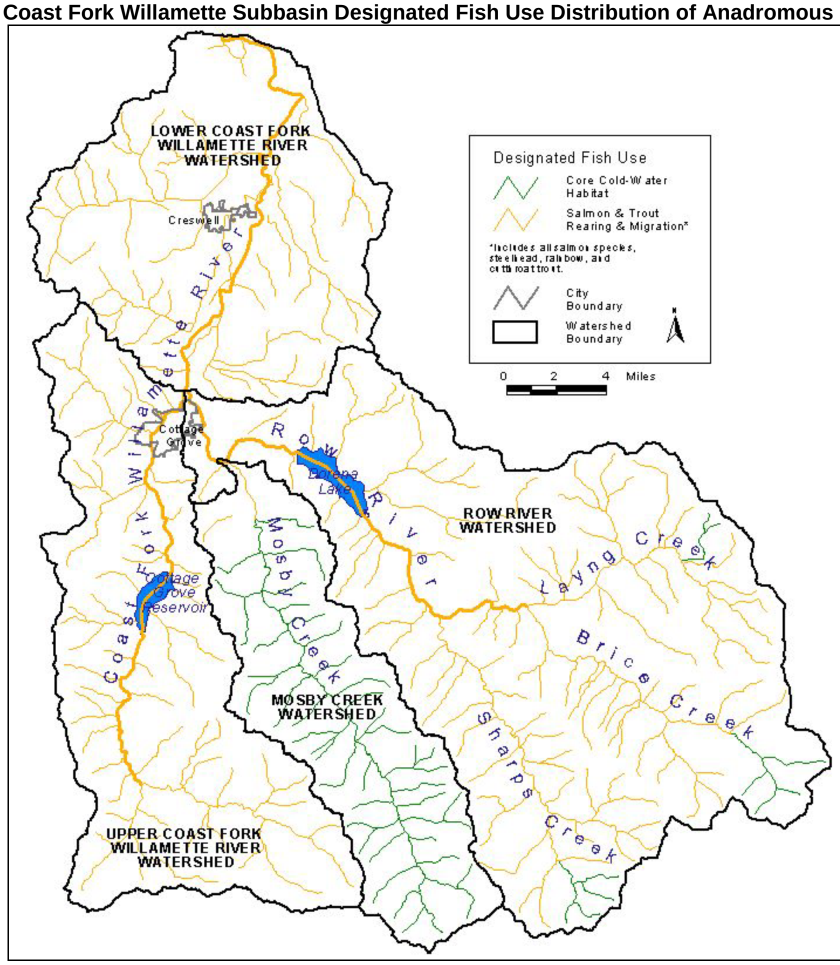
Oregon's water quality criteria for temperature are designed to protect beneficial uses, such as cold-water salmon and trout species, based on specific salmonid life stages. The temperature criteria include both narrative and numeric criteria. Table 13.5 lists the temperature criteria that are applicable to the Coast Fork Willamette Subbasin. Maps 13.4 and 13.5 illustrate designated subbasin fish use and salmonid spawning use. The maps indicate where salmonid spawning through fry emergence criterion, salmonid rearing and migration criterion, and the core cold water species apply. For subbasin waters where fisheries uses are not identified the applicable criteria are the same as the nearest downstream waterbody that is identified in fish use maps. Willamette Basin fish use and spawning use maps are available for electronic download on ODEQ's website at:
http://www.deq.state.or.us/wq/standards/FishUseMapsFinal/FFigure340A_Willamette.pdf and
http://www.deq.state.or.us/wq/standards/FishUseMapsFinal/FFigure340B_Willamette.pdf

Table 13.5 Oregon's Biologically Based Temperature Criteria.

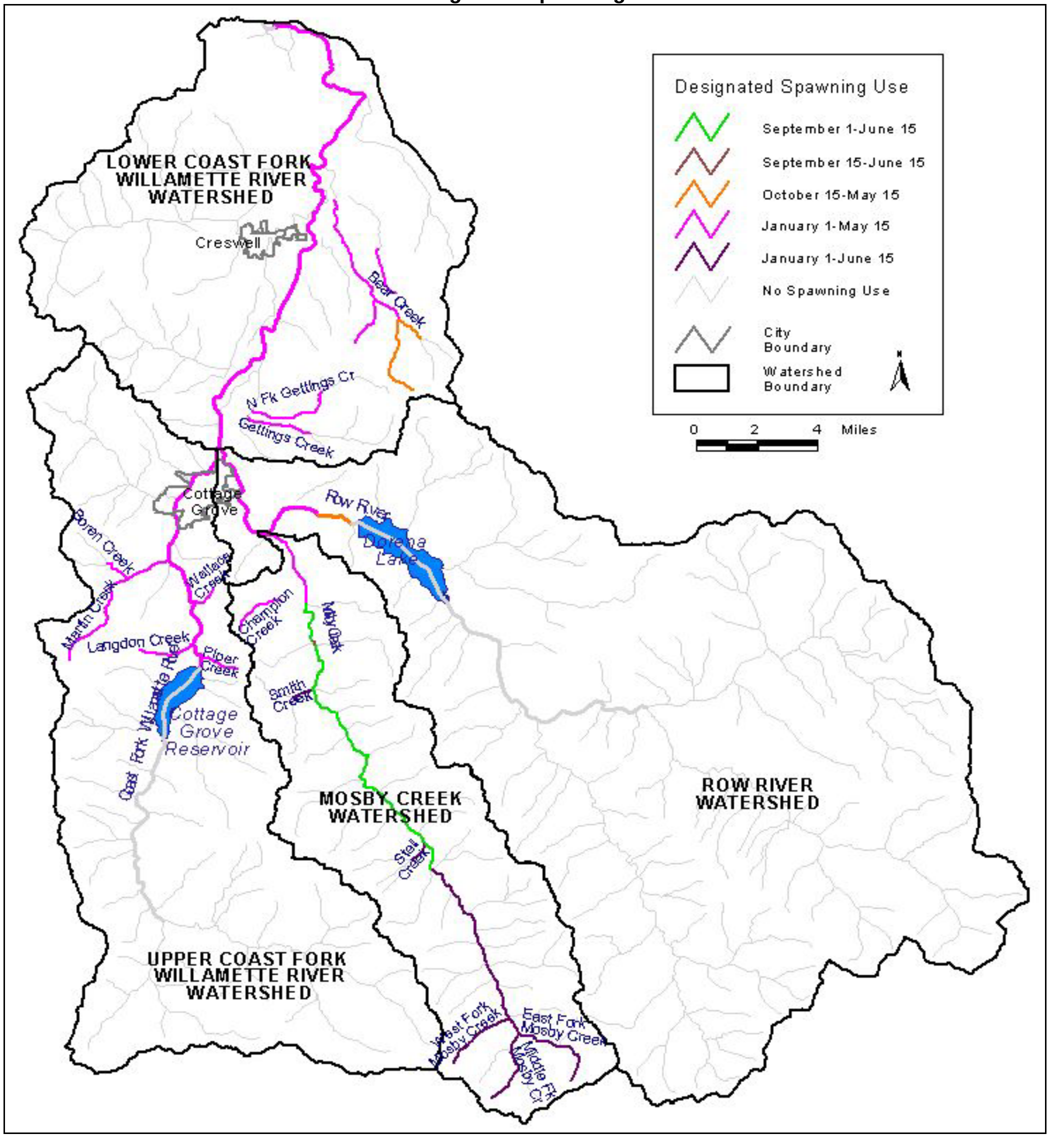
Beneficial Use	Criteria
Salmon and Steelhead Spawning	∗13.0°C (55.4°F)
Core Cold Water Habitat Identification	*16.0°C (60.8°F)
Salmon and Trout Rearing and Migration	∗18.0 °C (64.4 °F)

∗ Stream temperature is calculated using the average of seven consecutive daily maximum temperatures on a rolling basis (7-day calculation).

Map 13.4 Coast Fork Willamette Subbasin Designated Fish Use Distribution of Anadromous Salmonids



Map 13.5 Coast Fork Willamette Subbasin Designated Spawning Use Distribution of Anadromous Salmonids



The narrative criteria that apply to the Coast Fork Willamette Subbasin describe the conditions under which biological numeric criteria may be superseded. The criteria acknowledge that in some instances the biologically based numeric criteria may not be achieved because the natural thermal potential of the stream temperature is warmer than the biologically based numeric criteria. A stream that is free from anthropogenic influence is considered to be at natural thermal potential. When it exceeds the appropriate biologically based criterion, the natural thermal potential becomes the natural condition numeric temperature criterion for that specific stream or stream segment. This often occurs in low elevation streams in the basin during summer months.

Following a temperature TMDL or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.

A more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the 1992-1994 Water Quality Standards Review Final Issue Papers (ODEQ, 1995) and in EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (USEPA, 2003).

Existing Heat Sources

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

Sources of heat pollution include nonpoint sources and point sources. Nonpoint sources are generally more diffuse in nature and cannot be traced back to a particular location. These sources are defined below in terms of land use. Dams and reservoir operations are also included as nonpoint sources of pollution although their effects on water quality are generally more identifiable than dispersed land use activities. Point sources are individual facilities that discharge a pollutant from a defined conveyance (e.g. an outfall pipe) and are regulated by permit.

Nonpoint Sources of Heat

Land use activities. Riparian vegetation, stream morphology, hydrology (including groundwater interactions), 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. Disturbance or removal of vegetation near a stream reduces stream surface shading because of decreased vegetation height, width and density. This results in greater amount of solar radiation reaching the stream surface.

Riparian vegetation also influences channel morphology. Vegetation supports stream banks during erosive, high flow events and slows floodwaters and promotes sediment deposition when floodwaters overtop the banks. Loss or disturbance of riparian vegetation may precede lateral stream bank erosion and channel widening. This decreases the effectiveness of remaining vegetation to shade the stream and increases the stream surface area exposed to heat exchange processes, particularly solar radiation.

Dam and Reservoir operations. Dams and reservoir operations affect stream temperature through the modification of flow regimes and through the delivery of heat stored within the system. Flow augmentation during the low flow periods of the year may be beneficial to stream segments below the dam as higher flows increase stream volume and therefore the loading capacity of the segment. Also, higher volumes correspond to greater stream velocities and shorter travel times through stream reaches exposed to solar radiation. However, operations that divert flows from natural channels during low flow periods may substantially diminish the loading capacity of the stream while also increasing solar loading to the stream because of lower velocities and greater travel times through exposed reaches.

The release of water from reservoirs may also increase down stream temperatures as the heat held by the impounded water is also released. The timing, duration and magnitude of such impacts are dependent upon reservoir characteristics such as surface area, depth, and whether water is released from the bottom of the reservoir or may be selectively withdrawn at various depths.

There are two reservoirs in the Coast Fork Willamette Subbasin, Cottage Grove Reservoir and Dorena Reservoir, both impacting the mainstem Coast Fork Willamette River. A discussion of the impacts of these reservoirs on the Coast Fork Willamette River and the Row River are discussed in Chapter 4.

Point Sources of Heat

Point source discharges play a limited role in stream heating in the streams of the Coast Fork Willamette Subbasin. There are five individual NPDES permitted sources in the Coast Fork Willamette Subbasin, including two sources that discharge directly into the Coast Fork Willamette River downstream of Cottage Grove Reservoir. Sources in this portion of the subbasin are addressed in the mainstem Willamette TMDL discussed in Chapter 4. The remaining three individual NPDES point sources include two industrial and one municipal source. The industrial sources are Short Mountain Landfill which discharges year round to Hill Creek, and Foster Farms which discharges during the fall-winter-spring (November 1 to April 30) to Camas Swale Creek (Map 13.6 and Table 13.6). Creswell domestic waste water treatment plant discharges treated sewage to Camas Swale Creek during the fall-winter-spring (November 1 to May 31).

In addition to the individual NPDES point sources identified above, there are 38 general NPDES permits in the subbasin. There are 21 stormwater permits in the subbasin but these sources are not considered to have reasonable potential to contribute to exceedances of numeric temperature criteria. Stormwater sources will therefore not be further addressed in this TMDL. Evaluation of other point sources is discussed briefly below and again in the waste load allocation section of the TMDL.

Map 13.6 Coast Fork Willamette Subbasin NPDES Permit Locations.

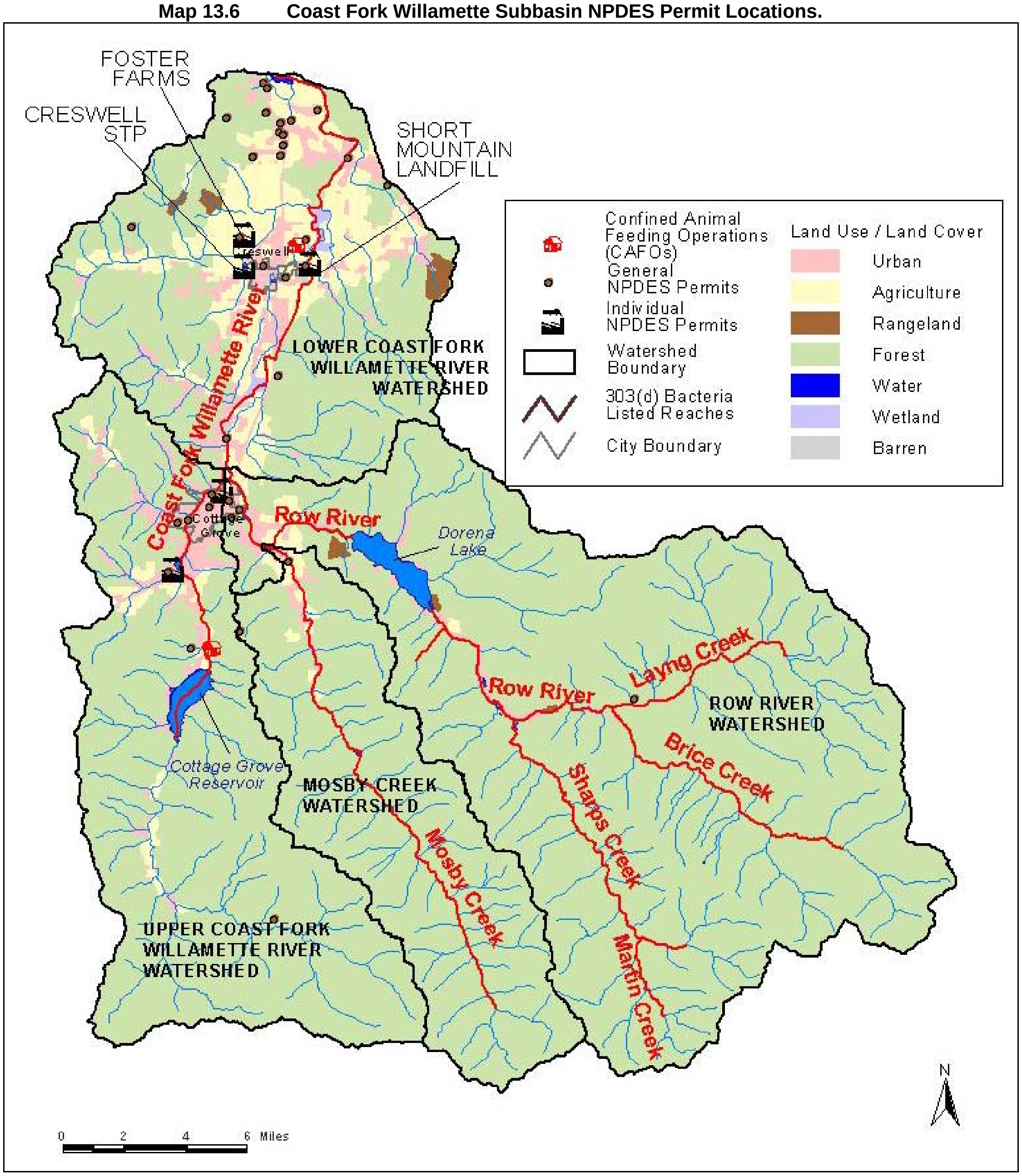


Table 13.6 Individual NPDES facilities in the Coast Fork Willamette Subbasin, which do not discharge to the mainstem Coast Fork Willamette River and Row River.

Facility Name	Permit Type	Permit Description	Receiving Stream	River Mile	Type of Discharge	Season of Discharge
SHORT MOUNTAIN LANDFILL	NPDES-IW-O	Industrial Wastewater; NPDES non-process wastewater NEC	Hill Creek	0.1	Process Water	Year Round
FOSTER FARMS	NPDES-IW-N	Industrial Wastewater; NPDES process wastewater NEC	Camas Swale Creek	3	Process Water	F-W-S
CRESWELL STP	NPDES-DOM-Db	Sewage - less than 1 MGD with lagoons	Camas Swale Creek	4	Wastewater	F-W-S

FWS = Fall-Winter-Spring; approximately October through May
NEC = Not Elsewhere Classified

Temperature TMDL Approach Summary

Coast Fork Willamette Subbasin stream temperature TMDLs were developed at the watershed scale. These TMDLs include all surface waters that affect the temperatures of 303(d) listed water bodies because stream temperature is affected by heat loads from upstream as well as local sources. Point and nonpoint sources of heat may not cause an increase in temperature of more than the human use allowance (0.3˚C) when fully mixed with a stream and at the point of maximum impact. For the purposes of Willamette Basin TMDLs, the human use allowance has been divided among various sources using a framework established by ODEQ with input from the Willamette TMDL Council. The framework allocates to point sources heat loads that yield a cumulative increase in stream temperature of no more than 0.2˚C. The framework allocates nonpoint sources an increase in temperatures of 0.05˚C and a heat load equivalent to 0.05˚C is held as reserve capacity. Where less than the 0.2˚C cumulative increase in temperature is actually used by point source discharges, the remainder is allocated to reserve capacity. The actual allocation of heat within the human use allowance is not specified in the water quality standards and this framework is used simply as guidance for implementation of the TMDL.

