Water Quality

Water's physical, chemical, and biological characteristics are measured against a set of established standards to define its quality. Water quality is determined by variables that include temperature, sediment and organic input, and contaminants (DNR 2004; Sharpe and DeWalle 1980). These variables are influenced by factors such as local weather and climate, stream morphology, hydrology, sources of erosion, levels of chemical use, contaminant migration pathways, and the amounts and types of vegetation near streams. The most important function of water is to sustain life, which requires supplies of healthy surface and groundwater.

In the OESF, all Type 1 through Type 4 waters will be protected by the interior buffers with expected averages similar to those outlined in the 1997 *Habitat Conservation Plan* (HCP; (Table IV.5, p. IV.58). These standards are designed to protect areas where groundwater enters into surface water supplies; prevents harvesting of trees in riparian management zones within 25 feet of a stream; and reduce overall sediment delivery to streams by limiting erosion from timber harvest and roads. Management objectives in the OESF are to protect all Type 5 waters that cross unstable ground, as well as those that occupy stable ground but have identifiable channels[1] with evidence of water discharge or material transport. In the OESF, this is 95 percent of Type 5 waters (DNR 1997a).

What Are the Criteria for Water Quality?

DNR's overarching management guidance has been to follow state and federal laws to protect water quality (DNR 1997a, 2006a, 2006b). The federal *Clean Water Act* delegates authority to the state to protect aquatic habitat and domestic water supplies, among other beneficial uses.

Washington State Department of Ecology (Ecology) Rules define the acceptable water quality standards for temperature, sediment, and turbidity levels. These levels were used in DNR's 2004 *Sustainable Harvest Final EIS*, "to provide for the protection of designated uses, including public water supply; wildlife habitat; and salmon spawning, rearing and migration" and is incorporated here by reference (DNR 2004, p. 4-127). DNR complies with these standards in its day-to-day operations.

What Are the Indicators for Assessing Water Quality?

DNR focuses on three measures to assess water quality: temperature, sediment, and turbidity levels. Changes in these variables have an impact on the water quality necessary for beneficial uses, most importantly, aquatic habitat. These indicators are measured by examining the level of harvest activities within the Riparian Inner and Outer Zones.

WATER TEMPERATURE

Water temperature is affected by solar radiation, groundwater inflow and outflow, and other factors. Extreme fluctuations in water temperature in streams, rivers, and lakes can affect the suitability of habitat for fish and aquatic life. Streamside vegetation — particularly trees and large shrubs— shade water bodies, thereby limiting extreme daily fluctuations in temperature. Groundwater inflow and outflow in streams also can reduce these fluctuations. This is important since lower stream temperatures are able to maintain higher dissolved oxygen levels (DNR 1996a), which benefits fish because reduced levels of dissolved oxygen in streams can adversely affect fish health and reproductive conditions. The same holds true for other aquatic life. Groundwater seeping into a stream also provides stream

[1] An identifiable channel is one in which the channel banks are well-defined and measurable (Chorley and others 1994).

recharge in low flow areas (Boyd and Sturdevant 1997), and may be tied to lower stream temperatures. Factors such as air temperature, channel width and depth, and flow volume also can affect stream temperature, but are particular to location and season and therefore are not discussed here. For the methods used to assess stream channels refer to *Stream Channels*.

SEDIMENT

Water quality is affected when sediment is transported and deposited in a water body. The amount and size of sediment is directly related to the volume of flowing water moving it downstream. Sediment deposited into streams, lakes, rivers, and wetlands can affect fish habitat. Sediment entering into spawning gravels inhibits the circulation of oxygenated water which can suffocate and kill eggs. For more details on the effects of sediment on fish habitat, refer to *Fish*. DNR is incorporating by reference the *Final EIS on Alternatives for Forest Practices Rules* (2001, p. 3-7). Another negative impact of sediment on water can occur when suspended soil particles carry nutrients such as nitrogen into streams, causing changes in stream chemistry (Brooks and others 1997). Increased nutrient levels can lead to algal blooms or aquatic plant growth, which then reduces oxygen levels in water.

TURBIDITY

Turbidity is the measure of cloudiness in the water column attributable to suspended sediment, such as silt and organic or inorganic material. Low turbidity means that the water is clear. As with air quality, solids that are invisible to the naked eye may be harmful (Brooks and others 1997; EPA of South Australia 2008; Princeton University 2006). Increased turbidity in streams may lead to decreased levels of primary productivity and overall food production; which, in turn, may decrease the numbers of juvenile salmonids and other aquatic wildlife (Haggerty 2004).

Approach to Water Quality Analysis

Water quality is influenced by the functions of riparian and wetland areas, soils, forest management activities, climate, and water quantity. DNR management activities—including timber harvesting, and road construction and use—can affect water quality substantially because the management activities can alter both sediment input and temperature. For this analysis, projected modeling results about harvesting activities within riparian areas are used to assess potential impacts to water quality. While dust or runoff from forest roads provides a direct input into water bodies, DNR is not adding roads to the OESF network and therefore is not analyzing the impacts of additional roads to implement either of the alternatives. However, the impacts of sediment delivery from the current road network are discussed in the *Soils* section.

DNR protects beneficial uses of water by protecting areas where groundwater enters surface water as well as key riparian plant species. The direction, outlined in the *Forest Practices Rules* and the 1997 *Habitat Conservation Plan*, is designed to restrict harvest activities within certain riparian areas, reduce erosion, and ensure adherence to the rules for applying pesticides, herbicides, and fertilizers so they do not enter streams or other water bodies.

