Chapter 173-201A WAC

Preliminary Draft
Benefit, Cost, and Least Burden Analysis for the Proposed Amendments to Washington's Surface Water Quality Standards

June 2006
Publication Number: 06-10-044

Original printed on recycled paper

Blank page

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Chapter 173-201A WAC

Preliminary Draft
Benefit, Cost, and Least Burden Analysis for the Proposed Amendments to Washington's Surface Water Quality Standards

Prepared for the Department of Ecology
Water Quality Program
Watershed Management Section

Prepared by:

Science Applications International Corporation
11251 Roger Bacon Drive
Reston, VA 20190

June 2006
Publication Number: 06-10-044

Original printed on recycled paper

Download this report from the Department of Ecology's Web site
at http://www.ecy.wa.gov/biblio/0610044.html

If you need this publication in an alternate format, please call the Water Quality Program at. 360-407-6404. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Table of Contents

List of Exhibits

Acronyms and Abbreviations

7-DADM	7-day average daily maximum
7Q10	Minimum 7-day average flow recurring once in 10 years
AFW	Agriculture, Fish and Water
BMPs	Best management practices
CREP	Conservation Reserve Enhancement Program
CWA	Clean Water Act
DMR	Discharge monitoring report
DNR	Department of Natural Resources
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
fps	Feet per second
FTE	Full time equivalent
ga	gauge
GIS	Geographic information system
GMA	Growth Management Act
gpm	Gallons per minute
HP	Horsepower
LA	Load allocation
LID	Low-impact development
mgd	Million gallons per day
NOAA	National Oceanic and Atmospheric Administration
NPDES	National pollutant discharge elimination system
O&M	Operation and maintenance
PCS	Permit compliance system
POTW	Publicly owned treatment work
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
TMDL	Total maximum daily load
USDA	United States Department of Agriculture
WLA	Wasteload allocation
WQS	Water quality standards
WRIA	Water Resource Inventory Area
WTP	Willingness to pay

Executive Summary

The Washington State Department of Ecology (Ecology) is proposing revised aquatic life use designations applicable to waters of the state. Washington administrative procedures require two types of economic analyses before adopting a significant legislative rule – a cost-benefit and a small business impact analysis. This report provides these analyses of potential impacts that may be associated with the proposed rule.

On July 28, 2003, the state of Washington submitted revisions to its water quality standards (WQS) to EPA for review pursuant to Clean Water Act (CWA) section 303(c)(2)(A). Certain of these revisions identified specific numeric temperature and dissolved oxygen (DO) criteria to protect critical life stages of salmonids, including criteria for salmonid rearing and spawning. On January 12, 2004, EPA approved some of the revised standards submitted by Washington, including provisions on recreational uses and bacteria criteria, freshwater water supply uses, nutrient criteria for lakes, radioactive substances, toxics and aesthetics, variance procedures, site-specific criteria, and use attainability analysis. However, EPA did not take action on a number of other provisions, including specific aquatic life use designations and their associated temperature criteria, because it needed additional time to complete an internal evaluation.

After reviewing the available fish distribution data, EPA Region 10 disapproved:

- The narrative spawning criteria of 13°C and 9°C for protection of salmonid and char spawning, respectively, because Ecology did not specify when or where the criteria are needed.

And certain waters that Ecology designated for:

- Noncore rearing with a 17.5°C temperature criterion because they should be designated for core summer salmonid habitat with a temperature criterion of 16°C.
- Noncore rearing with a temperature criterion of 17.5°C or core rearing with a 16°C temperature criterion because they should be designated for char habitat with a 12°C temperature criterion.
- Rearing and migration only with a 17.5°C temperature criterion because they should be designated salmonid spawning, rearing, and migration with a 17.5°C temperature criterion.

Thus, Ecology is proposing to correct the inadequacies of its 2003 WQS revision identified by EPA Region 10. As a result of these designated use changes, more stringent DO criteria will also apply. Specifically, the minimum DO criterion would increase from 8.0 mg/L to 9.5 mg/L for waters designated for noncore rearing under the 2003 WQS revision that should be designated for either char or core summer salmonid habitat, and from 6.5 mg/L to 8.0 mg/L for waters designated for salmonid rearing and migration only under the 2003 WQS revision that should be designated for salmonid spawning, rearing, and migration.

Exhibit ES-1 provides a summary of the changes.

Exhibit ES-1. Comparison of 2003 WQS Revision and the 2006 Proposed Rule

2003 WQS Revision			Proposed Rule		
Designated Use	Temperature Criteria[1]	DO Criteria[2]	Designated Use	Temperature Criteria[1]	DO Criteria[2]
Char	12°C	9.5 mg/L	Char	12°C	9.5 mg/L
Salmonid Spawning, Core Rearing, and Migration	16°C	9.5 mg/L	Core Summer Salmonid Habitat	16°C	9.5 mg/L
Salmonid Spawning, Noncore Rearing, and Migration	17.5°C	8.0 mg/L	Salmonid Spawning, Rearing, and Migration	17.5°C	8.0 mg/L
Rearing and migration only	17.5°C	6.5 mg/L	Rearing and migration only	17.5°C	6.5 mg/L
Spawning (narrative)	13°C	NA	Spawning (location and date specified)	13°C	NA

NA = not applicable.
1. Criteria specified as 7-DADM temperatures.
2. Criteria specified as 1-day minimum DO concentrations.
2. Spawning criteria are to be specified where Ecology determines that temperature criteria established for a water body would likely not result in protection of spawning and incubation.

The impacts identified in this analysis represent the incremental costs and benefits above and beyond those associated with the 2003 WQS revision. Ecology developed a cost-benefit analysis for the 2003 WQS revision to reflect the potential impacts associated with the change from the 1997 standards to the 2003 revision. The 2006 proposal reflects an incremental increase in the stringency of temperature and DO criteria for waters for which EPA disapproved the 2003 use designations. The 2006 proposal also specifies the date and locations for the spawning standards in place of the narrative spawning temperature criteria. Thus, the 2003 revision represents the baseline for estimating the incremental costs and benefits of the 2006 proposed standards.

Point Sources

Approximately 50 individual industrial and municipal facilities (5 majors and 45 minors) may discharge to waters for which the rule establishes revised uses and criteria compared to the 2003 WQS revision.[1] Major facilities have the greatest potential to influence costs due to their large flows. Since relatively few majors are affected, the estimated costs reflect evaluations of each facility. For minors, costs represent estimates for a sample of facilities in each use classification reflecting a change in temperature criteria, extrapolated to all such minor facilities in each

[1] General permitted facilities are not included in the cost analysis. Data for these facilities are extremely limited, and flows from such facilities are usually negligible. In addition, few general permits currently contain requirements to monitor for temperature, DO, BOD, or nutrients, and none of them currently contain numeric effluent limits. Thus, there are no data available to evaluate the impact that the revised 2006 standards would have on general facilities. However, Ecology is beginning to require additional monitoring in a number of general permits. If such monitoring shows that the discharger has the potential to cause or contribute to an exceedance of the proposed criteria, the permits could be changed to include temperature or DO limits, or an individual permit may be issued with requirements for temperature or DO in the context of a TMDL.

category (e.g., minor facilities affected by a change in use classification from noncore rearing to core summer salmonid habitat, and those discharging to waters specifically designated for char and spawning). Each of the facilities affected by a change in DO criteria is also affected by the change in temperature criteria (45 of 50 facilities). Thus, the sample of facilities used in the temperature analysis provides a means of estimating the incremental impacts attributable to the revised DO criteria. Potential compliance costs vary based on these proposed changes in use designations and associated temperature and DO criteria.

However, available data indicate that few facilities would have incremental impacts associated with the proposed rule. Annual estimated control costs range from $178,000 to $318,000, and reflect land application of a portion of the discharge during periods of high effluent temperature or nutrient and biochemical oxygen demand (BOD) concentrations.

Nonpoint Sources and Other Activities

Nonpoint sources that affect instream temperatures and DO concentrations include agriculture, forestry, and urban development. In the TMDLs Ecology developed to meet existing temperature standards, increased effective shade is the primary nonpoint source control for reducing stream temperatures; the primary measure for nonpoint source control is riparian buffers. Thus, riparian buffers are also likely to be the primary means for nonpoint sources to comply with the temperature provisions of the proposed rule.

Riparian buffers would reduce stream temperatures by increasing effective shade, improving thermal microclimates, reducing erosion and improving stream bank stability, increasing woody debris, and reducing channel width. A 100-foot buffer on either side of waters affected by the revised temperature criteria should provide maximum effective shading while also providing microclimate and other benefits.

Approved TMDLs for DO in Washington indicate that the DO criteria can be achieved through reductions in stream temperatures and BOD and nutrient (e.g., nitrogen and phosphorus) loads. Riparian buffers not only provide shade and microclimate benefits, reducing stream temperatures, but also provide filtration and serve other functions that reduce nutrient loadings to water. Reduced loadings of nutrients and sediment (including organic matter) will result in reduced BOD, which will in turn lead to higher instream DO concentrations. Lower stream temperatures also contribute to higher DO levels, since oxygen is more soluble in lower temperature water. Thus, for streams not affected by the change in temperature criteria (i.e., those waters upgraded from salmonid rearing and migration only to salmonid spawning, rearing, and migration), the incremental costs of achieving the DO criteria would include construction of a riparian buffer.

Riparian buffers are already required in some instances. The Washington Forest Practices Act and associated rules contain an array of best management practices (BMPs), including riparian buffer requirements, to protect water quality and achieve other environmental goals. Thus, the proposed standards do not represent new requirements for the forestry sector.

As for point sources, compliance with the 2003 WQS revision represents the baseline control scenario for nonpoint sources; only incremental controls and costs needed to achieve further reductions represent the impact of the proposed rule. However, water quality modeling would likely be needed to determine baseline temperatures after implementation of controls (including riparian buffers) needed to attain the 2003 revision. An upper-bound scenario of the extent of riparian buffers that may be needed is all potentially plantable land adjacent to affected waters; this scenario likely overstates acreage needed and costs for compliance with the proposed rule.

Based on GIS analysis of USGS land cover data, there are 39,300 acres of agricultural, urban, or other potentially plantable (not including forest lands) land within 100 feet of waters affected by the proposed rule. Implementation costs of riparian buffers include unit costs of planting buffers and any opportunity costs associated with changing land use in the buffer area. Unit costs for planting riparian buffers range from $38/ac/yr to $43/ac/yr, and opportunity costs range from $0 to $5,592/ac/yr, depending on current land use. Assuming that riparian buffers would be implemented on all potentially plantable acres (e.g., agriculture, urban, and other potentially plantable lands) adjacent to affected waters, annual costs are approximately $2.8 million for newly designated core summer salmonid habitat waters, $2.2 million for newly designated spawning waters, $0.1 million for newly designated char waters, and $0.1 million for newly designated salmonid spawning, rearing, and migration waters (i.e., those waters affected only by the change in DO criteria), with a total annual cost of approximately $5.2 million.

The potential impact of the proposed rule on existing water rights is likely to be limited. State laws that protect instream water flows do not affect existing rights for off-stream water use (Ecology, 2004d). To enhance instream flows, the state can purchase existing water rights from willing owners. In these instances, the state bears the cost voluntarily (which implies that the benefits exceed the costs).

There are 146 dams within a 500-foot buffer of affected waters, 14 of which are federally-owned. Sufficient monitoring data are not available to assess the impact that each of these dams may have on downstream stream temperatures or DO concentrations. To achieve the temperature criteria on spawning waters and the DO criteria on newly designated core summer salmonid habitat, char habitat, and salmonid spawning, rearing, and migration waters, dam modifications (e.g., change location of reservoir outlet) may be necessary, although for hydropower dams, any potential actions will be addressed during federal relicensing and 401 certifications. Given the factors that influence which control actions should be implemented and the lack of available data, it is not possible to estimate incremental control costs for dams associated with the proposed rule. However, it is likely that controls necessary to meet the 2003 WQS revisions (i.e., baseline standards) would also result in compliance with the 2006 proposed standards.

Benefits

Actions to reduce water temperature and increase DO concentrations will have a variety of beneficial impacts on state waters. Achieving the primary goal of pollution reduction will improve fishery habitat, with favorable impacts on population growth in the target species. Greater fish stocks could enhance the human use of aquatic resources, which would have associated incremental benefits. Population recovery among depleted or at-risk fish stocks may also provide passive use benefits that arise from a range of motives such as the desire to protect and preserve fish species for future generations. Ancillary water quality and habitat restoration benefits of the actions taken to reduce stream temperatures and increase DO concentrations may also contribute to salmon restoration and preservation efforts, flood control, bird and wildlife restoration, and other indirect benefits associated with streamside repair.

Existing survey research by Layton et al. (1999) provides a means for estimating the value of programs that improve fish populations in Washington. The survey results provide willingness-to-pay (WTP) estimates per household for different levels of fishery improvement. Based on a break-even analysis, per household WTP of $2.29 per year generates benefits big enough to offset annual costs of approximately $5.5 million. This WTP value corresponds to a fishery population increase on the order of 0.4 percent. Consequently, the benefits of the proposed standards will exceed the costs for a relatively small fish population increase.

Comparison of Costs and Benefits

Because it is state policy to meet federal requirements for water quality, Ecology must revise its water quality standards to obtain EPA approval. Consequently, a cost-benefit analysis of the revision does not inform the decision to meet the federal standards. If there were alternative ways to revise the standards, a cost-benefit analysis could identify the alternative that maximizes net benefits, which equals benefits minus costs. In this instance, however, the proposed revisions are minimum standards to meet Federal requirements, and any feasible alternatives will exceed the requirements and cost more.

Exhibit ES-2 summarizes the potential costs and benefits of the proposed rule. The incremental increase in fish populations that would need to result from the proposed standards for benefits to equal or exceed costs is small.

Exhibit ES-2. Comparison of Costs and Benefits

Component	Estimate
Estimated Annual Costs (2005$)	
Point Sources[1]	$318,000
Nonpoint Sources[2]	$5,201,000
Total	$5,519,000
Percent Increase in Annual Fish Populations for Benefits to Equal Costs[3]	0.4%

1. High end of estimated cost range.
2. Upper bound scenario of planting riparian buffers on all plantable lands adjacent to affected waters (excluding forest lands).
3. Calculated using WTP estimates from Layton et al. (1999), updated to 2005 dollars.

The largest uncertainties in the analysis relate to the potential magnitude of costs for nonpoint sources, and the impact on the breakeven analysis of salmonid recovery periods that exceed the 20-year period used in the valuation survey. Some portion of the estimated riparian buffer costs may be incurred for compliance with the 2003 revision; these costs would not be attributable to the proposed rule. In addition, some of the streams reflected in the buffer cost estimate may already be in compliance with the proposed rule. In comparison, because standards may not be achieved for more than 20 years, the benefits estimates from the 1999 survey may not accurately reflect the value of the proposed standards. Household WTP values for fish population recovery over a longer time period may differ from the study values.

Small Business Impacts

Washington administrative procedures define a small business (an entity that is owned and operated independently from all other businesses, and has fifty or fewer employees) and specify a particular comparison of business impacts -- cost of compliance for small businesses to the cost of compliance for the ten percent of businesses that are the largest businesses required to comply with the proposed rule using one or more of the following as a basis for comparison: cost per employee; cost per labor hour; cost per one hundred dollars of sales.

Small business impacts are based on private compliance costs, which may differ from the estimates of social costs used in an analysis of costs and benefits. For example, a transfer payment such as a tax is a private cost that is not a social cost. Similarly, there are social costs that do not have corresponding out-of-pocket expenses and, therefore, are not included in private cost estimates. For example, buffer costs that are offset by funding from a cost-sharing program do not represent incremental expenses to the farmer, and are not included in evaluating impacts on small farm businesses.

The proposed rule does not include any specific requirements on businesses. However, the proposal establishes temperature and DO criteria for several waters in the state, and businesses that discharge to or otherwise affect these waters may need to alter their production processes. The analysis of costs and benefits indicated that minor industrial facilities may require incremental controls under the rule. However, only 1 out of 20 minor industrial facilities with individual NPDES permits located on waters affected by the proposed rule meets the definition of a small business, and this facility is not likely to experience impacts as a result of the proposed rule. Therefore, there are not likely to be disproportionate impacts on small industrial dischargers.

The analysis of costs and benefits indicated that agricultural producers may require incremental controls under the rule. The cost to farmers of installing riparian buffers equals the installation cost minus the cost share, and any reduction in net revenues minus any land rental payments (payments for taking land out of production). Because agricultural BMPs are generally voluntary, and implementation efforts focus on technical assistance and financial incentives from government (Ecology 2000a), the potential for impacts on either small or large agricultural producers is minimal.

However, in the case that farmers install riparian buffers along all land adjacent to affected waters under less than full funding (e.g., a 75 percent cost share), actual impacts will vary with farm size, location, riparian acreage, and type of foregone production, if any. Although data for the specific farms that may ultimately be affected by the rule are not available, average farm data and “model” farm assumptions can be used to evaluate the potential for disproportionate impacts on small farms. Based on an analysis of potential impacts assuming 75 percent of implementation costs are shared and no land rental payments are made to farmers, the cost per $100 of sales would be approximately $1.67 for a model small business farm (assuming 18 buffer acres), and $0.63 for a model farm that is among the largest 10 percent of farms (assuming 44 buffer acres) that may install riparian buffers. This hypothetical example indicates that pretax costs per $100 of sales would be higher for the model small business farm by a factor of about 2.7 ($1.67/$0.63). Under an alternative assumption that 10 percent of implementation costs are shared, the cost per $100 of sales would be $4.13 for the model small business farm, and $0.93 for the model farm that is among the largest 10 percent of farms. Under this scenario, pretax costs per $100 of sales for small farms would be higher for the model small business farm by a factor of about 4.5 ($4.13/$0.93).

Based on this hypothetical example, there is a potential for disproportionate impacts on small agricultural operators in a less than full funding scenario. However, any impacts on small business farms could be reduced through the following:

- Increasing cost-share funding to small business farms.
- Giving higher priority for small business farms in the process of awarding grant or loan funds.
- Improving loan terms for small business farms (e.g., lower interest rates, longer terms).

Least Burden Analysis

This rule is being adopted to correct deficiencies identified by the federal Environmental Protection Agency. Therefore this is the least burdensome rule that the state can adopt without the federal government adopting regulations for Washington State.

1. Introduction

The Washington State Department of Ecology (Ecology) is proposing revised aquatic life use designations applicable to certain waters of the state. This report provides an analysis of the potential impacts of the proposed rule. Specifically, this report provides estimates of the potential incremental costs that point source dischargers may incur as a result of changes to their National Pollutant Discharge Elimination System (NPDES) permits and nonpoint sources may experience as a result of state implementation of the water quality criteria. This report also provides an analysis of the incremental benefits of the proposed standards, and the potential incremental impacts on small businesses.

1.1 Regulatory Background

The Clean Water Act (CWA) directs states, with oversight by EPA, to adopt water quality standards (WQS) to protect the public health and welfare, enhance the quality of water, and serve the purposes of the CWA. Under Section 303, states' water quality standards must include at a minimum: (1) designated uses for all water bodies within their jurisdictions, (2) water quality criteria sufficient to protect the most sensitive of the uses, and (3) an antidegradation policy consistent with the regulations at 40 CFR 131.12. States are also required to hold public hearings once every three years for the purpose of reviewing applicable WQS and, as appropriate, modifying and adopting standards. The results of this triennial review must be submitted to EPA, and EPA must approve or disapprove any new or revised standards. Section 303(c) also directs the EPA Administrator to promulgate WQS to supersede state standards that have been disapproved or in cases where the Administrator determines that a new or revised standard is needed to meet CWA requirements.

On July 28, 2003, the state of Washington submitted revisions to its WQS to EPA for review pursuant to CWA section 303(c)(2)(A). Certain of these revisions identified specific numeric temperature and DO criteria to protect critical life stages of salmonids, including criteria for salmonid rearing and spawning. On January 12, 2004, EPA approved some of the revised standards submitted by Washington, including provisions on recreational uses and bacteria criteria, freshwater water supply uses, nutrient criteria for lakes, radioactive substances, toxics and aesthetics, variance procedures, site-specific criteria, and use attainability analysis. However, EPA did not take action on a number of other provisions, including specific aquatic life use designations and their associated temperature criteria, because it needed additional time to complete an internal evaluation.

After reviewing the available fish distribution data, EPA Region 10 disapproved:

- The narrative spawning criteria of 13°C and 9°C for protection of salmonid and char spawning, respectively because Ecology did not specify when or where the criteria are needed.

And certain waters that Ecology designated for:

- Noncore rearing with a 17.5°C temperature criterion because they should be designated for core summer salmonid habitat with a temperature criterion of 16°C.
- Noncore rearing with a temperature criterion of 17.5°C or core rearing with a 16°C temperature criterion because they should be designated for char habitat with a 12°C temperature criterion.
- Rearing and migration only with a 17.5°C temperature criterion because they should be designated salmonid spawning, rearing, and migration with a 17.5°C temperature criterion.

Thus, Ecology is proposing to correct the inadequacies of its 2003 WQS revision identified by EPA Region 10. As a result of these designated use changes, more stringent DO criteria will also apply. Specifically, the minimum DO criterion would increase from 8.0 mg/L to 9.5 mg/L for waters designated for noncore rearing under the 2003 WQS revision that should be designated for either char or core summer salmonid habitat, and from 6.5 mg/L to 8.0 mg/L for waters designated for salmonid rearing and migration only under the 2003 WQS revision that should be designated for salmonid spawning, rearing, and migration.

1.2 Purpose of the Analysis

The Washington Administrative Procedures Act (RCW 34.05.328) requires that, before adopting a significant legislative rule, state agencies determine that the probable benefits are greater than the probable costs, taking into account both qualitative and quantitative analysis and the specific directives of the statute being implemented. The act defines a significant legislative rule as one that adopts a new, or makes significant amendments to an existing, policy or program. The act also requires the agency to analyze alternatives to rule making and the consequences of not adopting the rule, and determine that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and objectives of the statute requiring it.

Ecology (2003a) outlined the general goals and specific objectives of the state's water quality standards regulations (Chapter 90.48, RCW):

> It is declared to be the public policy of the state of Washington to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington. Consistent with this policy, the state of Washington will exercise its powers, as fully and as effectively as possible, to retain and secure high quality for all waters of the state. The state of Washington in recognition of the federal government's interest in the quality of the navigable waters of the United States, of which certain portions thereof are within the jurisdictional limits of this state, proclaims a public policy of working cooperatively with the federal government in a joint effort to extinguish the sources of water quality degradation, while at the same time preserving and vigorously exercising state powers to insure that present and future standards of water quality within the state shall be

determined by the citizenry, through and by the efforts of the state government, of the state of Washington.

Under federal regulations (Title 40 CFR Part 131.20), states are required to establish water quality standards that meet the requirements of the CWA. States must also review their standards at least every three years to incorporate new science, and consider changes to better meet federal laws and regulations, including new EPA guidance.

In 2003, Ecology adopted revisions to the state's WQS (WAC 173-201A) pursuant to state statutory authority under the Water Pollution Control Act (90.48 RCW), and the CWA as described above. Ecology determined that the probable benefits of the 2003 WQS revision likely exceeded the potential costs. However, EPA determined that the proposed use designations and associated temperature criteria for certain waters do not meet the requirements of the CWA because they do not provide adequate protection of core summer salmonid habitat, salmonid spawning, rearing, and migration, and char habitat. Thus, these portions of the 2003 WQS revision are not viable (i.e., do not meet the specific objectives of the statute being implemented).

Therefore, Ecology is proposing the minimum provisions that will meet EPA's approval: locations of state waters designated for salmonid spawning, rearing, and migration, core summer salmonid habitat, spawning, and char use that will be subject to specific temperature and DO criteria. The purpose of this analysis is to provide information on the potential incremental benefits, costs, and impacts to small businesses that may be associated with proposed provisions. If the state does not adopt water quality standards that are approved by EPA, EPA may promulgate such standards for the state.

Although water quality standards establish the instream conditions deemed necessary to support the designated uses, states have flexibility in implementing these standards. Therefore, the ultimate economic impact depends in large part on state implementation. For example, total maximum daily loads (TMDLs) can reflect alternative (i.e., most cost-effective) means for achieving needed pollutant reductions across affected sources, and trading programs provide opportunities for minimizing control costs for some pollutants. Thus, least burdensome implementation of water quality standards can be achieved at the watershed level.

1.3 Scope of the Analysis

This analysis addresses the incremental costs and benefits from the proposed rule. The impacts identified are above and beyond those associated with the 2003 WQS revision.[2] Analysis of both costs and benefits is based on existing sources of temperature and DO; incorporating benefits and costs for future new sources is generally infeasible in this case.[3] Analysis of the potential

[2] The exception is that some portion of the costs associated with planting riparian buffers on agricultural land may represent a baseline cost of the 2003 rule. Water quality modeling of the nature Ecology conducts in developing TMDLs would be necessary to determine the extent that controls needed to achieve the 2003 standards also achieve compliance with the proposed rule.

[3] Such analysis would require hypothetical projections of discharger (i.e., any source affecting temperature or DO) behavior (e.g., location decision with respect to affected waters, discharge quality and quantity), and baseline water quality, with and without the proposed standards to evaluate the impact of the rule. Analysis of benefits would also

benefits is based on the assumption that the standards represent the most accurate and appropriate information regarding support of aquatic life uses for the affected waters. Evaluation of all categories of costs, benefits, and impacts is based on publicly available data and information.

1.4 Organization of the Report

This report is organized as follows. Section 2 outlines the baseline for the analysis. Section 3 provides a description of the proposed rule, potentially affected waters, and potentially affected sources that may contribute to temperature or DO impairments. Section 4 presents the analysis of costs. Section 5 provides the analysis of benefits. Section 6 provides a comparison of costs and benefits. Section 7 provides analysis of potential impacts on small entities. The appendices provide additional supporting information and analysis.

---

require projections of the avoided fishery impacts or fishery improvements that result from the proposed standards, to estimate incremental effects in the future. In both cases, the projections are highly speculative and the estimates are not likely to be reliable.

2. Baseline for the Analysis

This section describes the baseline conditions relevant to evaluating the potential impact of the proposed rule, including current water quality standards and implementation procedures, ambient water quality, activities affected instream temperature and DO levels, and other existing regulations already affecting these dischargers.

2.1 Water Quality Standards

sState's waters. These criteria are specified for different classes of aquatic life uses.

Exhibit 2-1. Existing Water Quality Criteria for Temperature (1997 Rule)

Class	Use	Temperature Criteria[1]	DO Criteria[2]
Class AA (extraordinary)	Salmonid and other fish migration, rearing, spawning, and harvesting.	16°C	9.5 mg/L
Class A (excellent)	Salmonid and other fish migration, rearing, spawning, and harvesting.	18°C	8.0 mg/L
Class B (good)	Salmonid and other fish migration, rearing, and harvesting. Other fish spawning.	21°C	6.5 mg/L
Lake Class	Salmonid and other fish migration, rearing, spawning, and harvesting.	No measurable change from natural	4.0 mg/L

1. Represents daily maximum temperature.
2. Represents a daily minimum DO concentration.

In 2003, Ecology adopted revisions to the state's WQS (**Exhibit 2-2**). These, revisions include establishing use-based categories for waters. Ecology adopted a category for char habitat protection; designated the existing Lake Class, and Class AA waters not otherwise designated as char, for salmon and trout spawning, core rearing, and migration use (core rearing); designated existing Class A waters not otherwise designated for char, for salmon and trout spawning, noncore rearing, and migration use (noncore rearing); and designated existing Class B water for salmon and trout rearing and migration use only.

Exhibit 2-2. 2003 WQS Revision for Temperature
(7-day average of maximum daily temperatures)

Use	Description	2003 Criteria	
		Temperature[1]	DO[2]
Char Spawning[3]	For protection of char spawning where Ecology determines that temperature criteria established for a water body would likely not result in protection of spawning and incubation	9°C	None specified
Char	For protection of spawning and early tributary rearing (e.g., first year juveniles) of native char (bull trout and Dolly Varden), and other associated aquatic life.	12°C	9.5 mg/L
Salmon Spawning[3]	For protection of salmon spawning where Ecology determines that temperature criteria established for a water body would likely not result in protection of spawning and incubation	13°C	None specified

Exhibit 2-2. 2003 WQS Revision for Temperature
(7-day average of maximum daily temperatures)

Use	Description	2003 Criteria	
		Temperature[1]	DO[2]
Salmon and Trout Spawning, Core Rearing, and Migration	For protection of spawning, core rearing, and migration of salmon and trout, and other associated aquatic life.	16°C	9.5 mg/L
Salmon and Trout Spawning, Noncore Rearing, and Migration	For protection of spawning, noncore rearing, and migration of salmon and trout, and other associated aquatic life.	17.5°C	8.0 mg/L
Salmon and Trout Rearing and Migration Only	For protection of rearing and migration of salmon and trout, and other associated aquatic life.	17.5°C	6.5mg/L
Nonanadromous Interior Redband Trout	For protection of waters where the only trout species is a nonanadromous form of self-reproducing interior redband trout (*O. mykis*), and other associated aquatic life.	18°C	8.0 mg/L
Indigenous Warm Water Species	For protection of waters where the dominant species under natural conditions are temperature tolerant indigenous nonsalmonid species. Examples include dace, redside shiner, chiselmouth, sucker, and northern pikeminnow.	20°C	6.5 mg/L

1. Represents the maximum of the 7-day average of the daily maximum (DADM) temperature.
2. Represents the 1-day minimum DO concentration.
3. Represents a narrative temperature criterion that applies when and where Ecology determines necessary. There is no narrative criterion for DO.

Ecology developed a cost-benefit analysis for the 2003 WQS revision (Ecology, 2003a) to reflect the potential impacts associated with the change from the 1997 standards to the 2003 revisions. The proposed rule (2006 proposal) reflects an incremental increase in the stringency of temperature and DO criteria for specific waters for which EPA disapproved the 2003 use designations. The 2006 proposal also specifies the date and locations for the spawning standards in place of the narrative spawning temperature criteria. Thus, the 2003 revisions represent the baseline for estimating the incremental costs and benefits of the 2006 proposed standards.

2.2 Water Quality

There are 732 category 5 (exceeding criteria and without a current TMDL or pollution prevention plan) water body segments representing 336 water bodies on Washington’s 2002/2004 303(d) list that are impaired due to high temperatures, and 318 category 5 water body segments representing 170 water bodies that are impaired due to low DO levels. These listings reflect a number of different causes of impairment, including point sources, agriculture, forestry, urban development, and hydromodification.

Exhibit 2-3 summarizes the results of temperature TMDLs in the state. The control scenarios include load allocations (LAs) for nonpoint sources, wasteload allocations (WLAs) for point sources, and additional recommendations to achieve WQS. Not all of these plans will result in attainment of the temperature standards. In most cases, standards will not be attained on at least some reaches, or Ecology could not determine if standards would be attained. A key action in all of the TMDLs is increasing effective shade, which can be accomplished by planting riparian buffers on exposed land. However, riparian buffers generally do not reach the height needed for decades, meaning that even if standards are attainable, attainment typically would not occur for 75 to 80 years (Ecology, 2001a, 2003c, 2004c).

Exhibit 2-3. Summary of TMDLs Addressing Temperature Impairments in Washington

TMDL	Standard	LA	WLA	Recommended Actions	Attainment
South Prairie Creek (Ecology, 2003c)	18°C	Increase effective shade (varies by water body segment)	POTW1: Te (°C) <[0.452/Qe]+18.1 POTW2: Te (°C) <[0.104/Qe]+18.1	• Riparian areas in National Forest managed for mature vegetation • Prohibition of new water withdrawals • Voluntary retirement of existing water withdrawals	Yes
Selah Ditch (Ecology, 2005a)	17.5°C	90% effective shade	POTW: 18°C Storm water: 18°C (Apr. to Oct., 25°C otherwise)	• No additional actions	Yes
Little Klickitat River (Ecology, 2003b)	18°C	Increase effective shade (varies by water body segment)	POTW: 18.3°C	• Limit Bloodgood Creek withdrawals (cold water creek) • Lower width to depth ratio in parts of Klickitat and West Prong	No
Lower Skagit Tributaries (Ecology, 2004b)	18ºC	Increase effective shade (varies by water body segment)	None	• No increase in withdrawals • Improve stream bank stability in two streams • Maintain current hydrographs (no additional storm water)	Yes, except at Lake McMurray, Big Lake, and East Fork Nookachamps Creek outflows.
Simpson Northwest Timberlands (Ecology, 2000b)	16ºC or 18ºC	89.3% effective shade (varies by water body segment)	None	• Implementation of Habitat Conservation Plan • Monitoring • Reduce sediment inflows	Unknown
Stillaguamish (2004c)	16ºC or 18ºC	Max effective potential shade from mature vegetation	Upstream temperature + 0.3ºC at edge of chronic mixing zone	• Voluntary reforestation on nonforest lands (e.g., buffers) • Encourage projects to increase groundwater inflows • Voluntary retirement or purchase of existing water rights • Reduce sediment loads and erosion	No
Teanaway (2001a)	16ºC or 18ºC	Reduce solar load (varies by water body segment)	None	• Assessment of sediment budget to maintain stream morphology • Restrict water withdrawals	Unknown, but not likely where >100% effective shade needed
Upper Chehalis River (2001b)	18ºC	Increase effective shade (varies by water body segment) Reduce stream width to depth	Critical periods (based on stream flow): 18.3ºC at edge of chronic mixing zone when criterion exceeded	• Possible restrictions on future water withdrawals	Several reaches will not attain

Exhibit 2-3. Summary of TMDLs Addressing Temperature Impairments in Washington

TMDL	Standard	LA	WLA	Recommended Actions	Attainment
		ratio (in 3 of 8 streams)	Noncritical periods: use WQS equation New sources: meet criterion end-of-pipe		
Upper Humptulips River (2001c)	16ºC or 18ºC	Increase effective shade (varies by water body segment)	None	None	Unknown
Wenatchee National Forest (Ecology, 2003d)	16ºC	Implement max potential shade across watershed	None	• Possible further restrictions (unspecified)	Unknown, but not likely (max potential shade < shade required to meet criterion)
Willapa River (Ecology, 2005b)	18ºC	Increase effective shade (varies by water body segment)	18.18ºC to 19.3ºC (shade rearing ponds)	• Encourage projects to increase surface water or groundwater inflows • Reduce upstream sediment loads and stream bank erosion • Increase woody debris • Prevent livestock damage • Close nonessential roads in riparian areas • Use reduced-till or lower impact agricultural practices	Likely (possible nonattainment in furthest downstream section)
Wind River (Ecology, 2002)	16ºC or 18ºC	Increase effective shade (varies by water body segment)	None	• Reduce sediment loads • Reduce channel widths • Remove Hemlock Dam[1] • Reduce consumptive water withdrawals • Decommission forest roads	Yes (with increased effective shade and removal of Hemlock Dam)

1. Hemlock Dam is a small (154' wide) dam with small storage owned and operated by the Forest Service.
LA = load allocation.
POTW = publicly owned treatment works.
Qe = effluent flow in mgd.
Te = effluent temperature.
WLA = waste load allocation.
WQS = water quality standards.