Point Source Approach. Allocations or permit limits are developed for individual point source discharges that ensure the combined increase in temperature for all discharges does not exceed 0.2˚C at the point of maximum impact. Wasteload allocations for individual point sources are generally based on a quarter of the human use allowance and yield less than a 0.08ºC increase in temperature at the point of maximum impact. Individual waste load allocations may be greater than 0.08 based on an analysis of site specific needs provided the overall point source allocation is within the established human use allowance framework. The specific methods and equations used to develop wasteload allocations are contained in the Allocation section of this chapter.

Nonpoint Source Approach. Removal or disturbance of riparian vegetation is the primary nonpoint source activity with respect to stream temperatures in the subbasin. The temperature model Heat Source was used to calculate load allocations in Mosby Creek. Surrogate measures are used to represent nonpoint source heat loads. While heat from solar radiation in excess of natural background rates is considered the pollutant, the surrogate measure is effective shade. Effective shade targets, through the use of shade curves can be translated into site-specific load allocations such as langleys per day. Both shade curves and system potential vegetation objectives were developed for the fifteen geomorphic units in the Coast Fork Willamette Subbasin.

Temperature TMDL Analytical Methods Overview

Load capacity is the assimilative capacity of each stream when anthropogenic sources of heat warm the stream no more than 0.3ºC above its natural thermal potential. Natural thermal potential is realized when point sources discharges of heat are eliminated and vegetation near the stream is undisturbed by management activities. Small additional heat load allocations can be made once these conditions are identified. Wasteload allocations for individual point sources are based on a change in river temperature at the point of maximum impact. These allocations are expressed in energy units such as kilocalories per day. Load allocations for nonpoint sources for Mosby Creek are based on kilocalories per day and the surrogate measure of percent effective shade.

Development of stream temperature TMDLs requires the identification of load capacity for each impaired stream. This often demands extensive data collection to support the development of detailed and complex models that are in turn used to simulate system responses to changes in pollutant loads. However, in many stream systems in the Coast Fork Willamette Subbasin the primary sources of anthropogenic heat are land use activities that affect riparian and near-stream vegetation. Identification of load capacity in these systems first requires determination of stream shade conditions when these disturbances of vegetation are eliminated. This drives the need to determine system potential vegetation and its shade producing characteristics.

System potential vegetation is vegetation that can grow and reproduce at a near-stream site given climate, elevation, soil properties, plant community requirements and hydrologic processes. System potential vegetation is an estimate of the riparian condition where land use activities that cause stream warming are minimized. It is not intended to be an estimate of pre-settlement conditions, but is an important element in the determination of the natural thermal potential of a stream. In the absence of significant point sources of heat or stream flow modification, system potential vegetation is the basis for identification of natural thermal potential temperatures. These natural thermal potential temperatures serve as the natural conditions temperature criterion in many low elevation streams throughout the Willamette Basin.

The Oregon Administrative Rule for temperature has defined both natural conditions and natural thermal potential.

- OAR 340-041-0002(38) states:
  "Natural conditions" means conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the State that are not influenced by past or present anthropogenic activities. Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation, diseased vegetation are considered natural conditions.

- OAR 340-041-0002(39) states:
  "*Natural Thermal Potential" means the determination of the thermal profile of a water body using best available methods of analysis and the best available information on the site potential riparian vegetation, stream geomorphology, stream flows and other measures to reflect natural conditions.*

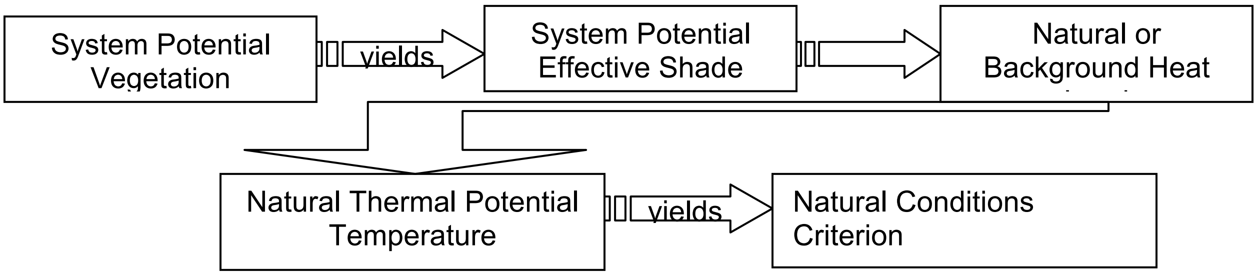
Coast Fork Willamette Subbasin temperature TMDLs are based on the identification of system potential vegetation for each impaired waterbody and the calculation of the amount of shade provided by that vegetation to the stream. System potential vegetation in this analysis does allow for some level of natural disturbance such as fire and this is reflected as smaller tree heights and lower canopy densities in the calculation of shade levels. Put another way, mature vegetation was not used to simulate target conditions throughout the subbasin.

Effective shade is the percent of daily solar radiation that is blocked by vegetation and topography. System potential vegetation characteristics are used to estimate effective shade for each riparian community. These estimated effective shade values are often referred to as system potential effective shade when in the absence of human disturbance.

Solar radiation is a function of regional and local characteristics and is a factor in determining water temperature in the absence of significant point source influences. Regional factors such as latitude and topography determine potential solar radiation loading whereas local factors such as stream aspect, stream width and streamside vegetation characteristics determine actual solar radiation loading to the stream. Streamside vegetation characteristics that determine effective shade include vegetation height, canopy density, overhang, setback or distance from the edge of the stream, and the width of the riparian buffer. Mature, well-stocked riparian stands generally provide more effective shade to a stream than sparsely stocked riparian stands or stands of early successional plant communities. For more information on system potential vegetation refer to Appendix C, "Potential Near-Stream Land Cover for Willamette Basin".

Effective shade is a surrogate measure used for development of temperature load allocations. The use of effective shade targets alone will not support calculation of natural thermal potential stream temperatures. Extensive modeling is required to describe heat and water movement through the stream system and support the estimation of stream temperatures. Stream temperature estimation at system potential vegetation is calculated using the Heat Source Model. The Heat Source Model version 6.5 was used to calculate stream temperatures and effective shade at system potential vegetation. A description of the Heat Source model, model calibration statistics, and overview of the analytical analysis are described in Appendix C. An overview of Heat Source is also found on-line: http://www.heatsource.info/ Effective shade targets will allow for the calculation of the amount of solar loading reaching the stream and perhaps most importantly shade targets translate nonpoint source load allocations into site specific vegetation targets for land owners and managers.

The diagram below illustrates this process:



Stream temperature analysis discussed in this chapter is limited to stream systems in the Coast Fork Willamette Subbasin. The water quality restoration strategies identified are applicable to all streams in the subbasin. Application of these strategies contributes to the basin-scale effort to restore and protect cooler water temperatures in other Willamette River tributaries. This broad scale application to all tributaries is an important element in the protection of coldwater aquatic life in the Willamette Basin. Although these streams are not likely to individually affect temperatures in the Willamette River, collectively they provide important localized sources of cool water and temporary thermal refugia for resident or migrating coldwater fish.

Seasonal Variation

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

Streams in the Coast Fork Willamette Subbasin exceed biologically based rearing criteria starting in late spring and through late summer. Maximum temperatures typically occurred in late July and early August. Long-term temperature recorders deployed by ODEQ, BLM, and Watershed Sciences, LLC indicate that summer stream temperatures exceed the 18.0ºC (64.4ºF) migration and rearing, 16.0ºC (60.8ºF) core cold water habitat, and 13.0ºC (55.4ºF) salmon and steelhead spawning criteria. Temperatures in Coast Fork Willamette River tributary streams were commonly above the criterion during summer months. The seven day moving maximum temperatures in Mosby Creek ranged from 15.0°C (59.0°F) in the headwaters to 25.0 °C (77.0°F) at RM 0.5 during the summer, Figure 13.1. Streams exceeding the temperature criteria include the Coast Fork Willamette River upstream of Cottage Grove Reservoir, Big River, Mosby Creek, and Sharps Creek, Figures 13.1 to 13.9. Several streams in the Coast Fork Willamette Subbasin lack sufficient riparian vegetation to shade wide stream channels, see photos in Figures 13.10 to 13.12.

In June 2002, ODEQ, BLM, and Watershed Sciences, LLC placed temperature thermisters in-stream at various locations throughout the Coast Fork Willamette Subbasin, Map 13.7. Thermisters were removed from the stream before stream flow conditions became hazardous, in late August 2002. In late July, ODEQ and BLM staff conducted field sampling exercises to record instantaneous flow, characterize the stream channel, take an audit of in-stream temperatures, and to characterize the riparian vegetation. Digital photos and a Geographical Positioning System (GPS) determined latitude and longitude were recorded at each temperature monitoring location. Thermal Infra-red Radiometry (TIR) and visible video imagery data were collected for Mosby Creek, Sharps Creek, Big River, and the Coast Fork Willamette River July 21 and July 22, 2002, by Watershed Sciences, LLC. TIR data collection was timed to capture daily maximum stream temperatures, which typically occur between 13:00 and 17:00 hours (1:00 pm and 5:00 pm). TIR imagery, color video imagery, and longitudinal profile of stream and tributary temperatures show that the Coast Fork Willamette River upstream of Cottage Grove Reservoir, Big River, Sharps Creek, and Mosby Creek have several cold water springs, typically 4.0°C (7.2°F) lower in temperature that cool the stream by 2.0°C (3.6°F), Figures 13.3 to 13.8.

Map 13.7 Temperature Monitoring Locations in the Coast Fork Willamette Subbasin

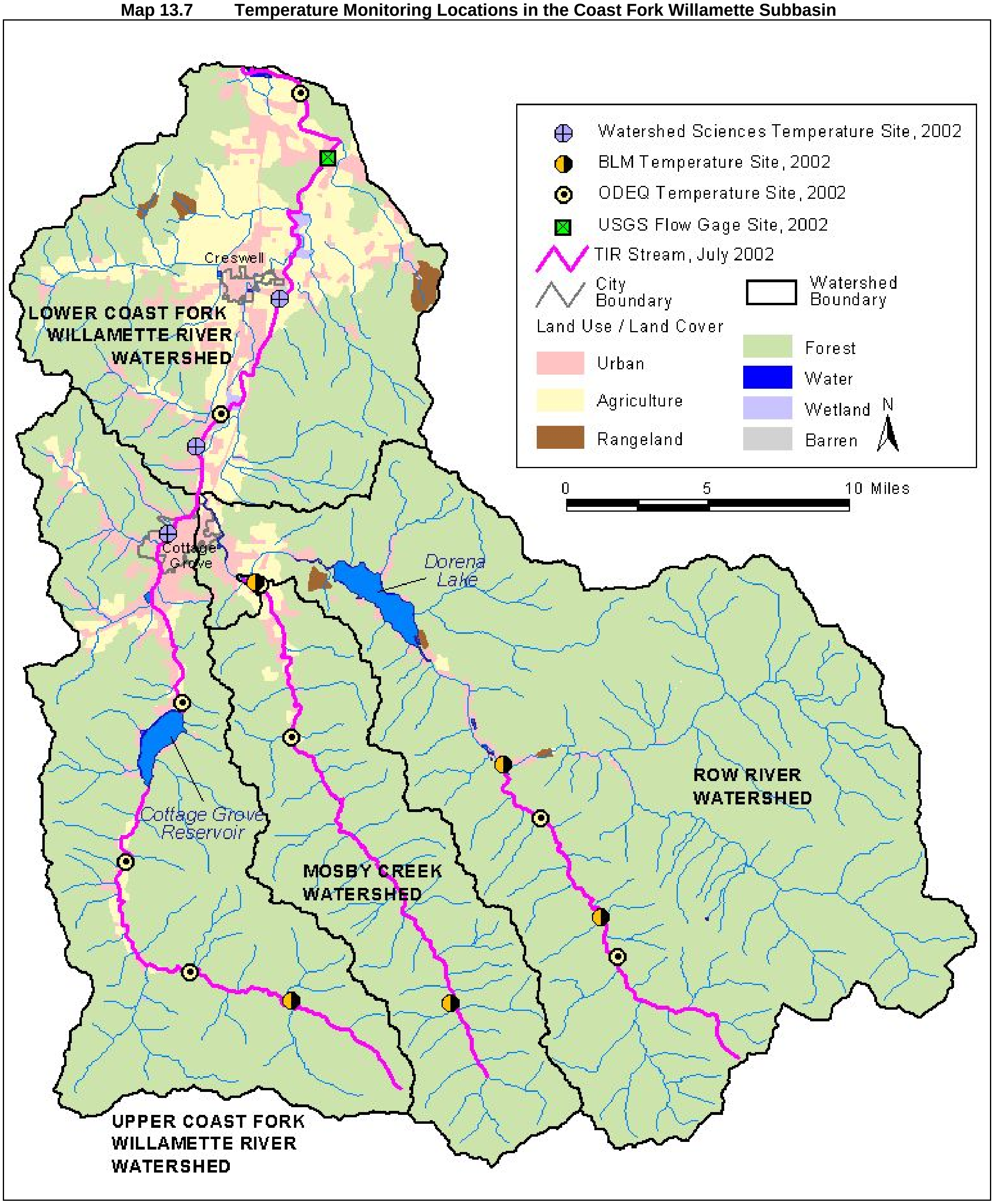
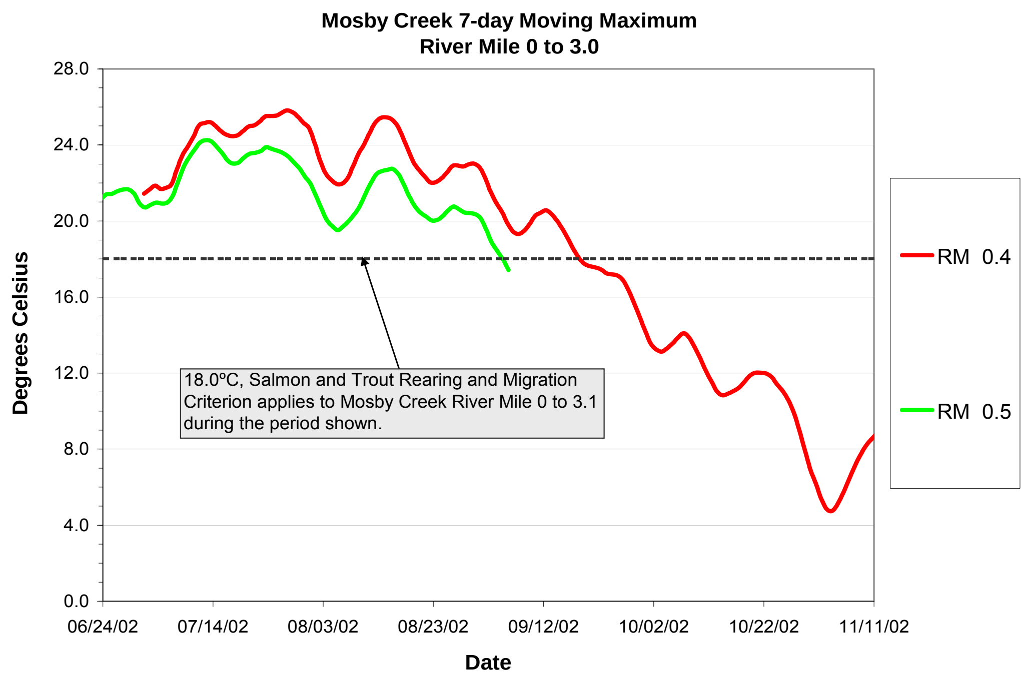


Figure 13.1 Temperature Profiles for Mosby Creek, RM 0 to 3.0 and RM 3.1 to headwaters.



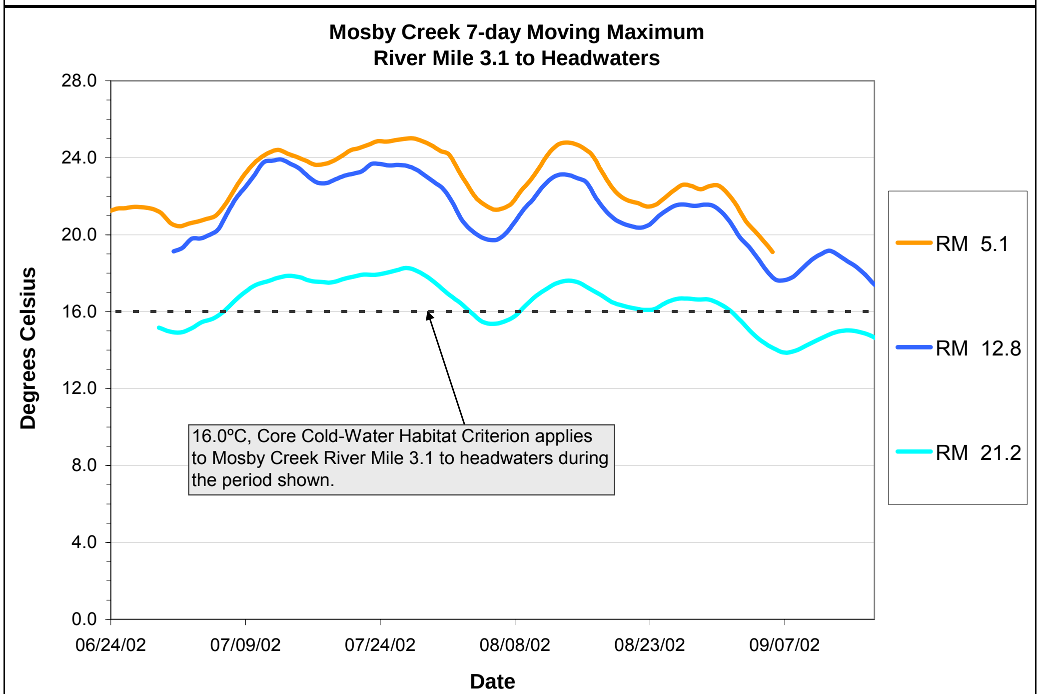


Figure 13.2 Longitudinal TIR median temperatures for the Coast Fork Willamette River and Big River. River miles are calculated from the mouth of the Coast Fork Willamette River. The graph also shows the location and names of tributary and other surface water inflows. Big River July 21, 2002; Coast Fork Willamette River July 22, 2002.