WATERSHED ANALYSIS

'Watershed Analysis' is an approach adopted by the Washington Forest Practices Board in 1992 to address the cumulative effects of forest practices activities on fish, water quality, and public improvements. The purpose of the water quality module contained in the Watershed Analysis Manual is to determine the vulnerability of a specific aquatic resource to a proposed forest practices activity. Vulnerability is defined as the reasonable likelihood that state water quality standards may be exceeded by the effects of forest practices. This module also addresses other indicators of water quality that are within the authority of the Forest Practices Board, although they may not necessarily have been adopted with numeric water quality criteria.

HARVESTING EFFECTS ON WATER QUALITY

Water quality can be impacted by forest practices activities in a variety of ways. Sediment concentrations can increase due to accelerated erosion; water temperatures can increase due to removal of overstory riparian shade (Brown 1969; Sullivan and others 1990; Adams and Sullivan 1990); slash and other organic debris can accumulate in water bodies, depleting dissolved oxygen, and altering water pH (Plamondon and others 1982). Additionally, wetlands may be directly altered or created by physical modification resulting from culvert installation and placement of road fill material (Binkley and Brown 1993; Richardson 1994; Shepard 1994). Dissolved oxygen, nutrients, and pH can have direct and indirect effects on stream water chemistry and aquatic ecosystems, but problems with these parameters usually are not associated with well-managed forest practices activities. The degree of change in water quality that may result from forest practices activities depends on a number of factors including the water quality parameter, the type of water body, the physical and vegetative condition of the watershed, the type and location of land use, the design and application of forest practices, the intensity of site disturbance, and climatic conditions (Riekerk 1989). Site-specific analysis, addressing these factors, is done no matter which alternative is adopted.

LAND MANAGEMENT PRACTICES

The *Soils* and *Riparian* sections describe the processes which cause sediment to move into streams and how wetlands and riparian areas intercept displaced sediment. In order to reduce sediment delivery to streams, DNR follows current policies and procedures to limit impacts associated with management activities by protecting streambanks and their vegetation from disturbance which generally keeps sediment intact, at least at the source.

Comparison of Management Alternatives Regarding the Effects of Water Quality

Trends in the distribution of selected forest stand development stages within the land classes are shown in Charts 3-20 through 3-25 (*Forest Conditions*). These charts show how the Ecosystem Initiation and Structurally Complex stand development stages change within the Riparian's Inner and Outer Zones over the 100-year modeling simulation. A complete set of charts for each stand development stage within these land classes is provided in Appendix D. Stand composition within the Riparian's Inner Zone is similar under both alternatives, with the exception of the proportion of stands in the Ecosystem Initiation stage (Chart 3-20). This trend shows that the amount of Ecosystem Initiation stands decreases after the first decade; this is most likely due to restoration activities taking place within the first 75 feet of water bodies. Both alternatives continue to increase in structurally complexity over the 100-year planning horizon as shown in Chart 3-21.

Direct, Indirect, and Cumulative Effects to Water Quality

The conclusions between the alternatives contained in the *Riparian* and *Soils* sections are similar for water quality, meaning the Landscape Alternative has a higher likelihood of potential impacts to water quality. The *Stream Channel*

Table 3-57. Changes in Acres of Structurally Complex Forests (2010-2110), by Alternative for the OESF

Alternatives	Riparian		Upland	Wetland
	Inner Zone	Outer Zone		
Landscape	(+) 6,933 ac	(+) 1,676 ac	(+) 6,503 ac	(-) 31 ac
No Action	(+) 8,245 ac	(+) 4,142 ac	(+) 5, 605 ac	(+) 1,306 ac

section assesses the sensitivity of stream channels to sediment inputs. The impacts to water quality were assessed by examining the amount of riparian activities (in the Inner and Outer Zones) within varying distances from the stream channel and the changes in stand development stages over time.

Under both management alternatives, forests in the Structurally Complex stand development stage are projected to increase from about 30,000 acres to 50,000 acres across the OESF. Specific increases by land class are presented in Table 3-57.

The No Action Alternative projects a slightly greater increase in the development of Structurally Complex forests in the Inner (1,300 acres) and Outer (2,400 acres) Riparian Zones and Wetland areas (1,300 acres) over ten decades than the Landscape Alternative. The Landscape Alternative is projected to have 900 acres more structurally complex forests in Uplands area after ten decades over the No-Action Alternative.

The riparian area (inner and outer assessment areas) accounts for approximately 45 percent of the forested area in the OESF (115,000 acres of 255,533 acres). Under the Landscape Alternative, more of the riparian area (inner and outer assessment areas) is projected to be harvested in both the short, medium, and longer terms than under the No-Action Alternative (Table 3-11, in *Forest Conditions*). Also, under the Landscape Alternative, the percentage of the riparian area projected to be harvested is 1 to 1.3 percent of the riparian area per year. Under the No-Action Alternative, the projected harvest area is about a third to half of the Landscape Alternative (0.3 to 0.5 percent of the riparian area). For both alternatives, the projected level of harvest in riparian assessment areas is predominately from the outer riparian assessment area, that is, more than 75- to-100 feet from the stream channel (Table 3-11). For additional analysis related to habitat response from harvest activities within defined distances of the stream channel refer to *Riparian*.

Current Mitigation in place for Water Quality from Forest Management Activities

DNR's *Forest Practices Rules*, agency policy, and procedures, and the conditions set forth in the 1997 *Habitat Conservation Plan*, provide mitigation measures associated with any probable, significant, adverse environmental impact as the selected alternative is implemented.

The OESF Forest Land Plan is a non-project SEPA action. At this level, DNR cannot say with certainty that future site-specific actions will result in probable, significant, adverse, environmental impacts that will not be mitigated. All future site-specific actions resulting from this plan, such as proposed timber sales and road construction, will receive additional environmental review under SEPA.