Exhibit 2-4 summarizes the results of DO TMDLs in the state. The control scenarios include LAs for nonpoint sources, and WLAs for point sources for biochemical oxygen demand (BOD) and ammonia. The TMDLs indicate that decreasing BOD and ammonia loads can be accomplished by planting riparian buffers on exposed land and implementing BMPs that reduce runoff.

Exhibit 2-4. Summary of TMDLs Addressing DO Impairments in Washington

TMDL	Standard	LA	WLA	Recommended Actions	Attainment
Upper Chehalis River Basin (Ecology, 2000c)	8.0 mg/L and 9.6 mg/L	Most NH3 and BOD allocations are set at background although varies by water body segment; also no allocations for future growth	POTWs: 3 different BOD limits and 4 different limits apply based on flows Industrial: may not discharge at flows less than 500 cfs (May to Oct) or from Nov to Apr	• Implement WLAs through revised NPDES permits • Land waste applications must ensure activities do not increase CBOD or NH3 levels in groundwater • Implement BMPs for storm water, livestock operations, landfills, and septic systems	Yes
Colville River (Ecology, 1997)	8.0 mg/L	None	WLAs for 3 separate discharge periods (Jun-Oct; Nov-Feb; Mar-May)	• Revise NPDES permits to include maximum daily load limits for BOD and NH3	Yes
Johnson Creek (Ecology, 2000d)	8.0 mg/L	BOD: natural background conditions during critical low flow (late summer); reductions range from 41%-83%	No point source discharges to water body	• Implement farm plans and BMPs on dairy and agriculture farms • Encourage riparian vegetation enhancement projects implemented by CDID 31	Yes
Stillaguamish River Watershed (Ecology, 2004e; 2005c)	8.0 mg/L	BOD allocations vary by water body segment	POTWs and storm water: max BOD loads range from 0 to 179 lbs/day	• Work with livestock owners to ensure that nutrients associated with manure do not reach the river and creeks • Reduce nutrients from on-site septic waste or with fertilizer use • Implement riparian streambank and channel improvements • Adopt and enforce critical areas ordinances and shoreline management plans that protect riparian buffers.	Yes

BOD = biochemical oxygen demand
LA = load allocation
NH3 = ammonia-nitrogen
POTW = publicly owned treatment works
WLA = waste load allocation.

2.3 Activities Affecting Stream Temperature and DO Levels

A number of sources affect water body temperatures and DO levels, including discharges from municipal and industrial facilities, discharges from nonpoint sources such as agriculture, forestry, urban areas, and other human activities such as hydromodifications and water withdrawals. Stream characteristics such as depth, velocity, width, and water clarity affect temperature and DO levels. In the case of decreased DO levels, BOD is one of the main contributors to instream levels (Viessman and Hammer, 1998). In addition to BOD, other pollutants such as temperature, suspended solids, and nutrients (different species of nitrogen and phosphorus) may also lead to reduction in DO levels by stimulating excess algae and plant growth, thus increasing buildup of decomposing organic matter in sediments (Viessman and Hammer, 1998).

2.3.1 Point Source Dischargers

The state's NPDES permit database indicates that there are 370 individually permitted facilities in Washington. EPA classifies over 75 percent of these facilities as minor dischargers [facilities discharging less than 1 million gallons per day (mgd) and not likely to discharge toxic pollutants in toxic amounts]. **Exhibit 2-5** provides a summary of all individual permits by industry and permit type.

Exhibit 2-5. Summary of Individual NPDES Permitted Dischargers in Washington[1]

Standard Industrial Classification		Number of Facilities	
		Majors	Minors
Agriculture, Forestry, and Fishing			
01	Agricultural Production – Crops	-	4
02	Agricultural Production – Livestock and Animal Specialties	-	7
07	Agricultural Services	-	3
09	Fishing, Hunting, and Trapping	1	23
Mining			
10	Metal Mining	1	-
12	Coal Mining	1	1
14	Nonmetallic Minerals	-	3
Construction			
16	Heavy Construction	-	1
Manufacturing			
20	Food and Kindred Products	1	32
24	Lumber and Wood Products	-	15
26	Paper and Allied Products	15	1
28	Chemicals and Allied Products	1	7
29	Petroleum and Coal Products	5	3
32	Stone, Clay, and Glass Products	-	4
33	Primary Metal Industries	8	3
34	Fabricated Metal Products	-	1
35	Industrial Machinery and Equipment	-	1
36	Electronic and Other Electronic Equipment	-	3
37	Transportation Equipment	1	12
38	Measuring, Analyzing, and Controlling Instruments	-	1

Exhibit 2-5. Summary of Individual NPDES Permitted Dischargers in Washington[1]

Standard Industrial Classification		Number of Facilities	
		Majors	Minors
Transportation and Public Utilities			
42	Trucking and Warehousing	-	5
44	Water Transportation	-	1
45	Transportation by Air	-	1
47	Transportation Services	-	1
49	Electric, Gas, and Sanitary Services; except 4952	1	5
4952	Sewerage Services (POTWs)	30	135
Wholesale Trade			
51	Wholesale Trade – Nondurable Goods	-	8
Retail Trade			
55	Automotive Dealers and Service Stations	-	2
Services			
70	Hotels and Other Lodging Places	-	1
80	Health Services	-	2
82	Educational Services	-	2
87	Engineering, Accounting, Research, Management, and Related Services	1	3
Public Administration			
95	Administration of Environmental Quality and Housing Programs	-	1
96	Administration of Economic Programs	-	1
97	National Security and International Affairs	-	7
99	Nonclassifiable Establishments	-	1
	No SIC Code (blank in PCS)	-	3
	Total	66	304

'-' = None.
1. Source: Based on Washington State GIS files of NPDES facilities.

There are also 1,691 general permit dischargers (all classified as minor dischargers), most of which are small commercial facilities, small agricultural operations (e.g., cattle feed lots and dairy farms), and construction operations (e.g., sand and gravel pits). **Exhibit 2-6** provides a summary of the general permits by industry.

Exhibit 2-6. Summary of General NPDES Permitted Dischargers in Washington[1]

Standard Industrial Classification		Number of Facilities
Agriculture, Forestry, and Fishing		
01	Agricultural Production – Crops	1
02	Agricultural Production – Livestock and Animal Specialties	88
07	Agricultural Services	82
08	Forestry	4
09	Fishing, Hunting, and Trapping	77
Mining		
10	Metal Mining	3
12	Coal Mining	1
14	Nonmetallic Minerals	355
Construction		
16	Heavy Construction	1

Exhibit 2-6. Summary of General NPDES Permitted Dischargers in Washington[1]

Standard Industrial Classification		Number of Facilities
17	Construction – Special Trade Contractors	1
Manufacturing		
20	Food and Kindred Products	37
22	Textile Mill Plants	2
24	Lumber and Wood Products	52
25	Furniture and Fixtures	1
26	Paper and Allied Products	10
27	Printing, Publishing, and Allied Products	2
28	Chemicals and Allied Products	37
29	Petroleum and Coal Products	26
30	Rubber and Miscellaneous Plastic Products	27
31	Leather and Leather Products	1
32	Stone, Clay, and Glass Products	64
33	Primary Metal Industries	8
34	Fabricated Metal Products	54
35	Industrial and Commercial Machinery and Computer Equipment	22
36	Electronic and Other Electrical Equipment and Components	6
37	Transportation Equipment	105
38	Measuring, Analyzing, and Controlling Instruments	4
39	Miscellaneous Manufacturing Industries	8
Transportation and Public Utilities		
40	Railroad Transportation	5
41	Local and Interurban Passenger Transit	13
42	Trucking and Warehousing	70
44	Water Transportation	26
45	Transportation by Air	10
49	Electric, Gas, and Sanitary Services; except 4952	36
4952	Sewerage Services (POTWs)	7
Wholesale Trade		
50	Wholesale Trade – Durable Goods	24
51	Wholesale Trade – Nondurable Goods	10
59	Miscellaneous Retail	1
Services		
73	Business Services	1
76	Miscellaneous Repair Services	2
79	Amusement and Recreation Services	1
82	Educational Services	1
Public Administration		
95	Administration of Environmental Quality and Housing Programs	2
97	National Security and International Affairs	2
99	Nonclassifiable Establishments	1
	No SIC Code (blank in PCS)	400
	Total	1,691

1. Source: Based on Washington State GIS files of NPDES facilities.

2.3.2 Agriculture

Approximately 15,318,000 acres of land in Washington are used for production of crops or livestock for commercial sale and personal benefit (USDA, 2004). The most common agricultural activities leading to temperature and DO impairments are those associated with crop growing (clear cutting), livestock access to riparian areas, and excess nutrients from runoff or irrigation return flows. Cultivating crops, clear cutting trees, and grazing livestock too close to stream banks can reduce stream shading, increase nutrients in runoff, and increase erosion rates which may lead to increases in stream temperatures and decreases in DO levels.

In 1999, a coalition of farmers, environmental groups, government agencies, legislators, and tribes joined in a collaborative effort, known as the "Agriculture, Fish, and Water" (AFW) process, to address fish recovery and pollution control on farmland. The goal of this effort was to identify agriculture BMPs that could be placed into rule similar to the forest practices rules (see Section 2.3.3). However, the effort was unsuccessful, and Ecology staff and conservations districts are currently working directly with farmers to get them to take actions necessary to prevent water pollution.

State and federal agencies also encourage pollution control efforts by providing technical and financial assistance to producers to implement structural and practice BMPs. For example, the Washington State Conservation Reserve Enhancement Program (CREP), authorized in 1998, set aside $250 million in state and federal funding over 15 years to help pay for installation and other costs associated with riparian buffers on agricultural land (USDA, 1998). In addition, existing regulations in some counties require new agricultural operations to keep or plant riparian buffers (Ecology, 2003a).

2.3.3 Forestry

Over 20 million acres of private, state, and federal lands are managed for commercial timber harvest (Ecology, 2000a). Forestry activities that can impair temperature and DO include harvest and road construction. Washington regulates forestry activities on state and private lands through the Washington Forest Practices Act (chapter 76.09 RCW) and the associated forest practices rules (Title 222 WAC). The forest practices rules dictate how the Forest Practices Act should be implemented, and although the rules are primarily implemented by the Department of Natural Resources (DNR), Ecology has authority to independently enforce the "water quality" components. The Washington Forest Practices Board (the authority empowered to enforce forest practices rules) designed and adopted the forest practice rules, in part, to meet the requirements of the CWA and state water quality standards. The rules contain an array of BMPs, including riparian buffer requirements, to protect water quality, provide fish and wildlife habitat, protect capital improvements, and ensure that harvested areas are reforested.

2.3.4 Urban Development

Urban development affects stream temperatures and DO levels mainly through the higher temperatures and increased quantities of storm water runoff from impervious surfaces, and increased erosion of stream banks (Ecology, 2000a). Urban land tends to be six to eight degrees

Fahrenheit warmer in the summer, and two to four degrees Fahrenheit warmer in the winter, than nonurban land (CWP, 2003). Storm water management is related primarily to land use. The regulation of land use is governed by the state environmental picy act (SEPA), the shoreline management act (SMA), and the gowth management act (GMA).

SEPA (43.21C RCW) requires a comprehensive environmental review for all projects that need a permit or approval from a state or local government entity (e.g., many construction activities), unless they fall into certain exempted categories.

SMA (90.58 RCW) provides authority for local governments to plan and regulate land uses on upland areas within 200 feet of shorelines, which include all marine waters, lakes over 20 acres in area, and streams with a mean annual flow of greater than 20 cubic feet per second (cfs). Under the SMA, each city and county adopts a shoreline master program based on state guidelines tailored to the specific needs of the community. More than 200 cities and all 39 counties have shoreline master programs. Most of these master programs contain provisions that require replanting in disturbed areas after project completion, prohibit beach enhancement within spawning, nesting, or breeding habitat, and ensure that shoreline uses and activities are conducted in a manner that minimizes environmental damage (e.g., implementation of reasonable setbacks, buffers, and storage basins for storm water.)

The GMA (36.70A RCW) requires certain counties and cities to update their comprehensive plans with the intent to reduce urban sprawl. Each comprehensive plan shall include chapters on land use, transportation, housing, capital facilities, utilities, shorelines, and rural (for counties). Chapters addressing economic development and parks and recreation also are required, if state funding is provided (CTED, 2005). The plans are carried out by development regulations, such as zoning and land division codes. If the plans and regulations are inconsistent with the GMA, citizens, other local governments, or state agencies can challenge them before a growth management hearings board (CTED, 2005). The plans are also required to incorporate the city or county's shoreline management plan.

Additional programs support nonregulatory approaches for controlling pollution from urban sources, including the DNR's Urban and Community Forestry program, and local government plans and activities under the Watershed Planning Act (Ecology, 2000a).

2.3.5 Hydromodification

Hydromodification involves alteration of hydrologic characteristics of surface waters. Examples of hydromodification activities include stream channelization and channel modification, dam building, and vegetative clearing that leads to streambank and shoreline erosion. Hydromodification is regulated under SEPA and SMA (described above), as well as the Hydraulic Code (75.20 RCW). The Hydraulic Code and SMA require permits for projects at the land-water interface; the Hydraulic Code governs activities in the water, whereas the SMA governs those on land. The regulations implementing the Hydraulic Code state, in part, that "channel change/realignment projects shall only be approved where the applicant can demonstrate benefits or lack of adverse impact to fish life," and that these projects "shall incorporate mitigation measures as necessary to achieve no-net-loss of productive capacity of fish and shellfish habitat." The regulations also require erosion protection for disturbed areas, as well as other practices to avoid or reduce nonpoint source pollution (Ecology, 2000a).

2.3.6 Water Withdrawals

Water withdrawals are permitted by Ecology's Water Resources Program. The primary statutes relating to flows and flow setting are:

- Water Code (Ch. 90.03 RCW) – gives Ecology the exclusive authority to set flows and condition permits to established flows
- Minimum Water Flows and Levels Act of 1967 (Ch. 90.22 RCW) – establishes process for protecting instream flows and among other provisions, requires Ecology to consult with the Department of Fish and Wildlife and conduct public hearings
- Water Resources Act of 1971 (Ch. 90.54 RCW) – contains provisions that require base flows to be retained in streams except where there are "overriding considerations of the public interest," and allocation of water generally be based on the securing of "maximum net benefits" to the people of the state, and authorizes Ecology to reserve waters for future beneficial uses
- Construction Projects in State Waters (Ch. 77.55 RCW) – requires Ecology to consult with the Department of Fish and Wildlife prior to making a decision on any water right application that may affect flows for food and game fish
- Watershed Planning Act (Ch. 90.82 RCW) – requires local government to assess the impacts of current water withdrawals, and recommends the establishment of instream flows to protect aquatic ecosystems.

Ecology is required by law to protect instream flows by adopting regulations and to manage water uses that affect streamflow (Ecology, 2004c). An instream flow rule sets the minimum flows needed during critical times of the year to protect water quality. However, existing water rights are unaffected by such a rule (Ecology, 2004d).

3. Impact of the Proposed Rule

This section describes the provisions of the proposed rule, including the waters for which it designates uses, and the criteria associated with those uses. This section also discusses the potential impact on sources and activities that affect stream temperatures and DO levels.

3.1 Water Quality Criteria and Designated Uses

The proposed rule corrects several areas of the 2003 WQS revision that EPA Region 10 disapproved, including:

- The narrative spawning criteria of 13°C and 9°C for protection of salmonid and char spawning, respectively because Ecology did not specify when or where the criteria are needed.

A0nd certain waters that Ecology designated for:

- Noncore rearing with a 17.5°C temperature criterion because they should be designated for core summer salmonid habitat with a temperature criterion of 16°C.
- Noncore rearing with a temperature criterion of 17.5°C or core rearing with a 16°C temperature criterion because they should be designated for char habitat with a 12°C temperature criterion.
- Rearing and migration only with a 17.5°C temperature criterion because they should be designated salmonid spawning, rearing, and migration with a 17.5°C temperature criterion.

As a result of these designated use changes, more stringent DO criteria will also apply. Specifically, the minimum DO criterion would increase from 8.0 mg/L to 9.5 mg/L for waters designated for noncore rearing under the 2003 WQS revision that should be designated for either char or core summer salmonid habitat, and from 6.5 mg/L to 8.0 mg/L for waters designated for salmonid rearing and migration only under the 2003 WQS revision that should be designated for salmonid spawning, rearing, and migration.

The economic analysis encompasses only those waters for which the 2006 proposal includes a more stringent criterion (e.g., there are no impacts related to temperature for the change from rearing and migration to salmonid spawning, rearing, and migration and no impacts related to DO for the change from core rearing to char habitat.) **Exhibit 3-1** provides a summary of these areas of discrepancy.

Exhibit 3-1. Comparison of 2003 WQS Revision and the 2006 Proposed Rule

2003 WQS Revision			Proposed Rule		
Designated Use	Temperature Criteria[1]	DO Criteria[2]	Designated Use	Temperature Criteria[1]	DO Criteria[2]
Char	12°C	9.5 mg/L	Char	12°C	9.5 mg/L
Salmonid Spawning, Core Rearing, and Migration	16°C	9.5 mg/L	Core Summer Salmonid Habitat	16°C	9.5 mg/L

Exhibit 3-1. Comparison of 2003 WQS Revision and the 2006 Proposed Rule

2003 WQS Revision			Proposed Rule		
Designated Use	Temperature Criteria[1]	DO Criteria[2]	Designated Use	Temperature Criteria[1]	DO Criteria[2]
Salmonid Spawning, Noncore Rearing, and Migration	17.5°C	8.0 mg/L	Salmonid Spawning, Rearing, and Migration	17.5°C	8.0 mg/L
Rearing and migration only	16°C	6.5 mg/L	Rearing and migration only	16°C	6.5 mg/L
Spawning (narrative)[2]	13°C	NA	Spawning (location and date specified)	13°C	NA

NA = not applicable.
1. Criteria specified as 7-DADM temperatures.
2. Criteria specified as 1-day minimum DO concentrations.
2. Spawning criteria are to be specified where Ecology determines that temperature criteria established for a water body would likely not result in protection of spawning and incubation.

The maps below show the affected waters in each of the 62 water resource inventory areas (WRIAs). **Exhibits 3-2** through **3-4** show the waters affected by more stringent temperature criteria:

- Exhibit 3-2 shows the waters that the proposed rule designates for char habitat.
- Exhibit 3-3 shows the waters that the proposed rule designates for core summer salmonid habitat (that are not also specifically designated for spawning, which would be at least as protective.)
- Exhibit 3-4 shows the waters that the proposed rule designates revised temperature criteria for spawning (that are not also specifically designated for char, which would be at least as protective.)

Exhibit 3-5 shows the waters affected by more stringent DO criteria: waters that the rule designates for salmonid spawning, rearing, and migration, core summer salmonid habitat, and char habitat. Note that most of the waters in Exhibit 3-5 are also in Exhibits 3-2 to 3-4 because the waters affected by the changes in temperature and DO criteria overlap.

Exhibit 3-2. Waters with Revised Temperature Criteria for Protection of Char Habitat by WRIA

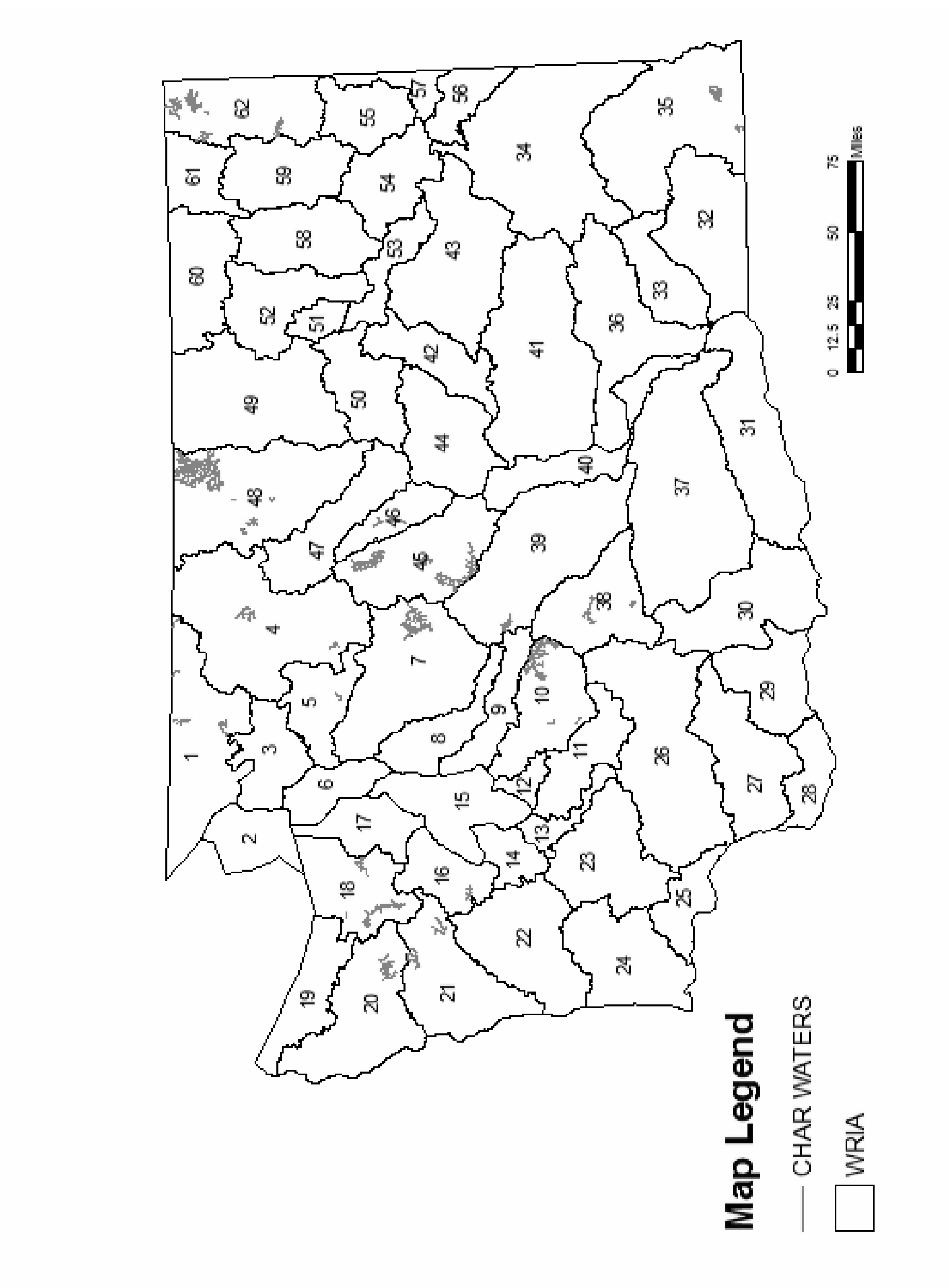
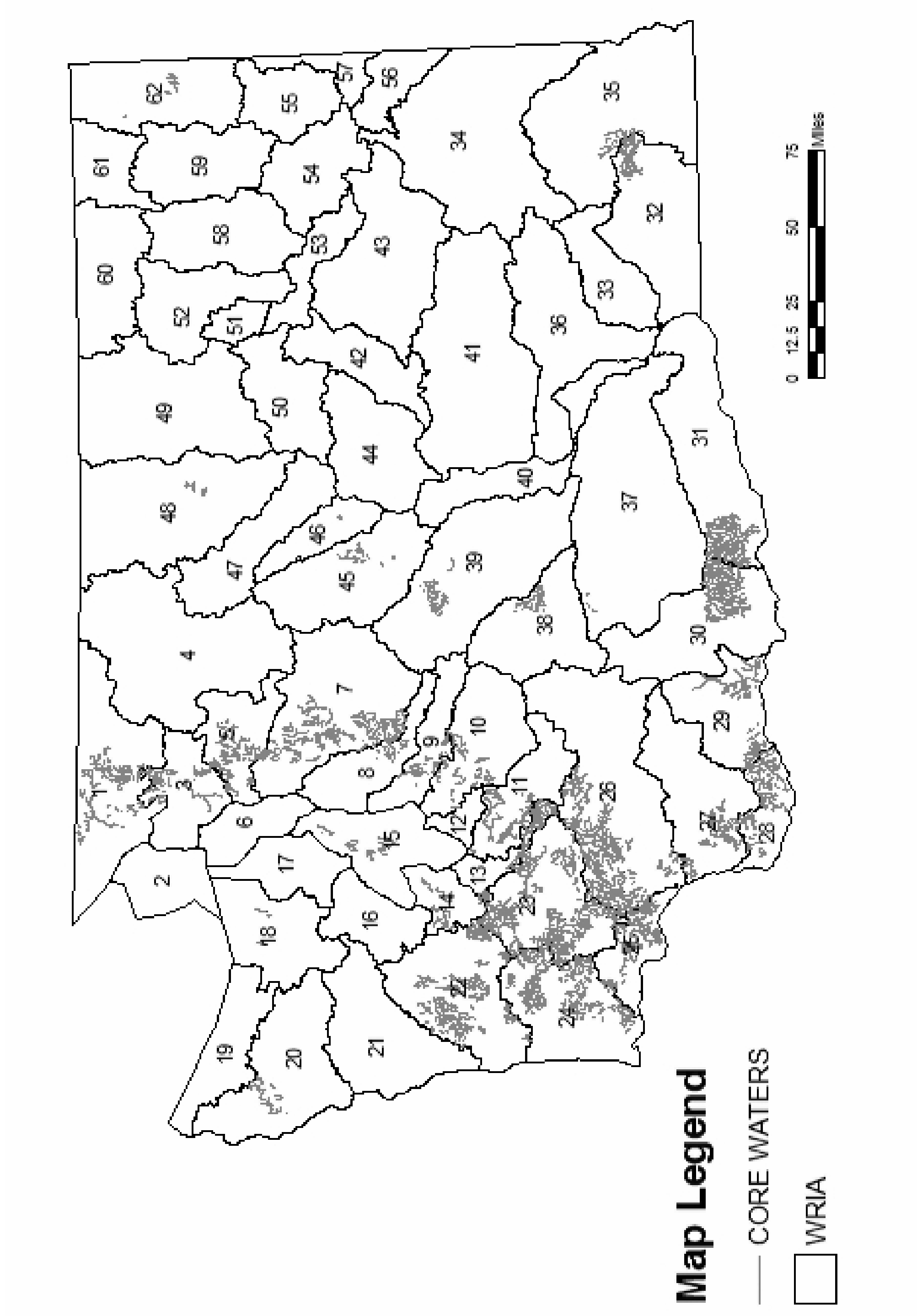
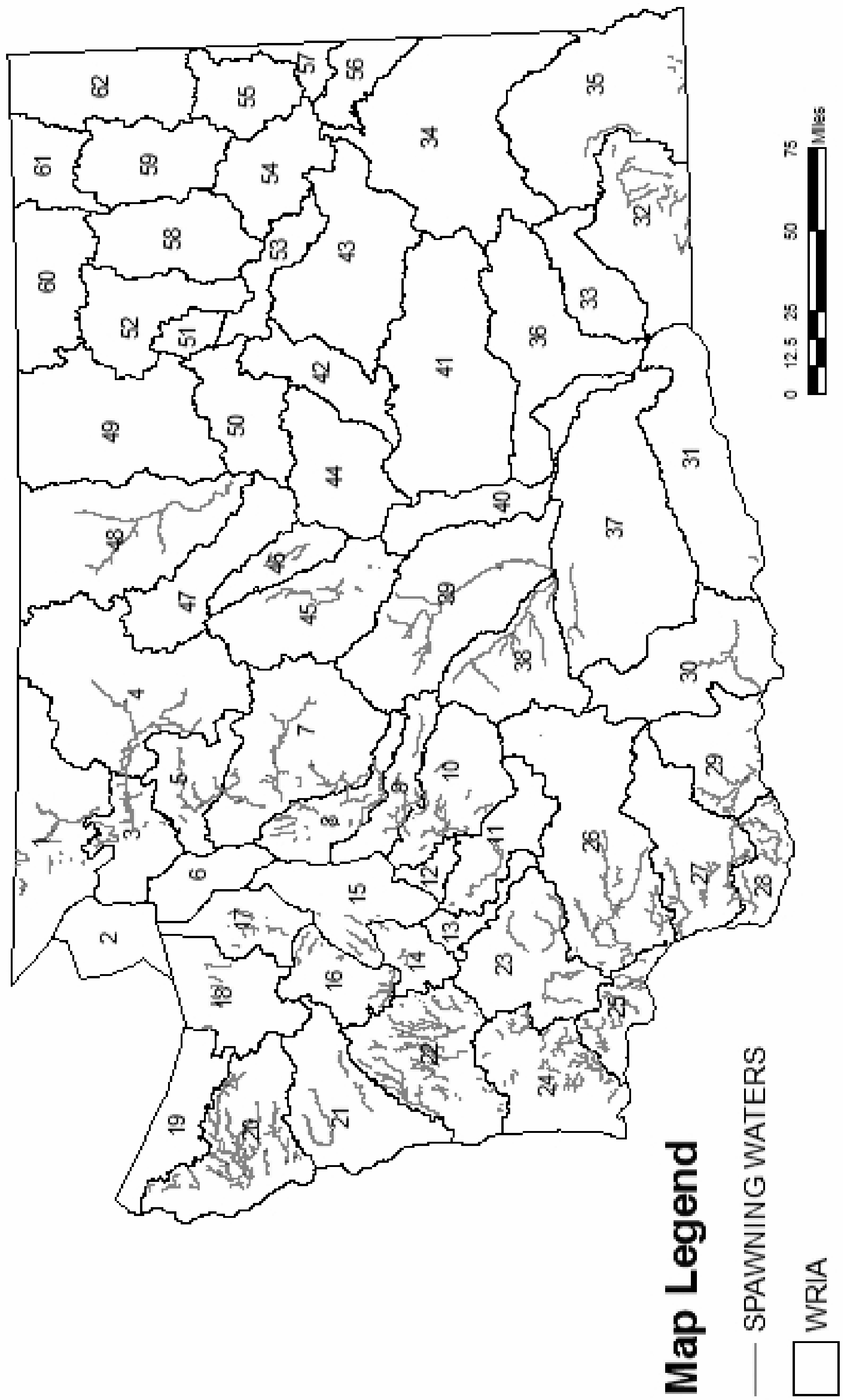


Exhibit 3-3. Waters with Revised Temperature Criteria for Core Summer Salmonid Habitat by WRIA[1]



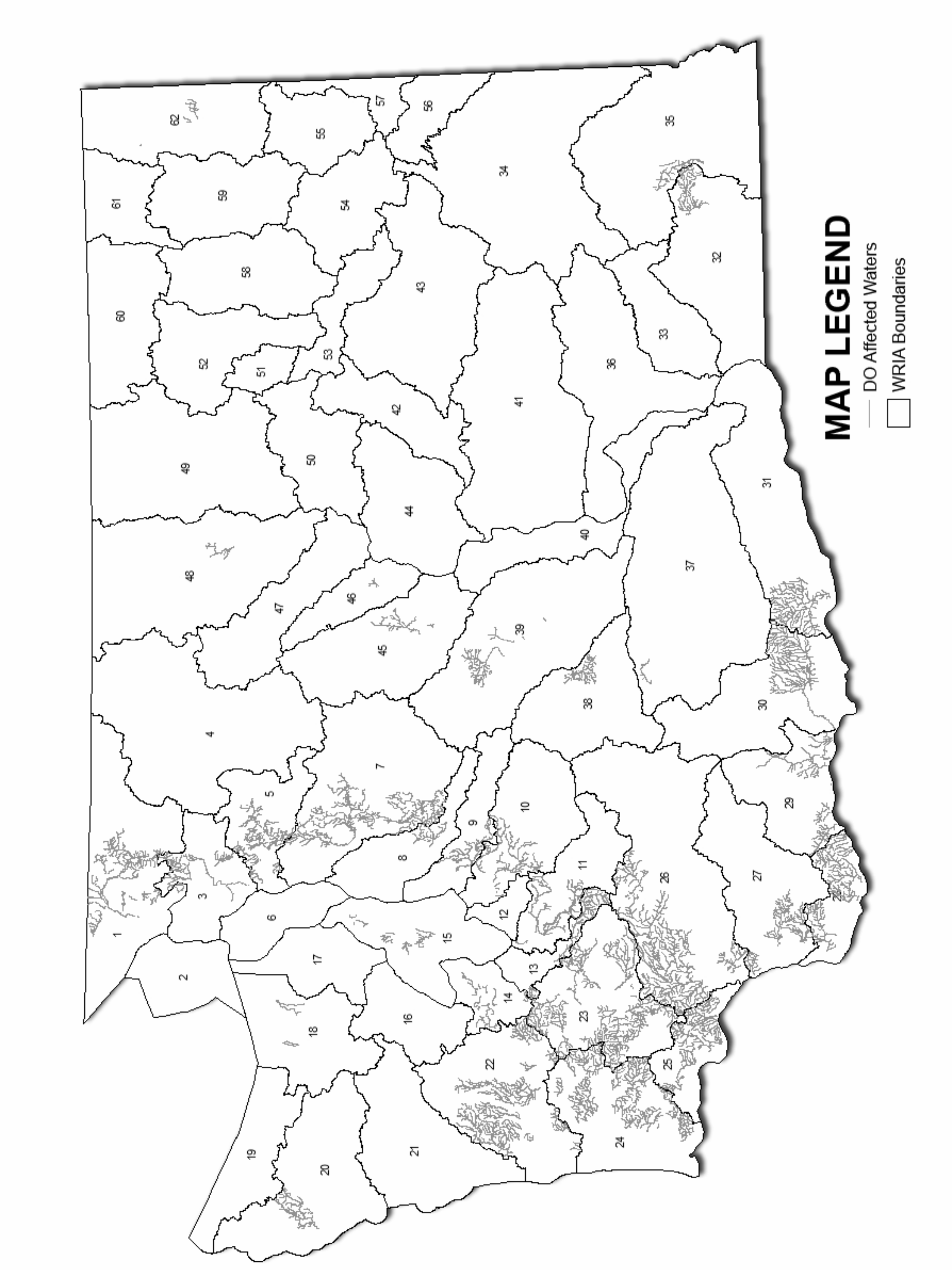
1. Does not include waters also designated for spawning under the proposed rule.