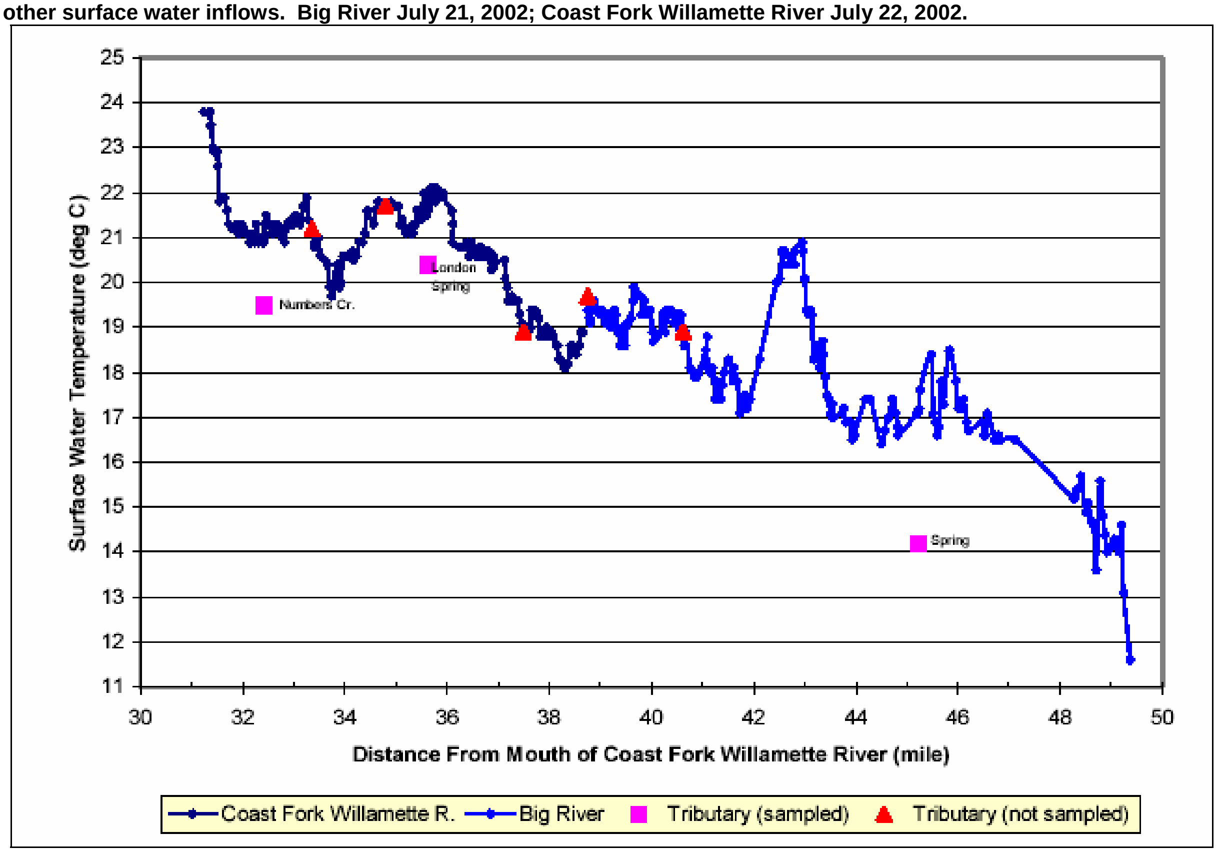


Figure 13.3 TIR/color video image pair showing a spring (14.2ºC) along the left bank of Big River (17.2ºC) at RM 6.6 *(frame: cfbr0730).* July 21, 2002.

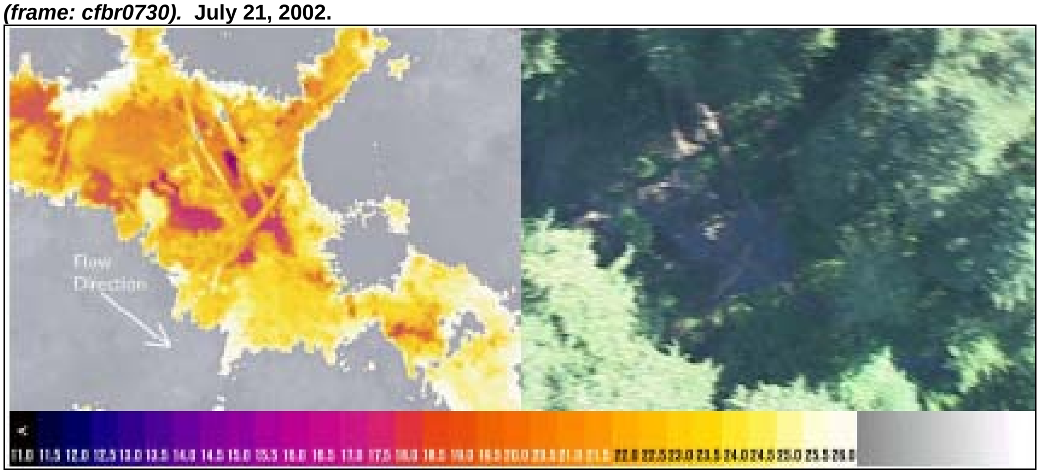


Figure 13.4 Longitudinal TIR median temperatures for Sharps Creek. River miles are calculated from the mouth of the Sharps Creek. The graph also shows the location and names of tributary and other surface water inflows. July 21, 2002.

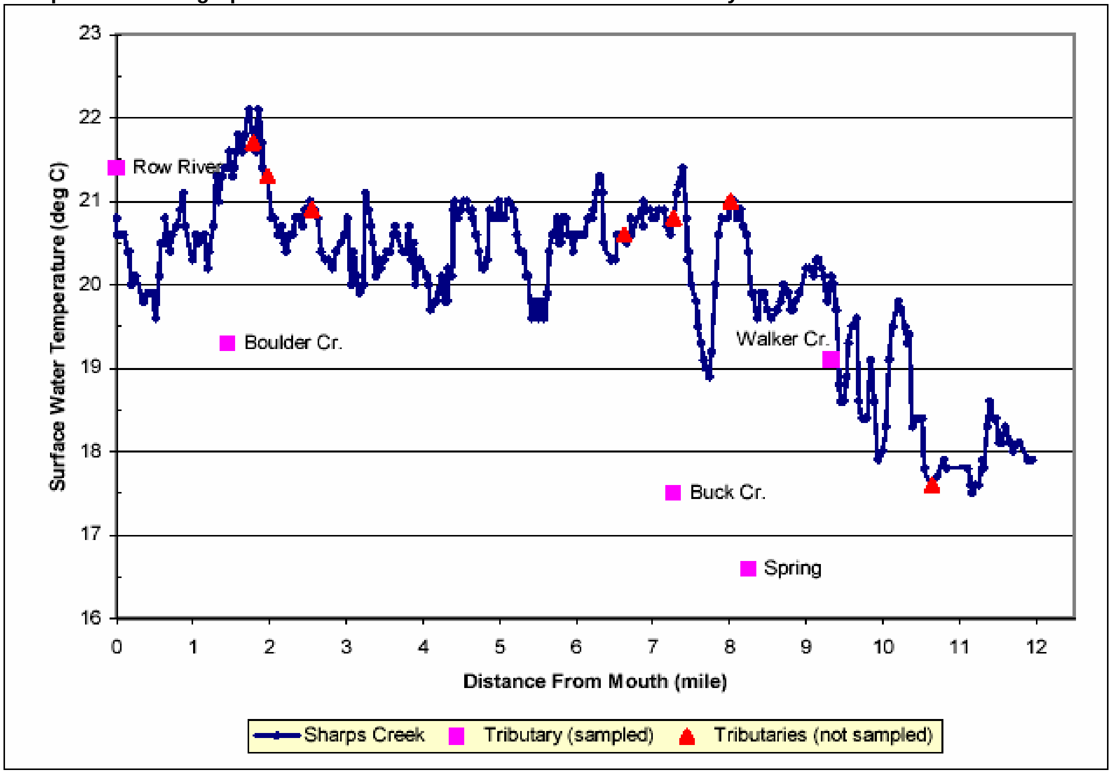


Figure 13.5 TIR/color video image pair showing the location of an apparent spring on the left bank of Sharps Creek at RM 1.8. The spring measures approximately 16.0ºC while the main stem of Sharps Creek is 21.7ºC *(frame: shar0133).* July 21, 2002.

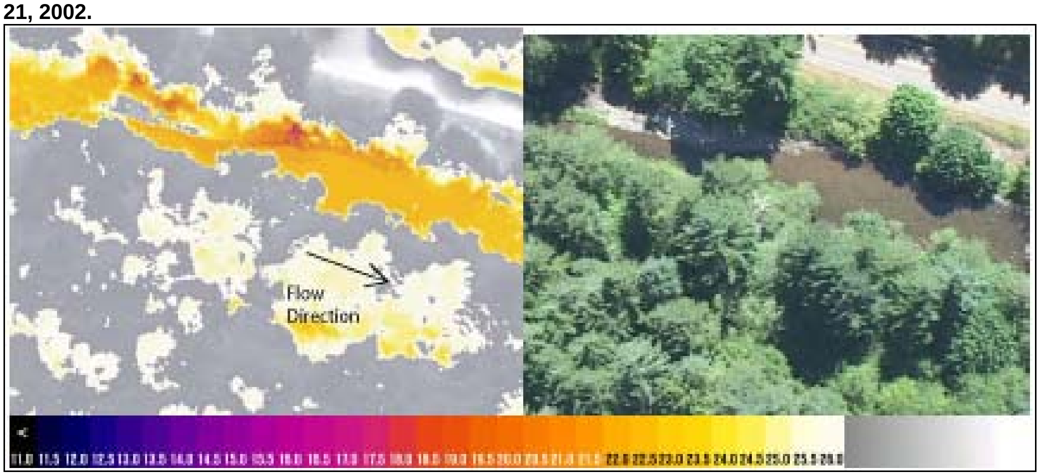


Figure 13.6 TIR/color video image pair showing the location of a spring (16.6ºC) on the right bank of Sharps Creek (20.4ºC) at RM 8.2 *(frames: shar0540-0544).* July 21, 2002.

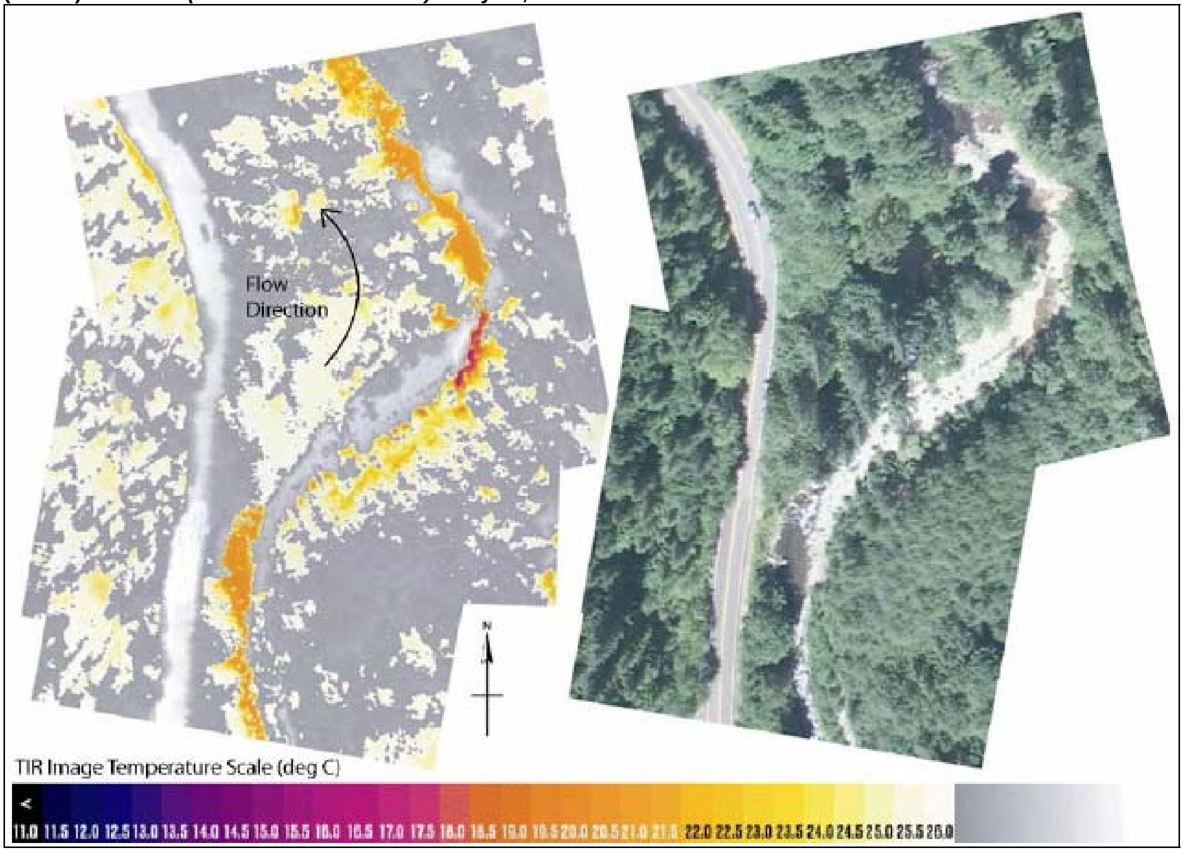


Figure 13.7 Longitudinal TIR median temperatures for Mosby Creek. River miles are calculated from the mouth of Mosby Creek. The graph also shows the location and names of tributary and other surface water inflows. July 21, 2002.

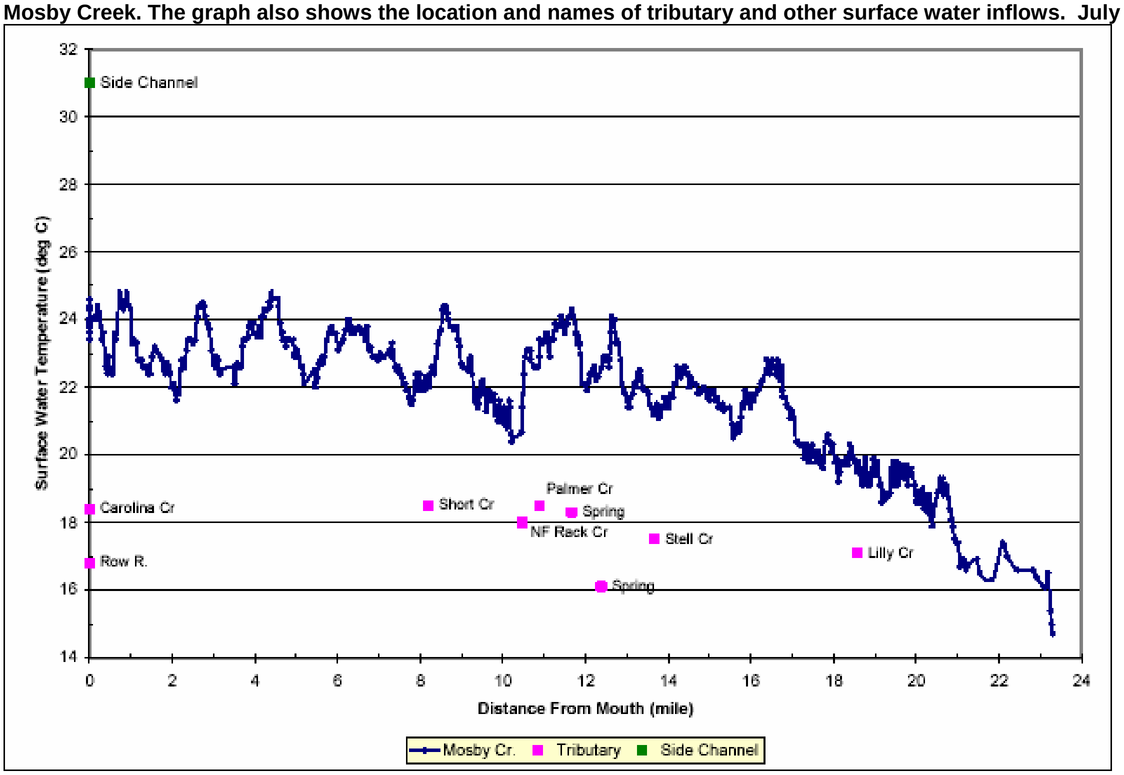


Figure 13.8 TIR/color video image showing Mosby Creek (22.4ºC) at RM 12.4. The flow direction is from the top to bottom of the image. A possible spring (16.1ºC) is visible along the LB (*looking downstream*). Although visible shadows make classification difficult, the location has visible surface water and is considerably cooler than other shadowed areas (*frame: mos0699*). July 21, 2002.

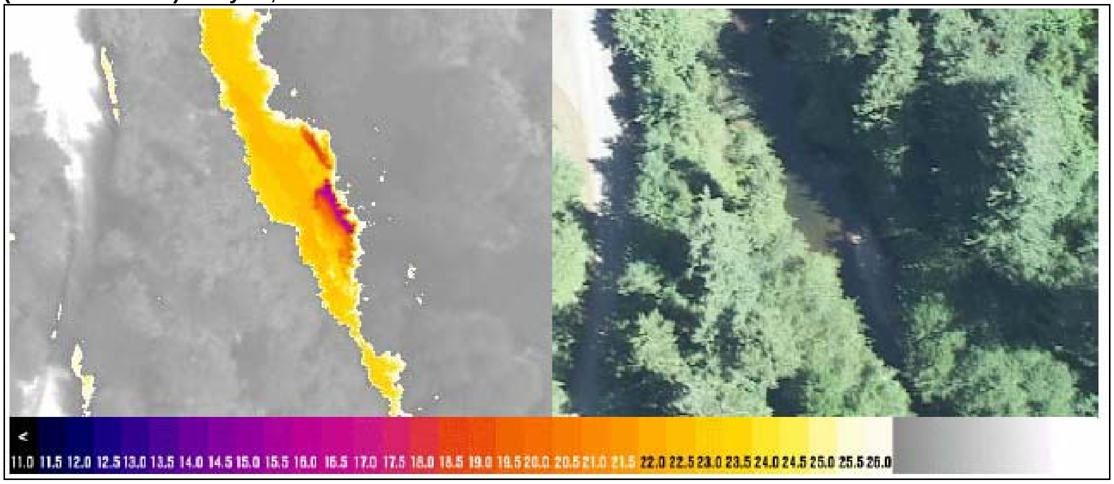


Figure 13.9 TIR/color video image pair showing the confluence of Mosby Creek (23.6ºC) and the Row River (16.8ºC). Carolina Creek (18.4ºC) enters on the left bank of Mosby Creek just upstream of its confluence with the Row River *(frames: mosb0007-0022)*. July 21, 2002.

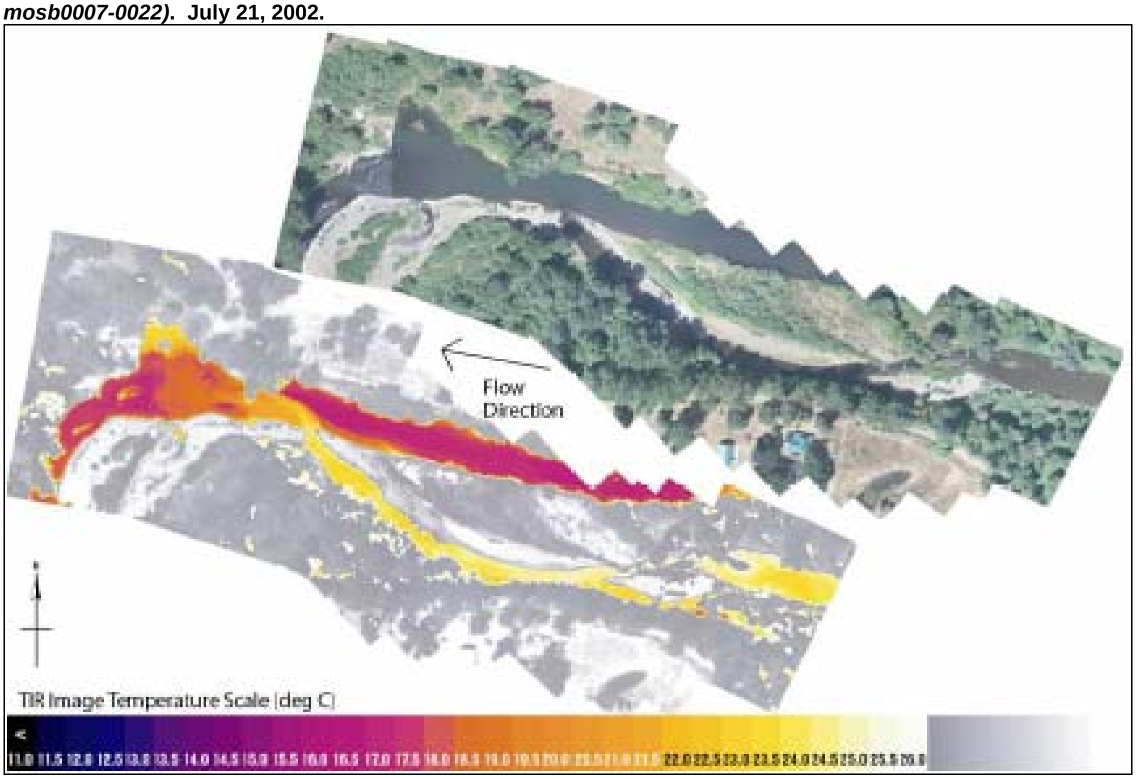


Figure 13.10 Mosby Creek at RM 12.8. Wide channel with no riparian vegetation at edge of stream during summer period.

Figure 13.11 Sharps Creek at RM 5.0 with a wide stream channel and minimal left bank riparian vegetation.

Figure 13.12 Big River at RM 0.0 with minimal riparian vegetation.

Loading Capacity

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

The loading capacity is the total amount of a pollutant that a water body can assimilate without exceeding a water quality criterion or impairing a beneficial use. This is the pollutant load that may be divided among all point and nonpoint sources as allocations.

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with water quality standards. USEPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*" (40 CFR § 130.2(f)). Oregon's temperature criteria states that a surface water temperature increase of no more than 0.3°C (0.54ºF) above the applicable criterion is allowed from all anthropogenic sources at the point of maximum impact.

The loading capacity is dependent on the available assimilative capacity of the receiving water. For water bodies whose natural thermal potential temperatures are at or above the temperature criterion for a given period, there is no available assimilative capacity beyond the 0.3°C (0.54ºF) human use allocation. The loading capacity is essentially consumed by non-anthropogenic sources. When natural thermal potential temperatures are less than biological based numeric criteria, the load capacity may be somewhat greater than the human use allowance provided additional heat loads do not prevent attainment of water quality standards in downstream waters.

Critical Condition

The critical condition for stream temperature and heat loading is the seasonal period of maximum stream temperatures and lowest stream flows. Maximum stream temperatures are a function of combining the effects of atmospheric inputs (solar radiation) and low stream flows that usually occur during the summer period. For many point sources the most critical condition for complying with the human use allowance occurs during the period of low stream flow and cooler river temperatures. This is usually in late summer to early fall.

Allocations

40 CFR 130.2(g), 40 CFR 130.2(h)

Loading capacity is allocated among point sources as wasteload allocations and to nonpoint sources as load allocations. Allocations to anthropogenic sources are only available where surface water temperatures throughout a given stream meet the applicable water quality criteria plus the human use allowance. The general principle for allocation in the Coast Fork Willamette Subbasin is to target natural background heat inputs from nonpoint sources and to limit point source loads to small allocations within the human use allowance.

Wasteload Allocations

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

A wasteload allocation (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria. Waste load allocations for temperature are expressed as heat load limits assigned to individual point sources of treated industrial and domestic waste. Waste load allocations are provided for all NPDES facilities that have reasonable potential to warm the receiving stream when the applicable criteria are exceeded. The WLA methodology discussed in this chapter are for point sources to waterbodies other than the Coast Fork Willamette River up to Cottage Grove Reservoir and the Row River up to Dorena Reservoir. Point sources that discharge directly to this portion of the Coast Fork Willamette River and Row River have been considered as part of Chapter 4. Point source facilities in the Coast Fork Willamette Subbasin that may require heat load allocation in this TMDL are identified in Table 13.6, on page 13-14.

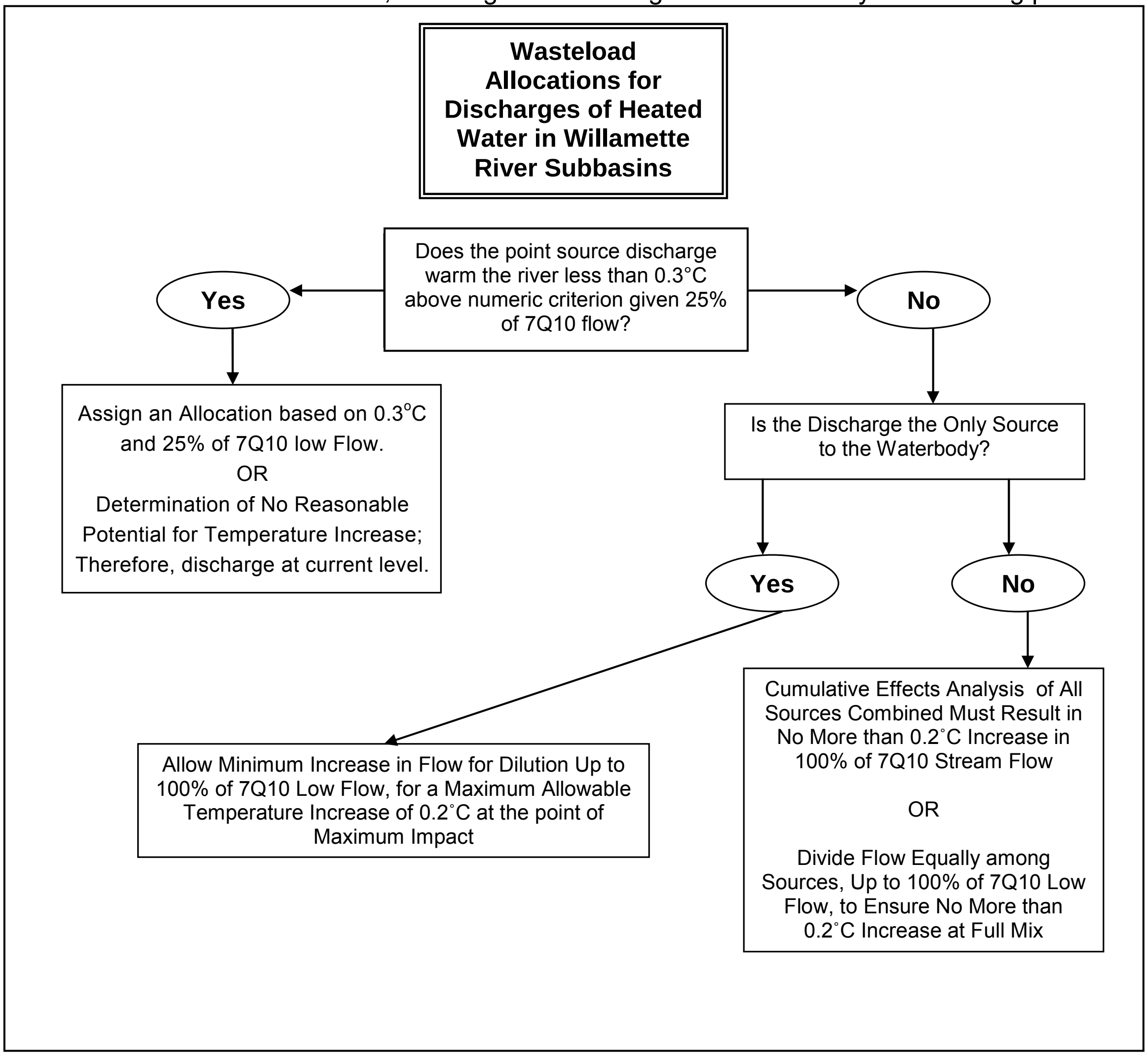
Waste Load Allocations in Small Streams

Discharges were screened to determine which would likely receive a wasteload allocation based on the type of discharge, and the volume and temperature of effluent. General permits that are unlikely to discharge significant volumes of warm water during critical periods (e.g., stormwater permits) are not expected to have a reasonable potential to increase instream temperatures. General permits that discharge heated effluent (e.g., boiler blowdown), were considered as potential sources. For discharges with insufficient information (absence of stream flow data) to screen for effects or develop a wasteload allocation (WLA), a WLA will be calculated at the time of permit renewal by the method described below.

Oregon's temperature standard [OAR 340-041-0028(12)] allows an insignificant increase in temperature from all point source and nonpoint sources combined as a Human Use Allowance (HUA = 0.3˚C). Prior to development of a TMDL, the standard allows the assumption that a 0.3˚C increase in ¼ of the receiving stream flow or the volume of the temperature mixing zone (whichever is more restrictive) will not cause an impairment.

The waste load allocation scheme below assumes an allowable change in temperature above criteria of 0.3˚C within 25% of the 7Q10 low flow (a calculation of the seven-day, consecutive low flow with a ten year return frequency). This is the initial step in the development of a waste load allocation on smaller streams or when information is insufficient to allow a greater proportion of receiving water flow for mixing. The resultant temperature increase in fully mixed receiving water would be limited to 0.08˚C. More than the minimum flow allowance (25% of 7Q10 low flow) may be allocated to an individual source when analysis demonstrates standards attainment. The resulting temperature increase in this scenario depends on the proportion of low flow allocated, but should not exceed the point source sector allocation of 0.2°C over the entire waterbody. Moreover, each discharge is also required to ensure the local effects of discharge will not cause impairment to health of fish by meeting thermal plume requirements adopted under OAR 340-41-0053(2)(d).

Where information was available, discharge heat loading was assessed by the following process:



The pre-TMDL limits in the flow chart above refer to currently permitted discharge limits for existing point sources. Wasteload allocations are expressed in terms of heat load (kilocalories per day). These heat loads are calculated from estimates of river flow, effluent flow, effluent temperature, and either the appropriate biologically based criterion or the natural thermal potential at the point of discharge. Heat load is calculated with Equation 1 (below). Where in-stream and effluent flow information is sufficient, allocations, and effluent limits may be developed based on flow rates for time periods other than monthly or an entire season (e.g., daily loads). The QZOD term may vary depending upon the situation for the discharger as explained in the decision tree above, but will usually be ¼ of the 7Q10 low flow on either a monthly or a yearly basis dependent on data availability.

Equation 1:

$$H_{PS} = (Q_{ZOD} + Q_{PS})\frac{1 \cdot ft^3}{1 \cdot sec} \cdot \frac{1 \cdot m^3}{35.31 \cdot ft^3} \cdot \frac{1000 \cdot kg}{1 \cdot m^3} \cdot \frac{86400 \cdot sec}{1 \cdot day} \cdot \Delta T_{ZOD} \cdot c = \frac{Kcal}{day}$$

Where:

- H_{PS}: Heat from point source effluent received by river (kcal/day)
- Q_{ZOD}: River flow volume allowed for mixing- ¼ of 7Q10 low flow statistic (cfs)
- Q_{PS}: Point source effluent discharge (cfs)
- ΔT_{ZOD}: Change in river temperature at point of discharge - 0.3^{o}C allowable (^{o}C)
- c: Specific heat of water (1 Kcal / 1kg 1ºC)

Estimates of effluent temperature were calculated using mass loading equations (**Equation 2**) taking into account river flow and temperature, and effluent flow and temperature. Allocations are usually calculated to ensure an increase in temperature of no more than 0.3°C (0.54°F) in one-quarter of the volume of the receiving stream. When this volume is fully mixed with the receiving stream, this increase in temperature would be limited to 0.08°C. Where more than the minimal flow volume is allocated, either to allow more heat load to an individual discharger on a stream, or to calculate the cumulative effects of multiple discharges, the allocation is no more than 0.2°C (0.36°F) increase given the entire flow of the river receiving the cumulative discharges. If new or more comprehensive information (e.g. flow data, temperature data, mixing zone characteristics) is available at the time permits are renewed, permit limits will reflect revised wasteload allocations as calculated using **Equation 1** above and the best information available.

Equation 2:

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

Where:

T_R: Temperature Criterion or Upstream potential river temperature (^{o}C)
T_{WLA}: Maximum allowable point source effluent temperature (^{o} C)
ΔT_{ZOD}: Change in river temperature at point of discharge - 0.3^{o}C allowable (^{o}C)
Q_{ZOD}: River flow volume allowed for mixing- ¼ of 7Q10 low flow statistic (cfs)
Q_{PS}: Point source effluent discharge flow volume (cfs)

Three permitted discharges to subbasin streams in the Coast Fork Willamette Subbasin may require permit limits to ensure water quality standards are met, Table 13.7. These facilities are Short Mountain Landfill, Foster Farms, and Creswell WWTP. All discharges have the potential to increase water temperature, but currently available information is insufficient to allow calculation of wasteload allocations. This information will be gathered prior to renewal of these permits, and limits will be developed as described above to ensure temperature in receiving waters is not increased beyond permissible limits.

Table 13.7 Individual NPDES facilities in the Coast Fork Willamette Subbasin, which do not discharge to the mainstem Coast Fork Willamette River and Row River.

Facility Name	Permit Type	Permit Description	Receiving Stream	River Mile	Type of Discharge	Season of Discharge
SHORT MOUNTAIN LANDFILL	NPDES-IW-O	Industrial Wastewater; NPDES non-process wastewater NEC	Hill Creek	0.1	Process Water	Year Round
FOSTER FARMS	NPDES-IW-N	Industrial Wastewater; NPDES process wastewater NEC	Camas Swale Creek	3	Process Water	F-W-S
CRESWELL STP	NPDES-DOM-Db	Sewage - less than 1 MGD with lagoons	Camas Swale Creek	4	Wastewater	F-W-S

FWS = Fall-Winter-Spring; approximately October through May
NEC = Not Elsewhere Classified

Load Allocations

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

Load Allocations are portions of the loading capacity divided among natural, current anthropogenic, and future anthropogenic nonpoint pollutant sources. Load allocations (i.e. distributions of the loading capacity) are provided in Table 13.8 for Mosby Creek.

In this TMDL, load allocations are allowed 0.05˚C of the human use allowance (0.3˚C). This heat allowance is in addition to the load that streams would receive when they are at system potential and would allow activities that might increase the loading (such as riparian management activities) or for human disturbance that may not easily be addressed (e.g. presence of a road near a stream that would limit shading). The 0.05°C increase in temperature above criteria (1/6th of the HUA) is dedicated to nonpoint sources but is not allocated to individual sources at this time.

The current loading from nonpoint sources is much greater than that which would exist under natural thermal potential. This requires nonpoint sources to reduce thermal inputs to reach natural thermal potential conditions through allocation of a surrogate measure, effective shade. The principal means of achieving this condition is through protection and restoration of riparian vegetation. Additional measures may also be taken to improve summer temperatures. For example, water conservation measures that improve summer stream flows will benefit stream temperatures through an increase in load capacity. Stream restoration efforts that result in narrower stream channel widths will improve the effectiveness of existing vegetation to shade the stream surface.

Nonpoint source allocations were assigned natural background loads and are implemented as shade curves for upland forests and each geomorphic unit. This allocation also applies to tributaries of temperature listed waterbodies. Shade curves illustrate the relationship between each potential vegetation cover type, channel width and the resulting effective shade level.