Exhibit 3-4. Waters with Revised Temperature Criteria for Protection of Spawning by WRIA[1]



1. Does not include waters also designated for char under the proposed rule.

Exhibit 3-5. Waters with Revised DO Criteria by WRIA



3.2 Potentially Affected Point Sources

Exhibits 3-6 and **3-7** show the individual NPDES-permitted facilities located within a 2,000-foot buffer of the stream segments identified in Exhibits 3-2 to 3-5. State geographic information system (GIS) files for NPDES permit holders do not include exact location information for the outfall of the discharge. A 2,000-foot buffer may over or underestimate facilities discharging to affected stream segments.

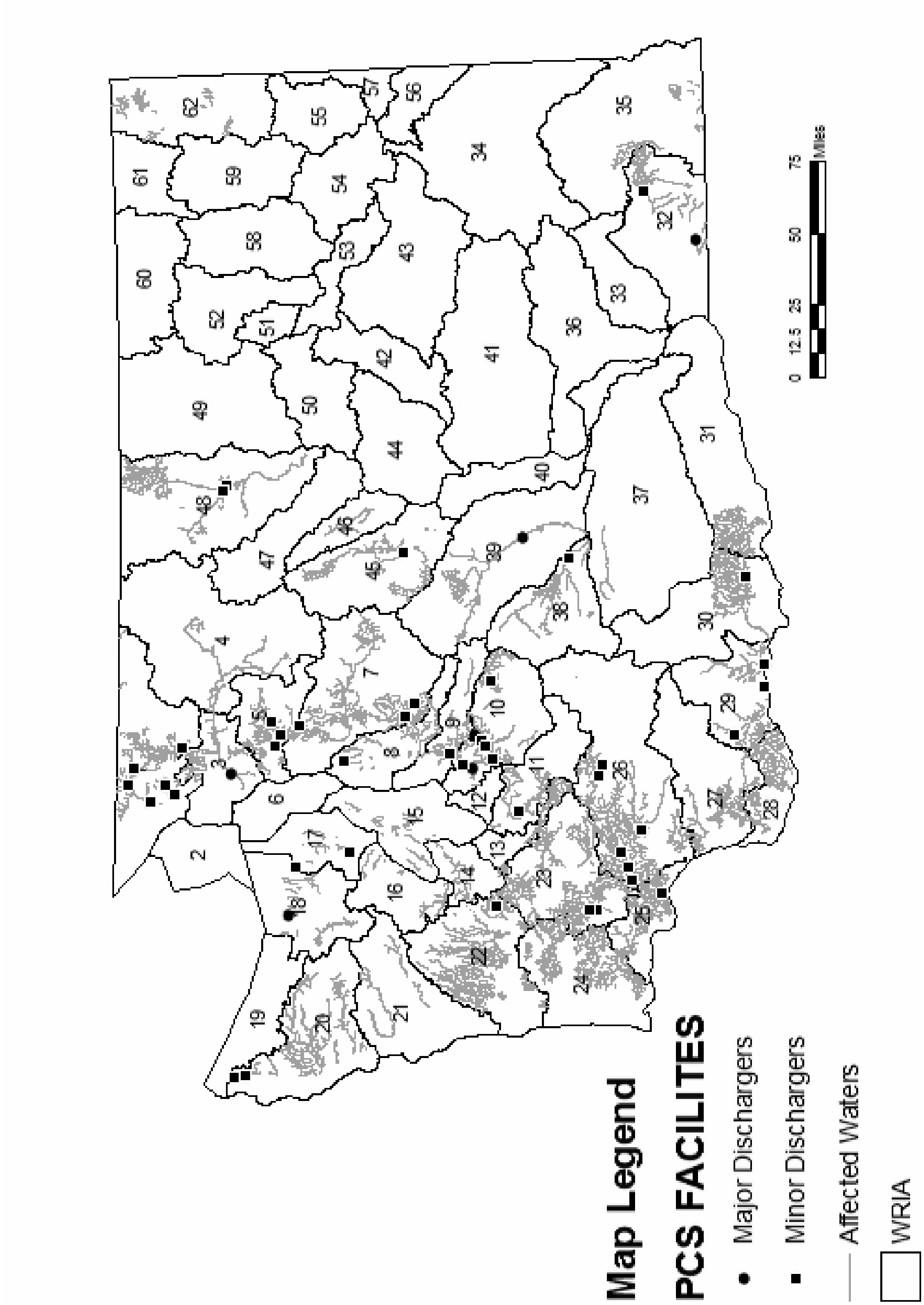
The exhibits do not include general permitted facilities. Data for these facilities are extremely limited, and flows from such facilities are usually negligible. In addition, few general permits currently contain requirements to monitor for temperature, DO, BOD, or nutrients, and none of them currently contain numeric effluent limits. Thus, there are no data available to evaluate the impact that the revised 2006 standards would have on general facilities. However, Ecology is beginning to require additional monitoring in a number of general permits. If such monitoring shows that the discharger has the potential to cause or contribute to an exceedance of the proposed criteria, the permits could be changed to include temperature or DO limits, or a general permitted facility may be issued an individual permit with requirements for temperature or DO in the context of a TMDL.

Exhibit 3-6. Summary of Potentially Affected Facilities[1]

Standard Industrial Classification		Number of Facilities	
		Majors	Minors
Agriculture, Forestry, and Fishing			
01	Agricultural Production – Crops	-	1
09	Fishing, Hunting, and Trapping	-	10
Manufacturing			
24	Lumber and Wood Products	-	4
37	Transportation Equipment	-	1
Transportation and Public Utilities			
42	Trucking and Warehousing	-	1
4952	Sewerage Services (POTWs)	5	25
Services			
87	Engineering, Accounting, Research, Management, and Related Services	-	1
Public Administration			
97	National Security and International Affairs	-	1
99	Nonclassifiable Establishments	-	1
	Total	5	45

Source: Based on Washington State GIS files of NPDES facilities and affected waters.
'-' = None.
1. Does not include general permits.

Exhibit 3-7. Major and Minor Facilities Potentially Affected by the Proposed Rule



Source: Based on Washington State GIS files of NPDES facilities and affected waters.

3.3 Potentially Affected Nonpoint Sources

Exhibit 3-8 summarizes the number of affected stream miles identified in Exhibits 3-2 to 3-4, and the associated uses of adjacent land.

Exhibit 3-8. Summary of Land Adjacent to Waters Affected by Revised Temperature Criteria

Land Cover	Number of Miles			
	Char[1]	Core Summer Salmonid[2]	Spawning[3]	Total
Forest Land				
Deciduous Forest	42	1,081	547	1,670
Evergreen Forest	894	2,168	1,357	4,419
Mixed Forest	27	1,006	574	1,607
Agriculture				
Fallow Crops	0	6	3	9
Row Crops	0	8	14	22
Small Grains	0	80	35	115
Pasture/Hay	1	259	149	409
Orchards/Vineyards/Other	0	13	36	49
Urban				
Commercial/Industrial/Transportation	1	23	30	54
High Intensity Residential	0	0	0	0
Low Intensity Residential	0	58	69	127
Urban/Recreational Grasses	0	1	1	2
Other Potentially Plantable Land				
Grasslands/Herbaceous	28	84	66	178
Shrubland	28	239	182	449
Transitional	31	135	50	216
Unplantable Land				
Bare Rock/Sand/Clay	22	6	47	75
Emergent Herbaceous Wetlands	0	1	5	6
Open Water	47	148	689	884
Perennial Ice/Snow	0	0	0	0
Quarries/Strip Mines/Gravel Pits	0	0	1	1
Woody Wetlands	5	83	81	169
Total	1,126	5,383	3,933	10,443

Note: Totals may not add due to rounding.
Source: USGS (1999a), reflecting data from 1986 to 1996. Note that the reliability of the land cover data is greatest at the State or multi-State level (see USGS, 1999b).
1. Waters that Ecology designated for either noncore or core rearing in the 2003 WQS revision that should be designated for char habitat.
2. Waters that Ecology designated for noncore rearing in the 2003 WQS revision that should be designated for core summer salmonid habitat.
3. Waters for which the salmonid spawning criterion applies at specific locations and times of the year.

Exhibit 3-9 summarizes the number of affected stream miles identified in Exhibit 3-5 and the associated land uses. Note that the miles of waters in the first two columns in the table below represent a subset of the miles of waters in Exhibit 3-8. Only those waters in the third column below are not also included in the waters affected by the temperature criteria changes.

Exhibit 3-9. Summary of Land Adjacent to Waters Affected by Revised DO Criteria

Land Cover	Number of Miles			
	Char[1]	Core Summer Salmonid[2]	Salmonid SRM[3]	Total
Forest Land				
Deciduous Forest	0	1,393	0.01	1,393
Evergreen Forest	3.2	2,791	0.5	2,795
Mixed Forest	0.1	1,326	0.01	1,326
Agriculture				
Fallow	0	7.2	0.01	7.2
Row Crops	0	14	1.7	16
Small Grains	0	129	0.01	129
Pasture/Hay	0.1	853	0.4	853
Orchards/Vineyards/Other	0	20	0.8	21
Urban				
Commercial/Industrial/Transportation	0.01	42	0.2	42
High Intensity Residential	0	0.1	0	0.1
Low Intensity Residential	0.04	94	0.8	95
Urban/Recreational Grasses	0	1.9	0	1.9
Other Potentially Plantable Land				
Grasslands/Herbaceous	0.2	105	0.1	105
Shrubland	0.2	273	1.1	275
Transitional	0.8	150	0	151
Unplantable				
Open Water	0.2	958	3.0	962
Bare Rock/Sand/Clay	0.01	33	0.1	34
Emergent Herbaceous Wetlands	0	5.6	0	5.6
Quarries/Strip Mines/Gravel Pits	0	0.4	0	0.4
Woody Wetlands	0.02	127	0	127
Total	4.9	8,325	8.6	8,338

1. Waters that Ecology designated for noncore rearing in the 2003 revision that should be designated for char habitat.
2. Waters that Ecology designated for noncore rearing in the 2003 revision that should be designated for core summer salmonid habitat.
3. Waters that Ecology designated for rearing and migration only in the 2003 revision that should be designated for salmonid spawning, rearing, and migration.

Forestry

Approximately 74 percent of the land cover adjacent to affected waters is forest land. As described in Section 2, existing regulations require riparian buffers to protect water quality; no additional practices would be required as a result of the proposed standards.

Agriculture

Agricultural and other plantable land make up the next largest land cover category (about 14 percent of the total). Riparian buffers may be needed on all agricultural and plantable land adjacent to affected waters to achieve the proposed standards. Note, however, that existing regulations in some counties require new agricultural operations to keep or plant riparian buffers (Ecology, 2003a), and thus, some of these costs are attributable to baseline regulations.

Urban Development

Urban development accounts for approximately two percent of the land cover adjacent to affected waters. Riparian buffers may be needed on all urban land adjacent to affected waters for compliance with the proposed standards, although existing regulations (SMA, GMA, and local ordinances prohibiting development on floodplains) already restrict intensive development adjacent to streams.

3.4 Hydromodification

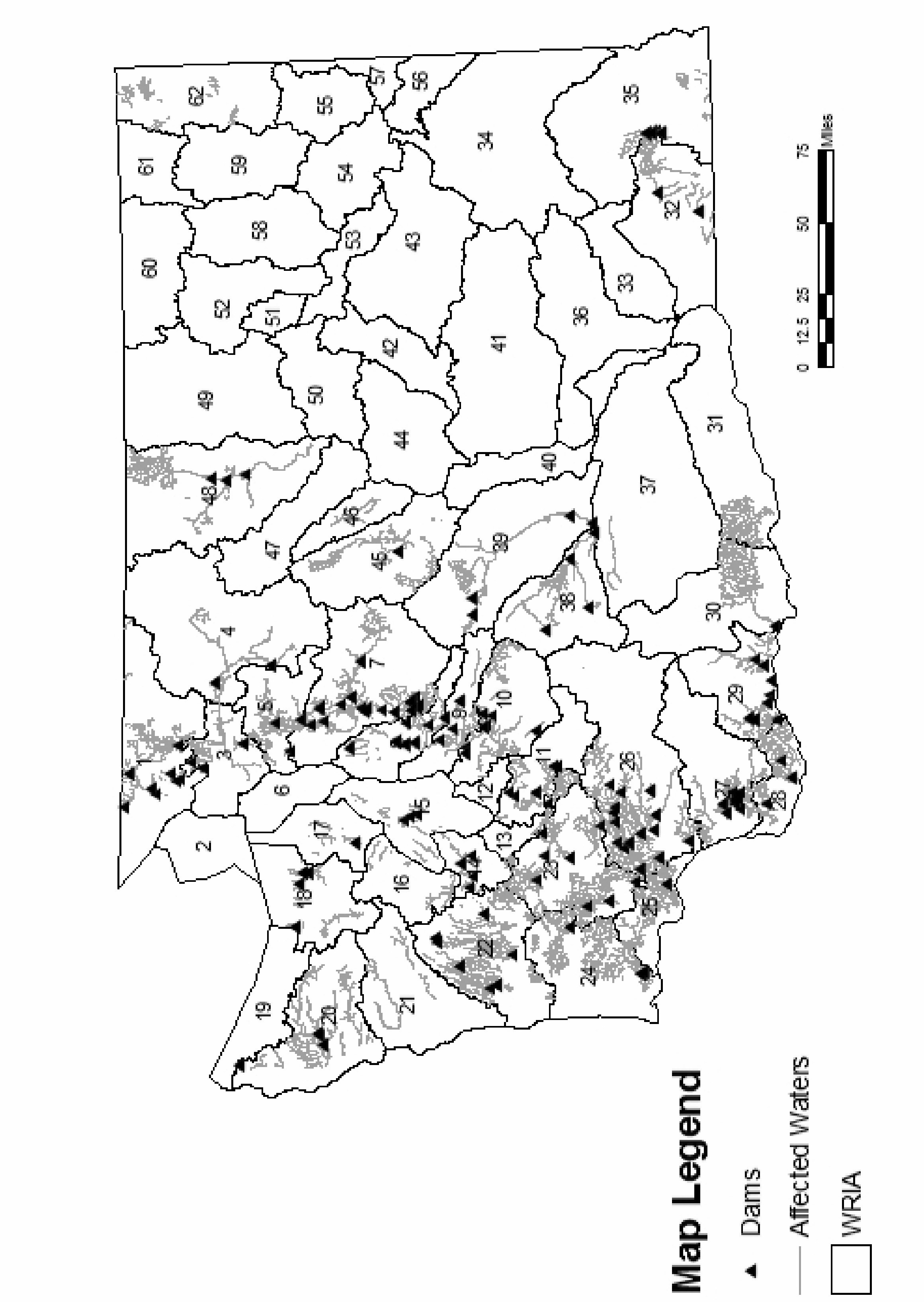
State data indicate that there are 146 dams within a 500-foot buffer of affected waters as shown in **Exhibit 3-10**. Fourteen of these dams are federally-owned; the rest are state- or privately owned. Dam modifications (e.g., reductions in storage capacity, relocating outlet) may be needed for those dams located upstream of affected waters for compliance with the proposed standards.

3.5 Water Withdrawals

The potential impact of the proposed rule on existing water rights is likely to be limited.[4] State laws that protect instream water flows do not affect existing rights for off-stream water use (Ecology, 2004d). To enhance instream flows, the state can purchase existing water rights from willing owners. In these instances, the state bears the cost voluntarily (which implies that the benefits exceed the costs).

[4] As discussed in Section 1.3, it is not feasible to assess the potential impact of the proposed rule on future water rights. Exhibit 2-3 shows that several TMDLs already include restrictions on future off-stream water rights to achieve existing temperature restrictions. Therefore, restrictions such as these occur as part of the baseline for the proposed rule. The incremental impact of the proposed rule on future TMDLs for waters that are impaired for temperature or DO will depend on whether restricting future water rights is more cost-effective than other alternatives for meeting temperature or DO requirements, and whether the rights restrictions would have been needed to meet the 2003 standards. Similar considerations apply when evaluating the incremental impact of the proposed rule on future water rights along streams that are not impaired. Thus, projections of potential impacts would be speculative, and the resulting costs of foregone offstream water use and benefits of avoided harm to fisheries would be unreliable.

Exhibit 3-10. Dams Potentially Affected by the Proposed Rule



4. Incremental Costs

This section provides a brief discussion of the incremental costs applicable to various types of economic analyses, and describes the analyses of costs for point and nonpoint source dischargers that may be affected by the rule.

4.1 Overview of Cost Analyses

Washington administrative procedures require two types of economic analyses – a cost-benefit analysis and a small business impact analysis. A cost-benefit analysis is an evaluation of whether a policy is efficient from an economic standpoint. Economic efficiency is based on the standard that the people who benefit should—in theory—be able to compensate the people who incur costs such that everyone is at least as well off as before the policy, and is demonstrated by benefits of an equal or greater magnitude than costs. This efficiency standard is applicable to decisions about whether to adopt a new policy.

In comparison, a small business economic impact analysis is a distributional analysis. Section 7 describes the purpose and method for a small business economic impact analysis.

Because it is state policy to meet federal requirements for water quality, Ecology must revise its water quality standards to obtain EPA approval. Consequently, a cost-benefit analysis of the revision does not inform the decision to meet the federal standards. Nevertheless, if there are alternative ways to revise the standards, a cost-benefit analysis could identify the alternative that maximizes net benefits, which equals benefits minus federal requirements, and any feasible alternatives will exceed the requirements and cost more.

Social Costs

The costs in a cost-benefit analysis are not the same as the expenses in a financial analysis. Cost-benefit analyses compare social costs and benefits, which include nonmonetary impacts as well as certain monetary impacts. The incremental social cost of a policy is the sum of the opportunity costs incurred by society from implementing the policy. Opportunity costs are the value of the goods and services foregone by society when resources are used to comply with a regulation. For example, if landowners install riparian buffers, they incur opportunity costs for the labor and materials used for the buffers that could have been put to alternative use. They also incur opportunity costs for the land the buffer occupies, which cannot be used for other purposes. However, these costs do not take into account any of the health, environmental, or other benefits of the policy that offset the social costs (EPA, 2000). These benefits (or costs or damages of *not* implementing the policy) are discussed in Section 6.

It is important to note that social costs do not include transfers such as taxes, licensing fees, or subsidies. Although these expenditures represent private or out-of-pocket costs, they are not costs to society because they do not reflect opportunity costs—they only reflect money moving from one entity to another without any goods and services foregone because of resource use (EPA, 2000).

EPA (2000) describes the components of social costs, which include real-resource compliance costs, government regulatory costs, social welfare costs, transitional costs, and indirect costs. Real-resource compliance costs are generally the principal component of total social costs, and include (EPA, 2000):

- Capital costs of new equipment
- Operation and maintenance of new equipment
- Waste capture and disposal, selling, or reuse
- Change in production processes or inputs
- Maintenance changes in other equipment.

Given the extent of incremental changes over the 2003 WQS revision, the potentially affected entities, and likely control costs, the potential for impacts in the remaining cost categories listed above (e.g., market impacts, such as higher prices and resource shifts) is small.

4.2 Point Sources

This section describes the methods for estimating the labor and equipment costs that may be incurred by point source dischargers as a result of the proposed rule, and summarizes the results. **Appendices A** and **B** provide the facility-level analyses for achieving the revised temperature and DO criteria, respectively.

4.2.1 Facility Evaluations

State location information in GIS format indicates that approximately 50 industrial and municipal facilities (5 majors and 45 minors) may discharge to waters for which the rule establishes revised uses and temperature criteria compared to the 2003 WQS revision. Of these, 40 are also affected by revised DO criteria. In estimating the potential impacts, major facilities have the greatest potential to influence costs due to their large flows. Since relatively few majors may be affected, the estimate of costs reflects individual estimates for each major facility. For minors, costs represent estimates for a random sample of facilities in each use classification reflecting a change in temperature criteria, extrapolated to all such minor facilities in each category (e.g., minor facilities affected by a change in use classification from noncore rearing to core summer salmonid habitat, and those discharging to waters specifically designated for char and spawning). **Exhibit 4-1** provides a comparison of the number of sample facilities and the total number of facilities affected by each use change.

Exhibit 4-1. Facilities Affected by the Revised Temperature Criteria

Discharger Category	Number of Facilities Affected	Number of Sample Facilities
Char[1]		
Minor Municipal	1	1
Core Summer Salmonid[2]		
Major Municipal	1	1
Minor Municipal	6	2
Minor Industrial	3	2
Spawning[3]		
Major Municipal	4	4

Exhibit 4-1. Facilities Affected by the Revised Temperature Criteria

Discharger Category	Number of Facilities Affected	Number of Sample Facilities
Minor Municipal	19	8
Minor Industrial	16	6
Total	50	24

1. Waters that Ecology designated for either noncore or core rearing in the 2003 WQS revision that should be designated for char habitat.
2. Waters that Ecology designated for noncore rearing in the 2003 WQS revision that should be designated for core summer salmonid habitat.
3. Waters for which the salmonid spawning criterion applies at specific locations and times of the year.

Because each of the facilities affected by the change in DO criteria is also affected by the change in temperature criteria, the sample facilities for estimating costs associated with the temperature standards provide a means of estimating the incremental impacts attributable to achieving the revised DO criteria. **Exhibit 4-2** provides a comparison of the number of sample facilities and the total number of facilities that may be affected the DO criteria changes.

Exhibit 4-2. Facilities Affected by the Revised DO Criteria

Discharger Category	Number of Facilities Affected	Number of Sample Facilities
Major Municipal	4	4
Minor Municipal	21	8
Minor Industrial	15	4
Total	40	16

The major facilities and sample of minor facilities for evaluation of impacts from the different use classifications are shown in **Exhibit 4-3**.

Exhibit 4-3. Sample Facilities for Estimating Incremental Impacts of the Proposed Rule

NPDES No.	Category	Type	Facility Name
WA0040789	Industrial	Minor	Weyerhaeuser Enumclaw Millpond
WA0024074	Municipal	Major	Mount Vernon Wastewater Utility
WA0022454	Municipal	Minor	Ferndale Wastewater Treatment Plant
WA0036927	Industrial	Minor	Hampton Drying Company
WA0022578	Municipal	Minor	Lynden Wastewater Treatment Plant
WA0031500	Industrial	Minor	Washington DFW Bellingham Hatchery
WA0020575	Municipal	Major	Enumclaw Sewage Treatment Plant
WA0023973	Municipal	Major	Port Angeles Sewage Treatment Plant
WA0023353	Municipal	Major	Sumner Wastewater Treatment Plant
WA0024627	Municipal	Major	Walla Walla Wastewater Treatment Plant
WA0022560	Municipal	Minor	Arlington Wastewater Treatment Plant
WA0023361	Municipal	Minor	Buckley Wastewater Treatment Plant
WA0000205	Industrial	Minor	Carson National Fish Hatchery
WA0031437	Industrial	Minor	Circle K Store (#5500) - BP Oil
WA0038695	Municipal	Minor	Cowlitz County - Ryderwood Sewage Treatment Plant
WA0020729	Municipal	Minor	Dayton Sewage Treatment Plant
WA0000213	Industrial	Minor	Little White Salmon National Fish Hatchery

Exhibit 4-3. Sample Facilities for Estimating Incremental Impacts of the Proposed Rule

NPDES No.	Category	Type	Facility Name
WA0040339	Industrial	Minor	Manke Lumber Company
WA0024040	Municipal	Minor	McCleary Sewage Treatment Plant
WA0020303	Municipal	Minor	Orting Wastewater Treatment Plant
WA0001872	Industrial	Minor	Quilcene National Fish Hatchery
WA0022349	Municipal	Minor	Sequim Sewage Treatment Plant
WA0000507	Industrial	Minor	U.S. FWS Abernathy Fish Technology Center
WA0020885	Municipal	Minor	Winthrop Wastewater Treatment Plant

4.2.2 Temperature Analysis

High effluent temperatures can cause or contribute to increases in instream water temperatures, especially where minimal or no dilution is available.

Determining Reasonable Potential

A facility may have reasonable potential to cause or contribute to an excursion above the applicable temperature criterion if the temperature at the edge of the mixing zone rises above allowable levels (see definition of allowable levels below). The temperature at the edge of the mixing zone can be calculated using the following equation (Ecology, 2004a):

$$T_{MZ} = \frac{T_E + (D * T_S)}{(D + 1)}$$

Where,

T_{MZ} = temperature at the edge of the mixing zone
T_E = effluent temperature
T_S = stream background temperature
D = dilution factor.

Effluent temperature can be estimated as the maximum monthly value over the last three years reported in monthly discharge monitoring reports (DMRs) (e.g., EPA's PCS database), or where daily effluent data are available, the maximum 7-DADM temperature for a given month. Stream background temperature is the maximum ambient temperature (either maximum monthly or maximum 7-DADM) or, when the ambient stream temperature exceeds the criterion (i.e., the water body is impaired), the applicable criterion. The dilution factor is calculated from the following equation (Ecology, 2004a):

$$D = \frac{Q_S + Q_E}{Q_E}$$

Where,

Q_S = portion of stream flow available for dilution
Q_E = effluent flow.

The dilution factor can be based on the 7Q10 (minimum 7-day average flow recurring once in 10 years) stream flow, and the average monthly effluent flow. Washington's current water quality standards state that no more than 25 percent of the 7Q10 flow be used in the dilution calculation (WAC 173-201A-400).

Washington's 2003 WQS revision allows for incremental increases in downstream temperatures at the edge of the regulatory mixing zone. For waters exceeding the criterion due to natural conditions, a 0.3°C increase in ambient temperature would be allowed, and for waters below the criterion, incremental increases based on the following equation, but not to exceed the criterion, would be allowed:

$$t = \frac{28}{(T+5)}$$

Where,

t = incremental temperature increase at the edge of the mixing zone

T = maximum ambient temperature upstream of the discharge

Therefore, any facilities discharging at temperatures that would increase the downstream temperature by more than specified above [0.3°C or 28/(T+5), depending on ambient stream temperatures] would have reasonable potential to cause an exceedance in the criterion, and may be required to implement controls to reduce effluent temperatures.

Note, however, Ecology's permit writer's manual indicates that when ambient data indicate that the water body is impaired (i.e., one 7-DADM value above criteria), interim limits should be implemented. The manual suggests establishing target effluent temperatures that will meet a 0.3°C increase at the boundary of the chronic mixing zone. This is attributed to a temperature TMDL likely showing that the natural condition exceeds the current criteria, or that with nonpoint source controls in place there will be a small amount of dilution (Ecology, 2004a).

Currently, reasonable potential and effluent limits for most facilities discharging to water bodies with maximum receiving water temperatures above the applicable criteria allow an incremental increase (0.3°C) in background temperature at the edge of the chronic mixing zone during the critical period (i.e., highest temperatures, lowest flow), regardless of whether background temperatures exceed the criteria (Omak POTW, 2003; Okanogan POTW, 2003; Kennewick POTW, 2003).

In addition, EPA Region 10 acknowledges in its guidance for temperature water quality standards (EPA, 2003) that, although the region's general practice is to require that numeric criteria be met end-of-pipe in impaired water bodies, there are instances where end-of-pipe limits for temperature may not be necessary to meet applicable water quality standards and protect salmonids in impaired waters. EPA Region 10 (2003) explains that temperature impairments in the Pacific Northwest are primarily due to nonpoint sources, and that temperature effects from point sources generally diminish downstream quickly as heat is added and removed from a water body through natural equilibrium processes. However, EPA Region 10 (2003) notes that where the discharge from a point source is significant relative to the size of the receiving water, end-of-pipe effluent limits may be warranted.

Region 10 (2003) suggests that facilities seeking to discharge heat into an impaired water body conduct a temperature study, and that effluent temperature limits ensure that any downstream temperature increases above the criterion are less than 0.3°C after mixing (i.e., calculate effluent limits assuming the receiving water temperature is the criterion and allowing dilution.) Therefore, based on Region 10's guidance, facilities discharging to waters impaired due to human activities would have reasonable potential if the discharge causes the temperature at the edge of the mixing zone to increase by more than 0.3°C above the applicable criterion.

Potential Compliance Actions

Any discharge with reasonable potential to cause an exceedance of the applicable criterion (i.e., a downstream temperature greater than the allowable increase) could require additional controls. There are a number of control options for reducing effluent temperatures, including:

- Optimizing treatment processes (e.g., switching to fine bubble aeration, installing shade cloths) to reduce the thermal loads to the waste stream, and controlling sources.
- Implementing alternative discharge options (e.g., land application, storage ponds, change outfall location.)
- Reducing the volume of discharge by reusing effluent.
- Installing treatment technology to reduce temperatures (e.g., cooling towers and chillers).

Facilities would first consider the feasibility of low cost control options, and only consider the more costly controls if necessary. The lowest cost option is likely the adjustment of existing treatment (process optimization). This option would be most feasible where relatively low temperature reductions on the order of less than 1°C are needed, or monitoring data indicate that influent temperatures increase significantly during the treatment process (i.e., net positive temperature increase from influent to effluent).

If adjusting existing operations would not be feasible or would not be sufficient to achieve the desired temperature reductions, source controls would be the next lowest cost control option. Source control could be used alone, or in conjunction with process optimization. The feasibility of source control efforts depends on the make-up of the influent and whether potential dischargers of high temperatures exist. For example, industrial discharges can be regulated through pretreatment permits, but residential sources would have to be targeted through public outreach and education, which has low participation rates and is not likely to result in significant reductions. Therefore, source control at a municipal wastewater treatment plant that treats primarily domestic waste may not be a feasible control option.

If these relatively low-cost controls would not be sufficient for compliance with the proposed rule, alternative discharge options or end-of-pipe treatment technologies (e.g., cooling towers and chillers) may be necessary. However, the feasibility of each would need to be considered first. For example, an evaporation pond may not be feasible for a major facility with a large flow because the necessary amount of land may not be available.

Potential Control Costs

Compliance with the 2003 WQS revision provides the baseline control scenario; only incremental controls and costs needed to achieve further reductions represent the impacts of the proposed rule. For some facilities, compliance with the 2003 revisions would enable compliance with the proposed rule; for others, additional actions may be necessary. The sections below describe the potential costs of controls that may be implemented for either compliance with the baseline or the proposed rule, indicated by analysis of the sample of facilities (Appendix A).

Alternative discharge options include land application and effluent reuse or changing the point of discharge. Costs for land application and reuse include trench excavation and backfill, piping, and pumps (**Exhibit 4-4**).