The total nonpoint source solar radiation heat load was derived for Mosby Creek. Current solar radiation loading was calculated by simulating current stream and vegetation conditions using the Heat Source Temperature Model version 6.5. Background loading was calculated by simulating the solar radiation heat loading that resulted with system potential vegetation. This background condition, based on system potential vegetation, reflects an estimate of nonpoint source heat load that would occur while meeting the temperature criterion. The relationships below were used to determine solar radiation heat loads for the current condition, anthropogenic contributions, and loading capacity derivations based on system potential, see diagram below:

Solar Radiation Heat Load Calculation Diagram

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

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

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

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

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

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

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

where,

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

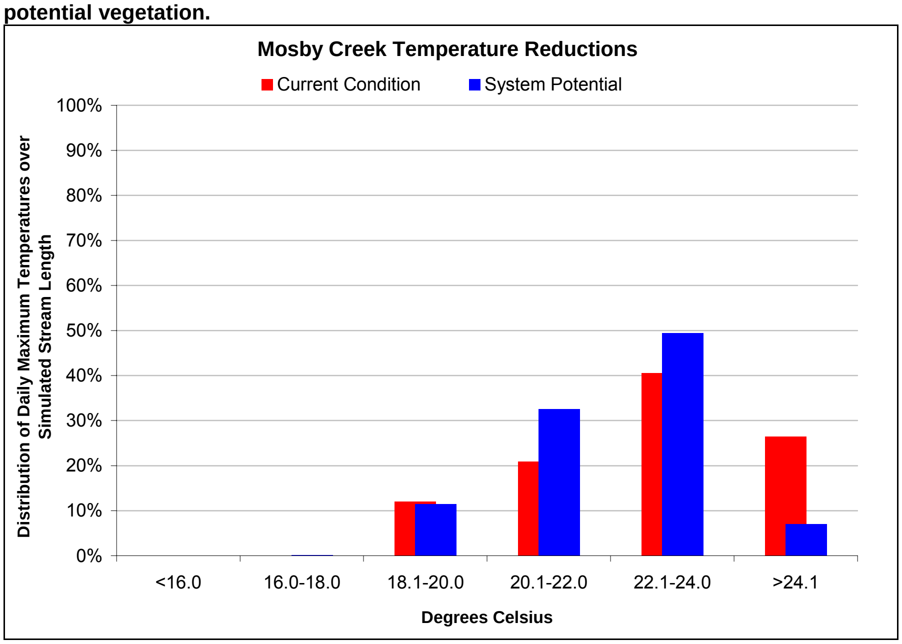
System potential vegetation was developed to simulate a natural stream system with non-anthropogenic, natural disturbance incorporated into the riparian vegetation distribution and attributes within each geomorphic unit. The term "geomorphic unit" refers to quaternary geologic units shown as polygons that were differentiated on the basis of stratigraphic, topographic, pedogenic, and hydrogeologic properties (O'Connor et al, 2001). In other words, surface deposits of unconsolidated material above bed rock shaped by processes of erosion, sediment transport and deposition.

- Flood
- Wind Throw
- Fire
- Insect Infestation

System potential vegetation includes the random distribution of conifer, mix conifer-hardwood, and hardwood species in each geomorphic unit. This random distribution of attributes within each geomorphic unit is intended to include the effects of natural disturbance in the system potential riparian vegetation condition. Some geomorphic units may also incorporate prairie. The proportions of forest, savanna and prairie to be used in each geomorphic unit were developed following rules detailed in Table 1 and on page 14 of the Potential Near-Stream Land Cover document included in Appendix C. As an example, in the quaternary alluvium unit (Qalc) which is unconsolidated silt, sand, and gravel of the Willamette River and major Cascade Range tributaries the vegetation distribution includes 80% forest, 17% savanna and 3% prairie. Forest land includes a mix of conifer (4%), hardwood (3%) and mixed (93%) forests, which determine the shade characteristics of the near-stream plant community.

A total of 21.5 river miles in the Coast Fork Willamette Subbasin were analyzed and simulated during the critical period of July 21st, 2002. Stream temperatures outputs from Mosby Creek with system potential riparian conditions are presented in Figure 13.13. These graphs represent the maximum daily stream temperatures observed longitudinally downstream. A decrease in the maximum observed daily maximum stream temperatures are observed for the creek when system potential riparian vegetation is applied. The stream temperatures that result from system potential riparian vegetation are the targeted condition for the Mosby Creek load allocation.

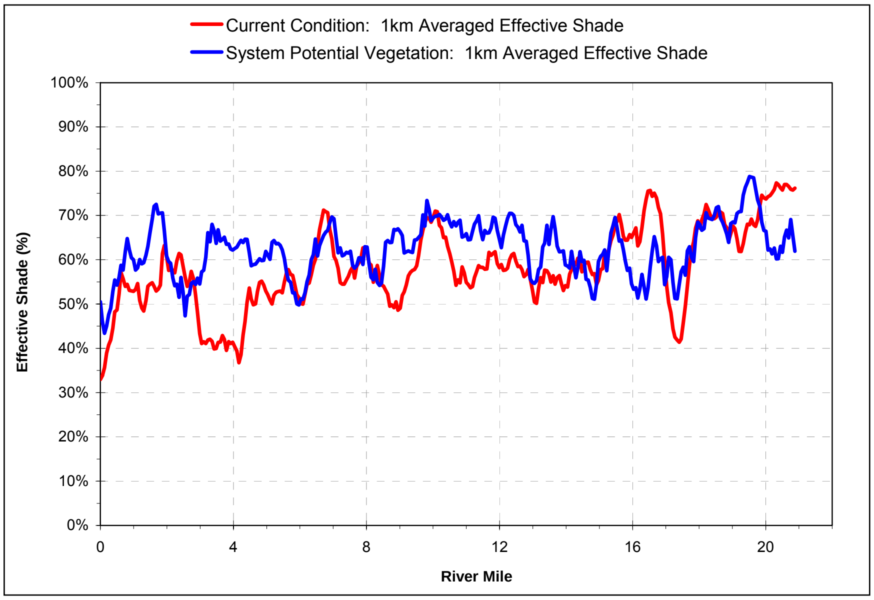
Figure 13.13 Mosby Creek distribution of maximum daily stream temperatures at current conditions and system potential vegetation.



The percent effective shade calculated for current conditions versus system potential vegetation conditions for Mosby Creek averaged over a 1 km (0.6 miles) distance is shown in Figure 13.14. Typically system potential vegetation provides greater percent effective shade values to the stream; however system potential effective shade values are lower than currently observed levels in specific reaches of the stream. This decrease in effective shade under system potential conditions is due in part to the random distribution of low shade values or disturbance in the system potential vegetation scenario. For example, the system potential condition in the headwaters of Mosby Creek may have accounted for a disturbance in the riparian community when in fact under current conditions the headwaters of Mosby Creek may not be disturbed.

Decreasing channel widths would also increase the effectiveness of the system potential vegetation to shade the stream and in effect decrease in-stream temperatures. In this single simulation, system potential vegetation produced an average 5% increase in effective shade over currently assessed effective shade levels in Mosby Creek.

Figure 13.14 Mosby Creek Longitudinal Percent Effective Shade Profile of Current Conditions versus System Potential Vegetation, averaged over a 1 km distance.



A summary of the solar radiation load for Mosby Creek at current and system potential conditions is shown in Table 13.8. The difference between current and system potential conditions is the calculated anthropogenic load for nonpoint sources. Modeling of Mosby Creek with system potential riparian vegetation indicates that 2.79×10^{8} kcal/day heat load is attributed to system potential condition and 3.8×10^{7} kcal/day is due to anthropogenic sources. Additional factors such as channel modification and flow modification were not assessed.

Table 13.8 Mosby Creek Solar Radiation Load Summary.

Stream	Current Condition (10^8 kcal/d) $H_{Total\ NPS}$	System Potential Condition (10^8 kcal/d) $H_{SP\ NPS}$	Anthropogenic $H_{Anthro\ NPS}$ (10^8 kcal/d)
Mosby Creek	3.18	2.79	0.38

The point of maximum impact for anthropogenic sources of heat is defined as the point in the stream where the maximum difference in temperature between natural thermal potential temperature and current temperatures are observed. In Mosby Creek the point of maximum impact occurs at RM 17, downstream of Dahl Creek. The difference between current condition stream temperatures and system potential vegetation temperatures at the point of maximum impact is 3.0°C (5.4°F). At the mouth of the creek the maximum current condition temperature is 26.4°C (79.5°F), and system potential vegetation simulations suggest this temperature would decrease to 24.9°C (76.8°F).

In addition to system potential vegetation other methods may decrease stream temperatures and increase effective shade, such as:

- Restoring stream channel morphology
- Increasing stream channel complexity
- Restoring floodplain processes
- Restoring natural stream flow
- Decreasing tributary stream temperatures

Excess Load

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

The excess load is the difference between the actual pollutant load and the loading capacity of a water body. Load allocations for nonpoint sources are based on system potential vegetation. Riparian information provided by the ODEQ, USFS, and BLM indicates that there is inadequate shade throughout the Coast Fork Willamette Subbasin. Excess heat loading occurs wherever inadequate shade levels are widespread. Excess load in Mosby Creek is shown Table 13.8 as the anthropogenic heat load but does not account for the small additional heat load represented in the human use allowance.

Surrogate Measures

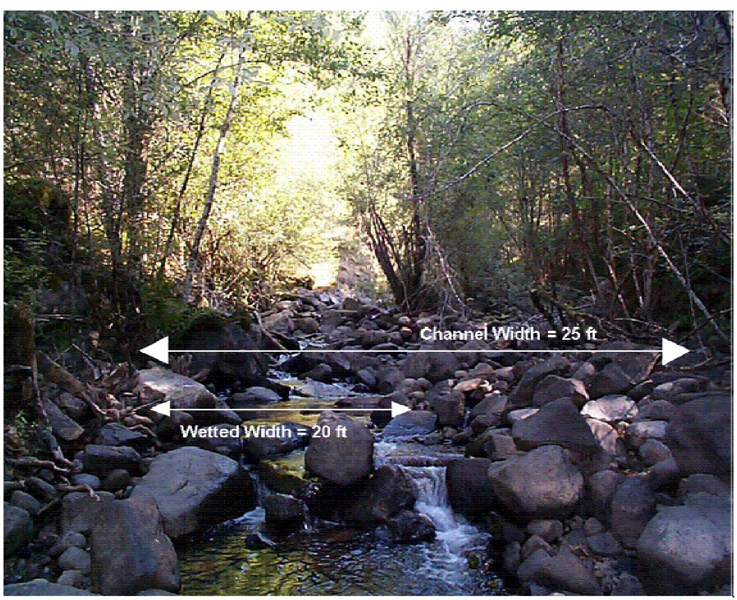
OAR 340-042-0040(5)(b), 40 CFR 130.2(i)

The Coast Fork Willamette Subbasin Temperature TMDL incorporates measures other than “daily loads” in allocating heat to nonpoint sources. These measures are termed surrogate measures. The applied surrogate measure in this temperature TMDL is percent effective shade expressed as a shade curve. Shade curves have been developed for each geomorphic unit in the Willamette Valley and upland forest area of the Cascade and Coast Ranges in the Willamette Basin. Shade curves determine the nonpoint source load allocation. They were developed using trigonometric equations estimating the shade underneath tree canopies.

Percent effective shade is perhaps the most straightforward stream parameter to monitor and calculate. It is easily translated into quantifiable water quality management and recovery objectives. Percent effective shade is defined as the percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface, commonly measured with a Solar Pathfinder.

Shade curves represent general relationships between the percent effective shade reaching the stream surface, solar radiation loading of the stream, system potential vegetation, stream aspect from north, and the width of the channel. The channel width, Figure 13.15, is the distance from the edge of right bank vegetation to the edge of left bank vegetation.

Figure 13.15 The Channel width approximates bankfull width.



System potential vegetation has been developed for each geomorphic unit in the Willamette Basin. It is defined as the riparian vegetation which can grow and reproduce on a site given the plant biology, site elevation, soil characteristics, and local climate. However, it does not include considerations for resource management, human use, and other human disturbances. A natural disturbance regime has been incorporated into the riparian composition for each geomorphic region that includes provisions for fire, disease, wind-throw, and other natural occurrences. Each shade curve translates the amount of percent effective shade that each geomorphic unit tree composition provides to the stream based on the streams channel width and stream aspect from north. Each geomorphic unit is composed of a percentage of forest, savannah, and prairie and reflects the tree species composition that will grow and reproduce in each geomorphic unit. For a detailed description of the system potential vegetation development and of the riparian tree species composition for each geomorphic unit please see Appendix C. A shade curve has been developed for each geomorphic and upland forest unit in the Coast Fork Willamette Subbasin, Map 13.8 to 13.12 and Figure 13.16.

The relative areas of the geomorphic classifications of the Coast Fork Willamette Subbasin are presented in Table 13.9. Despite the relatively fine scale of the geomorphic classifications, the differences among the various shade curves are subtle in some cases.

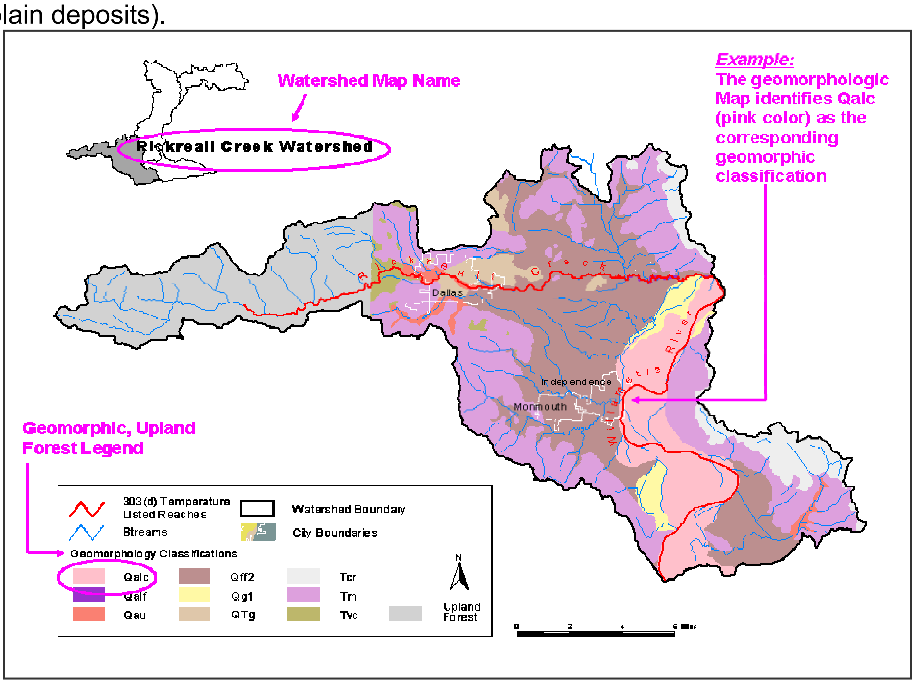
Table 13.9 Area of Geomorphic Units in the Coast Fork Willamette Subbasin. Values are Ranked in Order of Increasing Area.

Geomorphic Class	Acres	Square Miles	Relative Area (%)
Pre-Flood Quaternary sand/gravel (Qg2)	653	1	0.2
Undifferentiated Quaternary Alluvium (Qau)	3,461	5	0.8
Quaternary terrace gravels (QTg)	4,837	8	1.1
Tertiary Marine sedimentary rock (Tm)	5,812	9	1.4
Quaternary alluvium floodplain deposits (Qalc)	8,384	13	2.0
Quaternary fine-grained alluvium (Qbf)	8,973	14	2.1
Post Flood Quaternary sand/gravel (Qg1)	12,502	20	2.9
Western Cascades tertiary volcanics (Tvw)	82,919	130	19.5
Upland Forests (Uf)	297,727	465	69.8
Grand Total	**426,310**	**666**	**100.0**

How to Use a Shade Curve:

1. Determine the applicable geomorphic or upland forest unit that applies to the stream of interest.

Example: Rickreall Creek watershed, in the City of Independence along the west bank of the Willamette River. By using the appropriate map, below, identify the geomorphic unit of interest to be Qalc (Quaternary alluvium floodplain deposits).



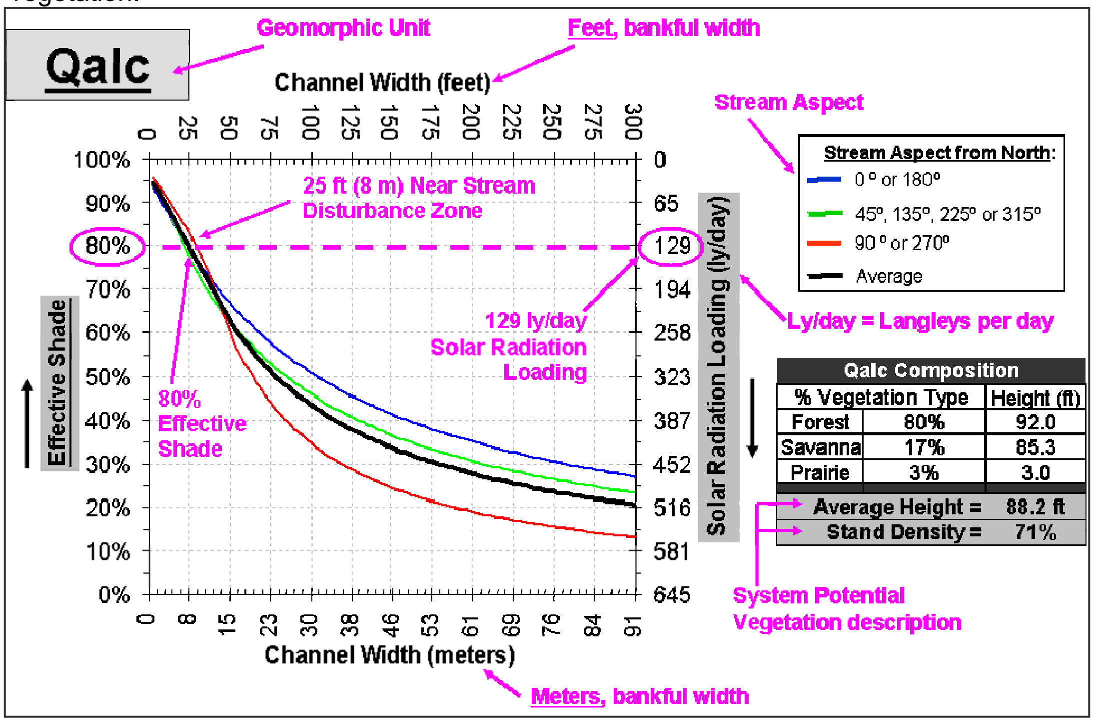
2. Determine the stream aspect from north.