Exhibit 4-4. Land Application Unit Costs

Component	Unit Cost[1]	Description
Excavation and Backfill	$0.87 per linear foot	Utility trench, 16" wide, 18" deep, with backfill, chain trencher, 40 HP
Pipe	$6.99 – $28.76 per l.f. (6" to 21" diameter); $60.35 per l.f. (36" diameter)	Sized assuming a velocity of 1.0 fps; 6" to 21" diameter: Extra strength, nonreinforced concrete; 36" diameter: Reinforced concrete
Pump	$1,198 - $193,648 per pumping station	0 to >350 gpm: Submersible sewage ejector or package station

Source: RS Means (2005).
fps = feet per second
ga = gauge
gpm = gallons per minute
HP = horsepower
1. Unit costs include materials, labor, equipment, and overhead and profit.

Engineering design and analysis of approximately 15 percent of total capital costs may also be needed (U.S. EPA, 1998). In addition, annual operation and maintenance (O&M) costs associated with maintaining the equipment and monitoring may amount to about four percent of the total capital costs (U.S. EPA, 1998), not including engineering design and analysis.

To determine the feasibility of land application or effluent reuse, a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue. Note, however, that costs for cooling towers based on estimates in EPA's Technical Development document for its 316(b) Rule (EPA, 2002) are similar to those for land application. Thus, the cost estimates for the sample facilities reflect a range of technologies.

4.2.3 Dissolved Oxygen Analysis

BOD is one of the main contributors to decreases in instream DO levels (Viessman and Hammer, 1998). However, other pollutants such as temperature, suspended solids, and nutrients (different species of nitrogen and phosphorus) may also lead to reduction in DO levels by stimulating excess algae and plant growth, thus increasing buildup of decomposing organic matter in sediments (Viessman and Hammer, 1998). Stream characteristics such as depth, velocity, width, and water clarity also affect DO levels.

Water Quality Modeling

To assist permit writers in determining the potential for DO standards to be violated, the Washington Department of Ecology (Ecology) developed the DOSAG2.xls spreadsheet model to be used as a screening tool. The spreadsheet assists permit writers in calculating the critical sag of DO downstream from a point source using the Streeter-Phelps equation (Viessman and Hammer, 1998):

$$D = \frac{K_D L_0}{K_R - K_D}\left(e^{-K_D x/u} - e^{-K_R x/u}\right) + D_0 e^{-K_R x/u}$$

Where,
D = DO deficit
K_D = rate of deoxygenation
K_R = rate of reaeration
L_0 = ultimate BOD at the point of waste discharge
x = downstream distance at which the DO deficit occurs
u = velocity of the stream
D_0 = DO at point of waste discharge.

Note that the model does not account for the discharge of nutrients or suspended solids. Discharge of these pollutants may also impact instream DO concentrations. Thus, potential impacts could be underestimated.

Ecology also warns that the model may even be overly simplistic for deriving limits for BOD. Therefore, Ecology (2004a) suggests using a more sophisticated model such as QUAL2E or WASP5 if the model indicates that the DO sag is close to or below the water quality standard. The QUAL2E and WASP5 models are designed to more accurately simulate water movements, mass transport, and water column processes to derive appropriate effluent limits (Ecology, 2004a). Generally, these more sophisticated models are used in the context of determining wasteload allocations under a TMDL and not for deriving effluent limits.

A number of input variables are needed to run the DOSAG2 model, including effluent carbonaceous BOD (CBOD), nitrogenous BOD (NBOD), and DO; upstream flow, CBOD, NBOD, DO, temperature, and elevation; and downstream channel slope, depth, and velocity. Ecology's permit writer's manual (2004a) indicates that the impact of BOD should be determined at the critical condition. The manual defines critical conditions in terms of effluent flow (design flow) and receiving water flow (7Q10). Values for the other input parameters should represent conditions at these flows.

For example, the permit for the Mount Vernon Wastewater Treatment Plant (WWTP) presents DO modeling based on DOSAG2 modified to evaluate DO, BOD, and ammonia within discrete segments of the river between the plant and mouth. Input variable values include a receiving water flow of 5,030 cfs (although only 30 percent of flow is used in dilution calculation), mean river velocity at discharge point of 1.81 feet per second (fps), upstream BOD of 0.6 mg/L (assumed), upstream ammonia of 0.023 mg/L, upstream DO of 9.7 mg/L (criterion is 8.0 mg/L), and upstream temperature of 17.5°C. Based on the results, the permit writer concludes that a numerical effluent limit for ammonia is not necessary, and technology-based limits for BOD are all that are necessary for the facility because downstream DO concentrations do not decrease below the current criterion of 8.0 mg/L.

The permit for the Buckley WWTP also reflects use of the DOSAG2 model. The analysis in the fact sheet indicates that the discharge would not cause a decrease in DO concentrations below the existing criterion of 8.0 mg/L. Note, however, that some of the values used in their model differ from those identified in the body of the fact sheet as being the most restrictive values in the immediate vicinity of the Buckley outfall (representative of critical conditions). For example, the modeling results in Appendix C of the fact sheet are based on values of 22.3°C for effluent temperature, 10.75 mg/L for upstream DO, 1.19 feet for channel depth, and 3.15 fps for channel velocity. However, the body of the fact sheet indicates that the most restrictive values are a maximum monthly average effluent temperature of 20.3°C, upstream DO of 11.32 mg/L, channel depth of 0.82 feet, and channel velocity of 1.45 fps. These values are actually less restrictive than those used in their DO modeling. There is no explanation in the permit or fact sheet as to why the values differ.

Water Quality Modeling for the Sample Facilities

Due to significant data limitations, use of a DO model more complex than the DOSAG2 model is not feasible. As discussed above, the Mount Vernon WWTP and the Buckley WWTP are the only two sample facilities for which DO modeling results are presented in their permits, and both are based on the DOSAG2 model. Thus, this analysis is based on modeling DO concentrations using the DOSAG2 model as well.

To model DO using DOSAG2 for the remaining sample facilities, the appropriate input parameters need to be collected or estimated. For example, effluent and receiving water CBOD and NBOD are available for only one sample facility (Buckley WWTP). These parameters could possibly be estimated from available BOD and ammonia concentrations or from facilities or streams with similar characteristics, but may not represent actual conditions.

Exhibit 4-5 summarizes the input data available for each of the sample facilities.

Exhibit 4-5. Summary of DO Model Input Parameters Available for Sample Facilities

	Effluent Inputs					Receiving Water Inputs								
Facility Name	Flow (cfs)[1]	CBOD (mg/L)	NBOD (mg/L)	DO (mg/L)	Temp (° C)	Flow (cfs)	CBOD (mg/L)	NBOD (mg/L)	DO (mg/L)	Temp (° C)[2]	Elevation (ft)	D/S Channel Slope (ft/ft)	D/S Channel Depth (ft)	D/S Channel Velocity (fps)
Enumclaw STP	4	- -[3]	- -[4]	6	21	130	- -	- -	11.32	12.7	736	0.0066	0.82	1.45
Mount Vernon WWTP	8.7	- -[3]	- -[4]	4.5	23	5030	- -	- -	9.7	16	17.2	0.00079	13	1.8
Sumner WWTP	5.3	- -[3]	- -[4]	- -	21	199	- -	- -[4]	11.05	16	31.95	0.00466	1.43	1.01
Walla Walla WWTP	0.7	5.9	- -[4]	8.99	17	6.6	- -	- -	- -	10.7	835	0.0116	1.74	1.6
Buckley WWTP	1.6	51.5	17.7	4	22.3	130	0.9	0.21	10.75	12.7	720	0.0066	1.19	3.15
Cowlitz Co - Ryderwood STP	0.53	- -[3]	- -[4]	ND	15.8	10.1	- -	- -	- -	16	232.5	0.0396	0.75	1.11
Dayton STP	0.52	- -[3]	- -[4]	6.7	22.8	32	- -[3]	- -[4]	3.98	16	1567	0.0453	2.05	1.70
Ferndale WWTP	5.0	22	- -[4]	- -	21	664	- -	- -[4]	11.3	16	12.6	0.000114	2.11	2.95
Lynden WWTP	1.9	- -[3]	- -	- -	- -	856	- -	- -[4]	10.4	16	65.2	0.0011	2.33	2.3
McCleary STP	0.21	- -[3]	- -[4]	8	22	1.17	- -[3]	- -[4]	6.0	16	252.6	0.0179	0.43	0.22
Orting WWTP	1.4	- -[3]	- -[4]	2	20	148	- -	- -[4]	8.0	16	193	0.00412	0.96	2.18
Winthrop WWTP	0.24	- -[3]	- -	1.4	24	149	- -	- -	- -	16	1743	0.00316	3.77	2.07
Hampton Drying Company	None	- -	- -	- -	- -	- -	- -	- -	- -	16	981	0.078	0.64	1.09
Manke Lumber Company	- -	- -	- -	- -	- -	553	- -	- -	- -	16	69	0.0156	4.5	1.86
FWS Abernathy Fish Technology Center	0.45	- -	- -	- -	- -	4.69	- -	- -	- -	16	141	0.0328	1.4	1.31
DFW Bellingham Hatchery	0.009	- -[3]	- -	- -	- -	32.6	- -	- -	- -	16	308	0.025	1.8	1.66

"- -" = No data available.

1. Represents flow during critical period after temperature controls have been implemented.
2. Represents the revised temperature criterion during the critical period (core summer salmonid habitat criterion of 16°C), unless data indicate that temperatures are below the criterion (e.g., for Walla Walla WWTP and Buckley WWTP).
3. No CBOD data are available, however, there are BOD data available from which CBOD could possibly be estimated.
4. No NBOD data are available, however, there are ammonia data available from which NBOD could possibly be estimated.

Effluent data are available primarily from facility fact sheets, although some data is available from EPA's PCS database or facility discharge monitoring reports (DMRs) provided by EPA. Receiving water data are primarily from facility fact sheets. Other data sources include Ecology's Environmental Information Management (EIM) System database, United States Geological Survey (USGS) National Hydrology Dataset, and USGS 30-meter resolution maps (provide elevations). However, the data in the facility fact sheets may or may not always represent critical conditions (i.e., data from the summer and early fall when stream flows are most likely closest to the 7Q10). For example, the fact sheet for the Enumclaw WWTP indicates that the most restrictive receiving water temperature in the vicinity of the discharge is 12.7°C. However, monitoring data from Ecology's EIM database indicate that the maximum temperature for the White River about 2 miles upstream from the facility is 16.8°C in July. **Exhibit 4-6** shows how such a discrepancy (with all other inputs being the same) could affect the results of DO modeling (using the DOSAG2 model).

Exhibit 4-6. DO Modeling Results for Varying Upstream Temperatures, Enumclaw STP

	Upstream Temp of 12.7°C	Upstream Temp of 16.8°C
INPUT		
1. EFFLUENT CHARACTERISTICS		
Discharge (cfs):	4	4
CBOD5 (mg/L):	14.7[1]	14.7[1]
NBOD (mg/L):	13.3[2]	13.3[2]
Dissolved Oxygen (mg/L):	5.6	5.6
Temperature (deg C):	20.6	20.6
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	130	130
Upstream CBOD5 (mg/L):	8.2	8.2
Upstream NBOD (mg/L):	0.059[2]	0.059[2]
Upstream Dissolved Oxygen (mg/L):	11.32	11.32
Upstream Temperature (deg C):	12.7	16.8
Elevation (ft NGVD):	736	736
Downstream Average Channel Slope (ft/ft):	0.0066	0.0066
Downstream Average Channel Depth (ft):	0.82	0.82
Downstream Average Channel Velocity (fps):	1.45	1.45
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	39.66	39.66
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.93	0.93
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	8.4	8.4
NBOD (mg/L):	0.5	0.5
Dissolved Oxygen (mg/L):	11.1	11.1
Temperature (deg C):	12.9	16.9
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	33.54	36.86
BOD Decay (day^-1):	0.68	0.81
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	12.3	12.3
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	12.8	12.8
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L)[3]:	10.276	9.429
Initial Deficit (mg/L):	-0.87	-1.72
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.16	0.16
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	3.88	3.79
7. CRITICAL DO DEFICIT (mg/L):	0.23	0.25
8. CRITICAL DO CONCENTRATION (mg/L):	10.05	9.18

Source: Based on Ecology's DOSAG2 model.

1. CBOD5 based difference between BOD concentration (28 mg/L in effluent) and NBOD concentration
2. NBOD based multiplying ammonia concentration (2.91 mg/L in effluent and 0.013 mg/L in receiving water) by 4.57 (Ecology, 2004a).
3. The amount of DO that water can hold under natural equilibrium conditions is called the saturation value.

The exhibit indicates that changing a single receiving water input parameter could have a significant impact on results. However, neither scenario provides a good indication of the actual impact that the discharge itself has on downstream DO concentrations. The model can be used to isolate the impact that the discharge may have on the stream by setting:

- DO concentrations at the criterion of 9.5 mg/L or the saturation level[5] (based on initial mixed stream temperature and elevation), whichever is lower.
- CBOD and NBOD concentrations at zero.
- Upstream temperatures at the applicable criterion (e.g., 16°C for core summer salmonid habitat).

This "zero background" method provides estimates of whether a particular facility by itself is likely to preclude compliance with the revised DO standards, and thus is a preliminary indication of whether revised effluent limits requiring controls would be likely. A discharger may have a significant impact on downstream DO concentrations if DO concentrations decrease by more than 0.2 mg/L. Ecology uses a 0.2 mg/L threshold value in the Colville DO TMDL (Ecology, 2003a), as well as to assess the downstream impacts of human activities on waters that have DO concentrations naturally below the criterion (e.g., waters in which the saturation value is less than 9.5 mg/L) (Ecology, 2003b).

Potential Compliance Actions

Any discharge that may have a significant impact on downstream DO concentrations could require additional controls. There are a number of control options for reducing effluent the effluent parameters that affect instream DO levels, including:

- Optimizing treatment processes (e.g., modifications to secondary treatment to enhance nitrification/denitrification) to reduce the nutrient and organic pollutant loads.
- Reviewing effluent characteristics of major industrial dischargers (i.e., more stringent pretreatment requirements.)
- Implementing alternative discharge options (e.g., land application, storage ponds, change outfall location.)
- Reducing the volume of discharge by reusing effluent.
- Installing treatment technology to reduce BOD, ammonia, and nutrient loads (e.g., biological nitrogen removal, chemical precipitation.)

As for controlling temperature, facilities would first consider the feasibility of low cost control options, and only consider the more costly controls if necessary.

[5] The amount of DO that water can hold under natural equilibrium conditions is called the saturation value. This value varies with stream temperature, salinity, and elevation (or atmospheric pressure). For example, the saturation value for a stream 1,000 feet above sea level with a temperature of 16°C is approximately 9.5 mg/L. A stream is considered supersaturated if DO levels exceeded the saturation value. Therefore, if the saturation value is less than the DO criterion, achieving the criterion may not be feasible even once all point and nonpoint sources are controlled without instream DO addition (e.g., through side stream aeration or water parks).

Potential Control Costs

Impacts of revised DO criteria represent the incremental controls and costs needed to achieve reductions beyond those required for compliance with the 2003 WQS revision. For some facilities, compliance with the 2003 revisions would enable compliance with the proposed rule; for others, additional actions may be necessary.

For simplicity, the potential costs of controls for achieving the DO criteria can be estimated based on the unit costs for land application and effluent reuse shown in Exhibit 4-4 in the temperature analysis section. To determine the feasibility of land application or effluent reuse a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue.

4.2.4 Statewide Point Source Costs

The facility analyses provide a basis for estimating potential statewide compliance costs for point sources. **Appendix C** describes the method, which consists of summing the costs for major facilities, and extrapolating the results for the different samples of minor facilities to all minor facilities potentially affected by the specific criteria revisions. **Exhibit 4-7** provides the results.

Exhibit 4-7. Summary of Incremental Point Source Costs (2005$)

Facility Type	Capital Costs	O&M Costs	Annual Costs[1]
Temperature			
Major Municipal	$1,284,000	$45,000	$127,000
Minor Municipal	$523,000	$18,000 - $29,000[2]	$52,000 – $63,000[1]
Minor Industrial	$0 - $729,000[3]	$0 - $26,000[3]	$0– $72,000[2]
Temperature Total	$1,807,000 - $2,537,000	$63,000 - $100,000	$178,000 - $261,000
Dissolved Oxygen			
Major Municipal	$0	$0	$0
Minor Municipal	$0 - $579,000[4]	$0 - $20,000[4]	$0 -$57,000[4]
Minor Industrial	$0	$0	$0
Dissolved Oxygen Total	$0 - $579,000	$0 - $20,000	$0 - $57,000
Total	$1,807,000 - $3,115,000	$63,000- $120,000	$178,000 - $318,000

Note: Total may not add due to rounding.
NA = not applicable (no major industrial facilities are affected by the proposed rule).
1. Capital costs annualized using a social discount rate of 2.4 percent over 20 years, plus annual O&M costs.
2. Range represents uncertainty associated with estimated costs for McCleary STP (see Appendix A).
3. Range represents uncertainty associated with estimated costs for U.S. FWS Abernathy Fish Technology Center (see Appendix A.)
4. Range represents uncertainty associated with estimated costs for Cowlitz County – Ryderwood STP (see Appendix B).

4.3 Nonpoint Sources and Other Activities Affecting Temperature

This section describes the methods for estimating the costs likely to result from the proposed rule associated with nonpoint sources and other activities affecting temperature and DO (see Section 3), and summarizes the results.

4.3.1 Identifying Potential Temperature Controls

Ecology (2004c) recommends the following types of actions to control temperature pollution from nonpoint sources:

- Increase effective shade
- Improve riparian microclimate
- Improve streambank stability and reduce erosion
- Increase woody debris
- Reduce channel width
- Encourage future projects that increase groundwater inflows

Planting riparian tree buffers would increase effective shade because near-stream vegetation produces shadows that can reduce solar heat flux to the water surface. Riparian vegetation also creates a thermal microclimate that tends to maintain lower temperatures, higher relative humidity, and cooler ground temperatures. Riparian buffers would also help to reduce erosion and improve streambank stability, which in turn would help to maintain existing channel width. Over time, riparian buffers would tend to increase woody debris in streams as near-stream trees drop limbs due to natural causes (Ecology, 2004c). Increased riparian vegetation could also contribute to reducing channel width to some degree, although not as quickly as building up stream banks directly.

Several factors influence stream shade, including season and time, geographic position, the width, height, and density of riparian vegetation, stream width and aspect (direction of flow), and solar position (Ecology, 2004c). Thus, the maximum shade potential achievable from riparian buffers depends on buffer height, width, and density as well as other factors. Research on the relationship between buffer width and effective shade shows that 75- to 100-foot-wide buffers on either side of streams tend to result in maximum effective shade (Ecology, 2004c).

In terms of creating a beneficial microclimate, research shows that a buffer width of at least 150 feet on each side of the stream is required to maintain a natural riparian microclimate for small forest streams (channel width less than 4 meters) in the foothills of the western slope of the Cascade Mountains in western Washington (Ecology, 2004c). In the temperature modeling performed for the TMDLs summarized in Section 2, buffer widths (where the width was noted in the document) generally range from 100 to 150 feet on each side of the stream (Ecology, 2003b, 2004b, 2004c, 2005b). Buffer heights for mature vegetation generally range from 100 to 180 feet (Ecology, 2001b, 2002, 2003c, 2004b, 2005b).

In the TMDLs Ecology developed to meet existing temperature standards (Exhibit 2-3), increased effective shade is the primary nonpoint source control for reducing stream temperatures; the primary measure for nonpoint source control is riparian buffers. Thus, riparian buffers are also likely to be the primary nonpoint source measure implemented for compliance with the temperature standards of the proposed rule. Increasing groundwater inflows could be achieved by adding retention/detention basins and swales in built up areas and near roadways. However, high cost (per acre) controls such as removing existing infrastructure or altering topography (e.g., excavating detention basins) are unlikely to be pursued until all lower cost options have been exhausted.

4.3.2 Identifying Potential DO Controls

Three of the four approved TMDLs for DO in Washington include load allocations for nonpoint sources (Ecology, 2005; 2004b; 2000). These TMDLs state that the DO criteria can be achieved through reductions in stream temperatures and BOD and nutrient (e.g., nitrogen and phosphorus) loads. The TMDLs indicate that these reductions can be achieved through existing regulations and programs.

The section above describes how planting 100 foot wide riparian buffers on land adjacent to affected waters would likely reduce temperatures for compliance with the revised temperature standards. Riparian buffers not only provide shade and microclimate benefits, reducing stream temperatures, but also provide filtration and serve other functions that reduce nutrient loadings to water. Reduced loadings of nutrients and sediment (including organic matter) will result in reduced BOD, which will in turn lead to higher instream DO concentrations. Lower stream temperatures also contribute to higher DO levels, since oxygen is more soluble in lower temperature water.

Almost all phosphorus removed by buffers is adsorbed to sediment, particularly fine clay particles (Environmental Defense, 2003). Thus, buffer zones primarily reduce phosphorus (and sediment) by filtering runoff. Unlike phosphorus, nitrate is quite soluble; buffer strips primarily reduce nitrogen by uptake or denitrification (conversion of nitrate into nitrogen gas) (Wenger, 1999). There is some evidence that grass buffers more efficiently remove phosphorus from runoff than forest buffers, since grass buffers tend to provide a denser root system that more efficiently traps fine particles (Environmental Defense, 2003). However, Wenger (1999) states that both grass and forest buffers have been proven effective at reducing total phosphorus. Both grass and forest buffers are effective at reducing nitrogen as well, with some evidence indicating that riparian buffers provide more uptake and grass buffers provide more denitrification (Wenger, 1999).

Environmental Defense (2003) reports that based on available studies, the optimal buffer width (whether grass or forest) for reducing nitrogen, phosphorus, and sediment is 15 to 30 meters (50 to 100 feet) for gently sloped areas. Studies show that trapping or removal efficiency does not increase for wider buffers. Based on studies reviewed by Wenger (1999), in gently sloping areas (e.g., 0-10 percent slopes), 100-foot riparian buffers remove over 80 percent of phosphorus and nitrogen and 90 percent of sediment. Therefore, because 100 foot riparian buffers may already be needed on those streams affected by the revised temperature standards (i.e., waters upgraded from noncore rearing to core summer salmonid or char habitat), the incremental costs of achieving the revised DO criteria on those waters may be zero.

For streams not affected by the change in temperature criteria (i.e., those waters upgraded from salmonid rearing and migration only to salmonid spawning, rearing, and migration), the incremental costs of achieving the revised DO criteria would include construction of a 100 foot riparian buffer.

4.3.3 Identifying Potential Controls for Dams

Sufficient monitoring data are not available to assess the impact that each of the dams identified in Section 3 may have on downstream temperatures and DO levels. To achieve the temperature criteria on spawning waters and the DO criteria on newly designated core summer salmonid habitat, char habitat, and salmonid spawning, rearing, and migration waters, dam modifications (e.g., change location of reservoir outlet) may be necessary. The necessary control actions would depend on a number of site-specific factors such as:

- Dam size – modifications may depend on the depth of the reservoir (e.g., for large dams with deep reservoirs, the reservoir outlet could be changed to draw water from the bottom of the reservoir where water is cooler, shallow impoundments (which are not likely to stratify) are more likely to discharge higher average DO concentrations than deep impoundments that stratify
- Dam use – this may dictate the feasibility of each control action
- Existing water quality – if the stream is already impaired for another pollutant such as sediment, certain modifications may add to those impairments.
- Trophic status – eutrophic (i.e., rich in organic nutrients that promote a proliferation of plant life) impoundments are more likely to discharge high DO water during the day and low DO water at night or low DO water continually than mesotrophic (i.e., medium level of nutrients and submerged beds of aquatic plant life) or oligotrophic (i.e., lacking in nutrients and plant life) impoundments, particularly during the summer.

Specific control actions that may be used to improve discharge temperatures and DO concentrations include:

- Aerating deep areas of an impoundment that have low DO concentrations.
- Modifying the discharge structure to increase turbulence or decrease outlet temperatures.
- Changing the location of the discharge source (e.g., shallower or deeper).

The Ecology and the U.S. Army Corps of Engineers both maintain databases of dams in Washington. The information in the databases includes parameters such as dam name, owner, crest width, depth of crest to original stream bed, maximum storage capacity, average storage capacity, and material of which the dam is constructed. However, neither database indicates the trophic status of the impoundment, the discharge type, the discharge source, or other factors that allow assessment how the discharge affects downstream temperatures and DO concentrations.

Ecology does not issue permits for dams, but provides a 401 certification for Federal Energy Regulatory Commission (FERC)-issued permits for hydropower dams. The 401 certification, issued during the FERC relicensing process evaluates whether the dam would be consistent with state water quality standards (i.e., would not cause exceedances of water quality standards.) FERC licenses have terms that range from 30 to 50 years, so relicensing of individual dams is an infrequent occurrence.

Because dams may have an effect on downstream temperatures and DO concentrations, modifications may be needed for dams located on or upstream of affected waters. However, given the factors that influence which control actions should be implemented and the lack of available data, it is not possible to estimate incremental control costs for dams associated with the proposed rule. However, it is likely that controls necessary to meet the 2003 WQS revisions (i.e., baseline standards) would also result in compliance with the 2006 proposed standards.

4.3.4 Area for Riparian Buffers

The costs for implementing riparian buffers on affected waters include implementation costs that depend on the area of land planted and the unit costs of planting buffers, and any opportunity costs associated with changing land use in the buffer area. Based on modeling of potential shade from a number of temperature TMDLs, a 100-foot buffer on either side of affected waters should provide sufficient effective shading while also providing microclimate benefits (Ecology, 2003b, 2004b, 2004c, 2005b).

As for point sources, compliance with the 2003 WQS revision represents the baseline control scenario; only incremental controls and costs needed to achieve further reductions represent the impact of the proposed rule. However, as discussed in Section 1.3, water quality modeling would be needed to determine baseline temperatures after implementation of controls (including riparian buffers). An upper-bound scenario of the extent of riparian buffers that may be needed is all potentially plantable land adjacent to affected waters. However, this scenario likely overstates acreage needed and costs for compliance with the proposed rule; for example, in some reaches, the buffers that would be required to meet the 2003 revisions would be sufficient to meet these proposed 2006 standards.

There is some indication from current monitoring data that substantially less than all affected waters will need nonpoint source controls. However, because not all affected waters are monitored, and exceedances at existing stations could reflect exceedances in upstream reaches, the current data may not be a good indication of potential compliance with the rule. More detailed analysis would be needed to determine the actual extent of needed controls.

Exhibit 4-8 shows existing land cover in a 100-foot buffer on both sides in acres (Exhibits 3-8 and 3-9 show affected stream miles). Approximately 40,000 acres are plantable land (excluding forest lands) that may require riparian buffers (see **Appendix D** for land cover data by county for the waters affected by change in temperature standards). As mentioned above, buffer costs are only estimated for the waters affected by the change in DO criteria in which the use designation changes from rearing and migration only to salmonid spawning, rearing, and migration because the rest of the waters are already included in the compliance scenario for the proposed temperature criteria changes.

Exhibit 4-8. Land Cover Adjacent to Affected Waters (acres)

Land Cover	Char[1]	Core Summer Salmonid[2]	Spawning[3]	Salmonid SRM[4]	Total
Forest Land					
Deciduous Forest	1,007	26,191	13,241	0	40,440

Exhibit 4-8. Land Cover Adjacent to Affected Waters (acres)

Land Cover	Char[1]	Core Summer Salmonid[2]	Spawning[3]	Salmonid SRM[4]	Total
Evergreen Forest	21,676	52,557	32,907	12	107,152
Mixed Forest	656	24,378	13,917	0	38,952
Agriculture					
Cropland	0	2,299	1,248	40	3,587
Fallow	0	154	71	0	225
Row Crops	0	199	337	40	576
Small Grains	0	1,946	840	0	2,786
Pasture/Hay	17	6,273	3,615	10	9,915
Orchards/Vineyards/Other	0	308	868	18	1,195
Urban					
Commercial/Industrial/Transportation	17	550	737	5	1,309
High Intensity Residential	0	2	1	0	3
Low Intensity Residential	4	1,410	1,671	18	3,103
Urban/Recreational Grasses	8	33	33	0	74
Other potentially plantable land					
Grasslands/Herbaceous	681	1,927	1,599	3	4,209
Shrubland	671	5,569	4,408	26	10,673
Transitional	749	3,261	1,206	0	5,216
Unplantable					
Bare Rock/Sand/Clay	527	144	1,135	73	1,879
Emergent Herbaceous Wetlands	4	24	109	2	140
Open Water	1,137	3,573	16,697	0	21,407
Perennial Ice/Snow	11	0	0		11
Quarries/Strip Mines/Gravel Pits	1	5	15	0	21
Woody Wetlands	121	2,003	1,950	0	4,074
Total	27,287	130,507	95,357	208	253,360

1. Waters that Ecology designated for noncore or core rearing in the 2003 revision that should be designated for char habitat.
2. Waters that Ecology designated for noncore rearing in the 2003 revision that should be designated for core summer salmonid habitat.
3. Waters for which the salmonid spawning criterion applies at specific locations and times of the year.
4. Waters that Ecology designated for rearing and migration only in the 2003 revision that should be designated for salmonid spawning, rearing, and migration.

4.3.5 Unit Control Costs

The unit cost to install and maintain riparian buffers comprises costs for the following components:

- Site preparation
- Seedling planting (original and replacement planting)
- Shelters from herbivory
- Practices to reduce vegetative competition (e.g., mulch or herbicide)
- Opportunity costs of taking land out of the current use

The estimated cost of these components, and total unit costs, are discussed below.

Site Preparation Costs

Site preparation usually involves using mechanical, fire, or chemical means to remove existing vegetation that would compete with trees planted in the buffer. Sources of riparian buffer implementation costs have suggested that site preparation costs can be as low as $12 per acre for mowing and disk harrowing in agricultural settings (Palone and Todd, 1998; in 1996 dollars). However, in a model developed for small landowners to estimate the costs of reforestation projects (not only in riparian areas) in the Pacific Northwest, Rose and Jacobs (1999) use costs of $50 to $400 for site preparation by hand slashing, $60 to $175 per acre for tractor clearing, and $60 to $193 for clearing using hand-applied herbicides (all in 1999 dollars). Agricultural land may be less compacted and have less existing vegetation than other land uses such as shrubland. Thus, for agricultural lands, the costs for mowing and disk harrowing ($12/acre in 1996 dollars) and the low end of costs for tractor clearing ($60/acre in 1999 dollars) may be reasonable estimates of site preparation costs. After adjusting both costs to 2005 dollars using the U.S. Department of Agriculture (USDA) index for prices paid by farmers for all production items (USDA, 2005a), the average of these costs is $39/acre.

For areas that have more compacted ground or more existing vegetation that must be cleared for seedlings to compete effectively, site preparation may be more costly. The cost estimate for these areas reflects a unit cost based on the midpoint of the cost range for tractor scarification [$118/acre in 1999 dollars, calculated from Rose and Jacobs (1999)] and the midpoint of the range for hand clearing [$225/acre in 1999 dollars, calculated from Rose and Jacobs (1999)]. After adjusting both costs to 2005 dollars using the USDA index for prices paid by farmers for all production items (USDA, 2005a), the average site preparation cost for these land uses is $185/acre.

Seedling and Planting Costs

Costs for planting seedlings include materials and labor. **Exhibit 4-9** shows the costs for deciduous and coniferous species (all native) with moderate or rapid growth rates, tolerance or preference for moist, wet, or saturated soil, and with heights at maturity of between 160 and 300 feet (Sound Native Plants, 2003). The prices shown are from 2005-2006 price lists for two nurseries in Washington that specialize in reforestation stock (Webster Forest Nursery, 2005; Segal Ranch Hybrid Poplars, 2005). The average cost per plant (in 2005 dollars) is $0.32.

Exhibit 4-9. Tree Species and Costs Used in Riparian Buffer Cost Estimate

Species	Type	Height at Maturity (feet)	Soil Moisture Requirements	Growth Rate	Cost per seedling[1]
Sitka spruce	coniferous	200	Riparian	Moderate to rapid	$0.22
Grand fir	coniferous	260	Moist to dry	Moderate	$0.22
Black cottonwood	deciduous	160	Saturated to moist	Rapid	$0.44
Douglas fir	coniferous	200-300	Moist to dry	Moderate to rapid	$0.22
Western red cedar	coniferous	200	Wet to moist	Moderate	$0.40
Western hemlock	coniferous	200	Wet to moist	Moderate	$0.40

na = not available.
Sources: Sound Native Plants (2003), Webster Forest Nursery (2005), and Segal Ranch Hybrid Poplars (2006).

Exhibit 4-9. Tree Species and Costs Used in Riparian Buffer Cost Estimate

Species	Type	Height at Maturity (feet)	Soil Moisture Requirements	Growth Rate	Cost per seedling[1]

1. The black cottonwood price is based on purchasing over 500 9-inch cuttings; all other seedling prices are based on purchasing 1,000 seedlings. Prices for sitka spruce, grand fir, and Douglas fir reflect seedlings grown in a seedbed for two years. Prices for western red cedar and western hemlock reflect seedlings grown in a greenhouse for one year and in a nursery bed for one year.

The labor cost per seedling depends on the wage rate and how many trees, on average, can be planted in an hour. Rose and Jacobs (1999) state that an experienced planter can plant 1,100 seedlings per 8-hour day (138 per hour) in good conditions, but slower rates would likely apply for riparian areas due to more challenging planting conditions. The cost analysis is based on an assumption that the planting rate is 480 seedlings per day, or 60 per hour, which is slightly less than half the planting rate for good conditions.

The wage for tree planters is assumed to be $11.34 per hour (2004 dollars), which is the mean national wage for forest and conservation workers (including tree planters) according to the 2004 Occupation Employment Statistics survey (BLS, 2005a; Standard Occupational Classification 45-4011). Escalated using the Employment Cost Index (BLS, 2005b), this is $11.54 in 2005 dollars. Employee benefits equal about 42 percent of the base wage rate (BLS, 2005c). Thus, the fully loaded cost for tree planters would be about $16.39 per hour (2005 dollars). If seedlings are planted at a rate of 60 per hour, the average cost is $0.27 per seedling. This estimate will overstate social costs if farm workers plant the seedlings because the average national wage for farm workers is $8.23 (2004 dollars; BLS, 2005a; Standard Occupational Classification 45-2092).

The total cost per seedling, including labor and materials, is $0.59 (**Exhibit 4-10**). Based on ten-foot by ten-foot spacing between seedlings, an acre requires 436 seedlings on average. The total cost to initially plant an acre of seedlings is $257.

Iowa State University Extension (1996) indicates that approximately ten percent of trees may need to be replanted to account for losses to predation, vegetative competition, or other reasons. This rate is based on one- or two-year old transplants. Assuming ten percent of seedlings may require replacement after the first year, the total cost for initial plus replacement planting is approximately $283 per acre (2005 dollars).

Exhibit 4-10. Summary of Transplant Costs

Item	Cost
Seedling cost ($/seedling)	$0.32
Cost of planting ($/seedling)[1]	$0.27
Total cost, including materials and planting ($/seedling)	$0.59
Cost/acre, based on 436 trees/acre	$257
Cost/acre for replacement planting (10%)	$26
Total Cost/acre	**$283**

1. Unit cost equals total hourly cost of $16.39 divided by a planting rate of 60 seedlings per hour.

Shelter Costs

Installing tree shelters protects seedlings from damage that may result from browsing animals. Three sources provide estimates of the cost for shelters:

- $3.10 per tree (1999 dollars) (USDA, 1999)
- $5 per tree (1996 dollars) (Palone and Todd, 1998)
- $0.51 to $0.71 per tree (1999 dollars) (Rose and Jacobs, 1999)

All three of the above estimates include installation costs. Adjusting each cost [using the midpoint estimate from Rose and Jacobs (1999)] to 2005 dollars using the USDA index of prices paid by farmers for all production items (USDA, 2005a), results in an average cost of $3.27 per tree (2005 dollars) across the sources. Assuming 436 seedlings per acre, the cost to install shelters is $1,424 per acre. The estimates shown below reflect a 50 percent tree shelter implementation rate across all plantable acres.

Weed Control Costs

Seedlings may also need mulch, herbicide, or mowing to reduce competition from weeds. Rose and Jacobs (1999) estimate the cost for heavy paper mulch mats at $0.65 to $0.75 per tree including application (1999 dollars), which is $283 to $327 per acre assuming 436 trees per acre. Using the midpoint of this range and adjusting to 2005 dollars using the USDA index for prices paid by farmers for all production items (USDA, 2005a), results in a cost of $328 per acre.

Opportunity Costs

Finally, there may be opportunity costs associated with removing land from agricultural production or other uses. The opportunity cost would tend to vary depending on the current land use, including the type of crop planted. As shown in Exhibit 4-8, the types of agricultural land cover include:

- Pasture and hay
- Cropland (small grains, fallow land, and row crops)
- Orchards, vineyards, and similar uses

Exhibit 4-11 shows potential opportunity costs for pasture and hay, small grains, and row crops. For pasture and hay, the estimates are based on estimated revenues and costs for hay other than alfalfa. Most of the land in small grains (i.e., wheat, oats, and barley) that is adjacent to affected waters is in five counties: Columbia, Klickitat, Lewis, Walla Walla, and Yakima (see Appendix D). Within these counties, according to the 2002 Census of Agriculture, wheat comprises over 90 percent of the acreage in small grains. Thus, opportunity costs for small grains are based on estimated revenues and costs for wheat. The estimates for fallow acres also reflect these data.

Most of the land in row crops (i.e., corn and vegetables) that is adjacent to affected waters is in four counties: Lewis, Pierce, Walla Walla, and Whatcom (Appendix D). Within these counties, the main row crops are corn, potatoes, vegetables, and dry beans. Thus, the estimates for row crops reflect a weighted average of net revenues for these crops.

Exhibit 4-11. Potential Opportunity Costs for Cropland

Crop Type	Revenue ($/ac/yr)	Cost ($/ac/yr)	Net Revenue ($/ac/yr)	Notes[1]
Wheat[2]	$256	$192	$64	May be representative of small grain acres
Hay (excluding alfalfa)[3]	$361	$147	$214	May be representative of pasture/hay acres
Row crops				
Potatoes[4]	$2,798	$1,865	$933	Represent approximately 18% of row crop acres
Corn[5]	$753	$627	$126	Represent approximately 35% of row crop acres
Onions (storage)[6]	$7,833	$2,241	$5,592	May be representative of vegetables, which represent approximately 36% of row crop acres
Dry beans[7]	$431	$450	-$19	Represent approximately 11% of row crop acres

Note: All costs updated to 2005 dollars using the USDA index of prices paid by farmers and all revenues updated to 2005 dollars using the USDA index of prices received by farmers (USDA, 2005a). The USDA index of prices received by farmers shows the price index was declining or flat between 2001 and 2005. Therefore, some revenue estimates in 2005 dollars are lower than their value in an earlier year.

1. Weights used for weighted average cost for row crops are based on the percentages of acres harvested for different types of row crops within Lewis, Pierce, Walla Walla, and Whatcom Counties, from USDA (2004).
2. For wheat, revenues are based on yield of 70 bushels/acre and prices of $3.70/bushel (WASS, 2004). Costs are from a Washington State University (WSU) enterprise budget for winter wheat in Columbia County, WA (WSU, 1997), and reflect variable costs only ($169/acre in 1997 dollars).
3. For hay, revenues are based on average revenue per acre for non-alfalfa hay in 2003 (WASS, 2004). Costs are from an enterprise budget for eastern Oregon (OSU, 1995) of $123/acre in 1995 dollars.
4. For potatoes, revenues and costs represent average of processing and fresh potatoes. Processing potato revenues are based on price of $4.80/cwt (WASS, 2004) and yield of 29.5 tons/acre (WSU, 2001); costs are $1,931 in 2001 dollars (WSU, 2001). Fresh potato revenues and costs are based on price of $5.25/cwt (WASS, 2004) and yield of 27 tons/acre (WSU, 2001); costs are $1,644 in 2001 dollars (WSU, 2001).
5. For corn, revenues are based on average revenue of $763 per acre for silage corn in 2003 (WASS, 2004). Costs are from an enterprise budget for north central Oregon (OSU, 1991) of $497/acre in 1991 dollars.
6. Storage onions are the largest vegetable crop in Washington (WASS, 2004) and are used to approximate net revenues for vegetables. Revenues and costs are based on yield of 35 tons/acre (WSU, 2004) and prices of $11.33/cwt (average price for 2001 to 2003, according to WASS, 2004). WSU (2004) reports variable production costs of $2,197 in 2004 dollars.
7. Dry bean revenue and cost estimates are based on yields of 22 cwt/acre (WSU, 2002) and prices of $19.80/cwt (average price for 2003 according to WASS, 2004). Costs were $437/acre in 2002 dollars (WSU, 2002).

As Exhibit 4-11 shows, the estimated net revenue for dry beans is negative. Although agricultural land uses may sometimes result in negative net revenue, using a negative value to reflect the next best alternative use will understate opportunity cost because there is at least one better alternative – not growing a crop, which has a net revenue of zero (assuming the maintenance costs for fallow land are negligible). Recalculating the weighted average to include an opportunity cost of zero for dry beans results in a weighted average value of $2,204/acre, which can be used to estimate the annual net revenue loss associated with row crop acres that would otherwise be planted.

Orchards, groves, vineyards, and nurseries are likely already set back at least 100 feet from streams because of regulations concerning pesticide application near streams. For instance, several commonly used orchard pesticides may not be applied within 25 to 300 feet of streams

(WSDA, 2002). Thus, opportunity costs associated with streamside buffers on this land are likely minimal.

The full implementation of riparian buffers would also require planting buffers on land classified as residential, commercial, industrial, or other urban built-up land. Opportunity costs on urban land are likely zero because riparian areas are not likely to be in active commercial or industrial production, given flooding risks. Furthermore, most of the acres are in residential land use (3,106 of the 4,490 acres in urban or built-up areas, as shown in Exhibit 4-8), and trees in residential settings often provide benefits that offset potential opportunity costs of land use changes. For example, Palone and Todd (1998) report that the value of lots where buffers are present may exceed the value of lots where no buffers are present by 5 percent or more, and National Association of Home Builders Research Center and U.S. EPA (2001) state that lots and communities that contain natural vegetation resources often sell at a premium compared to developments without such resources.

Finally, Exhibit 4-8 shows some acres of land that is potentially plantable to riparian buffers, but not urban or agricultural. This land includes grasslands/herbaceous cover, shrubland, and transitional land. The opportunity cost on this land is also likely zero because the land is not likely to be intensively managed, which means the marginal productivity of the land is likely small.

Total Unit Costs for Riparian Buffers

Exhibit 4-12 summarizes the components of unit costs for riparian buffers (not including opportunity costs). Upfront costs reflect annualizing at a social discount rate of 2.4 percent. The annualization period should reflect the useful life of the asset purchased. However, the trees listed in Exhibit 4-8 may live for 80 or 100 years or more. Therefore, the estimates in Exhibit 4-11 reflect a tree buffer useful life of 80 years, although the tree buffers could remain in place indefinitely. In 2005 dollars, the estimated annual cost of implementing riparian buffers ranges from $38/acre/yr to $43/acre/yr for agricultural and nonagricultural areas, respectively.

Exhibit 4-12. Summary of Total Costs for Planting Riparian Buffers (2005$)

Component	Agricultural Land	Nonagricultural Land
Site preparation ($/acre)	$39	$185
Planting and replanting ($/acre)	$283	$283
Shelters ($/acre; 50% implementation rate)	$712	$712
Weed control ($/acre)	$328	$328
Total Upfront Costs ($/acre)	$1,363	$1,508
Total Annualized Costs ($/acre/yr)[1]	$38	$43

Detail may not sum to totals because of independent rounding.
1. Represents total upfront costs annualized at a social discount rate of 2.4 percent over 80 years.

4.3.6 Statewide Nonpoint Source Costs

The estimated buffer area (Exhibit 4-8) and unit planting cost estimates (Exhibits 4-11 and 4-12) can be combined to estimate potential Statewide costs. **Exhibit 4-13** shows the resulting costs.

Exhibit 4-13. Annual Statewide Costs for Riparian Buffers

Land Cover	Buffer Cost ($/acre/yr)	Opportunity Cost ($/acre/yr)	Temperature Costs			Dissolved Oxygen Costs[2]	Total Costs
			Noncore to Core[1]	Spawning	Noncore/ Core to Char		
Forest Land	$0	$0	$0	$0	$0	$0	$0
Cropland							
Fallow	$38	$64	$16,000	$7,000	$0	$0	$23,000
Row Crops	$38	$2,204	$446,000	$755,000	$400	$89,500	$1,291,000
Small Grains	$38	$64	$198,000	$86,000	$0	$0	$284,000
Pasture/Hay	$38	$214	$1,581,000	$911,000	$4,000	$2,400	$2,498,000
Orchards/Vineyards	$38	$0	$12,000	$33,000	$0	$700	$45,700
Urban	$43	$0	$86,000	$105,000	$1,000	$1,600	$193,600
Other plantable land	$43	$0	$462,000	$310,000	$90,000	$3,200	$865,200
Unplantable	$0	$0	$0	$0	$0	$0	$0
Total	n/a	n/a	$2,801,000	$2,207,000	$95,400	$97,400	$5,201,000

Note: Totals may not add due to rounding.
1. Core = core summer salmonid habitat
2. Represents costs for those waters formerly designated for rearing and migration only that are now designated for salmonid spawning, rearing, and migration.

Thus, annual costs are $2.8 million for newly designated core summer salmonid habitat waters, $2.2 million for newly designated spawning waters, $0.1 million for newly designated char waters, and $0.1 million for newly designated salmonid spawning, rearing, and migration waters (i.e., those waters affected only by the change in DO criteria), with a total cost of approximately $5.2 million. However, applying riparian buffers to all potentially plantable land adjacent to affected waters likely overstates potential compliance costs associated with the proposed rule. Not all waters affected by the rule may require buffers; some waters may already be achieving the proposed standards. In addition, buffers may be needed to achieve compliance with the 2003 WQS revision, and thus would not represent an incremental cost of the proposed standards.

4.4 Summary of Estimated Costs

Exhibit 4-14 summarizes the total potential incremental annual costs associated with the proposed rule.

Exhibit 4-14. Potential Incremental Annual Statewide Costs ($2005)

Category	Annual Costs
Point Sources[1]	$318,000
Nonpoint Sources[2]	$5,201,000
Total	$5,519,000

1. High end of estimated cost range.
2. Upper bound scenario of planting riparian buffers on all plantable lands adjacent to affected waters (excluding forest lands).

Exhibit 4-15 summarizes the limitations of the analysis.

Exhibit 4-15. Limitations of the Cost Analysis

Limitation/Assumption	Potential Impact on Costs	Comment
Point Source Costs		
Point source compliance cost based on the maximum daily effluent temperature where daily effluent data are not available.	+	The criteria are 7-DADM temperatures. In general, the maximum daily temperature is about 1°C higher than the 7-DADM temperature. Thus, the reductions needed may be overestimated.
If no effluent temperature data are available, costs are based on assumption of no reasonable potential to cause an exceedance of the proposed standards.	-	Effluent temperature data could reveal that a facility is likely to cause an increase in temperature at the edge of the mixing above the proposed criteria.
Estimates for 5 of 24 sample facilities reflect temperature control through land application of effluent.	?	To determine the feasibility of land application or effluent reuse a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Other feasible options may be more or less costly.
Nonpoint Source Costs		
Costs based on planting trees on all plantable nonforest land.	+	Land adjacent to streams may already contain riparian buffers, or there may be existing requirements (generally through Shoreline Management Plans) for agricultural operations to have riparian buffers. In addition, the affected stream may already be in compliance with the proposed standards.
Baseline nonpoint source controls (i.e., controls needed for compliance with the 2003 revisions) not estimated.	+	Buffers needed for compliance with the 2003 WQS revision may also enable compliance with the proposed rule in some reaches.
Costs for agricultural sector include opportunity costs of all buffer acres.	+	Although the GIS analysis may identify the land use adjacent to a stream as cropland or pasture/hay, some land within 100 feet of the stream may not be planted and, therefore, no opportunity cost would occur.
Nonpoint source costs based on constant unit BMP costs (including foregone net revenue).	?	Actual BMP costs and foregone revenue per acre may vary from site to site.
Nonpoint source costs based on 100-foot wide riparian buffers.	?	In some sites, wider or narrower buffers may be needed for compliance with the proposed standards.
Coarse resolution of vegetation and land cover data may result in misclassifications of land use.	?	The actual riparian land cover may differ from the dominant land cover of the pixel.
Vegetation and land cover may have changed since the date of the data collection.	?	Changes in land cover since the data collection date may have increased or decreased the amount of land that is currently in land cover types for which buffers would (e.g., agriculture) or would not (e.g., forest) be needed.

Key: + = Costs are potentially overstated.
- = Costs are potentially understated.
? = Effect on costs is unknown.

5. Incremental Benefits

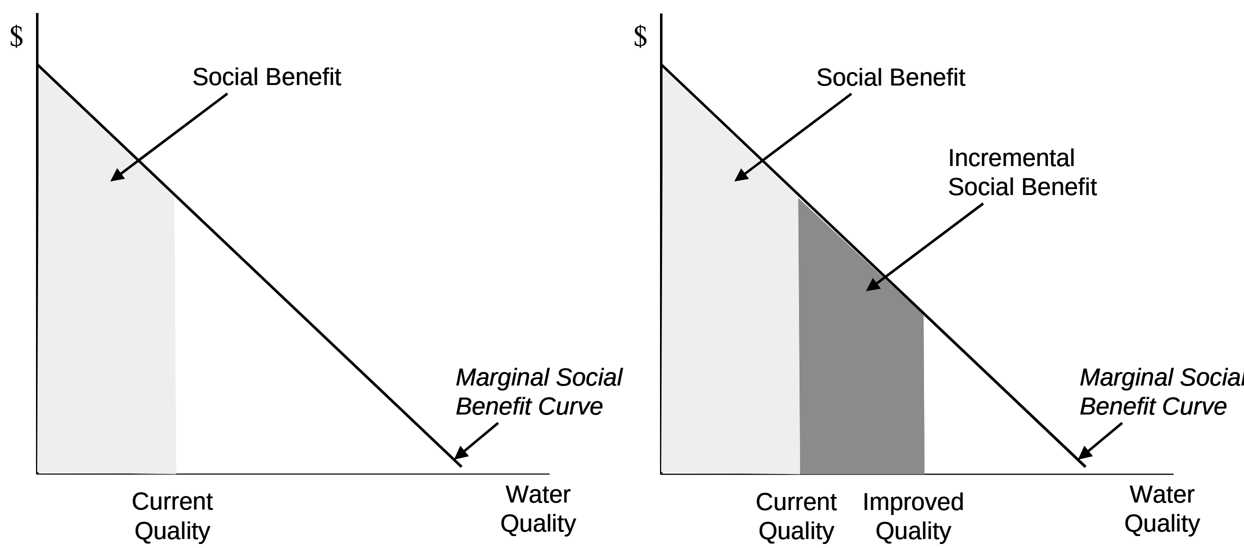
This section provides a brief overview of environmental benefits, describes literature providing estimates of the value to Washington State residents of programs designed to improve fish populations, and discusses the implications of this research for the potential benefits of the proposed rule.

5.1 Overview of Benefits Analysis

A social benefit-cost analysis is not the same as a financial analysis. Many types of benefits are never identified or valued in a purely financial analysis, and conversely, several types of financial impacts commonly generated by environmental projects may not be true social benefits included in a benefit-cost analysis. Therefore, before examining valuation methods, it is crucial to first understand how social benefits are defined in the context of environmental projects.

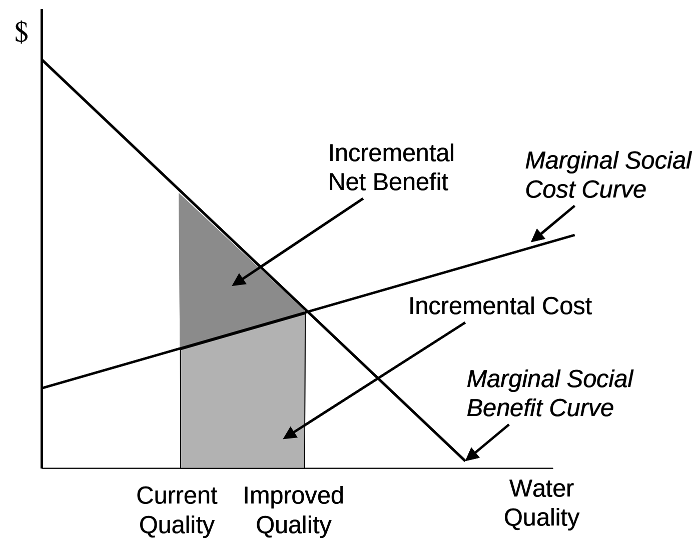
Social benefits refer to the total value of the goods, services, or amenities associated with a particular level of water quality in Washington streams. The graphs in **Exhibit 5-1** illustrate this concept of total value. The exhibits contain a downward sloping marginal social benefit curve, which is similar to the demand curve for a market good. This curve represents the maximum amount that society would be willing to pay for each additional increment of water quality; willingness-to-pay (WTP) theoretically declines as water quality improves. The total social benefit for the current level of water quality equals the area under the marginal benefit curve up to this level (see graph on left in Exhibit 5-1). When a policy improves water quality, then the incremental social benefit of the policy equals the increase in total social benefit between current water quality and improved water quality (see graph on right in Exhibit 5-1). This incremental benefit can be measured as the willingness-to-pay across all households for improved water quality.

Exhibit 5-1. Social Benefit and Incremental Social Benefit Illustrations



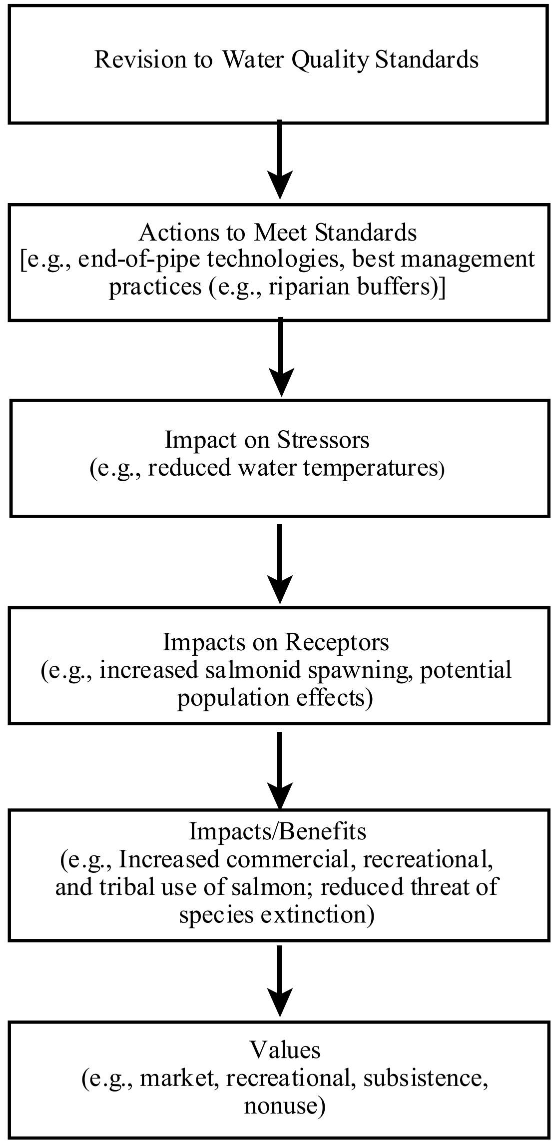
The incremental **net** benefits of a policy equal the incremental benefits minus the incremental social costs. The graph in **Exhibit 5-2** includes a social cost curve, which represents the value of the goods and services foregone to improve water quality. It does not include costs that are not opportunity costs, such as transfer payments, because no real resource costs are incurred.

Exhibit 5-2. Incremental Social Benefit Illustration



A benefits analysis seeks to estimate the total incremental value of changes in water quality. The analysis requires several steps to link the policy with incremental benefits or changes in the goods and services that society values. **Exhibit 5-3** shows these steps as a series of events potentially resulting from the incremental temperature policy to changes in water quality that ultimately lead to social benefits. Ideally, all of these benefits would be quantified and valued, but some may not be quantifiable or amenable to a dollar value.

Exhibit 5-3. Steps in Identifying and Valuing Environmental Benefits



5.2 Potential Incremental Benefits

Actions such as installing riparian buffers to reduce water temperature will have a variety of impacts on state waters. Achieving the primary goal of temperature reduction will improve fishery habitat, with favorable impacts on population growth in the target species. Greater fish stocks could enhance the human use of aquatic resources (e.g., improve commercial fishing catches, enhance recreational fishing opportunities, and restore cultural uses). There are incremental benefits associated with these types of impacts. Population recovery among depleted or at-risk fish stocks may also provide passive use (or “nonuse”) benefits that arise from a range of motives such as a desire to protect and preserve fish species for future generations.

There may also be ancillary water quality and habitat restoration benefits of the actions taken to reduce stream temperatures (e.g., installing or preserving riparian buffers) such as reducing sediment and other contaminant loadings, increasing woody debris in streams (which increases instream habitat diversity), and reducing streambank erosion (which maintains stream width). These improvements may also contribute to salmon restoration and preservation efforts.

Finally, there may be ancillary benefits that are not related to reducing stream temperatures. For example, riparian buffers may have aesthetic benefits that improve land values, especially in suburban and urban areas. These areas can also provide habitat for nonaquatic species.

5.3 Benefits of Programs to Improve Fish Populations

Existing survey research for the State of Washington provides estimates of the value of programs to improve fish populations. Layton et al. (1999) used stated preference data from a 1998 survey of Washington State residents to estimate the value of changes in five Washington State fish populations:

- Eastern Washington and Columbia River freshwater fish
- Eastern Washington and Columbia River migratory fish
- Western Washington and Puget Sound freshwater fish
- Western Washington and Puget Sound migratory fish
- Western Washington and Puget Sound saltwater fish.

In general, stated preference data come from surveys that use hypothetical policy scenarios to obtain willingness to pay information that cannot be observed otherwise. The valuation survey used by Layton et al. (1999) asked respondents to evaluate program options to improve future fish populations throughout the state. The first option represented the status quo with no additional programs and no incremental future cost to households. Depending on the survey version, this option had either fishery populations that would remain stable over the next 20 years (the "high status quo" survey version), or populations that would gradually decline in the future (the "low status quo" survey version) (see **Exhibit 5-4**).

Exhibit 5-4. Fish Population Trends Used in the Survey (millions)

Fish Type	Population 20 years ago	Population Today	Population in 20 Years with No New Programs (High Status Quo)[1]	Population in 20 years with No New Programs (Low Status Quo)[2]
Eastern Washington/Columbia				
Freshwater	192	120	120	75
Migratory	8	2	2	0.5
Western Washington/Puget Sound				
Freshwater	93	70	70	53
Migratory	10	5	5	2.5
Saltwater	860	215	215	54

Source: Layton et al. (1999).

1. Assumes stable fish populations over the next 20 years. Half of the survey recipients saw this status quo scenario.

2. Assumes declining fish populations over the next 20 years. The percentage of decline equals the percentage decline between the historical and current estimates. For example, the Columbia/Eastern Freshwater fish population declined by 38 percent over the past 20 years, and will decline by 38 percent in the next 20 years. Half of the survey recipients saw this status quo scenario.

The survey also contains descriptions of four optional fishery recovery programs, each with an associated monthly cost to Washington households and recovery rates over the next 20 years for each of the five fisheries.[6] Survey respondents rated each of the four fishery program options on a scale of –5 (much worse than the status quo option) to +5 (much better than the status quo option.) The program costs correspond to values in earlier survey questions that required each respondent to consider how her or his household's spending would change if household income were reduced by comparable amounts. This survey feature sought to make the cost impact of the programs less hypothetical.

Of the 2,819 randomly selected households in 1998 that received the survey, titled "The Future of Washington State Fish: What is Your Opinion?," 1,917 returned the survey (68 percent response rate). Following review of the responses, 1,611 of the surveys provided complete and useable data for the program ratings.

Using statistical analysis, the authors estimated valuation functions for the two status quo scenarios. These functions provide estimates of current average per-household WTP for any recovery rate for each of the five fisheries over the next 20 years as long as the rate is within the ranges used in the survey. As an example, the authors illustrate the WTP results for a 50 percent increase in each population. **Exhibit 5-5** provides these results. The WTP estimates are larger for the low status quo scenario, and for the two migratory fish populations. The authors state that the estimates represent a total value (use and nonuse value).[7]

Exhibit 5-5. Average WTP for a 50 percent Increase in Fish Type (1998$)

Fish Type	High Status Quo[1]		Low Status Quo[2]	
	WTP for 50% Increase[3]	Increase in Fish (millions)	WTP for 50% Increase[3]	Increase in Fish (millions)
Columbia/Eastern Freshwater	$14.27	60	$14.55	37.5
Columbia/Eastern Migratory	$9.92	1	$18.97	0.25
Puget Sound/Western Freshwater	$15.52	35	$28.84	26.5
Puget Sound/Western Migratory	$20.83	2.5	$28.63	1.25
Puget Sound/Western Saltwater	$21.07	107.5	$31.28	27

[6] The set of nonzero programs costs ($/month for 20 years) were: $4, $8, $12, $25, $45, and $75. Population increases were:
- Eastern Washington/Columbia freshwater: 0%, 5%, 15%, 33%, and 60%
- Eastern Washington/Columbia migratory: 0%, 5%, 10%, 33%, 80%, and 150%
- Western Washington/Puget Sound freshwater: 0%, 5%, 15%, 33%, and 50%
- Western Washington/Puget Sound migratory: 0%, 5%, 15%, 33%, 60%, and 100%
- Western Washington/Puget Sound saltwater: 0%, 5%, 15%, 33%, 60%, and 100%.

There are over 32,000 possible combinations of the population growth rates and household costs. From these, the authors generated 35 survey versions each with four combinations or programs for each of status quo scenarios, being careful to avoid versions with strictly superior programs (i.e., offering the same or higher population growth rates for less cost than another program).

[7] WTP values for different percentage changes are based on the valuation function:
WTP = [A x – ln(fish %)] / B, where A is the estimated parameter value for one of the five fish types, and B is the estimated parameter on the program cost variable. Under the high status quo scenario, the value for B is –0.0266, and the values for A are: Columbia/Eastern freshwater, 0.0969; Columbia/Eastern migratory, 0.0673; Puget Sound/Western freshwater, 0.1051; Puget Sound/Western migratory, 0.1416; and Puget Sound/Western saltwater, 0.1428. All of the parameter estimates have t-statistic values above 4.7 and, therefore, are statistically significant.

Exhibit 5-5. Average WTP for a 50 percent Increase in Fish Type (1998$)

Fish Type	High Status Quo[1]		Low Status Quo[2]	
	WTP for 50% Increase[3]	Increase in Fish (millions)	WTP for 50% Increase[3]	Increase in Fish (millions)

Source: Layton et al. (1999).
1. Respondents were told that, in the absence of any new programs, future fish populations would remain stable over the next 20 years (no more declines).
2. Respondents were told that, in the absence of any new programs, future fish populations would continue to decline over the next 20 years at the same rate that they declined during the previous 20 years.
3. Average monthly WTP per household.

The number of Washington households in 2004 is 2.4 million, based on the total population estimate of 6.06 million and an average household size of 2.51 (U.S. Census Bureau, 2005, 2004 American Community Survey, http://factfinder.census.gov/). Thus, the total statewide annual WTP for programs that would increase Eastern Washington, Columbia River, Western Washington, and Puget Sound migratory fish populations by 50 percent over the next 20 years is $886 million under the high status quo scenario [2.4 million x ($9.92 + $20.83) x 12 months/year]. Under the low status quo scenario, the total WTP is $1.37 billion [2.4 million x ($18.97 + $28.63) x 12 months/year]. Both of these estimates are in 1998 dollars; adjusted to 2005 dollars the values are $1.05 billion and $1.62 billion, respectively (updated using the Consumer Price Index). These values are for Washington State households only; it is likely that other households in the Pacific Northwest and across the United States also value increased fish populations in the state of Washington.

Surveys that implement a stated preference approach to obtain valuation estimates need to be carefully designed, administered, and evaluated to ensure that the results are valid estimates. The basis for claiming validity remains somewhat subjective and continues to evolve, but one benchmark of survey quality was established by a panel of economists convened to assist the National Oceanic and Atmospheric Administration (NOAA) in its effort to develop analytical procedures for assessing the damages caused by natural resource injuries. Although the panel was concerned primarily with identifying the survey standards necessary to establish a rebuttable presumption in litigation, many of their guidelines (58 FR 4601, January 15, 1993) can be used as benchmarks to evaluate survey quality in the context of policy analysis. **Exhibit 5-6** lists the guidelines and provides information regarding how the Layton et al. (1999) survey compares. The survey conforms to most of the recommended guidelines, the primary exception is that the survey was mailed rather than conducted in person, which adversely affected the response rate and raises the question of whether the values of the respondent group are representative of the values for all survey recipients. The authors do not address this issue in Layton et al. (1999).

Exhibit 5-6. Comparison of Surveys with NOAA Panel Guidelines

Guideline	Layton et al. (1999)
Use personal interview (face-to-face or telephone)	No (mail survey)
Pretest for interviewer effects and survey instrument	Yes - pretested survey with four professionally conducted focus groups
Use willingness to pay elicitation format instead of willingness to accept payment	Yes
Use referendum elicitation format	Used contingent ranking, which avoids many of the same bias problems as the referendum format

Exhibit 5-6. Comparison of Surveys with NOAA Panel Guidelines

Guideline	Layton et al. (1999)
Provide accurate description of good or service	Yes - specified increases in fish populations
Provide reminder of substitute goods or services	Yes - asked households how spending would change if income were reduced by amount equal to the cost of the programs
Provide "no answer" options	No - respondent must give an opinion (rank the programs)
Use follow-up questions to obtain information on respondents= attitudes and characteristics	Not specified in WTP paper
Use a probability sample of sufficient size	Yes - 1,611 usable responses
Minimize nonresponse	Survey response rate is 68%

5.4 Potential Benefits of the Proposed Rule

The Washington Governor's Salmon Recovery Office developed draft recovery plans to restore viable and sustainable populations of salmon, steelhead, and other at risk species (http://www.governor.wa.gov/gsro/regions/recovery.htm). These plans identify recovery actions needed within four sectors: harvest, hatcheries, hydropower, and habitat. The implication is that many programs are needed to achieve the level of population improvements among migratory and freshwater salmonids contemplated by the valuation survey results. Reducing ambient temperatures to levels protective of spawning, rearing, and migration is a necessary program, but temperature reductions alone will not achieve target population increases.