Example: Based on your location on a tributary to the west bank of the Willamette River in Independence, standing in-stream mid-channel, facing north you determine the river's aspect as 0º or 180º from north (this means the river reach runs south to north).

3. Determine the channel width of the stream reach.

Example: At your location you measure the channel width using a tape measure or lasar range finder, you determine the stream width is 25 feet.

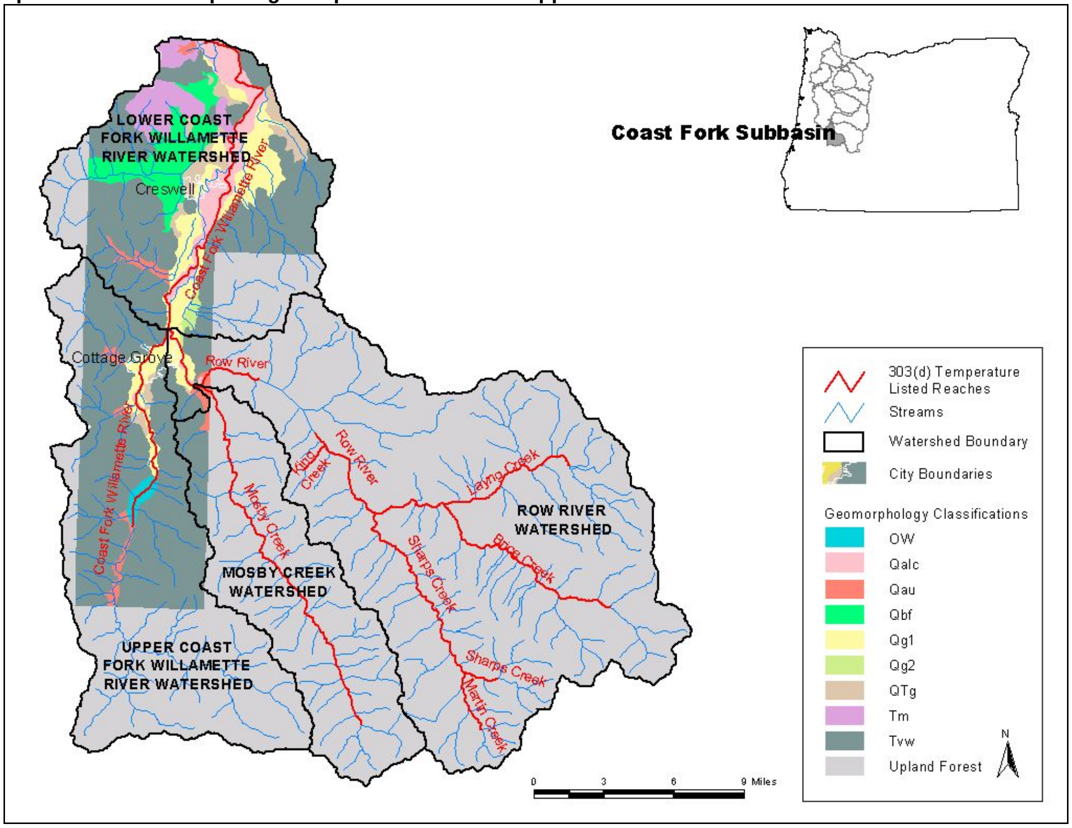
4. Using the appropriate geomorphic or upland forest Shade Curve, using the appropriate stream aspect line and channel width (x-axis), read the y-axis to determine the percent effective shade and solar radiation loading. This is the loading capacity of the stream reach at system potential vegetation.



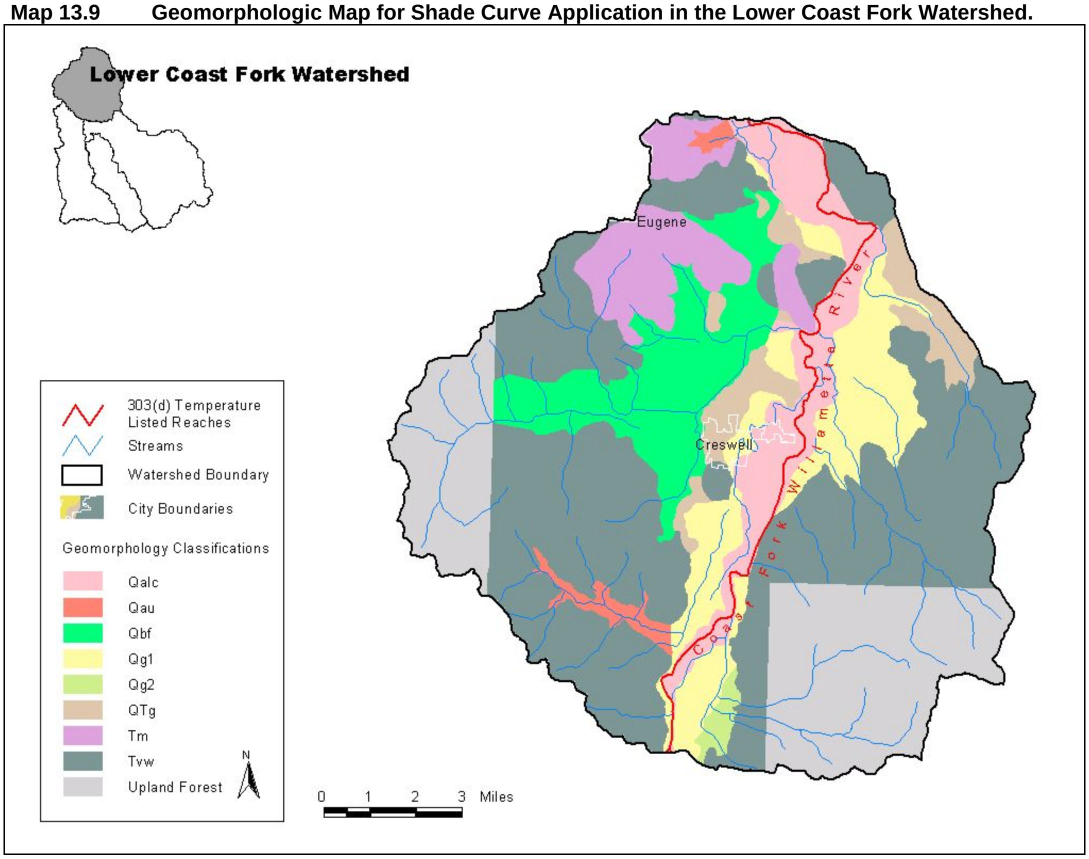
Example: A tributary to the Willamette River on the west bank near Independence with a stream aspect from north of 0º or 180º (blue line) and a channel width of 25 feet: using the blue line to determine the loading capacity from the x-axis identify the 25 feet (8 m) mark and read the y-axis, the solar radiation loading would be 129 Langleys/day with 80% effective shade when system potential vegetation is applied to the left and right bank of the stream reach. System potential vegetation identifies the riparian average height, 88.2 feet (26.9 m), and stand density (tree canopy density), 71 %, that would be established in the riparian area. If it is difficult to determine the streams aspect from north, the average stream aspect from north, black line, can be used to determine the solar radiation loading and effective shade.

Conclusion: A land owner or manager living on the west side of the Willamette River near the city of Independence, measures the channel width of the tributary stream as 25 feet (8 m), with a stream aspect from north of 0º or 180º. By using the geomorphic map for shade curve development that is specific to the areas watershed, provided by ODEQ, in this case Rickreall Creek Watershed geomorphic map. The land owner identifies their location and the corresponding geomorphic unit as Qalc in this example. The land owner then uses the Qalc shade curve to identify what the effective shade and solar radiation loading reaching the stream would be when the land owner establishes a riparian area corresponding to the system potential vegetation description. This is considered the nonpoint source load allocation.

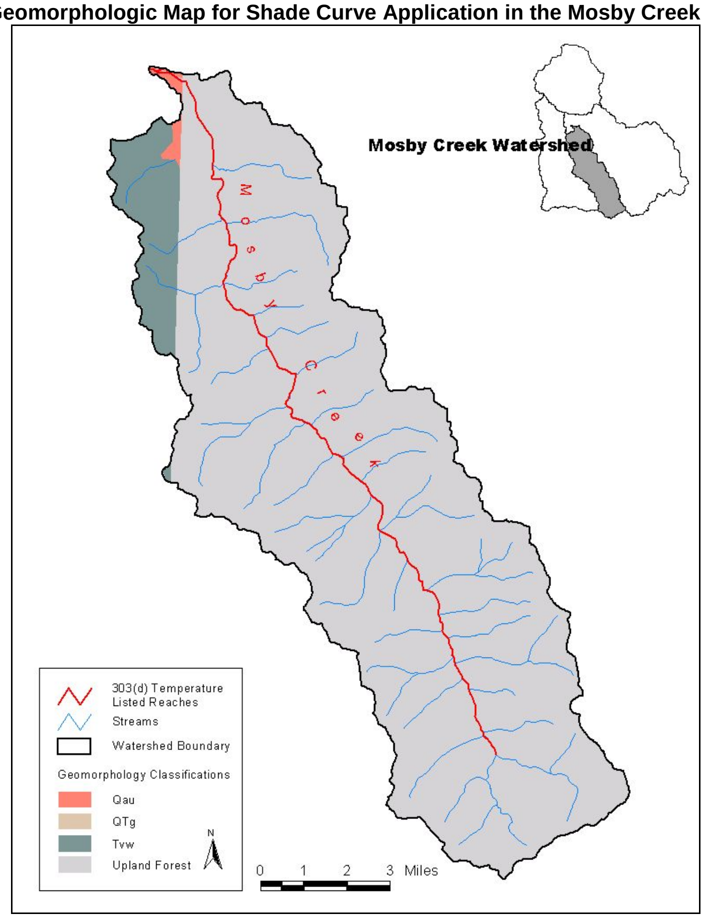
Map 13.8 Geomorphologic Map for Shade Curve Application in the Coast Fork Willamette Subbasin.



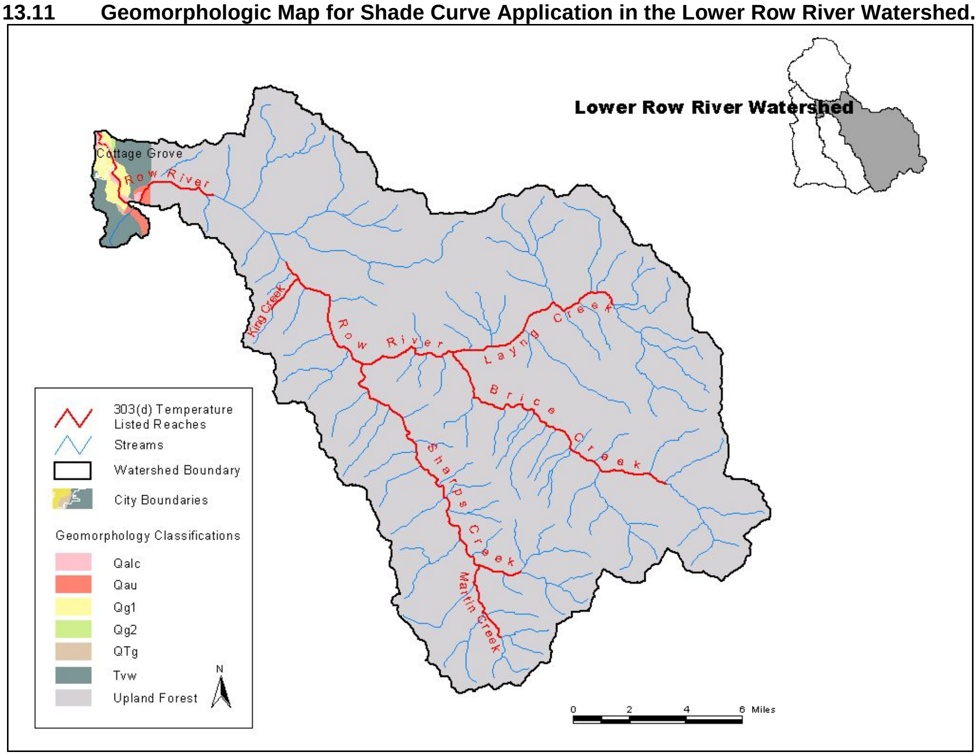
Map 13.9 Geomorphologic Map for Shade Curve Application in the Lower Coast Fork Watershed.



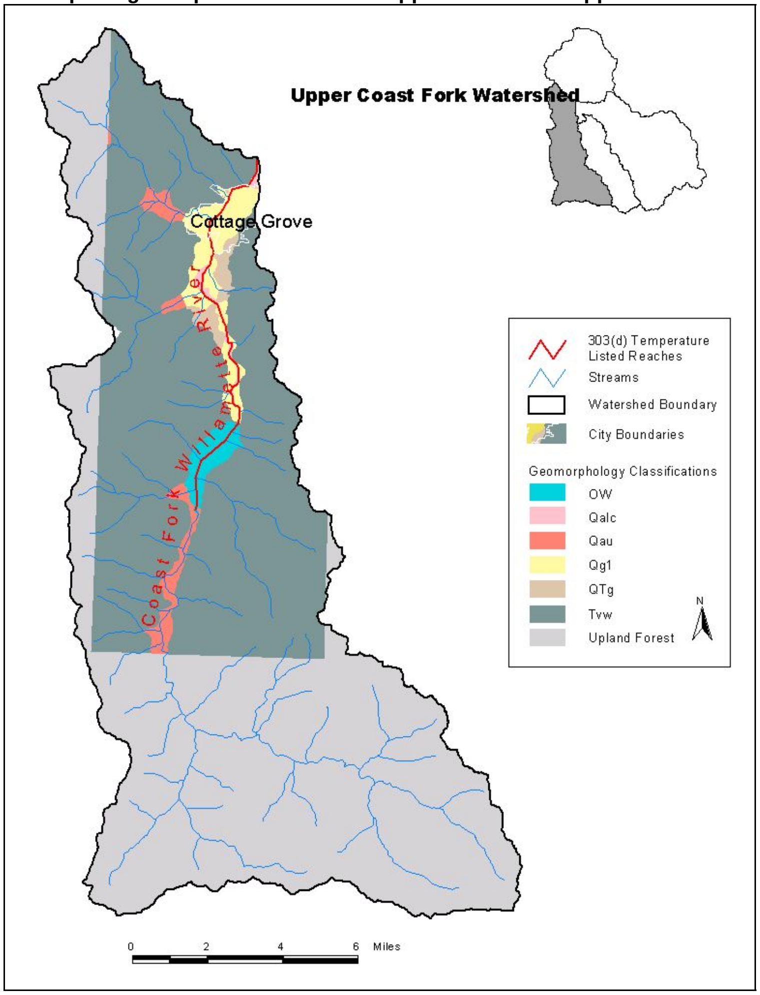
Map 13.10 Geomorphologic Map for Shade Curve Application in the Mosby Creek Watershed.



Map 13.11 Geomorphologic Map for Shade Curve Application in the Lower Row River Watershed.



Map 13.12 Geomorphologic Map for Shade Curve Application in the Upper Coast Fork Watershed.



The shade curve method provides no information on existing shade conditions or the expected system potential stream temperature. It does provide estimates of the allocations necessary to eliminate temperature increases resulting from anthropogenic impacts on stream shading. The shade curves presented in Figure 13.16 apply to all water bodies in the Coast Fork Willamette Subbasin based on the geomorphic and upland forest unit of the reach. The shade curves represented in each figure have been calculated based on the average height for each unit as defined by system potential vegetation. Interpretation and implementation of the shade curves requires the identification of the geomorphic or upland forest unit that applies to the stream reach (Map 13.8 to 13.12), measuring the streams channel width (bankful width), and then depending on the streams aspect from north reading the shade curves graph to determine the percent effective shade and solar radiation loading that the system potential vegetation composition will provide. For a list of geomorphic class abbreviations for each shade curve please see Table 13.8 titled "Area of Geomorphic Units in the Coast Fork Willamette Subbasin", above.

Geomorphic unit code Pre Flood Quaternary Sand/Gravel (Qg2) is represented in the Coast Fork Willamette Subbasin. The shade curve for Qg2 has not been developed. Historically the geomorphic unit code Qg2 had 90% prairie vegetation along streams that historically became subsurface in the summer and for which water is currently artificially diverted to maintain summer flows. Historic vegetation is probably not a good guideline for modeling potential present day stream temperature. Instead, ODEQ will use the nearest adjacent geomorphic code as determined by the geomorphologic maps, Map 13.8 to 13.12.

Figure 13.16 Shade Curves for Coast Fork Willamette Subbasin Geomorphic Classifications.