Nevertheless, Ecology's analysis of the potential effect of the 2003 WQS revision on summer spawning populations suggests that temperature reduction can have some independent impact on success rates throughout the spawning process. For example, colder temperatures reduce prespawning egg losses and incubation losses (Ecology, 2003a, Appendix C). A quantitative analysis of these types of incremental population impacts of the proposed rule would involve a complex analysis of temperature impacts on population with substantial uncertainties that could render even a simple bounding analysis meaningless. However, a "break-even" analysis can be used to answer the question of how big the population impact would need to be for benefits to at least equal costs.

Break-even analysis identifies the minimum, per-household WTP values needed to generate benefits that at least equal costs (i.e., $5.5 million annually). Given 2.4 million households in 2004, the average annual WTP per household for all fishery impacts attributable to the proposed temperature changes needs to be at least $2.29 ($5.5 / 2.4). WTP values from Layton et al. (1999) provide the link between household WTP values and fish population increases. A key assumption is that the survey options pertain to fish recovery rates over a 20-year period. It is possible that the full impact of riparian buffers on stream temperatures will take longer than 20 years. Whether the survey respondents would value a longer recovery period the same is uncertain.

The paper by Layton et al. (1999) provides valuation functions to estimate average household WTP for any percentage increase in fish populations for each of the five types of fisheries (within the ranges included in the survey options). **Appendix E** provides the valuation functions and WTP estimates in 1998 dollars. **Exhibit 5-7** shows estimated household WTP values in 2005 dollars for percentage increases that range from 0.4 percent to 5 percent for the fisheries in

Layton et al. (1999) that are likely to benefit from the proposed temperature standards (all but the saltwater fishery, to which the standards don't apply): Eastern Washington/Columbia migratory fish, Eastern Washington/Columbia freshwater fish (which may include landlocked salmonids), Western Washington/Puget Sound freshwater fish, and Western Washington/Puget Sound migratory fish.

The WTP values are additive across the fisheries. The average WTP per household for these four fisheries is $2.30 for a 0.39 percent population increase (based on the "high" status quo scenario, which results in a lower or more conservative estimate of benefits than the WTP values based on the "low" status quo scenario). Therefore, the minimum value of $2.29 per household can be attained if the proposed standards result in fishery population increases of about 0.39 percent in each of the four regions within the next 20 years. Slightly higher increases are needed if only some of the fish populations benefit (e.g., benefits will also exceed costs with 0.77 percent increases in each of the two migratory fisheries only.)

Consequently, the benefits of the proposed temperature standards will exceed the costs for relatively small fish population increases.

Exhibit 5-7. Household Willingness to Pay Values by Region ($2005)

Percent Change in Fish Population	Eastern Washington/Columbia Freshwater	Eastern Washington/Columbia Migratory	Western Washington/Puget Sound Freshwater	Western Washington/Puget Sound Migratory
0.30	$0.42	$0.29	$0.45	$0.61
0.35	$0.49	$0.34	$0.53	$0.71
0.39	$0.54	$0.38	$0.59	$0.79
0.40	$0.56	$0.39	$0.60	$0.81
0.45	$0.63	$0.43	$0.68	$0.91
0.50	$0.69	$0.48	$0.75	$1.02
0.75	$1.04	$0.72	$1.13	$1.52
1.00	$1.39	$0.97	$1.51	$2.03
1.10	$1.53	$1.06	$1.66	$2.23
1.30	$1.81	$1.25	$1.96	$2.64
1.50	$2.08	$1.45	$2.26	$3.05
1.70	$2.36	$1.64	$2.56	$3.45
1.90	$2.64	$1.83	$2.86	$3.86
2.00	$2.78	$1.93	$3.01	$4.06
3.00	$4.17	$2.90	$4.52	$6.09
4.00	$5.56	$3.86	$6.03	$8.12
5.00	$6.95	$4.83	$7.54	$10.16

Source: Based on Layton et al.'s (1999) results for the high status quo scenario, updated from 1998 to 2005 dollars using the Consumer Price Index (index value of 1.19).

This break-even recovery estimate is applicable for a baseline of no new fishery programs. The revised Washington Forest Practices Rules Implementing the Forests and Fish Report, however, will affect the baseline to the extent that riparian buffer activities lead to fish population growth. The cost-benefit analysis for the revised Forest Practices Rules does not report an estimate of the potential fishery impacts; the benefit analysis is based on a break-even approach. Given the magnitude of costs reported for that analysis, the conclusion was that "the breakeven point for benefit equating cost is likely to be associated with the first 5 percent increment in fish population. Any smaller increase in fish population would reduce the probable benefits to below probable costs" (Perez-Garcia, 2001).

Although this conclusion does not establish a five percent baseline for any subsequent programs, if all fishery population increases between zero percent and five percent are attributable to the revised Forest Practices Rules, then the incremental benefits of the proposed 2006 temperature revisions must be based on WTP differentials above a baseline increase of five percent. **Exhibit 5-8** shows incremental WTP for population increases greater than five percent. Appendix D explains the method for calculating incremental WTP above a nonzero baseline.

These incremental WTP values indicate that a breakeven population increase for the proposed 2006 temperature revisions occurs when the total population increase is about 5.67 percent. Thus, by accomplishing as little as two-thirds of one additional percentage point increase above a baseline of five percent population growth, the benefits could exceed the costs of the proposed temperature rule.

Exhibit 5-8. Incremental Household Willingness to Pay Values Above a Hypothetical Baseline of a 5 percent Population Increase ($2005)

Percent Change in Fish Population	Eastern Washington/Columbia Freshwater	Eastern Washington/Columbia Migratory	Western Washington/Puget Sound Freshwater	Western Washington/Puget Sound Migratory
5.00	$0.00	$0.00	$0.00	$0.00
5.50	$0.41	$0.29	$0.45	$0.60
5.67	$0.54	$0.38	$0.59	$0.79
5.75	$0.60	$0.42	$0.65	$0.88
6.00	$0.79	$0.55	$0.85	$1.15
7.00	$1.45	$1.01	$1.58	$2.12
8.00	$2.03	$1.41	$2.20	$2.97
9.00	$2.54	$1.76	$2.75	$3.71
10.00	$2.99	$2.08	$3.25	$4.37

Source: Based on Layton et al.'s (1999) results for the high status quo scenario, updated from 1998 to 2005 dollars using the Consumer Price Index (index value of 1.19).

A break-even approach does not have the same types of uncertainty that a built-up benefit approach with several computations and assumptions might have. Nevertheless, there are some uncertainties regarding the approach and the WTP values worth noting (**Exhibit 5-9**).

Exhibit 5-9. Limitations of the Benefit Analysis

Limitation/Assumption	Potential Impact on Benefits	Comment
Break-even approach considers WTP only for fish population increases and only among Washington State residents.	-	Cooler instream temperatures may have a variety of ecosystem benefits. Riparian buffers may have aesthetic and property value benefits. Residents in other States may also value increases in fish populations.

Exhibit 5-9. Limitations of the Benefit Analysis

Limitation/Assumption	Potential Impact on Benefits	Comment
WTP values reflect fishery impacts over 20 years while the full effect of riparian buffers will likely take longer.	?	Household WTP values for fish population recovery over a longer time period may differ from the study values.
Survey respondents for mail survey with a 68% response rate may not be representative of all survey recipients.	?	Survey respondents may have WTP values that are higher, lower, or the same as all survey recipients.
Household WTP values based on survey data and stated preference information.	?	Survey-based values may have one or more sources or error such as response bias, hypothetical bias, anchoring, and respondent fatigue.
Break-even approach does not provide a benefit estimate or range.	?	The potential magnitude of benefits is unknown. This approach only generates fish population increase thresholds that are small enough to result in plausible benefits that exceed costs.

Key: + = Breakeven analysis overstates benefits.
- = Breakeven analysis excludes benefits.
? = Effect on breakeven analysis result is unknown.

6. Comparison of Costs and Benefits

Exhibit 6-1 summarizes the potential costs and benefits of the proposed rule. Not estimated are potential costs for controls for dams. However, it is unclear whether such impacts will occur because compliance with the 2003 WQS revisions could result in compliance with the proposed rule as well. Also not estimated are potential ancillary benefits associated with installing riparian buffers in developed areas (e.g., aesthetic and property value benefits).

Exhibit 6-1. Comparison of Costs and Benefits

Component	Estimate
Estimated Annual Costs (2005$)	
Point Sources[1]	$318,000
Nonpoint Sources[2]	$5,201,000
Total	$5,519 ,000
Percent Increase in Annual Fish Populations for Benefits to Equal Costs[3]	0.4%

1. High end of estimated cost range.
2. Upper bound scenario of planting riparian buffers on all plantable lands adjacent to affected waters (excluding forest lands).
3. Calculated using WTP estimates from Layton et al. (1999), updated to 2005 dollars.

The largest uncertainties in the analysis relate to the potential magnitude of costs for nonpoint sources, and the impact on the breakeven analysis of salmonid recovery periods that exceed the 20-year period used in the valuation survey. Some portion of the estimated riparian buffer costs may be incurred for compliance with the 2003 revisions; these costs would not be attributable to the proposed rule. In addition, some of the streams reflected in the buffer cost estimate may already be in compliance with the proposed rule. In comparison, because standards may not be achieved for more than 20 years, the benefits estimates from the 1999 survey may not accurately reflect the value of the proposed standards. Household WTP values for fish population recovery over a longer time period may differ from the study values.

7. Small Business Impact

This section provides a brief description of the requirements for small businesses to comply with the proposed rule, analyzes the costs of compliance for businesses, and evaluates the potential impact of these costs.

7.1 Overview of Impact Analysis

Section 4 describes the role of a cost-benefit analysis in evaluating economic efficiency, and the method used to estimate social costs. In contrast, a small business economic impact analysis is a distributional analysis. Distributional analyses provide information about the economic impacts of a selected option (who gains and who loses, and by how much), and how those impacts might differ throughout the affected area. Distributional analyses include economic impact analysis, and a variety of equity analyses; equity analyses evaluate the impacts on particular subpopulations, such as small businesses. U.S. EPA (2000) describes various methods of distributional analysis.

Washington administrative procedures (RCW 19.85.040) specify a particular comparison of business impacts -- cost of compliance for small businesses to the cost of compliance for the ten percent of businesses that are the largest businesses required to comply with the proposed rules using one or more of the following as a basis for comparison: cost per employee; cost per labor hour; cost per one hundred dollars of sales.

Private Costs

An economic impact analysis, such as the small business impact analysis, involves evaluation of the private or "out-of-pocket" costs of the regulation. The private or out-of-pocket costs for new pollution control measures will most likely equal the social or opportunity costs of these actions. However, not all private costs represent social costs (a real resource allocation that has an opportunity cost). For example, a transfer payment such as a tax is a private cost that is not a social cost. A tax merely transfers money from one entity to another, but does not represent an opportunity cost of real resources such as the labor and materials used to implement treatment controls. Similarly, there are social costs that do not have corresponding out-of-pocket expenses and, therefore, are not included in private cost estimates. For example, buffer costs that are offset by funding from a cost-sharing program do not represent incremental expenses to the farmer, and are not included in evaluating impacts on small farm businesses.

Thus, in addition to the incremental control costs estimated in the cost-benefit analysis for the potentially affected source sectors, any private costs (e.g., taxes) that these entities experience are relevant in an impact analysis. The rule does not subject businesses to any new taxes or fees. However, since private entities can deduct the cost of pollution control equipment from income as a cost of business, private compliance costs may be lower than the estimated social costs.[8]

[8] Also true for farms, as farms can generally include expenses for conservation practices that are consistent with a farm plan or USDA area conservation plan (Durst and Monke, 2001). Farm households that file individual tax forms (i.e., as sole proprietors) can also deduct losses from the farm operation (including approved conservation expenses) from nonfarm income for the purpose of calculating taxes owed (Durst, 2005).

For agricultural producers, there may also be reductions in property taxes paid on land used for buffers rather than production (Ecology, 2003). To the extent that such assessed property value reductions occur, the result is a shift in tax burden to other property owners.

Another key difference between social and private costs is the effect of state and federal grant and loan programs that reduce the private or out-of-pocket costs for conservation measures such as riparian buffers or pollution control equipment. These programs typically offer financial and technical assistance in the form of grants or low-interest loans to install or implement structural or managerial practices to reduce pollution. For example, Ecology provides grants and low-interest loans to certain public and private entities through the Centennial Clean Water Fund, State Water Pollution Control Revolving Loan Fund, and Section 319 Nonpoint Source Fund (Ecology, 2005). Under this program, for instance, a local sewer district could use a low interest loan to pay capital costs for a treatment plant upgrade, with the effect of reducing debt repayment costs, and therefore, costs that could be passed through to local small businesses.

7.2 Industrial Sector Impacts

Analysis of the potential costs of the proposed rule indicates that minor industrial facilities may require incremental controls. However, only 1 out of 20 minor industrial facilities with individual NPDES permits located on waters affected by the proposed rule is considered a small business (i.e., an entity that is owned and operated independently from all other businesses, and has fifty or fewer employees): Brooks Manufacturing (WA0030805). This facility is not in the sample of point source facilities.

Reporting and recordkeeping requirements for this facility would not likely increase beyond what is already required for holders of individual NPDES permits. The permit for Brooks Manufacturing indicates that the facility may only discharge storm water. In addition, the permit does not mention temperature, DO, BOD, nitrogen, or phosphorus, which suggests that the facility is not likely to incur control costs. Therefore, there are not likely to be disproportionate impacts on small industrial dischargers.

It is also unlikely that the proposed rule will result in an impact on general permitted facilities. Currently, general permits do not include temperature or DO limits. However, if general permitted facilities receive individual permits with requirements for temperature or DO in the future, the potential compliance cost could be disproportionate in terms of cost per employee or cost per $100 of sales compared to compliance costs for the largest affected businesses.

7.3 Municipal Sector Impacts

Analysis of the potential cost of the proposed rule indicates that, municipal wastewater facilities are likely to incur control costs associated with the proposed rule. Municipal facilities are not small businesses. However, they could pass their control costs onto consumers (e.g., households and indirect commercial and industrial dischargers) through rate increases. Although it is not possible to predict which dischargers to each facility would be affected and by how much, potential rate increases could represent a disproportionate cost per employee or cost per $100 of sales for small businesses compared to the largest businesses.

7.4 Agricultural Sector Impacts

The cost to farmers of installing riparian buffers that may be necessary for compliance with the proposed rule is equal to the installation cost minus any cost share plus any reduction in net revenues minus any land rental payments (i.e., government payments for taking land out of production). Several programs provide grants or low-interest loans for agricultural BMPs including riparian buffers (**Exhibit 7-1**). As the exhibit shows, in some cases agricultural operators may be able to receive grants for a majority of installation costs for forest buffers (75 percent, 87.5 percent, or 90 percent of costs, depending on the program and the farmer's circumstances), in addition to receiving incentive and maintenance payments (under CREP). In other cases, operators may be able to receive low-interest loans.

Exhibit 7-1. Example Federal and State Grant and Loan Programs for Agricultural BMPs

Program	Description	Applicability to Small Operators
Environmental Quality Incentives Program (EQIP)	• Federal program with funding priorities established by local committees and reflective of local environmental goals • Cost-share grants for a portion of the costs of certain conservation practices • Incentive payments for up to three years (USDA, 2005a)	• Limited-resource producers can receive a greater proportion of cost-share funding (90% of eligible costs); other operators can receive 75% of eligible costs • A given operator may receive at most $450,000 in one year (USDA, 2005a), which means small operators could receive proportionally more funds compared to other business costs
Conservation Reserve Enhancement Program (CREP)	• Joint Federal and State program • Offers cost-share grants and incentives to encourage farmers and ranchers to enroll in contracts of 10 to 15 years duration to remove lands from agricultural production (USDA, 1998) • In Washington, funds include $250 million for riparian forest buffers; primary goals include reducing water temperature, reducing sediment pollution from agricultural lands, stabilizing stream banks along critical salmon streams, and restoring stream hydraulic and geomorphic conditions • Offers grants for up to 87.5% of installation costs, plus one-time incentive and annual maintenance and land rental payments (payments for taking land out of production)	• Funds appear to be equally available to small and large producers
Conservation Security Program	• Administered by USDA's Natural Resources Conservation Service • Supports ongoing stewardship of private agricultural lands by providing payments for maintaining and enhancing natural resources • Only applicable to one watershed in Washington (USDA, 2006) • Payments determined by tier of participation, conservation treatments completed, and acres enrolled: Tier I contracts are 5 years with maximum	• Provides equitable access to benefits to all producers, regardless of size of operation, crops produced, or geographic location

Exhibit 7-1. Example Federal and State Grant and Loan Programs for Agricultural BMPs

Program	Description	Applicability to Small Operators
	payment of $20,000/year; Tier II contracts are 5 to 10 years with maximum payment of $35,000/year; Tier III contracts are 5 to 10 years with maximum payment of $45,000/year (USDA, 2005b)	
Centennial Clean Water Fund, State Revolving Loan Fund, and Section 319 Nonpoint Source Fund	• Administered by Ecology's Water Quality Program • Offer loans and grants to reduce nonpoint sources of water pollution, including funding for agricultural BMPs such as forest buffers (Ecology, 2005) • Grants are provided for up to 75% of project costs, and low-interest loans (at 30% or 60% of market rates depending on the loan term) are provided for up to 100% of project costs (Ecology, 2005)	• Funds appear to be equally available to small and large producers

Sources: USDA (1998; 2005a; 2005b; 2006) and Ecology (2005).

State and federal agencies also encourage pollution control efforts by providing technical and financial assistance to producers to implement structural and practice BMPs. To the degree that agricultural BMPs are voluntary, with implementation efforts focused on technical assistance and financial incentives, the potential for impacts on both large and small agricultural producers is minimal.

Thus, the unit costs for implementing riparian buffers shown in Exhibit 4-12 may be less for farmers. **Exhibit 7-2** summarizes unit costs for various cost shares.

Exhibit 7-2. Summary of Costs to Farmers for Planting Riparian Buffers Under 75 percent, 25 percent, and 10 percent Cost Share (2005$)

Component	75% Cost Share	25% Cost Share	10% Cost Share
Total Upfront Costs ($/acre)	$1,363	$1,363	$1,363
Upfront Costs less Cost Share ($/acre)	$341	$1,022	$1,226
Annualized Upfront Costs ($/acre/yr)[1]	$32	$96	$116

Detail may not sum to totals because of independent rounding.

1. Represents total upfront costs annualized using a private interest rate of 7 percent [based on interest rates for conventional mortgages for 1998-2004 from FRB (2005)] and a 20-year loan term.

In the case that farmers install riparian buffers along all lands adjacent to affected waters under less than full funding (e.g., a 75 percent cost share), actual impacts will vary with farm size, location, riparian acreage, and type of foregone production, if any. Data for the specific farms that may ultimately be affected by the rule are not available. However, average farm data and "model" farm assumptions can be used to evaluate the potential for disproportionate impacts on small farms.

Washington administrative procedures (RCW 19.85.020) define a small business as one with fewer than 50 employees. According to the 2002 Census of Agriculture (USDA, 2004), the average number of employees per farm was 50 or fewer for all farms with less than $1 million in sales, while farms with more than $1 million in sales had 99 employees on average in 2002. The largest 10 percent of farms in Washington included those with $250,000 or more in sales. Thus, small farms are those with less than $1 million in sales, on average, in 2002, and the 10 percent of businesses that are the largest farms that may be required to comply with the proposed rule are those with $250,000 or more in sales (i.e., there is some overlap in these two categories).

Exhibit 7-3 summarizes the potential impact in terms of private costs per one hundred dollars of sales, and private costs per employee, for small agricultural producers and the largest 10 percent of agricultural producers in Washington. The estimates reflect the assumption that the amount of land that would be planted in riparian buffers is proportional to the farm size. Specifically, the estimates reflect a square-shaped "model" farm (i.e., with four boundaries, where length is equal to width) with a stream that is parallel to one of the boundaries. For example, the average size for small business farms is 347 acres, or 15.1 million square feet (sf). A square-shaped model farm would be 3,886 feet on a side. Assuming that a stream runs through the farm parallel to one boundary and the farmer plants a 100-foot-wide buffer on both sides, a total of 777,000 sf (3,886 x 200), or 18 acres, would be planted to buffers.

Exhibit 7-3. Potential Impacts on Farms Under 75 percent, 25 percent, and 10 percent Cost Share and No Land Rental Payments

Item	Small business farms	Largest 10% of all farms
Number of farms	35,006	3,702
Average farm size (acres)	347	2,088
Average # workers per farm (with hired labor)[1]	13	48
Average sales ($ per farm)	$60,623	$1,222,305
Estimated number of acres planted in buffers[2]	18	44
Net cash farm income less government payments (average $ per acre)	$25	$143
75% cost share		
Cost/acre/year for buffer implementation[3]	$32	$32
Cost/acre/year (implementation plus opportunity cost)[4]	$57	$175
Total cost/farm to plant buffers	$1,014	$7,684
Cost per $100 of sales	$1.67	$0.63
Cost per employee	$75	$160
25% cost share		
Cost/acre/year for buffer implementation (25% cost share)[3]	$96	$96
Cost/acre/year (implementation plus opportunity cost; 25% cost share)[4]	$121	$240
Total cost/farm to plant buffers	$2,161	$10,500
Cost per $100 of sales	$3.56	$0.86
Cost per employee	$161	$219
10% cost share		
Cost/acre/year for buffer implementation[3]	$116	$116
Cost/acre/year (implementation plus opportunity cost)[4]	$140	$259
Total cost/farm to plant buffers	$2,505	$11,345
Cost per $100 of sales	$4.13	$0.93
Cost per employee	$186	$237

Exhibit 7-3. Potential Impacts on Farms Under 75 percent, 25 percent, and 10 percent Cost Share and No Land Rental Payments

Item	Small business farms	Largest 10% of all farms

Source: USDA, 2004 (number of farms, average farm size, average number of workers per farm, average sales, net cash farm income less government payments per acre.)
1. Reflects only those farms with hired labor.
2. Number of acres planted in buffers is for a hypothetical, average-sized farm that is square-shaped and has a single stream running parallel to one boundary, both sides of which would be planted to 100-foot-wide buffers.
3. Unit cost less cost share annualized using a private interest rate of 7 percent [based on interest rates for conventional mortgages for 1998-2004 from FRB (2005)] and a 20-year loan term.
4. Opportunity cost is based on net cash farm income per acre less government payments (e.g., conservation payments, land rental). Does not reflect potential annual grants for the "model farm" for land rental (to offset opportunity costs) or maintenance, or upfront incentives; these types of payments are available from cost-share programs that encourage buffer implementation, such as CREP.

As the exhibit indicates, this hypothetical example for a small business farm and a farm among the largest 10 percent of farms in the State indicates that pretax costs per $100 of sales would be higher for the model small business farm. The ratio of costs per $100 of sales ranges from about 2.7 ($1.67/$0.63) under the 75 percent cost share assumption, to about 4.5 ($4.13/$0.93) under the 10 percent cost share assumption. While the example indicates a higher cost per employee for the average of the largest farms, the more appropriate measure of impact on the affected businesses is the cost per sales measure.

Based on this hypothetical example, there is a potential for disproportionate impacts on small agricultural operators. However, any impacts on small business farms could be reduced through one or more of the following actions:

- Increasing cost-share funding to small business farms (note that EQIP already provides for limited-resource farmers to receive cost-share grants that amount to a higher percentage of BMP costs.)
- Giving higher priority for small business farms in the process of awarding grant or loan funds.
- Improving loan terms for small business farms (e.g., lower interest rates, longer terms).

7.5 Urban Sector Impacts

Some riparian buffers may be needed on urban land. To the extent that buffers are paid for by local governments or the state (i.e., because they are located on public land), there would not be disproportionate impacts on small businesses since the cost to plant buffers would be paid for by tax revenues and spread over many entities.

To the extent that buffers are needed on privately owned land, such as land owned by a land developer leasing or selling property to residential or commercial customers, disproportionate impacts on small businesses are possible but unlikely. Land developers themselves would likely pass on any costs to the final lessee or buyer of the land, and net costs may be zero or negative due to the amenity value of riparian buffers [e.g., Palone and Todd (1998) suggest that riparian buffers improve the value of remaining lots such that the total value of developed land may increase]. Although the final lessee or buyer of developed land could be a small business, the decision to lease or buy land is voluntary, and if the market for land is relatively competitive, then the choice of a small business to lease or purchase land that is more expensive due to the existence of a riparian buffer suggests that the marginal benefits for that business equal or exceed the marginal costs attributable to the buffer.

7.6 Hydromodification Impacts

There is potential for impacts on businesses that own dams or as a result of costs passed through to small businesses served by dams that may need controls (e.g., hydroelectric power). However, without information to determine which dams may need controls as a result of the proposed rule or the nature of the controls needed, it is not possible to determine whether any impacts would disproportionately affect small businesses compared to the largest businesses. It is also likely that controls necessary to meet the 2003 WQS revisions (i.e., baseline standards) would also result in compliance with the 2006 proposed standards, such that there is no incremental impact of the proposed rule.

8. References

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1. Ellicott City, Maryland: Center for Watershed Protection.

Durst, R. 2005. Changing Federal Tax Policies Affect Farm Households Differently. Amber Waves, Volume 3, Issue 5. Economic Research Service, U.S. Department of Agriculture. Online at http://www.ers.usda.gov/AmberWaves/November05/Features/ChangingFederalTax.htm. November.

Durst, R., and J. Monke. 2001. Effects of Federal Tax Policy on Agriculture. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 800. Online at http://www.ers.usda.gov/publications/aer800/aer800.pdf.

Federal Reserve Bank (FRB). 2005. Selected Interest Rates, Historical Data. Federal Reserve Statistical Release H.15. Online at http://www.federalreserve.gov/releases/h15/data.htm, accessed November 8, 2005.

Iowa State University Extension. 1996. Stewards of our Streams: Buffer Strip Design, Establishment, and Maintenance. Ames, IA: Publication Number Pm-1626b.

Kennewick Publicly Owned Treatment Works. 2003. Fact Sheet For NPDES Permit No. WA-004478-4. Online at http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/kennewick/kennewick_fs.pdf.

Layton, D., G. Brown, and M. Plummer. 1999. Valuing Multiple Programs to Improve Fish Populations. Prepared for the Washington Department of Ecology.

National Association of Home Builders (NAHB) Research Center, Inc. and U.S. Environmental Protection Agency (U.S. EPA). 2001. Environmentally Green...Economically Green: Tools for a Green Land Development Program.

Okanogan Omak Publicly Owned Treatment Works. 2003. Fact Sheet For NPDES Permit No. WA-002236-5. Online at http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/okanogan/okanogan_fs.pdf.

Omak Publicly Owned Treatment Works. 2003. Fact Sheet For NPDES Permit No. WA-002094-0. Online at http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/omak/omak_fs.pdf.

Oregon Department of Environmental Quality (ODEQ). 2001. Temperature Management Plans: Internal Directive for Existing Point Source Dischargers.

Oregon State University Extension Service (OSU). 1995. Enterprise Budget: Native Hay, Eastern Oregon Region. Publication EM 8608.

Oregon State University (OSU). 1991. Enterprise Budget: Corn, Irrigated, North Central Region. Cross, T., and B. Smith. Publication EM 8458. March.

Palone, R.S. and A.H. Todd, eds. 1998. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. USDA Forest Service. NA-TP-02-97. Radnor, PA. Online at www.chesapeakebay.net/.

Perez-Garcia, J. 2001. Cost Benefits Analysis of the New Proposed Forest Practices Rules Implementing the Forest and Fish Report. Prepared for the Department of Natural Resources. DNR Agreement # FY00-133.

Rose, R., and D. Jacobs. 1999. Cost Analysis Spreadsheet for Determining General Costs of Reforestation. Corvallis, OR: Oregon State University Department of Forest Science, Oregon State University Extension Service. Online from http://www.cof.orst.edu/cof/teach/for442/cinfo/sprdsht.htm.

RS Means. 2005. Environmental Remediation Cost Data – Unit Price. 11th Edition.

Segal Ranch Hybrid Poplars. 2006. Segal Ranch Catalog. Grandview, WA. Online at http://hybridpoplar.com/home/sr1/smartlist/10/0.

Sound Native Plants. 2003. Sound Native Plants: Catalog for 2003 And Beyond. Olympia. WA. Online at http://www.soundnativeplants.com/PDF/Catalog%20in%20one%20document.PDF or from http://www.soundnativeplants.com/catalogintro.htm.

U.S. Bureau of Labor Statistics (BLS). 2005a. Occupational Employment Statistics: 2004 National Industry-Specific Occupational Employment and Wage Estimates. Washington, D.C.: U.S. Department of Labor. Online at http://www.bls.gov/oes.

U.S. Bureau of Labor Statistics (BLS). 2005b. Employment Cost Index, Historical Listing. Table 5a (Wages and Salaries Only, Civilian Workers). Washington, D.C.: U.S. Department of Labor. Online at http://www.bls.gov.

U.S. Bureau of Labor Statistics (BLS). 2005c. Employer Costs for Employee Compensation, June 2005. Table 2 (Civilian Workers). Washington, D.C.: U.S. Department of Labor. Online at http://www.bls.gov/ncs/ect/home.htm.

U.S. Department of Agriculture (USDA). 2006. Conservation Security Program Watersheds, FY-2006. Online at http://www.nrcs.usda.gov/Programs/csp/2006_CSP_WS/index.html.

U.S. Department of Agriculture (USDA). 2005a. Table 2-Normalized Market-Clearing Price Estimates, National-Level Indices. Washington, D.C.: USDA, Economic Research Service. Online from http://www.ers.usda.gov/Data/normalizedprices/.

U.S. Department of Agriculture (USDA). 2005b. Environmental Quality Incentives Program. USDA, Natural Resources Conservation Program. Online at http://www.nrcs.usda.gov/programs/eqip/, accessed November 8, 2005.

U.S. Department of Agriculture (USDA). 2005c. Conservation Security Program Fact Sheet. Online at http://www.nrcs.usda.gov/Programs/csp/pdf_files/csp_fs3_05.pdf.

U.S. Department of Agriculture (USDA). 2004. 2002 Census of Agriculture. Washington, D.C.: USDA, National Agricultural Statistics Service.

U.S. Department of Agriculture (USDA). 1999. CORE 4 Conservation Practices Training Guide. Washington, D.C.: USDA, Natural Resources Conservation Service.

U.S. Department of Agriculture (USDA). 1998. Conservation Reserve Program, Washington State Enhancement Program Fact Sheet. USDA, Farm Service Agency. Online at http://www.fsa.usda.gov/pas/publications/facts/wacrep.pdf , accessed November 8, 2005.

U.S. EPA. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002.

U.S. EPA. 2002. Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule. Office of Water, EPA 821-R-02-003.

U.S. EPA. 2000. Guidelines for Preparing Economic Analysis. EPA 240-R-00-003. September.

U.S. EPA. 1998. Detailed Costing Document for the Centralized Waste Treatment Industry. EPA 821-R-98-016. Online at http://www.epa.gov/ostwater/guide/cwt/chp1cost.pdf.

U.S. EPA. 1991. Technical Support Document for Water Quality-Based Toxics Control. EPA 505-2-90-001.

U.S. Geological Survey (USGS). 1999a. Washington Land Cover Data Set. Sioux Falls, South Dakota: U.S. Geological Survey. Online at http://edcftp.cr.usgs.gov/pub/data/landcover/states/washington.nlcd.bin.gz; also see http://landcover.usgs.gov/nlcd/show_data.asp?code=WA&state=Washington.

U.S. Geological Survey (USGS). 1999b. Washington Land Cover Data Set, Metadata FGDC File. Sioux Falls, South Dakota: U.S. Geological Survey. Online at ftp://edcftp.cr.usgs.gov/pub/data/landcover/states/washington_FGDC.txt; also see http://landcover.usgs.gov/nlcd/show_data.asp?code=WA&state=Washington.

Washington Agricultural Statistics Service (WASS). 2004. 2004 Agricultural Bulletin. Olympia, WA. Online at http://www.nass.usda.gov/wa/annual04/annual04.pdf, accessed October 20, 2005.

Washington Department of Community, Trade, and Economic Development (CTED). 2005. Citizens Building a Better Washington: Growth Management Act. Online at http://www.cted.wa.gov/_CTED/documents/ID_1014_Publications.pdf.

Washington Department of Ecology (Ecology). 2005a. *Selah Ditch Multiparameter Total Maximum Daily Load Technical Assessment.* Publication Number 05-10-020. January

Washington Department of Ecology (Ecology). 2005b. *Willapa River Watershed Temperature Total Maximum Daily Load (Water Cleanup Plan). Submittal Report and Detailed Implementation Plan.* Publication Number 05-10-073. August.

Washington Department of Ecology (Ecology). 2005d. FY2007 Funding Guidelines, Volume 1, for Centennial Clean Water Fund, Clean Water Act Section 319 Nonpoint Source Fund, and Washington State Water Pollution Control Revolving Fund. Publication Number 05-10-069. August. Online at http://www.ecy.wa.gov/pubs/0510069.pdf, accessed November 7, 2005.

Washington Department of Ecology (Ecology). 2004a. Water Quality Program Permit Writer's Manual. Publication Number 92-109.

Washington Department of Ecology (Ecology). 2004b. *Lower Skagit River Tributaries Temperature Total Maximum Daily Load Study*. Publication No. 04-03-001. January.

Washington Department of Ecology (Ecology). 2004c. *Stillaguamish River Watershed Temperature Total Maximum Daily Load Study.* Publication No. 04-03-010. March.

Washington Department of Ecology (Ecology). 2004d. *Guidance: Setting Instream Flows and Allocating Water for Future Out-of-Stream Uses*. September.

Washington Department of Ecology (Ecology). 2004e. *Stillaguamish River Watershed Fecal Coliform, Dissolved Oxygen, pH, Mercury, and Arsenic Total Maximum Daily Load Study.* Publication No. 04-03-017.

Washington Department of Ecology (Ecology). 2003a. Cost Benefit Analysis, WAC 170-201A, Surface Water Quality Standards for the State of Washington. June.

Washington Department of Ecology (Ecology). 2003b. *Little Klickitat River Watershed Temperature Total Maximum Daily Load. Submittal Report*. Publication Number 03-10-046. May.

Washington Department of Ecology (Ecology). 2003c. *South Prairie Creek Bacteria and Temperature Total Maximum Daily Load (Water Cleanup Plan). Submittal Report*. Publication Number 03-10-055. June.

Washington Department of Ecology (Ecology). 2003d. *Wenatchee National Forest Water Temperature Total Maximum Daily Load. Technical Report.* Publication Number 03-10-063. November.

Washington Department of Ecology (Ecology). 2002. *Wind River Watershed Temperature Total Maximum Daily Load. Submittal Report*. Publication No. 02-10-029. June.

Washington Department of Ecology (Ecology). 2001a. *Teanaway Temperature Total Maximum Daily Load. Submittal Report*. Publication No. 01-10-019. November.

Washington Department of Ecology (Ecology). 2001b. *Upper Chehalis River Basin Temperature Total Maximum Daily Load*. Publication No. 99-52. Revised July/

Washington Department of Ecology (Ecology). 2001c. *Upper Humptulips River Temperature Total Maximum Daily Load. Technical Report*. Publication Number 01-10-056. September.

Washington Department of Ecology (Ecology). 2000a. *Washington's Water Quality Management Plan to Control Nonpoint Source Pollutio*n. Publication Number 99-26.

Washington Department of Ecology (Ecology). 2000b. *Simpson Northwest Timberlands Temperature Total Maximum Daily Load*. Submittal Report. Publication No. 00-10-047. July.

Washington Department of Ecology (Ecology). 2000c. *Revised Upper Chehalis River Basin Dissolved Oxygen Total Maximum Daily Load*. Publication Number 00-10-018.

Washington Department of Ecology (Ecology). 2000d. *Johnson Creek Watershed Total Maximum Daily Load*. Publication Number 00-10-033.

Washington Department of Ecology (Ecology). 1998. *Total Maximum Daily Loads Workload Model: Program Definition and Cost*. Ecology Publication # 98-26.

Washington Department of Ecology (Ecology). 1997. *Colville River Water Quality: Pollutant Loading Capacity and Recommendation for Total Maximum Daily Loads*. Publication Number 96-349.

Washington State Department of Agriculture (WSDA). 2002. Technical Assistance Bulletin: Orchard Pesticide Use Restriction Information. Olympia, WA. Online at http://agr.wa.gov/PestFert/Pesticides/docs/OrchardUseRestrAsst.pdf.

Washington State University (WSU). 2004. *2004 Estimated Cost and Returns for Producing Onions in the Columbia Basin, Washington*. WSU publication EB1979E. Written by H. Hinman.

Washington State University (WSU). 2002. *2002 Cost of Producing Dry Beans, Sweet Corn and Green Peas Under Center Pivot Irrigation in the Columbia Basin of Washington State*. WSU publication EB1941E. Written by H. Hinman, G. Pelter, E. Sorensen and L.A. Fickle.

Washington State University (WSU). 2001. *2001 Cost of Producing Processing and Fresh Potatoes Under Center Pivot Irrigation, Columbia Basin, Washington.* WSU publication EB1906. Written by H. Hinman, G. Pelter, and E. Sorensen.

Washington State University (WSU). 1997. *1997 Enterprise Budgets, Winter Wheat, Dry Pea Rotation, Columbia County, Washington State*. WSU publication EB1617. Written by H. Hinman and R. Schirman.

Webster Forest Nursery. 2005. Public Price List for 2005-2006 Season. Olympia, WA: Washington State Department of Natural Resources. Online at http://www3.wadnr.gov/dnrapp3/webster/price.jsp.

Appendix A. Sample Facility Analyses: Temperature

Weyerhaueser Enumclaw Millpond
Mount Vernon Wastewater Utility
Ferndale Wastewater Treatment Plant
Lynden Wastewater Treatment Plant
Morton Forest Products Company
Washington DFW Bellingham Fish Hatchery
Enumclaw Sewage Treatment Plant
Port Angeles Sewage Treatment Plant
Sumner Wastewater Treatment Plant
Walla Walla Wastewater Treatment Plant
Arlington Wastewater Treatment Plant
Buckley Wastewater Treatment Plant
Carson National Fish Hatchery
Circle K Store (#5500) - BP Oil
Cowlitz County - Ryderwood Sewage Treatment Plant
Dayton Sewage Treatment Plant
Little White Salmon National Fish Hatchery
Manke Lumber Company
McCleary Sewage Treatment Plant
Orting Wastewater Treatment Plant
Quilcene National Fish Hatchery
Sequim Sewage Treatment Plant
U.S. FWS Abernathy Fish Technology Center
Winthrop Wastewater Treatment Plant

Facilities on Char Habitat Waters

Weyerhaueser Enumclaw Millpond

Facility Summary

The Weyerhaueser Company Enumclaw Millpond (NPDES No. WA0040789) is located in King County, WA. The facility originally functioned as a sawmill, a chipping facility, a truck and machinery shop, and a log pond when it was constructed in 1969. However, currently the only operating facility at the site is the truck shop, and the company is in the process of dismantling and demolishing the site. The facility discharges truck wash water into a series of detention ponds, which then flows through a grassy swale to Boise Creek.

Treatment Processes

The facility's 2004 fact sheet indicates that current treatment processes consist of a grit chamber followed by an oil-water separator and a series of detention ponds.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Boise Creek for core rearing. The rule also contained narrative criteria indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule Boise Creek is designated for the protection of char habitat. **Exhibit A-1** summarizes the applicable criterion and designated uses.

Exhibit A-1. Designated Use and Applicable Criteria, Weyerhaueser Enumclaw Millpond

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology Core rearing: 16°C	Char Habitat: 12°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility's DMRs from July 2005 to August 2005 indicate that the facility did not discharge during that time. In addition, the facility does not have effluent limits or monitoring requirements for temperature.

Summary of Receiving Water Data

There are no temperature data available for Boise Creek.

Controls Needed

The facility does not currently have effluent limits for temperature, and is not required to monitor its effluent for temperature. Due to the fact the facility is a minor discharger and likely receives significant dilution, it is unlikely that the facility has reasonable potential to cause an exceedance of the proposed criteria. Thus, compliance costs for this facility are zero.

Facilities on Core Summer Salmonid Habitat Waters

Mount Vernon Wastewater Utility

Facility Summary

The Mount Vernon Wastewater Utility (NPDES No. WA0024074) is located in Skagit County, Washington. The facility treats mostly domestic wastewater, although the flow from one significant industrial user accounts for about 10 percent of the influent flow. The facility is classified as a major facility, and discharges about 5.6 mgd to Skagit River. The current outfall is not equipped with a diffuser and does not provide significant mixing. However, the facility is currently constructing a new outfall, scheduled for completion during the fall of 2005, that will consist of a 48-inch diameter pipe equipped with a 36-inch Tideflex valve and extend to the channel's deepest point in the cross-section.

Treatment Processes

The facility's draft 2005 fact sheet indicates that current treatment processes consist of bar screens, primary clarification, activated sludge with nitrification and denitrification, secondary clarification, chlorination, and dechlorination. Biosolids removed are thickened and anaerobically digested prior to disposal for beneficial use as biosolid soil amendment.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Skagit River for noncore rearing. Under the proposed rule, the Skagit River is designated for core summer salmonid habitat. **Exhibit A-2** summarizes the applicable criterion and designated uses.

Exhibit A-2. Designated Use and Applicable Criteria, Mount Vernon Wastewater Utility

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core Summer Salmonid Habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is not required to monitor for temperature. However, the facility's draft 2005 fact sheet indicates that maximum effluent temperatures are about 23°C.

Summary of Receiving Water Data

Exhibit A-3 summarizes available maximum daily temperature data for the Skagit River, one mile north of Mount Vernon at the bridge crossing the river on Old Hwy 99.

Exhibit A-3. Maximum 7-DADM Temperatures, upstream of Mount Vernon Discharge (°C)

Year	Jul	Aug	Sep
2004	17.6	17.3	14.8

Source: Ecology (2005).

Controls Needed

Exhibit A-3 indicates that the Skagit River would most likely exceed the proposed criterion of 16°C during July and August (typically the hottest months of the year). Therefore, the facility would not be allowed to cause more than a 0.3°C increase above the criterion at the edge of the mixing zone. Due to a lack of ambient data, it can be assumed that the background temperature is equal to the criterion to be conservative (i.e., err on the side of higher potential costs). **Exhibit A-4** summarizes the potential compliance scenario.

Exhibit A-4. Summary of Compliance with Proposed Rule, Mount Vernon Wastewater Utility

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
January	26	23.0	16.0	16.3	0.3	0.3
February	26	23.0	16.0	16.3	0.3	0.3
March	26	23.0	16.0	16.3	0.3	0.3
April	26	23.0	16.0	16.3	0.3	0.3
May	26	23.0	16.0	16.3	0.3	0.3
June	26	23.0	16.0	16.3	0.3	0.3
July	26	23.0	16.0	16.3	0.3	0.3
August	26	23.0	16.0	16.3	0.3	0.3
September	26	23.0	16.0	16.3	0.3	0.3
October	26	23.0	16.0	16.3	0.3	0.3
November	26	23.0	16.0	16.3	0.3	0.3
December	26	23.0	16.0	16.3	0.3	0.3

1. The facility's 2005 draft fact sheet indicates that the chronic dilution factor for Outfall 001 is 26. Note, however, that with the completion of the facility's new outfall (Outfall 004), the chronic dilution factor will increase to 188.
2. Represent the maximum temperature as specified in the facility's 2005 draft fact sheet because there are no effluent temperature data available.
3. Represents the applicable proposed criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-4 indicates that the facility's discharge is not likely to cause the temperature at the edge of the mixing zone to increase above acceptable levels (e.g., 0.3°C). Therefore, the facility would not incur costs associated with the proposed temperature standards.

Ferndale Wastewater Treatment Plant

Facility Summary

The Ferndale Wastewater Treatment Plant (NPDES No. WA0022454) is located in Whatcom County, Washington. The facility is classified as a minor facility, and treats primarily domestic sewage from residential and light commercial activities. In addition, the facility receives ash leachate from RECOMP of Washington, pretreated meat processing wastewater from Ferndale Foods, and leachate from the Cedarville landfill and leachate lagoon, which is trucked to the plant. The treated effluent is discharged through a submerged single port outfall into the Nooksack River.

Treatment Processes

The facility's 2003 fact sheet indicates that current treatment processes consist of bar screens, dual power aerated lagoon process (a multi-cellular lagoon system with a single completely mixed first cell followed by a series of equal volume partially mixed cells), chlorination, and dechlorination. Solids removed from the clarifiers (lagoons) classified as Class B biosolids are dewatered and either hauled to a landfill outside Whatcom County or land applied on property owned by the city of Ferndale, under a permit from the Whatcom County Health District.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Nooksack River for noncore rearing. Under the proposed rule, the Nooksack River is designated for core summer salmonid habitat. **Exhibit A-5** summarizes the applicable criterion and designated uses.

Exhibit A-5. Designated Use and Applicable Criteria, Ferndale WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is required to monitor for temperature daily. However, because the facility does not have an effluent limit for temperature, the data are not in its monthly DMRs. Note, that the facility's 2003 fact sheet indicates that the effluent temperature specified in its 2003 permit application is 21°C.

Summary of Receiving Water Data

Exhibit A-6 summarizes available maximum monthly 7-DADM temperature data for the Nooksack River downstream of the discharge.

Exhibit A-6. Maximum 7-DADM Temperatures, downstream of Ferndale WWTP Discharge (°C)

Year	Jul	Aug	Sep
2004	18.4	18.6	14.8
2003	18.0	18.0	17.3
2002	15.8	16.7	16.2
2001	17.1	17.4	15.8
Maximum	18.4	18.6	17.3

Source: Ecology (2005).

Controls Needed

The receiving water data available suggests that the Nooksack River most likely exceeds the 2003 temperature criterion of 17.5°C during July and August, and the proposed 2006 criterion of 16°C from July through September. However, given a maximum temperature of 21°C and a chronic dilution factor of 29, it is unlikely that the facility would cause more than a 0.3°C increase above either criterion at the edge of the mixing zone (**Exhibit A-7**). Therefore, the facility may not incur control costs associated with the proposed rule.

Exhibit A-7. Compliance Summary, Ferndale WWTP

Component	2003 WQS Revision	Proposed Rule
Dilution Factor[1]	29	29
Effluent Temperature[2] (°C)	21.0	21.0
Background Temperature[3] (°C)	17.5	16.0
Temperature at Edge of Mixing Zone (°C)	17.6	16.2
Incremental Increase[4] (°C)	0.1	0.2
Allowable Increase[5] (°C)	0.3	0.3

1. The facility's 2003 fact sheet indicates that the chronic dilution is 29.
2. Represent the effluent temperature contained in the facility's 2003 permit application.
3. Represents the applicable criterion (either 2003 noncore or proposed 2006 core summer salmonid habitat).
4. Represents the incremental temperature increase above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Hampton Drying Company

Facility Summary

Hampton Drying Company (NPDES No. WA0036927) is located in Lewis County, Washington. The facility is one of Hampton Affiliates lumber mills.

Treatment Processes

Not available.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Johnson Creek for noncore rearing. Under the proposed rule Johnson Creek is designated for core summer salmonid habitat. **Exhibit A-8** summarizes the applicable criterion and designated uses.

Exhibit A-8. Designated Use and Applicable Criteria, Hampton Drying Company

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility's monthly DMRs indicate that there was no discharge from November 2002 through September 2003.

Summary of Receiving Water Data

There are no temperature data available for Johnson Creek.

Controls Needed

Because the facility is most likely not discharging, or discharging intermittently, control costs associated with the proposed rule are unlikely.

Lynden Wastewater Treatment Plant

Facility Summary

The Lynden Wastewater Treatment Plant (NPDES No. WA0022578) is located in Whatcom County, Washington. The facility treats domestic, commercial, and industrial wastewater, including wastewater from Darigold (food processing) and Versacold (cold storage). The facility is classified as a minor facility and discharges an annual average of 0.87 mgd to the Nooksack River.

Treatment Processes

The facility's 2000 fact sheet indicates that current treatment processes consist of mechanical bar screen, oxidation ditches, secondary clarification, and chlorination. Sludge is either treated on-site at the facility's composting area or transported to an off-site disposal area. Composted Class A sludge is available to the citizens of Lynden annually for garden use. The city also wholesales their compost. Class B sludge is transported to a farm regulated by the Whatcom County Health Department and land applied at agronomic rates.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Nooksack River for noncore rearing. Under the proposed rule, the Nooksack River is designated for core summer salmonid habitat. **Exhibit A-9** summarizes the applicable criterion and designated uses.

Exhibit A-9. Designated Use and Applicable Criteria, Lynden WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is not required to monitor for temperature.

Summary of Receiving Water Data

There are no temperature data available for the Nooksack River in the vicinity of the discharge. The only data available are from a station about 10 miles downstream of the discharge.

Controls Needed

The facility's 2000 fact sheet indicates that the chronic dilution factor is 60. Assuming that the background temperature is the proposed criterion (16°C), the facility would be able to discharge up to 34°C before the temperature at the edge of the mixing zone would increase by more than 0.3°C. Given maximum typical maximum temperatures at other wastewater treatment plants, it is unlikely that the facility's discharge would cause an exceedance of the proposed criterion. Therefore, the facility would not likely incur costs associated with the proposed rule.

Washington DFW Bellingham Fish Hatchery

Facility Summary

The Washington Department of Fish and Wildlife Bellingham Fish Hatchery (NPDES No. WA0031500) is located in Whatcom County, Washington. The facility contains ten concrete circular ponds, five fiberglass round ponds, and a bank of seven concrete raceways for rearing primarily steelhead and rainbow trout for release to lakes and streams as part of enhancement programs. This facility hatches about 1.2 million eggs annually to produce up to 90,000 pounds of fry fingerlings and catchables each year. There are no fish released directly to Whatcom Creek from this facility. Fish are removed from the ponds by a vacuum pump, placed in fish holding tanks, and trucked to the release sites in Whatcom, Skagit, Island, and San Juan Counties. The facility is classified as a minor facility, and discharges pond and raceway flow-through water through Outfall 001 into Whatcom Creek via a side bank discharge. The facility also discharges cleaning wastes to the City of Bellingham Post Point Pollution Control Facility through Outfall 002, located at the western end of the site.

Treatment Processes

The facility's draft 2005 fact sheet indicates that pond and raceway flow-through water is not treated prior to discharge.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Whatcom Creek for noncore rearing. Under the proposed rule, Whatcom Creek is designated for core summer salmonid habitat. **Exhibit A-10** summarizes the applicable criterion and designated uses.

Exhibit A-10. Designated Use and Applicable Criteria, WA DWF Bellingham Fish Hatchery

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is not currently required to monitor for temperature. The facility's draft 2005 fact sheet indicates that temperature was monitored during the first year of permit coverage, and that the facility does not have reasonable potential to exceed temperature standards. Based on this information, Ecology determined that further monitoring of temperature is not warranted, and eliminated the monitoring requirement from subsequent permits.

Summary of Receiving Water Data

There are no temperature data available for Whatcom Creek.

Controls Needed

Due to a lack of data, and given the fact that Ecology no longer requires the facility to monitor for temperature because it believes that no reasonable potential exists, it is unlikely that this facility would incur costs associated with the proposed rule.

Facilities on the Spawning Waters

Enumclaw Sewage Treatment Plant

Facility Summary

The Enumclaw Sewage Treatment Plant (NPDES No. WA0020575) is located in King County, Washington. The facility has design capacity of 2.45 mgd and treats domestic wastewater for a service population of 11,000. The facility is classified as a major facility and does not have any major indirect industrial dischargers. The facility discharges to the White River at river mile 23.1. Upstream of the discharge at river mile 24.3, up to 2,000 cfs the river flow is diverted through Lake Tapps for power generation and returned to the river at river mile 3.6 (Barreca, 2002). This diversion is regulated by the Federal Energy Regulatory Commission. In addition, a fish screen return flow of 20 cfs is returned to the river at river mile 21, just below the city of Buckley's WWTP outfall.

Treatment Processes

The facility's 2003 fact sheet indicates that current treatment processes consist of channel grinder, bar screen, grit chamber, primary clarification, rotating biological contractors, secondary clarification, and ultraviolet disinfection. Settled solids are transported to a primary anaerobic digester for stabilization. Sludge is then transferred to a secondary digester for settling and thickening. Stabilized sludge is hauled for land application at approved sites in the county.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the White River for noncore rearing. The rule also contained narrative criteria indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the White River is designated for spawning from September 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-11** summarizes the applicable criterion and designated uses.

Exhibit A-11. Designated Use and Applicable Criteria, Enumclaw STP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology Noncore rearing: 17.5°C	Spawning: 13°C, September 15 - July 1 Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Exhibit A-12 shows the maximum effluent temperatures for the facility for each month from March 2000 through March 2003.

Exhibit A-12. Maximum Effluent Temperatures, Enumclaw STP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	13.3	12.8	13.9	na	na	na	na	na	na	na	na	na
2002	12.2	11.7	11.1	13.9	15.6	17.8	20.0	20.0	20.0	18.3	na	15.0

Exhibit A-12. Maximum Effluent Temperatures, Enumclaw STP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	13.3	13.3	13.9	13.9	15.6	17.2	19.4	20.0	20.0	18.3	15.0	12.8
2000	na	na	12.8	14.4	16.1	18.3	19.4	20.6	20.0	18.3	16.1	13.9
Maximum	13.3	13.3	13.9	14.4	16.1	18.3	20.0	20.6	20.0	18.3	16.1	15.0

Source: EPA's PCS database
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

Exhibit A-13 summarizes available maximum monthly temperature data for the White River, about 2 miles upstream of the discharge.

Exhibit A-13. Maximum 7-DADM Temperatures, upstream of Enumclaw STP Discharge (°C)

Year	Jun	Jul	Aug	Sep1
2002	14.2	16.8	16.1	15.0

Source: Ecology (2005).
1. Data from 9/1/02 to 9/4/02.

The facility's 2003 fact sheet indicates that the upstream temperature from November to April (winter season) is about 8°C.

Controls Needed

Exhibit A-13 indicates that the stream is most likely meeting the State's 2003 baseline temperature criterion of 17.5°C for noncore rearing. However, it is likely that the stream is exceeding the proposed core summer salmonid habitat criterion of 16°C in July and August. The data also indicate that the stream is exceeding the spawning criterion in September and June, and possibly in October and May as well (note that, data from the facility's 2003 fact sheet indicate that temperatures from November to April are about 8°C.)

Upstream of the discharge, at river mile 24.3, a large portion of the White River is diverted through Lake Tapps for power generation. The instream flow of the natural channel is regulated by the Federal Energy Regulatory Commission (FERC), and is not permitted to fall below certain predetermined levels. Therefore, the dilution available varies each month, depending on the minimum allowable receiving water flow. **Exhibit A-14** summarizes the facility's compliance with the proposed temperature standards (i.e., whether the discharge is likely to cause an excursion above the proposed temperature standards at the edge of the mixing zone).

Exhibit A-14. Summary of Compliance with the Proposed Rule, Enumclaw STP

Month	Stream Flow[1] (cfs)	Effluent Flow[2] (cfs)	Dilution Factor[3]	Effluent Temp[4] (°C)	Background Temp[5] (°C)	Temp at Edge of Mixing Zone (°C)	Incremental Increase[6] (°C)	Allowable Increase[7] (°C)
Rearing (16°C)								

Exhibit A-14. Summary of Compliance with the Proposed Rule, Enumclaw STP

Month	Stream Flow[1] (cfs)	Effluent Flow[2] (cfs)	Dilution Factor[3]	Effluent Temp[4] (°C)	Background Temp[5] (°C)	Temp at Edge of Mixing Zone (°C)	Incremental Increase[6] (°C)	Allowable Increase[7] (°C)
Jul.	250	2.0	13.4	20.0	16.0	16.3	0.3	0.3
Aug.	250	1.9	14.5	20.6	16.0	16.3	0.3	0.3
Sep. (1-15)	275	1.7	17.2	20.0	16.0	16.2	0.2	0.3
Spawning (13°C)								
Sep. (16-30)	275	1.7	17.2	20.0	13.0	13.4	0.4	0.3
Oct.	250	1.9	14.5	18.3	13.0	13.3	0.3	0.3
Nov.	130	3.2	5.0	16.1	8.0	9.3	1.3	2.2
Dec.	130	3.2	5.0	15.0	8.0	9.2	1.2	2.2
Jan.	130	3.9	4.4	13.3	8.0	9.0	1.0	2.2
Feb.	200	2.9	7.8	13.3	8.0	8.6	0.6	2.2
Mar.	275	3.9	8.1	13.9	8.0	8.6	0.6	2.2
Apr.	350	2.8	13.6	14.4	8.0	8.2	0.2	2.2
May	350	2.5	15.1	16.1	13.0	13.2	0.2	0.3
Jun.	250	2.3	11.8	18.3	13.0	13.4	0.4	0.3

Note: Values presented are rounded to the nearest tenth.
1. Represents the minimum allowable flow as specified in the facility's 2003 fact sheet.
2. Represents the maximum monthly flow for each month from March 2000 to March 2003 from EPA's PCS database.
3. Calculated assuming that 10 percent of the receiving water flow is available for dilution (based on information in the facility's 2003 fact sheet).
4. Represent the maximum monthly temperature for each month from March 2000 to March 2003 from EPA's PCS database.
5. Represents the ambient background temperature or the applicable criterion for each month, whichever is lower.
6. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
7. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-14 indicates that the facility's discharge is likely to cause the temperature at the edge of the mixing zone to increase slightly above acceptable levels (e.g., 0.3°C) in June and September 16 to 30. Therefore, controls would be needed during these months for compliance with the proposed temperature standards.

One of the least costly options would be to land apply a portion of the effluent during the necessary months. Decreasing the amount of wastewater discharged would increase the dilution available; thus, decreasing downstream impacts on the receiving water temperature. To determine the feasibility of land application or effluent reuse, a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue.

Exhibit A-15 summarizes the amount of effluent that would need to be land applied for each month.

Exhibit A-15. Summary of Effluent Needing Treatment, Enumclaw STP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow (cfs)	Allowable Discharge to Receiving Water[1] (cfs)	Effluent to be Land Applied[2] (cfs)
June	18.3	2.32	1.50	0.82
Sep. (16-30)	20.0	1.70	1.23	0.47

1. Calculated by solving for the effluent flow (Q_e) in the mixing zone temperature and dilution equations (maximum effluent temperature, allowable incremental temperature increase at the edge of the mixing zone, and minimum stream flow shown in Exhibit A-14).
2. Calculated as the difference between the total effluent flow and the effluent flow that can be discharged without having an impact on the downstream temperature.

Costs for land application include excavation and backfill, piping, and pumping. Costs are estimated based on the maximum flow that would need to be land applied, 0.8 cfs in June, and assuming that the land application site (e.g., golf course, farm, park) is approximately two miles from the facility (there is a county park and golf course about two miles from the facility). **Exhibit A-16** summarizes potential compliance costs for the facility.

Exhibit A-16. Summary of Potential Incremental Annual Compliance Costs, Enumclaw STP

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	$430,500	$15,000	$42,400

Sources: RS Means (2005)
1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (U.S. EPA, 1998).
2. Capital costs annualized at 2.4 percent over 20 years plus annual O&M costs.

Note that in January 2004, Puget Sound Energy ceased operations at its Lake Tapps power generation facility because it could no longer afford to maintain operations under a new FERC license requiring an increase in minimum river flows intended to optimize fish conditions. Puget Sound Energy recently sold the lake and associated dams and canals to Cascade Water Alliance for development of Lake Tapps as a municipal water supply. Cascade Water Alliance anticipates that more water should be available to maintain stream flows at higher levels to benefit threatened fisheries in the White River (PSE, 2005). An increase in stream flows could increase the available dilution and eliminate the need for any control actions at this facility. Thus, compliance costs may also be zero.

Port Angeles Sewage Treatment Plant

Facility Description

The Port Angeles Sewage Treatment Plant (NPDES No. WA0023973) is located in Clallam County, Washington. The facility is classified as a major facility with a design flow of 6.7 mgd. The facility treats domestic, commercial, and industrial wastes, including wastewater from about a dozen or so minor industrial users consisting of laundries, printers, breweries, film developers, seafood, and leachate. Treated waster is discharged about 3,500 feet offshore into Port Angeles Harbor and the Strait of Juan de Fuca.

Treatment Processes

The facility's 2002 fact sheet indicates that current treatment processes consist of bar screens, grit separation and removal, trickling filter/solids contact treatment, secondary clarification, chlorination, and dechlorination. Sludge is anaerobically digested, processed through a gravity thickener to a holding tank and belt filter press. Biosolids are hauled to the city's composting facility where it is composted and/or stored for land application.

Applicable Designated Uses and Criteria

The Port Angeles Harbor and Strait of Juan de Fuca are both marine waters, and thus, not affected by the proposed rule. The use of a 2,000-foot buffer to determine the total number of potentially affected facilities may over or underestimate the number of facilities discharging to affected stream segments. For this facility, more detailed information revealed that it does not discharge to an affected water body. Thus, the facility would not incur costs associated with the proposed rule.

Sumner Wastewater Treatment Plant

Facility Summary

The Sumner Wastewater Treatment Plant (NPDES No. WA0023353) is located in Pierce County, Washington. The facility has design capacity of 2.62 mgd and treats domestic and industrial wastewater from the City of Sumner, the City of Bonney Lake and a small portion of Pierce County. The facility is classified as a major facility and discharges to the White River approximately 140 feet upstream of the confluence with the Puyallup River.

Treatment Processes

The facility's 2001 fact sheet indicates that current treatment processes consist of bar screens, an aerated grit chamber, barminutors, activated sludge, secondary clarification, chlorination, and dechlorination. Solids waste is pumped to the dissolved air flotation unit where it is thickened. The thickened sludge is then pumped to either the aerobic digesters or a holding tank for temporary storage. Stabilized sludge is disposed of by land application at several local farms and a few City-owned sites.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the White River at the discharge location (about 140 feet upstream of the confluence with the Puyallup River) for noncore rearing. Under the proposed rule, the use designation for this segment of the White River would not change. However, under the proposed rule the use designation for the Puyallup River would change from noncore rearing to core summer salmonid habitat. Therefore, because this facility's chronic mixing zone extends into the Puyallup River (length of mixing zone is 304 feet), the impact that the discharge has on the Puyallup River should be analyzed.

Summary of Effluent Data and Limits

Exhibit A-17 shows the maximum effluent temperatures for the facility for each month from March 2002 through March 2003.

Exhibit A-17. Maximum Effluent Temperatures, Sumner WWTP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	14	14	14	na	Na	na	na	na	na	na	na	na
2002	na	na	14	15	Na	na	21	21	20	19	16	15
Maximum	14	14	14	15	Na	na	21	21	20	19	16	15

Source: EPA's PCS database
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

There are no temperature data available for the Puyallup River near the discharge.

Controls Needed

Exhibit A-18 summarizes the facility's compliance with the proposed temperature standards (i.e., whether the discharge is likely to cause an excursion above the proposed temperature standards at the edge of the mixing zone.) Because there are no ambient stream data available, the core summer salmonid habitat criterion can be used as the background temperature.

Exhibit A-18. Summary of Compliance with the Proposed Rule, Sumner WWTP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
January	10.4	14	16.0	15.8	-0.2	0.3
February	10.4	14	16.0	15.8	-0.2	0.3
March	10.4	14	16.0	15.8	-0.2	0.3
April	10.4	15	16.0	15.9	-0.1	0.3
May	10.4	21*	16.0	16.4	0.4	0.3
June	10.4	21*	16.0	16.4	0.4	0.3
July	10.4	21	16.0	16.4	0.4	0.3
August	10.4	21	16.0	16.4	0.4	0.3
September	10.4	20	16.0	16.4	0.4	0.3
October	10.4	19	16.0	16.3	0.3	0.3
November	10.4	16	16.0	16.0	0.0	0.3
December	10.4	15	16.0	15.9	-0.1	0.3

*Represents highest effluent temperature for July through April because no effluent data are available for May or June.
1. The facility's 2001 fact sheet indicates that the chronic dilution is 10.4 at its maximum design flow of 3.26 mgd.
2. Represents the maximum temperature for each month from the facility's month DMRs.
3. Represents the proposed core summer salmonid habitat criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-18 indicates that the facility's discharge is likely to cause the temperature at the edge of the mixing zone to increase slightly above acceptable levels (e.g., 0.3°C) from May to September. Therefore, controls would be needed during these months for compliance with the proposed temperature standards.

One of the least costly options would be to land apply a portion of the effluent during the necessary months. Decreasing the amount of wastewater discharged would increase the dilution available; thus, decreasing downstream impacts on the receiving water temperature. To determine the feasibility of land application or effluent reuse, a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue.

Exhibit A-19 summarizes the amount of effluent that would need to be land applied for each month.

Exhibit A-19. Summary of Effluent Needing Treatment, Sumner WWTP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow[1] (cfs)	Allowable Discharge to Receiving Water[2] (cfs)	Effluent to be Land Applied[3] (cfs)
May	21	5.3	0.6	4.7
June	21	5.3	0.6	4.7
July	21	5.3	0.6	4.7
August	21	5.3	0.6	4.7
September	20	5.3	0.7	4.6

1. Represents expanded design flow.
2. Calculated by solving for the effluent flow (Q_e) in the mixing zone temperature and dilution equations (maximum effluent temperature, allowable incremental temperature increase at the edge of the mixing zone, and minimum stream flow of 199 cfs).
3. Calculated as the difference between the total effluent flow and the effluent flow that can be discharged without having an impact on the downstream temperature.

Costs for land application include excavation and backfill, piping, and pumping. Costs are estimated based on the maximum flow that would need to be land applied, 4.74 cfs, and assuming that the land application site (e.g., golf course, farm, park) is approximately 0.5 miles from the facility (there is a golf course less than 2,000 feet from the outfall.) **Exhibit A-20** summarizes potential compliance costs for the facility.

Exhibit A-20. Summary of Potential Incremental Annual Compliance Costs, Sumner WWTP

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	$853,900	$29,800	$84,100

Sources: RS Means (2005)
1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (U.S. EPA, 1998).
2. Capital costs annualized at 2.4 percent over 20 years plus annual O&M costs.