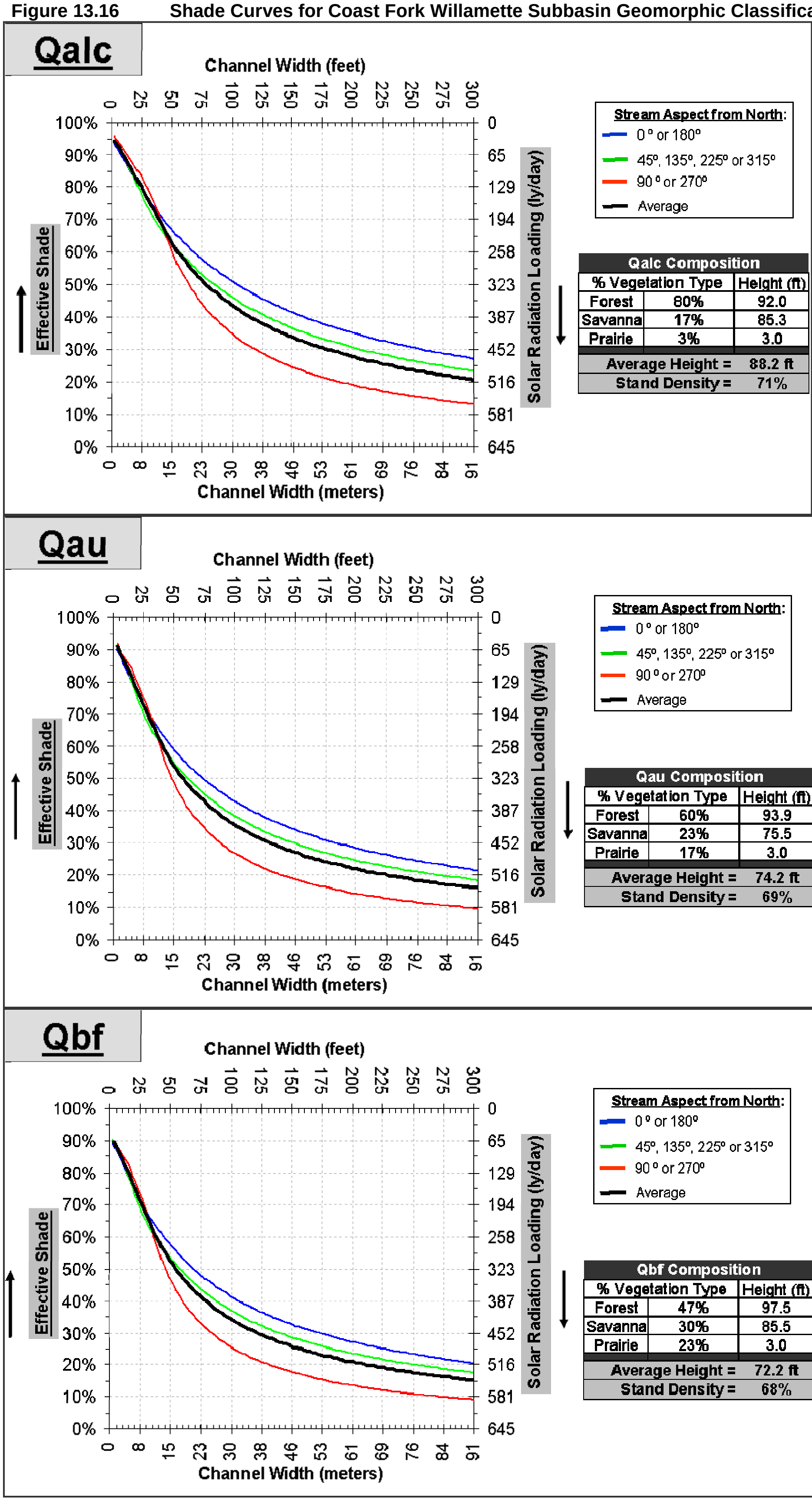
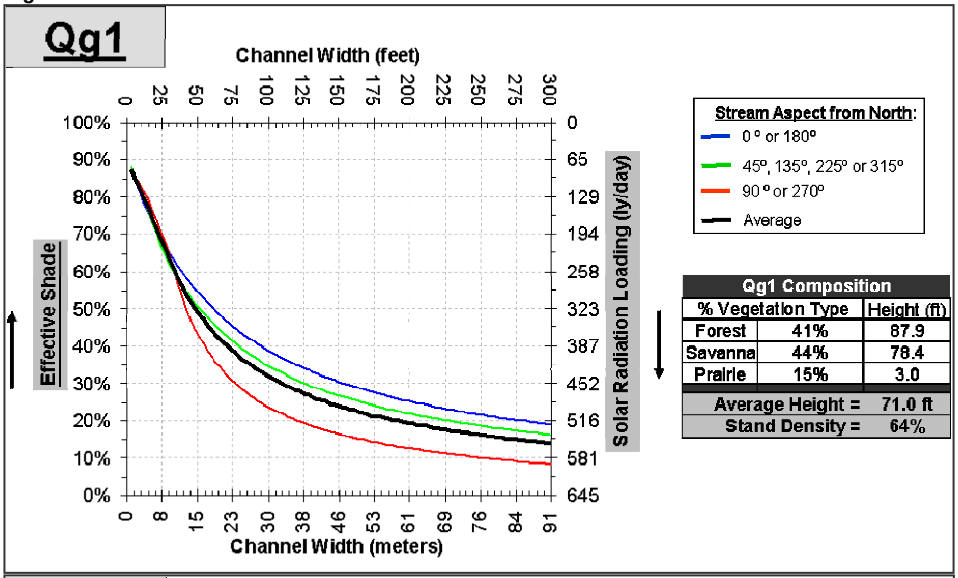
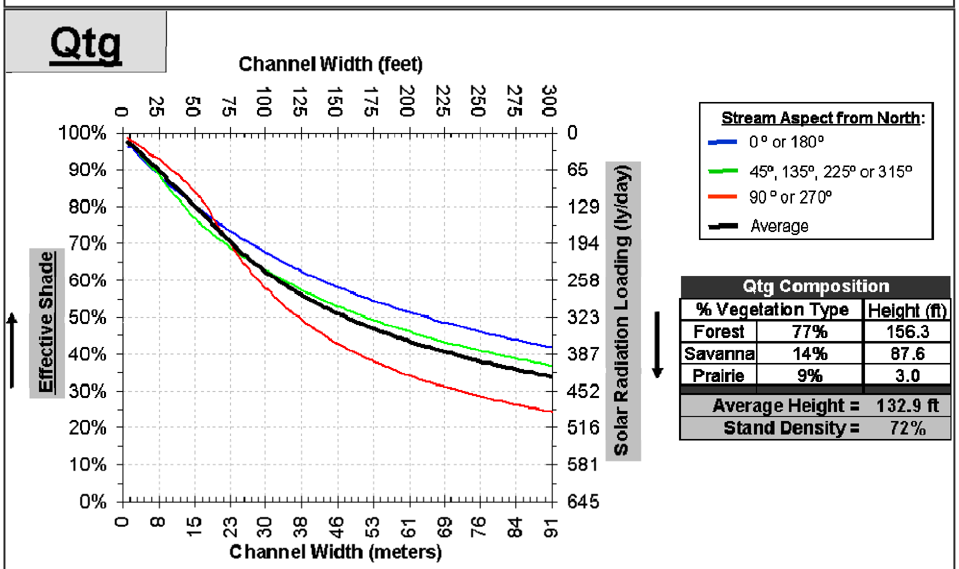


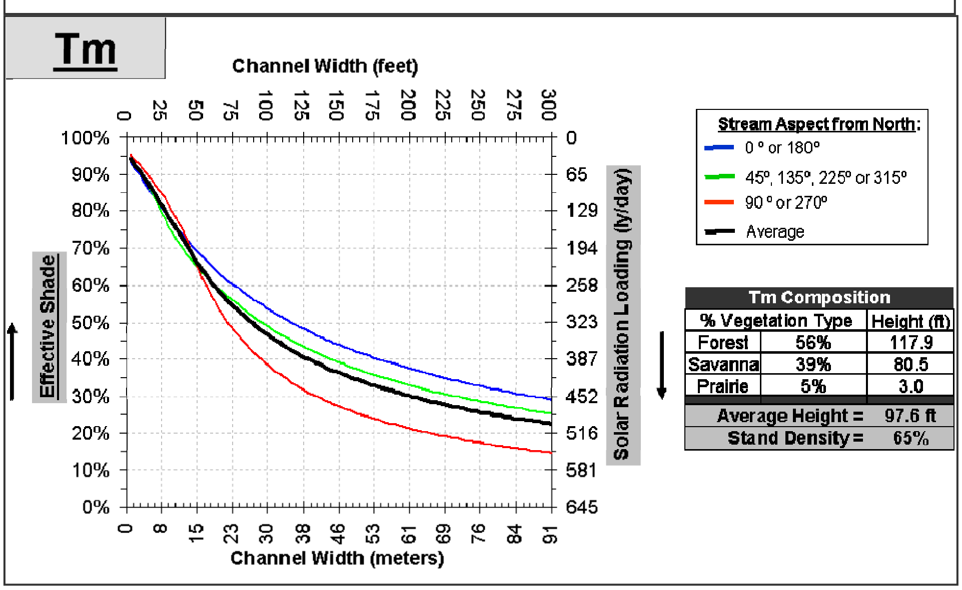
Figure 13.16 cont'd



Qg1 Composition		
% Vegetation Type		Height (ft)
Forest	41%	87.9
Savanna	44%	78.4
Prairie	15%	3.0
Average Height =		71.0 ft
Stand Density =		64%

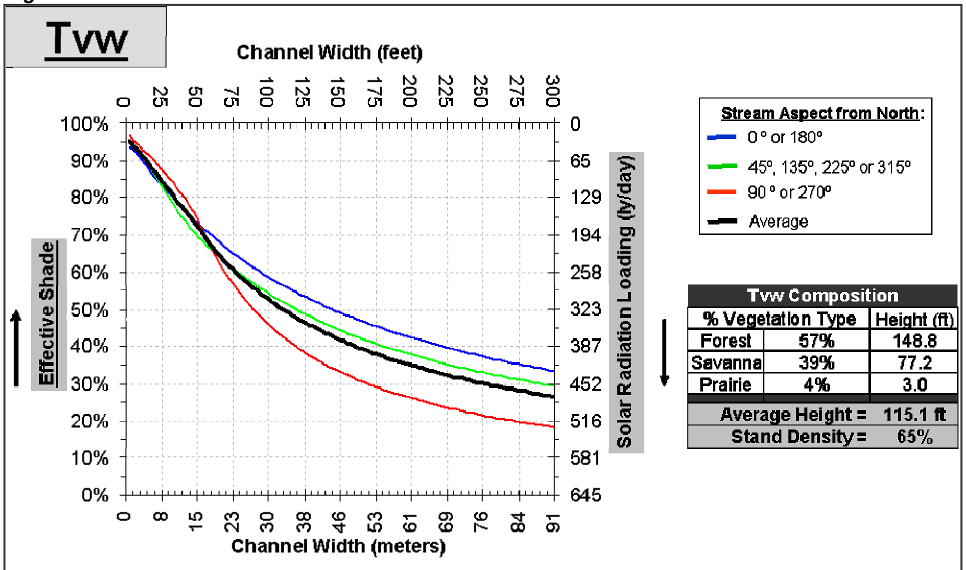


Qtg Composition		
% Vegetation Type		Height (ft)
Forest	77%	156.3
Savanna	14%	87.6
Prairie	9%	3.0
Average Height =		132.9 ft
Stand Density =		72%

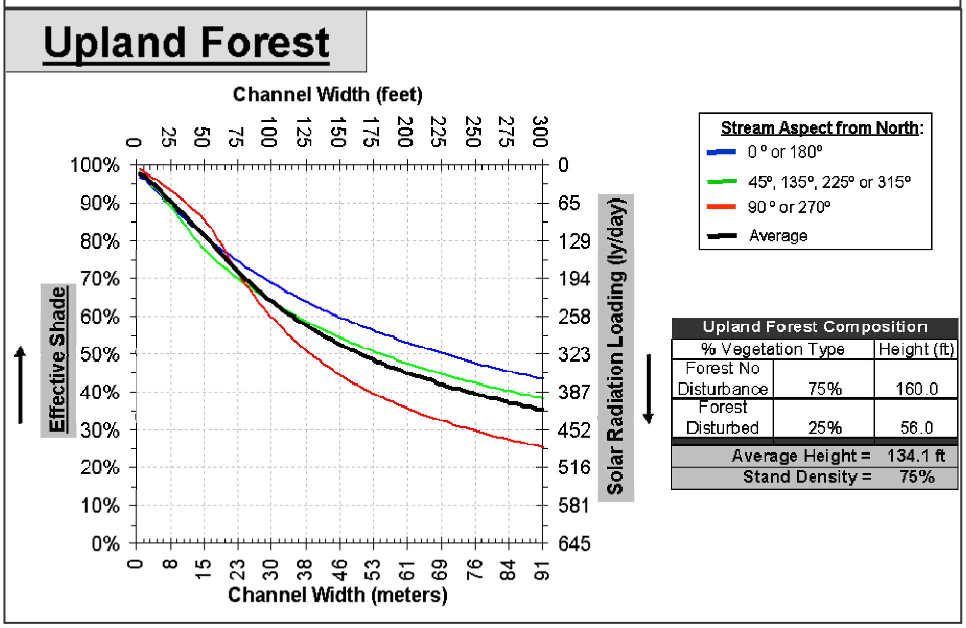


Tm Composition		
% Vegetation Type		Height (ft)
Forest	56%	117.9
Savanna	39%	80.5
Prairie	5%	3.0
Average Height =		97.6 ft
Stand Density =		65%

Figure 13.16 cont'd



Tvw Composition		
% Vegetation Type		Height (ft)
Forest	57%	148.8
Savanna	39%	77.2
Prairie	4%	3.0
Average Height =		115.1 ft
Stand Density =		65%



Upland Forest Composition		
% Vegetation Type		Height (ft)
Forest No Disturbance	75%	160.0
Forest Disturbed	25%	56.0
Average Height =		134.1 ft
Stand Density =		75%

Margin of Safety
OAR 340-042-0040(4)(i), CWA 303(d)(1)

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

The margin of safety may be implicit, as in conservative assumptions used in calculating the Loading Capacity, Wasteload Allocations, and Load Allocations. It 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 margin of safety documented. The margin of safety is not meant to compensate for a failure to consider known sources. Table 13.10 presents six approaches for incorporating a margin of safety 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 margin of safety, which results in an overall allocation, represent the best estimate of how standards can be achieved. The selection of the margin of safety 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 13.10 Approaches for Incorporating a Margin of Safety into a TMDL

Type of Margin of Safety	*Available Approaches*
Explicit	1. Set numeric targets at more conservative levels than analytical results indicate. 2. Add a safety factor to pollutant loading estimates. 3. Do not allocate a portion of available loading capacity; reserve for margin of safety.
Implicit	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.

A margin of safety has been incorporated into the temperature assessment methodology. Wasteload allocations are based on critical conditions that are unlikely to occur simultaneously. For example, it is unlikely that maximum effluent flows and maximum effluent temperatures are likely to occur simultaneously however those values were used to calculate point source heat loads. Furthermore, receiving stream values were also based on attainment of biological based criteria during low flow periods defined as the low flow of a ten year cycle.

Calculating a numeric margin of safety for nonpoint source loads is not easily performed with the methodology presented in this document. In fact, the basis for the loading capacities and load allocations is system potential conditions and it is not the purpose of this plan to promote riparian conditions and shade levels that exceed natural conditions.

Reserve Capacity

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

Reserve capacity has been allocated for temperature through much of the Willamette Basin. Explicit allocations have generally only been made in conjunction with point source wasteload allocations. Where there are multiple point sources in a waterbody, point sources in combination have been allocated 0.2˚C of the Human Use Allowance. Another 0.05˚C is allocated to nonpoint sources of heat. These latter sources have generally been limited to natural solar radiation levels determined by shade curves for a given area. The final 0.05˚C is allocated to reserve capacity and will be available for use by point sources or nonpoint sources by application to ODEQ. In total, these allocations may not increase temperature in a water quality limited waterbody by more than 0.3°C (0.54°F) at the point of maximum impact.

In those situations where the point source allocation is less than 0.2˚C or if there are no point sources, the remaining portion of the Human Use Allowance will be set aside as Reserve Capacity. The nonpoint source allocation will remain at 0.05˚C unless special circumstances exist that require a larger or smaller allocation. More information regarding the use of reserve capacity may be found in Chapter 14, Water Quality Management Plan, Part 2, under Temperature Implementation.

COAST FORK WILLAMETTE BACTERIA ANALYSIS

Reason For Action

In 1998, ODEQ placed the Coast Fork Willamette River, river mile 0 to 31.3, on the 303(d) List for exceeding water quality bacteria numeric criteria during Winter/Spring/Fall and Summer Seasons, Map 13.13, Table 13.11.

Map 13.13 303(d) listings for bacteria in the Coast Fork Willamette

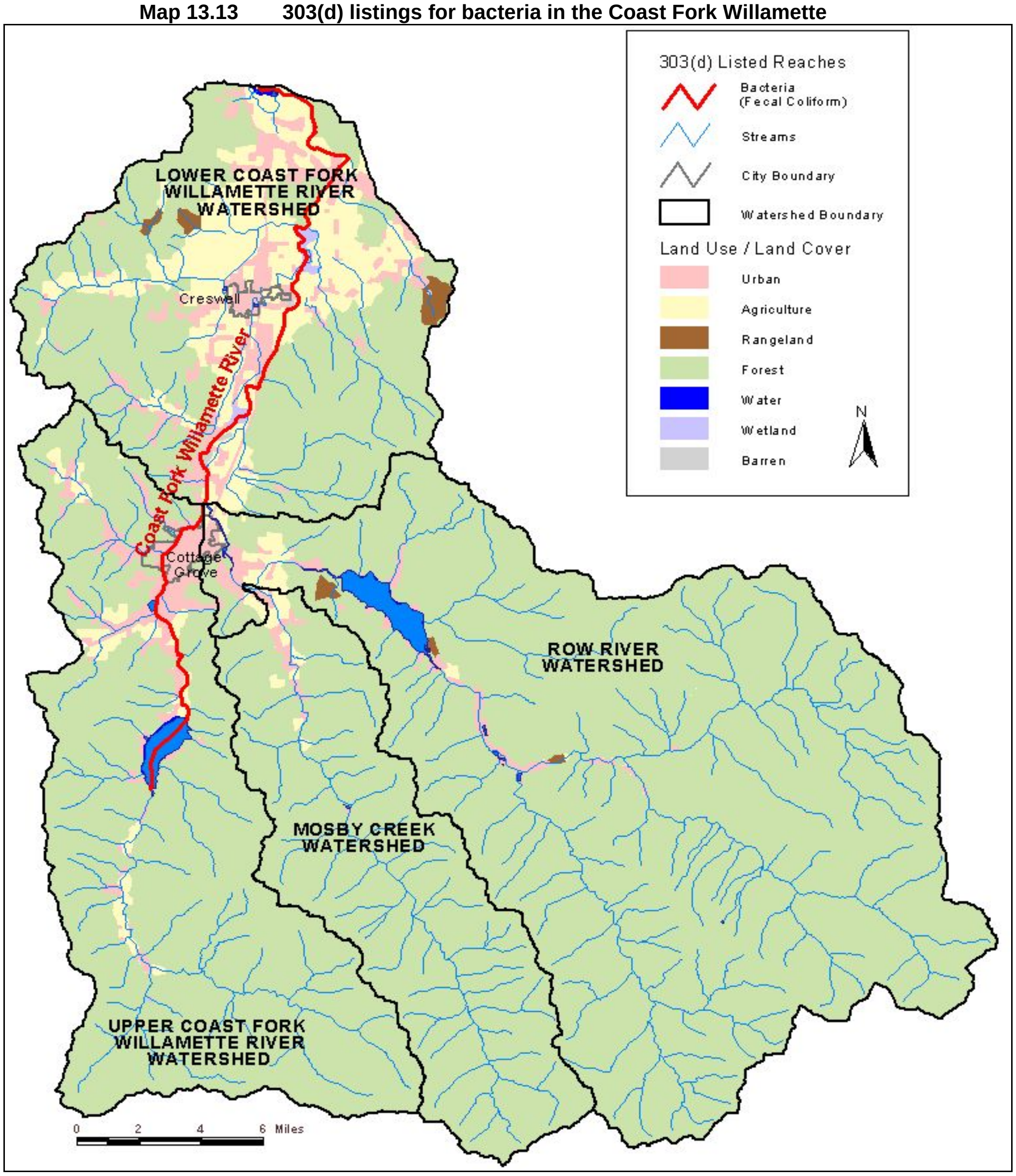


Table 13.11 Coast Fork Willamette Subbasin Bacteria 303(d) Listings

Waterbody Name	Listed River Miles	Parameter	Criterion	Season
Coast Fork Willamette River	RM 0 to 31.3	Fecal Coliform	Geometric Mean of 200 organisms per 100 ml, no more than 10% >400	Summer
Coast Fork Willamette River	RM 0 to 31.3	Fecal Coliform	Geometric Mean of 200 organisms per 100 ml, no more than 10% >400	Winter/Spring/Fall

Pollutant Identification

These bacteria are produced in the gastro-intestinal tracks of warm-blooded animals, and indicate the presence of pathogens that may cause illness in humans. These bacteria affect surface water quality relative to human contact during recreational use. The water quality bacteria data collected during 1996 to 2002 at ODEQ's ambient monitoring site, Coast Fork Willamette River at Mt. Pisgah Park (LASAR # 11275), River Mile 4, shows that a decreasing trend in the *E. coli* counts in the Coast Fork Willamette River is occurring and the river is in attainment of the bacteria standard.

Target Criteria Identification

Prior to March 1996, the water quality numeric criteria for bacteria was based on a geometric mean of five fecal coliform samples not to exceed 200 colonies per 100 ml. In addition, no more than 10% of the samples could exceed 400 colonies per 100 ml. Effective March 1996, the bacteria standard changed from fecal coliform to *E. coli.* The new criteria states that water quality *E. coli* samples are not to exceed a 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples; and no single sample exceeding 406 *E. coli* organisms per 100 ml. *E. coli* bacteria are a subset of fecal coliform bacteria and are a more direct reflection of contamination that carries pathogens harmful to humans. Thus, E. coli is correlated more closely with human disease.

Data Review

Table 13.12 is a summary of water quality fecal coliform data collected at ODEQ's ambient water quality monitoring site on the Coast Fork Willamette River at Mt. Pisgah Park between 1985 and 1996. The log mean was calculated using all fecal coliform data acquired between April 1985 and January 1996. Data were divided into summer and fall/winter/spring categories and the log mean was calculated using all data in the seasonal set. A total of 9 out of 107 samples exceeded the single sample criteria of 400 colonies per 100ml, with a summer maximum value of 460 colonies per 100ml and 1100 colonies per 100ml for the fall-winter-spring.

Table 13.12 Fecal Coliform Bacteria Samples, 1985 to 1996, for the Coast Fork Willamette River (colonies/100ml)

Coast Fork Willamette River 1985-1996 Fecal Coliform

		Summer				Fall-Winter-Spring			
RM	Station	Count	Log Mean[1]	Maximum	Percent >406	Count	Log Mean[1]	Maximum	Percent >406
4.0	Coast Fork Willamette At Mt Pisgah Park	46	68	460	2.5%	61	76	1100	8.8%

[1] The Log Mean indicated in this table does not represent a 30 day log mean as defined by DEQ water quality standards. Limited data required that the geometric be calculated using all available data for a site.

Water quality bacteria samples taken after March 1996 at Mt. Pisgah Park were analyzed to directly compare to the new *E. coli* bacteria numeric criteria. Table 13.13 summarizes the *E. coli* data collected from 1996 to 2002. The summer maximum *E. coli* count for this period is 72 colonies per 100 ml, and the fall-winter-spring maximum *E. coli* count is 150 colonies per 100 ml, both seasonal maximum E. coli counts are below the single sample bacteria numeric criteria of 406 *E. coli* organisms per 100 ml. To further demonstrate the decrease in in-stream *E. coli*, the *E. coli* data were applied to a load duration curve analysis.

Table 13.13 *E.coli* Bacteria Samples, 1996 to 2002, for the Coast Fork Willamette River (colonies/100ml)

Coast Fork Willamette River 1996-2002 E. coli

		Summer				Fall-Winter-Spring			
RM	Station	Count	Log Mean[1]	Maximum	Percent >406	Count	Log Mean[1]	Maximum	Percent >406
4.0	Coast Fork Willamette At Mt Pisgah Park	12	15	72	0.0%	26	23	150	0.0%

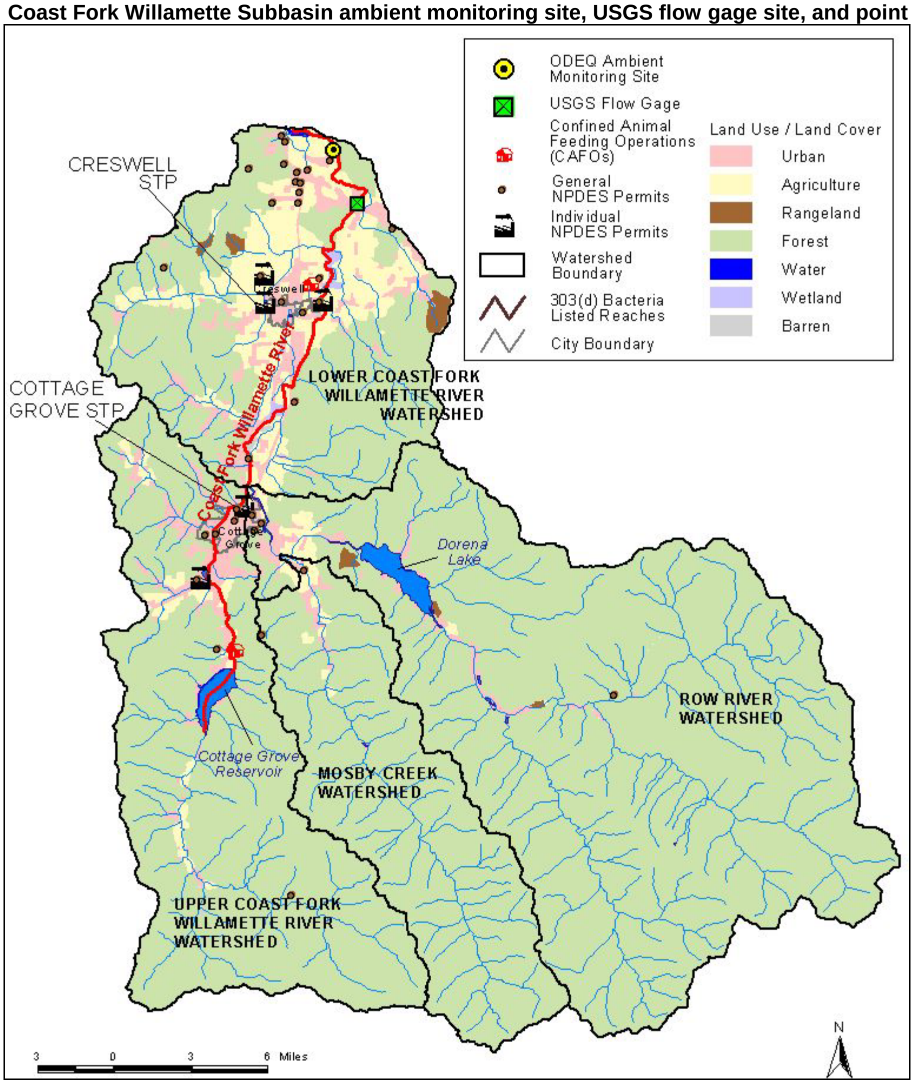
[1] The Log Mean indicated in this table does not represent a 30 day log mean as defined by DEQ water quality standards. Limited data required that the log mean be calculated using all available data for a site.

Load Duration Curve Analysis

A load duration curve was applied to the *E. coli* data collected for the Coast Fork Willamette River for the period of 1996 to 2002. The load duration curve methodology to quantify watershed percent reductions necessary to meet water quality standards. The load duration curve methodology was developed based on TMDLs completed by Kansas Department of Health and Environment and through technical assistance provided by Bruce Cleland of America's Clean Water Foundation (www.acwf.org). Load duration curves were applied because they offer a relatively simple and accurate methodology for determining the degree of water quality impairment and they are capable of illustrating relative impacts under various flow conditions. They can also be used for targeting appropriate water quality restoration efforts (Cleland 2002).

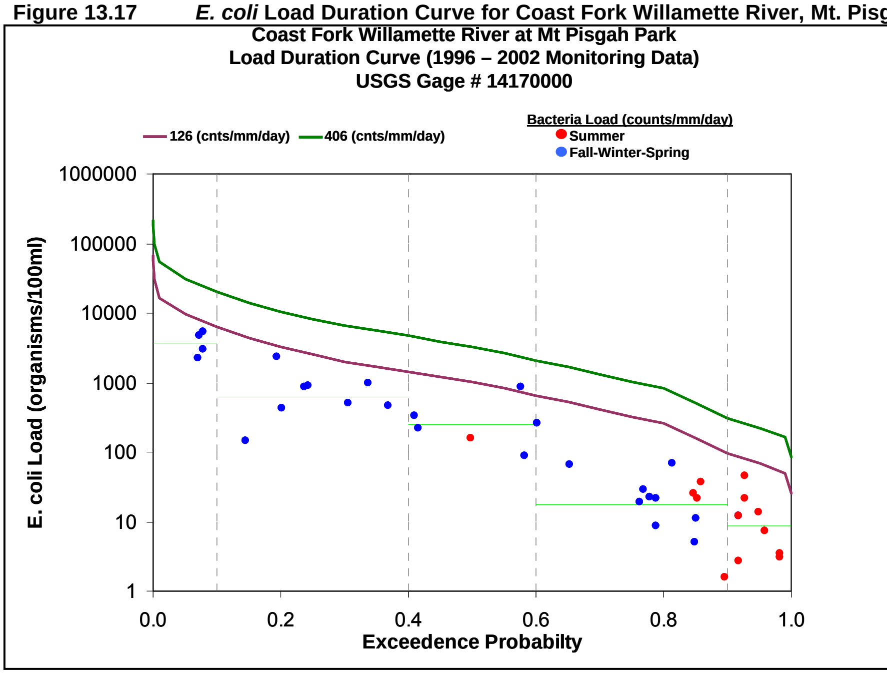
Load duration curves plot the flow exceedance probability versus bacteria load. The exceedance probability is the flow ranked over the period of record divided by the total flow records. Low exceedance probabilities represent high flows and high exceedance probabilities represent low flow conditions. The load duration curve for the Coast Fork Willamette River was developed using ODEQ's ambient water quality monitoring *E. coli* data collected at Mt. Pisgah Park (LASAR # 11275) and flow data recorded in the Coast Fork Willamette River at Goshen (USGS gage #14157500), Map 13.14. *E. coli* samples considered for this analysis were collected during a variety of weather and flow conditions between 1996 and 2002. Data reported as "estimate", "less than" or "greater than" values were not considered.

Map 13.14 Coast Fork Willamette Subbasin ambient monitoring site, USGS flow gage site, and point sources.



The *E. coli* data collected at Mt. Pisgah Park are plotted as a load duration curve in Figure 13.17. Points that plot above the 406 curve, the permissible loading function, represent deviations from the water quality standard. Those plotting below the curve represent compliance with water quality criteria. The green lines represent the log mean of samples of the corresponding flow regime. There are no exceedances of the 126 colonies per 100 ml log mean criteria and the single sample criteria of 406 colonies per 100 ml, as represented by the load duration curve below. An analysis of the bacteria data does demonstrate that the river is currently attaining the bacteria standard, Figure 13.17.

Figure 13.17 *E. coli* Load Duration Curve for Coast Fork Willamette River, Mt. Pisgah Park, 1996 to 2002



Bacteria Sources

Point Sources

ODEQ has issued two NPDES permits in the Coast Fork Willamette Subbasin, specifically to the cities of Creswell and Cottage Grove wastewater treatment plants (WWTP), Map 13.14. The WWTP's are a potential source of bacteria. The Discharge Monitoring Reports (DMR) from 2001 through 2003 were reviewed for the Cottage Grove WWTP and DMRs from 2001 were reviewed for Creswell WWTP. A total of three standard violations were recorded for the Cottage Grove WWTP. Table 13.13 summarizes monthly violations. Specific dates of violations are as follows, a 520 organisms per 100ml violation occurred November 27th, 2001 and two violations occurred in December of 2002 on the 17th and 18th, of 60,000 and 150,000 organisms per 100ml respectively. There were no violations recorded during 2002 for the Creswell WWTP, Table 13.15. Creswell is also in the process of upgrading its land application system by increasing the area effluent is applied during the summer months by 200 acres.

Table 13.14 Cottage Grove Wastewater Treatment Plant DMR Summary (bacteria/ 100ml)

Year		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2003	Log Mean	10	26	30	35	2	3	2	10	4	2	7	61
	Average	48	65	44	64	4	3	2	13	9	3	18	145
	Maximum	296	198	93	218	12	7	4	35	41	14	94	384
2002	Log Mean	49	9	14	7	4	2	4	4	5	3	2	39
	Average	77	16	38	16	13	3	4	7	9	3	3	21013
	Maximum	182	56	120	68	78	7	8	30	27	5	6	150000
2001	Log Mean	4	4	3	26	4		5	7	41	64	19	
	Average	5	4	4	70	5		8	9	61	147	93	
	Maximum	13	7	10	210	11		25	23	166	372	520	

A zero value indicates a sample result where as a bland ( ) represents an absence of sampling.

Table 13.15 Creswell Wastewater Treatment Plant DMR Summary (bacteria/ 100ml)

Year		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2002	Log Mean	92	N/A	3	N/A	1	7	N/A	N/A	N/A	N/A	28	N/A
	Average	50	0	5	0	1	27	0	0	0	0	12	0
	Maximum	140	0	11	0	1	53	0	0	0	0	40	0

A zero value indicates a sample result where as a bland ( ) represents an absence of sampling.

Recommendation for De-Listing

The 303(d) bacteria listing for the Coast Fork Willamette was based on fecal coliform data. With the acceptance of the *E. coli* standard in 1996, the current bacteria data analysis has indicated a reduction in the concentration of bacteria in stream. In addition, since the time of the listing improvements have been initiated to permitted point sources. Based on the ambient water quality data and the results of the load duration curve, bacteria concentrations in the Coast Fork Willamette River at Mt. Pisgah Park are below ODEQ's log mean and single sample criteria and the bacteria 303(d) listing should be removed for the Coast Fork Willamette River.

References

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U. S. Army Corps of Engineers, North Pacific Division. Portland, Oregon, 290 pp.

BLM. Row River Watershed Analysis. http://www.edo.or.blm.gov/planning/watershed_analysis/row_river/httoc.htm January, 2004.

BLM. 1997. Cottage Grove Lake / Big River Watershed Analysis. May, 1997.

Brett, J.R. 1952. Temperature Tolerance in Young Pacific Salmon, Genus Oncorhynchus. J. Fish. Res. Bd. Can., 9(6):265-323.

Cascadia Wildlands Project. http://www.cascwild.org/cg/Layng.htm January, 2004.

Cleland, B. 2002. TMDL Development from the "Bottom Up" – Part II: Duration Curves and Wet-Weather Assessments. Unpublished Manuscript.

Cleland, B. 2002. TMDL Development from the "Bottom Up" – Part III: Using Duration Curves to Connect the Pieces. Unpublished Manuscript.

Heath A. G. and G. M. Hughes. 1973. Cardiovascular and respiratory changes during heat stress in rainbow trout (Salmo gairneri). J. Exp. Biol., 59:323-338.

Hogan, J.W. 1970. Water temperature as a source of variation in specific activity of brain acetylcholinesterase of bluegills: Bulletin of Environ. Contamination and Toxicology 5(4):347-353.

Hokanson, K., C.F. Kleiner and T.W. Thorslund. 1977. Effects of Constant Temperatures and Diel Temperature Fluctuations on Specific Growth and Mortality Rates and Yield of Juvenile Rainbow Trout, Salmo gairdneri. J. Fish. Res. Bd. Can., 34:639-648.

O'Connor, Jim E., Sarna-Wojcicki, Andre, Wozniak, Karl C., Polette, Danial J. Fleck, Robert J. 2001. Origin , Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon. U.S. Geological Survey Professional Paper 1620. Denver, Co.

ODEQ. 1995. 1992-1994 Water Quality Standards Review. Portland, OR.

Pipes, W.O. 1982. Bacterial indicators of pollution. CRC Press, Boca Raton, Florida, USA.

USEPA. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards EPA 910-B-03-002, Region 10 Office of Water, Seattle, WA.

Watershed Sciences, LLC. 2003. Aerial Surveys in the Willamette River Basin. Preliminary Report. January 15, 2003. Corvallis, OR.