Walla Walla Wastewater Treatment Plant

Facility Description

The Walla Walla Wastewater Treatment Plant (NPDES No. WA0024627) is located in Walla Walla County, Washington. The city maintains two separate treatment systems, one for domestic and commercial waste and one for food processing wastewater originating from two food-processing plants. Domestic and food processing wastewaters are conveyed separately to the facility. Food processing wastewater is pumped to a 900-acre spray farm site for irrigation of nonfood crops for the majority of the year. However, during freezing weather, it is combined and treated with the domestic wastewater. The facility is classified as a major facility and discharges advanced secondary treated wastewater to the Gose and Blalock (#3) Irrigation Districts or directly to Mill Creek. The discharge to Mill Creek is limited to the winter months (December 1 to April 30), or when the irrigation districts do not take the water. Gose Irrigation District is entitled to 1.14 mgd, and Blalock Irrigation District's water right is 6.06 mgd.

Treatment Processes

The facility's 2005 fact sheet indicates that the facility must comply with the state's Class A Water Reclamation requirements by the end of 2008. The city is planning a phased approach to come into compliance. The initial phases included replacing the existing comminutors with mechanical fine screens, replacing the existing gaseous chlorine and sulfur dioxide systems with liquid sodium hypochlorite and sodium bisulfite systems for effluent chlorination and dechlorination, upgrading the existing solids handling facilities for sludge dewatering and adding dewatered sludge storage facilities, installing a new septage receiving facility, and remodeling the existing control building. Additional phases include construction of two oxidation ditch aeration basins with anaerobic and anoxic selector basins, installation of three secondary clarifiers, installation of diversion boxes and piping to allow discharge of primary clarifier effluent directly to the activated sludge system bypassing the trickling filters, installation of two belt filter presses, and installation of a new standby generator, additional influent mechanical screen, replacement of the chlorination system with ultraviolet as the primary disinfection system, and upgrades to the dual sand filtration system with coagulation.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Mill Creek for salmon and trout rearing only. The rule also contained narrative criteria indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule Mill Creek is designated for spawning from February 15 to June 1, and for salmon and trout rearing only the remainder of the year. **Exhibit A-21** summarizes the applicable criterion and designated uses.

Exhibit A-21. Designated Use and Applicable Criteria, Walla Walla WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology Rearing and Migration Only: 17.5°C	Spawning: 13°C, February 15 - June 1 Rearing and Migration Only: 17.5°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

In the facility's 2005 fact sheet an effluent temperature of 17°C is used in the reasonable potential analysis.

Summary of Receiving Water Data

There are no temperature data available for Mill Creek. However, in the facility's fact sheet an upstream temperature of 10.7°C is used in the reasonable potential analysis.

Controls Needed

Limited information on the receiving water temperature from the facility's fact sheet suggests that Mill Creek is most likely meeting the 2003 temperature criterion of 17.5°C during the critical period (usually the driest and warmest time of the discharge period), as well as the proposed spawning criterion of 13°C from February 15 to June 1. Thus, under the baseline (2003 WQS revision) and the proposed rule, because the upstream temperature is less than the criteria, the facility would be allowed to increase the temperature at the edge of the mixing zone by 1.8°C [28/(10.7°C + 5)]. **Exhibit A-22** summarizes the potential compliance scenarios.

Exhibit A-22. Compliance Summary, Walla Walla WWTP

Component	Baseline	Proposed Rule	
	Noncore Rearing (Dec 1-Apr 30)*	Salmonid Spawning, Rearing, and Migration (Dec 1-Feb 14)*	Spawning (Feb 15-Apr 30)*
Dilution Factor[1]	1.12	1.12	1.12
Background Temperature[2] (°C)	10.7	10.7	10.7
Effluent Temperature[3] (°C)	17.0	17.0	17.0
Temperature at Edge of Mixing Zone (°C)	13.7	13.7	13.7
Incremental Increase (°C)	3.7	3.7	3.7
Allowable Increase[4] (°C)	1.8	1.8	1.8

*Facility is only permitted to discharge to Mill Creek from December 1 to April 30.
1. Calculated from 7Q10 (6.6 cfs), effluent flow (13.7 cfs), and assuming that 25 percent of the stream flow is available for dilution.
2. From the facility's 2005 fact sheet. Represents the upstream temperature used in the reasonable potential analysis.
3. From the facility's 2005 fact sheet. Represents the effluent temperature used in the reasonable potential analysis.
4. The allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-22 indicates that the facility's discharge is likely to cause the temperature at the edge of the mixing zone to increase above acceptable levels (e.g., 0.3°C) under both baseline conditions and the proposed rule. In fact, the effluent temperature reductions needed are the same for compliance with baseline standards and the proposed rule. Therefore, once in compliance with baseline standards no additional controls would be necessary for compliance with the proposed rule. Thus, compliance costs for this facility would be zero.

Arlington Wastewater Treatment Plant

Facility Summary

The Arlington Wastewater Treatment Plant (NPDES No. WA0022560) is located in Snohomish County, Washington. The facility treats primarily domestic and commercial wastewater, although there are several industrial facilities that discharge to the treatment plant. These include Cossack Caviar, All Pro Finishing, Powder Fab, Gamma Metals, and Bayliner. The facility is classified as a minor facility, and discharges an average of approximately 1.3 mgd to the Stillaguamish River.

Treatment Processes

The facility's 1998 fact sheet indicates that current treatment processes consist of mechanical screening, grit chamber, sequencing batch reactors, flow equalization, and ultraviolet disinfection. Solids are dewatered and stabilized, and hauled in open top spreader trucks for surface land spreading at the Arlington Airport.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Stillaguamish River for noncore rearing. Under the proposed rule, the use designation for the Stillaguamish River would not change, and would remain designated for salmonid spawning, rearing, and migration (note that under the proposed rule the North and South Fork Stillaguamish River, located upstream of the Stillaguamish River and the facility, are designated for core summer salmonid habitat and spawning.) The use of a 2,000-foot buffer to determine the total number of potentially affected facilities may over or underestimate the number of facilities discharging to affected stream segments. For this facility, more detailed information revealed that it does not discharge to an affected water body. Thus, the facility would not incur costs associated with the proposed rule.

Buckley Wastewater Treatment Plant

Facility Summary

The Buckley Wastewater Treatment Plant (NPDES No. WA0023361) is located in Pierce County, Washington. The facility discharges about 2.4 mgd to the White River at river mile 21.8. Upstream of the discharge at river mile 24.3, up to 2,000 cfs the river flow was diverted through Lake Tapps for power generation and returned to the river at river mile 3.6 (Barreca, 2002). This diversion is regulated by the Federal Energy Regulatory Commission. In addition, a fish screen return flow of 20 cfs is returned to the river at river mile 21, just after the facility's outfall.

Treatment Processes

The facility's 2003 fact sheet indicates that current treatment processes consist of an aerated grit chamber, in-channel fine screening, two oxidation ditches, secondary clarification, chlorination, and dechlorinated with sulfur dioxide gas. Sludge is dried in drying beds and composted onsite for use as a soil amendment or taken to South Sound Soils in Tenino.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the White River for noncore rearing. The rule also contained narrative criteria indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the White River is designated for spawning from September 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-23** summarizes the applicable criterion and designated uses.

Exhibit A-23. Designated Use and Applicable Criteria, Buckley WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 15 - July 1
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Exhibit A-24 shows the maximum effluent temperatures for the facility for each month from May 2003 through August 2005.

Exhibit A-24. Maximum Effluent Temperatures, Buckley WWTP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	11.5	11.4	13.2	12.5	14.9	17.1	19.3	19.9	na	na	na	na
2004	10.5	11.3	12.9	14.6	16.6	18.6	20.7	20.8	18.8	16.6	14.1	12.6
2003	na	na	na	na	15.4	18.4	20.3	20.3	18.8	16.6	12.6	11.7
Maximum	11.5	11.4	13.2	14.6	16.6	18.6	20.7	20.8	18.8	16.6	14.1	12.6

Source: Buckley WWTP DMRs
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

Exhibit A-25 summarizes available maximum monthly temperature data for the White River, about 2 miles upstream of the discharge.

Exhibit A-25. Maximum 7-DADM Temperatures, upstream of Buckley WWTP Discharge (°C)

Year	Jun	Jul	Aug	Sep[1]
2002	14.2	16.8	16.1	15.0

Source: Ecology (2005).
1. Data from 9/1/02 to 9/4/02.

Controls Needed

Exhibit A-25 indicates that the stream is most likely meeting the state's 2003 baseline temperature criterion of 17.5°C for noncore rearing. However, it is likely that the stream is exceeding the proposed core summer salmonid habitat criterion of 16°C in July and August. The data also indicate that the stream is exceeding the spawning criterion in September and June.

Upstream of the discharge, at river mile 24.3, a large portion of the White River is diverted through Lake Tapps for power generation. The instream flow of the natural channel is regulated by the Federal Energy Regulatory Commission (FERC), and is not permitted to fall below certain predetermined levels. Therefore, the dilution available varies each month, depending on the minimum allowable receiving water flow. **Exhibit A-26** summarizes the potential compliance scenario.

Exhibit A-26. Summary of Compliance with the Proposed Rule, Buckley WWTP

Month	Stream Flow[1] (cfs)	Effluent Flow[2] (cfs)	Dilution Factor[3]	Effluent Temp[4] (°C)	Background Temp[5] (°C)	Temp at Edge of Mixing Zone (°C)	Incremental Increase[6] (°C)	Allowable Increase[7] (°C)
Rearing (16°C)								
Jul.	250	0.8	43.4	20.7	16.0	16.1	0.1	0.3
Aug.	250	1.6	22.7	20.8	16.0	16.2	0.2	0.3
Sep. (1-15)	275	1.5	26.1	18.8	16.0	16.1	0.1	0.3
Spawning (13°C)								
Sep. (16-30)	275	1.5	26.1	18.8	13.0	13.2	0.2	0.3
Oct.	250	2.9	12.9	16.6	13.0	13.3	0.3	0.3
Nov.	130	2.3	8.8	14.1	13.0	13.1	0.1	0.3
Dec.	130	2.9	7.2	12.6	13.0	13.0	0.0	0.3
Jan.	130	4.8	4.8	11.5	13.0	12.7	-0.3	0.3
Feb.	200	1.5	19.4	11.4	13.0	12.9	-0.1	0.3
Mar.	275	3.7	11.4	13.2	13.0	13.0	0.0	0.3
Apr.	350	2.7	19.0	14.6	13.0	13.1	0.1	0.3
May	350	2.2	23.5	16.6	13.0	13.1	0.1	0.3
Jun.	250	1.3	27.7	18.6	13.0	13.2	0.2	0.3

Exhibit A-26. Summary of Compliance with the Proposed Rule, Buckley WWTP

Month	Stream Flow[1] (cfs)	Effluent Flow[2] (cfs)	Dilution Factor[3]	Effluent Temp[4] (°C)	Background Temp[5] (°C)	Temp at Edge of Mixing Zone (°C)	Incremental Increase[6] (°C)	Allowable Increase[7] (°C)

Note: Values presented are rounded to the nearest tenth.
1. Represents the minimum allowable flow as specified in the facility's 2003 fact sheet.
2. Represents the maximum monthly flow for each month from May 2003 to August 2005 from Buckley WWTP DMRs.
3. Calculated assuming that 14 percent of the receiving water flow is available for dilution (based on information in the facility's 2003 fact sheet).
4. Represent the maximum monthly temperature for each month from May 2003 to August 2005 Buckley WWTP DMRs.
5. Represents the applicable proposed criterion.
6. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
7. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-26 indicates that the facility's discharge is not likely to cause the temperature at the edge of the mixing zone to increase above acceptable levels (e.g., 0.3°C). Therefore, the facility would not incur costs associated with the proposed temperature standards.

Carson National Fish Hatchery

Facility Summary

The Carson National Fish Hatchery (NPDES No. WA0000205) is located in Skamania County, Washington. The hatchery began rearing salmon and trout in 1937, and during the 1950s, began rearing spring Chinook salmon exclusively. Since 1960, hatchery production has helped spring Chinook populations recover in the lower Columbia River. Today Carson releases more than 2 million smolts (young salmon) annually. Funding for the Carson National Fish Hatchery is through Mitchell Act funds, which are administered by the National Marine Fisheries Service (NMFS). Rearing facilities include 46 raceways, two earthen rearing ponds, and two adult holding ponds. The main water source for the hatchery is Tyee Springs.

Treatment Processes

Not available.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Wind River for core rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the Wind River in the vicinity of the discharge is designated for spawning from August 15 to June 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-27** summarizes the applicable criterion and designated uses.

Exhibit A-27. Designated Use and Applicable Criteria, Carson National Fish Hatchery

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, August 15 - June 15
Core rearing: 16°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Not available.

Summary of Receiving Water Data

There are no temperature data available for the Wind River.

Controls Needed

There are no data available to indicate that the facility is causing or contributing to an exceedance of the proposed temperature standards, or would incur control costs associated with the proposed standards.

Circle K Store (#5500) – B.P. Oil

Facility Summary

The Circle K Store and B.P. Oil (NPDES No. WA0031437) is located in Snohomish County, Washington. The ground water at the site has been adversely impacted by petroleum hydrocarbons from former leaking underground storage tanks. In November 1994, ownership and daily operation of the B.P. retail service station was transferred to the Circle K/Tosco Corporation. Since the time of the transfer, B.P. Oil has maintained oversight of petroleum-related environmental restoration issues predating the change in ownership, including operation of the groundwater remediation system. The facility is classified as a minor discharge and discharges a daily maximum of 0.04 mgd of treated ground water from its groundwater recovery and treatment system to North Creek.

Treatment Processes

The facility's 2004 fact sheet indicates that current treatment processes consist of air sparging and air stripping.

Applicable Designated Uses and Criteria

In 2003, Ecology designated North Creek for core rearing. The rule also contained narrative criteria indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule North Creek in the vicinity of the discharge is designated for spawning from September 15 to May 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-28** summarizes the applicable criterion and designated uses.

Exhibit A-28. Designated Use and Applicable Criteria, Circle K Store

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 15 - May 15
Core rearing: 16°C	Core summer salmonid habitat: 16°C

1. Represents the rule 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is not required to monitor for temperature, and does not have effluent limits for temperature.

Summary of Receiving Water Data

There are no temperature data available for North Creek.

Controls Needed

There are no data to indicate that this facility would have reasonable potential to cause or contribute to an exceedance of the proposed temperature standards. In addition, groundwater temperatures are generally cooler than surface water or treated wastewater temperatures. Thus, it is unlikely that this facility would incur costs associated with the proposed rule.

Cowlitz County, Ryderwood Sewage Treatment Plant

Facility Summary

The Cowlitz County's Ryderwood Sewage Treatment Plant (NPDES No. WA0038695) is located in Ryderwood, Washington. The facility is classified as a minor facility and is designed to treat domestic wastewater for a population of 904 people. The facility is only permitted to discharge from October through June to Becker Creek.

Treatment Processes

The facility's 1997 fact sheet indicates that current treatment processes consist of facultative lagoons in series followed by chlorination.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Becker Creek for noncore rearing. Under the proposed rule Becker Creek is designated for core summer salmonid habitat. **Exhibit A-29** summarizes the applicable criterion and designated uses.

Exhibit A-29. Designated Use and Applicable Criteria, Cowlitz County WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

The use of a 2,000-foot buffer to determine the total number of potentially affected facilities may over or underestimate the number of facilities discharging to affected stream segments. For this facility, more detailed information revealed that it does not discharge to a water body designated for spawning under the proposed rule. Thus, the facility would only be affected by the change in use designation from noncore rearing to core summer salmonid habitat.

Summary of Effluent Data and Limits

The facility is not required to monitor for temperature. However, the facility's 1997 fact sheet indicates that the highest monthly average temperature is 15.8°C during the summer and 13.3°C in the winter.

Summary of Receiving Water Data

There are no temperature data available for Becker Creek.

Controls Needed

The facility is not permitted to discharge from July through September, typically the warmest months of the year. In addition, the maximum effluent temperature is less than the proposed criterion of 16°C. Therefore, the facility would most likely not incur costs associated with the proposed rule.

Dayton Sewage Treatment Plant

Facility Summary

The Dayton Sewage Treatment Plant (NPDES No. WA0020729) is located in Columbia County, Washington. The facility treats primarily domestic and commercial wastewater. The facility's only industrial user, Seneca, discharges vegetable process wastes to cropland for treatment, and discharges domestic waste to the treatment plant. The facility is classified as a minor facility and discharges.

Treatment Processes

The facility's 2000 fact sheet indicates that current treatment processes consist of screening and grit removal, primary clarification, refurbished tricking filtration with nitrification, secondary clarification, and ultraviolet disinfection.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Touchet River for noncore rearing. The rule also contained narrative criteria, indicating that where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule, the Touchet River is designated for spawning from February 15 to June 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-30** summarizes the applicable criterion and designated uses.

Exhibit A-30. Designated Use and Applicable Criteria, Dayton STP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, February 15 - June 1
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Exhibit A-31 shows the maximum effluent temperatures for the facility for each month from January 2002 through April 2005.

Exhibit A-31. Maximum Effluent Temperatures, Dayton STP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	11.7	10.0	13.3	15.6	na	na	na	na	na	na	na	na
2004	10.0	13.9	15.0	16.1	17.2	20.0	21.1	22.8	18.9	18.9	14.4	12.2
2003	11.7	11.1	13.3	14.4	18.9	20.0	22.2	22.2	20.0	18.9	12.8	20.6
2002	15.6	11.1	12.8	14.4	18.9	20.0	22.2	21.7	21.7	16.1	13.3	12.2
Maximum	15.6	13.9	15.0	16.1	18.9	20.0	22.2	22.8	21.7	18.9	14.4	20.6

Source: Dayton STP DMRs
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

There are no temperature data available for the Touchet River.

Controls Needed

Given that there are no temperature data available for Touchet River, a conservative assumption (i.e., erring on the side of overestimating costs) is that the ambient stream temperature is either at the criteria or above it, and the facility would not be allowed to cause more than a 0.3°C increase in temperature at the edge of the mixing zone. **Exhibit A-32** summarizes the potential compliance scenario under baseline conditions.

Exhibit A-32. Summary of Compliance with the 2003 WQS Revision, Dayton STP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
January	13.6	15.6	17.5	17.4	-0.1	0.3
February	13.6	13.9	17.5	17.3	-0.2	0.3
March	13.6	15.0	17.5	17.3	-0.2	0.3
April	13.6	16.1	17.5	17.4	-0.1	0.3
May	13.6	18.9	17.5	17.6	0.1	0.3
June	13.6	20.0	17.5	17.7	0.2	0.3
July	13.6	22.2	17.5	17.8	0.3	0.3
August	13.6	22.8	17.5	17.9	0.4	0.3
September	13.6	21.7	17.5	17.8	0.3	0.3
October	13.6	18.9	17.5	17.6	0.1	0.3
November	13.6	14.4	17.5	17.3	-0.2	0.3
December	13.6	20.6	17.5	17.7	0.2	0.3

1. The facility's 2005 fact sheet indicates that the chronic dilution is 13.6.
2. Represent the maximum temperature for each month from the facility's month DMRs.
3. Represents the 2003 noncore rearing criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-32 indicates that the facility's discharge is likely to cause the temperature at the edge of the mixing zone to increase slightly above acceptable levels (e.g., 0.3°C) in August. Therefore, controls would be needed for compliance with the baseline conditions (i.e., the 2003 revisions). The facility would need to decrease its maximum effluent temperature in August to 21.9°C [the calculation is: (17.5°C + 0.3°C)*(13.6 + 1) – (13.6*17.5°C)], or by is less than 1°C. Thus, it is likely that the facility would pursue process optimization or source control to reduce the thermal impact on downstream temperatures.

Under the proposed 2006 standards, the allowable downstream increase in temperature would be based on increasing either the core summer salmonid habitat criterion of 16°C or the spawning criterion of 13°C by less than 0.3°C. However, the effluent temperature in August (and possibly other months) would decrease once the controls needed for compliance with the 2003 WQS revision are implemented. **Exhibit A-33** shows potential compliance scenario under the proposed 2006 standards, once the facility is already in compliance with baseline conditions.

Exhibit A-33. Summary of Compliance with the Proposed Rule (2006), Dayton STP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
Core Summer Salmonid (16°C)						
January	13.6	15.6	16.0	16.0	0.0	0.3
February (1-14)	13.6	13.9	16.0	15.9	-0.1	0.3
June	13.6	20.0	16.0	16.3	0.3	0.3
July	13.6	22.2	16.0	16.4	0.4	0.3
August	13.6	21.9	16.0	16.4	0.4	0.3
September	13.6	21.7	16.0	16.4	0.4	0.3
October	13.6	18.9	16.0	16.2	0.2	0.3
November	13.6	14.4	16.0	15.9	-0.1	0.3
December	13.6	20.6	16.0	16.3	0.3	0.3
Spawning (13°C)						
February (15-28)	13.6	13.9	13.0	13.1	0.1	0.3
March	13.6	15.0	13.0	13.1	0.1	0.3
April	13.6	16.1	13.0	13.2	0.2	0.3
May	13.6	18.9	13.0	13.4	0.4	0.3

1. The facility's 2005 fact sheet indicates that the chronic dilution is 13.6.
2. Represent the maximum temperature for each month from the facility's month DMRs, or the effluent temperature after implementation of controls for compliance with baseline conditions.
3. Represents the applicable 2006 proposed criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as t = 28/(T+5), where T is the ambient stream temperature.

Exhibit A-33 suggests that the facility may need controls from July to September, as well as during May, for compliance with the proposed 2006 temperature standards. Assuming that the facility would pursue land application for reducing downstream temperatures, **Exhibit A-34** shows the portion of the effluent that would need to be land applied each month. Note however, that to determine the feasibility of land application or effluent reuse a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue.

Exhibit A-34. Summary of Effluent Needing Treatment Under 2006 Proposal, Dayton STP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow[1] (cfs)	Allowable Discharge to Receiving Water[2] (cfs)	Incremental Effluent to be Land Applied[3] (cfs)
May	18.9	0.68	0.43	0.25
July	22.2	0.59	0.52	0.07
August	21.9	0.48	0.26	0.22
September	21.7	0.65	0.42	0.23

Exhibit A-34. Summary of Effluent Needing Treatment Under 2006 Proposal, Dayton STP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow[1] (cfs)	Allowable Discharge to Receiving Water[2] (cfs)	Incremental Effluent to be Land Applied[3] (cfs)

1. Based on the maximum monthly effluent flow in the facility's monthly DMRs.
2. Calculated by solving for the effluent flow (Q_e) in the mixing zone temperature and dilution equations (maximum effluent temperature, allowable incremental temperature increase at the edge of the mixing zone, and minimum stream flow shown in Exhibit A-33).
3. Calculated as the difference between the effluent flow and the effluent flow that can be discharged without having an impact on the downstream temperature.

Costs for land application include excavation and backfill, piping, and pumping. Costs are estimated based on the maximum flow that would need to be land applied, 0.25 cfs in May, and assuming that the land application site (e.g., golf course, farm, park) is about 1 mile from the facility (there is a golf course less than one mile from the facility). **Exhibit A-35** summarizes potential compliance costs for the facility.

Exhibit A-35. Summary of Potential Incremental Annual Compliance Costs, Dayton STP

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	$220,400	$7,700	$21,700

Sources: RS Means (2005)

1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (U.S. EPA, 1998).
2. Capital costs annualized at 2.4 percent over 20 years plus annual O&M costs.

Note that control actions necessary for compliance with the baseline standards could result in decreases in temperatures during months other than August. Depending on the magnitude of reductions achieved, the need for any control actions at this facility could be greatly reduced or even eliminated. Thus, compliance costs may also be reduced or eliminated.

Little White Salmon National Fish Hatchery

Facility Summary

The Little White Salmon National Fish Hatchery (NPDES No. WA0000213) is located in Skamania County, Washington. The hatchery was established in 1896, and is the oldest Federal hatchery on the Columbia River. Rearing facilities include 9 covered raceways and 24 open raceways. The total nursery capacity is 11.25 million eggs.

Treatment Processes

Not available.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Little White Salmon River for core rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule, Little White Salmon River in the vicinity of the discharge is designated for spawning from February 15 to June 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-36** summarizes the applicable criterion and designated uses.

Exhibit A-36. Designated Use and Applicable Criteria, Carson National Fish Hatchery

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, February 15 - June 15
Core rearing: 16°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Not available.

Summary of Receiving Water Data

There are no temperature data available for Little White Salmon River.

Controls Needed

There are no data available to indicate that the facility is causing or contributing to an exceedance of the proposed temperature standards, or would incur control costs associated with the proposed standards.

Manke Lumber Company

Facility Summary

The Manke Lumber Company (NPDES No. WA0040339), located in Sumner, Washington is a sawmill and wood preserving plant. At the facility, raw timber is debarked and sawed into various lengths and dimensions. The lumber is either pressure treated with chromated copper arsenate (CCA) or amoniacal copper quaternary (ACQ) water-based formulations in a dilute solution. The CCA treatment process is a closed, two-stage process where CCA preservative is applied under pressure, agitated, and then vacuumed out under the first retort chamber. In the second retort chamber, hot water is applied under pressure, agitated, and then vacuumed out. All excess chemicals, fast-fix retort water, storm water run-on, and process debris are collected in a sump and recycled into the treating process. The ACQ treating system is also a closed system in which all excess chemicals, storm water runoff, and process debris are collected in the sump and recycled into the treating process. The sump systems are capable of storing a 24-hour, 25-year storm. The facility only discharges storm water through its two outfalls (Outfall 001 and Outfall 002) to the White River. Outfall 002 is located approximately 135 feet upstream of Outfall 001.

Treatment Processes

The facility's 2004 fact sheet indicates that storm water is collected in four vegetative bioswales prior to discharge. Sludge produced by both treating processes, which accumulate in the pump filters, are periodically removed, deposited in containers, labeled, manifested, and shipped to a hazardous waste landfill.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the White River for noncore rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the White River in the vicinity of the discharge is designated for spawning from September 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-37** summarizes the applicable criterion and designated uses.

Exhibit A-37. Designated Use and Applicable Criteria, Manke Lumber

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 15 - July 1
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is not required to monitor for temperature, and does not have an effluent limit for temperature.

Summary of Receiving Water Data

Exhibit A-38 summarizes available maximum monthly temperature data for the White River, located in the vicinity of the discharge.

Exhibit A-38. Maximum 7-DADM Temperatures, White River near Sumner (°C)

Year	Jun	Jul	Aug	Sep
2002	16.2	21.3	18.6	18.7

Source: Ecology (2005).

Controls Needed

Exhibit A-38 indicates that the White River is exceeding the baseline noncore rearing criterion in July, August, and September, as well the proposed core summer salmonid habitat and spawning criteria for those months in which data are available. Based on the 7Q10 stream flow (from the facility's 2004 fact sheet) and assuming that 25 percent of the stream flow is available for dilution (the maximum allowable stream flow under State regulations), the chronic dilution factor would be 72. Given this dilution factor, the facility would be able to discharge up to 39.7°C before it would cause or contribute to an exceedance of the baseline criterion of 17.5°C. Similarly, the facility would be able to discharge up to 38.2°C during the core summer salmonid habitat period and 35.2°C during the spawning period before the applicable criterion would be exceeded (**Exhibit A-39**). Since the facility is only discharging storm water, it is unlikely that the facility's discharge would cause an exceedance of the proposed criterion. Therefore, the facility would not likely incur costs associated with the proposed rule.

Exhibit A-39. Compliance Summary, Manke Lumber

Component	Baseline	Proposed Rule	
	Noncore Rearing	Core Summer Salmonid Habitat (Jul 2-Sep14)	Spawning (Sep 15-Jul 1)
Dilution Factor[1]	73	73	73
Background Temperature[2] (°C)	17.5	16	13
Temperature at Edge of Mixing Zone[3] (°C)	17.8	16.3	13.3
Allowable Effluent Temperature[4] (°C)	39.7	38.2	35.2

1. Calculated from 7Q10 (553 cfs), effluent flow (1.92 cfs), and assuming that 25 percent of the stream flow is available for dilution.
2. Represents the applicable criterion.
3. Represents the applicable criterion plus the allowable increase, 0.3°C.
4. Represents the maximum effluent temperature that can be discharged without causing an increase above 0.3°C in the temperature at the edge of the mixing zone.

McCleary Sewage Treatment Plant

Facility Summary

The McCleary Sewage Treatment Plant (NPDES No. WA0024040) is located in Grays Harbor County, Washington. The facility is classified as a minor facility, and primarily treats domestic wastewater. There are 630 residential connections, 40 commercial connections, and four industrial connections (one significant industrial, Simpson Door Factory) for a total of 674 actual connections, or 810 equivalent residential units. The facility discharges treated effluent into Wildcat Creek.

Treatment Processes

The facility's 2002 fact sheet indicates that current treatment processes consist of grit removal, primary sedimentation, rock trickling filtration, secondary clarification, biofiltration, final clarification, chlorination, dechlorination, and aeration. The facility is planning an upgrade that would include sequencing batch reactors, effluent chillers, ultraviolet light disinfection, and a new outfall diffuser. Solids are treated in an anaerobic digester, gravity dewatered, dried in sludge drying beds, and land applied under a permit from the Grays Harbor County Health District.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Wildcat Creek for noncore rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule Wildcat Creek in the vicinity of the discharge is designated for spawning from February 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-40** summarizes the applicable criterion and designated uses.

Exhibit A-40. Designated Use and Applicable Criteria, McCleary STP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, February 15 - July 1
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Exhibit A-41 shows the maximum effluent temperatures for the facility for each month from November 2002 through August 2005.

Exhibit A-41. Maximum Effluent Temperatures, McCleary STP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	13	12	15	16	18	19	20	20	na	na	na	na
2004	13	14	14	17	20	22	22	21	20	18	15	14
2003	13	13	13	15	16	19	21	22	20	19	14	13

Exhibit A-41. Maximum Effluent Temperatures, McCleary STP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	na	na	na	na	na	na	na	na	na	na	15	14
Maximum	13	14	15	17	20	22	22	22	20	19	15	14

Source: McCleary STP DMRs provided by EPA Region 10.
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

There are no temperature data available for Wildcat Creek. However, the facility's 2002 fact sheet indicates that the receiving water temperature at the critical condition is 18°C above Sam's Canal, and 18.1°C in Sam's Canal which is located just upstream of the facility on Wildcat Creek.

Controls Needed

The limited receiving water data available suggests that Wildcat Creek may exceed the 2003 temperature criterion of 17.5°C during the critical period (e.g., June through September). Thus, under the 2003 WQS revision, the facility would not be allowed to cause more than a 0.3°C increase above the criterion at the edge of the mixing zone. **Exhibit A-42** summarizes the potential compliance scenario under baseline conditions.

Exhibit A-42. Summary of Compliance with the 2003 WQS Revision, McCleary STP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
January	4.3	13	17.5	16.6	-0.9	0.3
February	4.3	14	17.5	16.8	-0.7	0.3
March	4.3	15	17.5	17.0	-0.5	0.3
April	4.3	17	17.5	17.4	-0.1	0.3
May	4.3	20	17.5	18.0	0.5	0.3
June	4.3	22	17.5	18.4	0.9	0.3
July	4.3	22	17.5	18.4	0.9	0.3
August	4.3	22	17.5	18.4	0.9	0.3
September	4.3	20	17.5	18.0	0.5	0.3
October	4.3	19	17.5	17.8	0.3	0.3
November	4.3	15	17.5	17.0	-0.5	0.3
December	4.3	14	17.5	16.8	-0.7	0.3

1. The facility's 2002 fact sheet indicates that the chronic dilution is 4.3.
2. Represent the maximum temperature for each month from the facility's month DMRs.
3. Represents the 2003 noncore rearing criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-42 indicates that the facility's discharge is likely to cause the temperature at the edge of the mixing zone to increase above acceptable levels (e.g., 0.3°C) from May to September. Therefore, controls would be needed during these months for compliance with the baseline conditions (i.e., the 2003 revisions). One of the least costly control options would be to land apply a portion the effluent during the necessary months to increase the available dilution and reduce the thermal impact on downstream temperatures. To determine the feasibility of land application or effluent reuse, a detailed engineering analysis would be needed to assess the quality of the wastewater and the need for water at sites such as golf courses, parks, open fields, or construction sites. Therefore, there is some uncertainty regarding the actual controls the facility would pursue.

Exhibit A-43 shows the portion of the effluent that would need to be land applied each month. The exhibit indicates that the facility's land application piping and pump station would need to be sized to handle a flow of at least 0.27 cfs.

Exhibit A-43. Summary of Effluent Needing Treatment Under Baseline Conditions, McCleary STP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow[1] (cfs)	Allowable Discharge to Receiving Water[2] (cfs)	Effluent to be Land Applied[3] (cfs)
May	20	0.36	0.16	0.20
June	22	0.36	0.09	0.27
July	22	0.36	0.09	0.27
August	22	0.36	0.09	0.27
September	20	0.36	0.16	0.20

1. Based on effluent flow used to calculate the dilution factor in the facility's 2002 fact sheet.
2. Calculated by solving for the effluent flow (Q_e) in the mixing zone temperature and dilution equations (maximum effluent temperature, allowable incremental temperature increase at the edge of the mixing zone, and minimum stream flow shown in Exhibit A-42.)
2. Calculated as the difference between the total effluent flow and the effluent flow that can be discharged without having an impact on the downstream temperature.

Under the proposed 2006 standards, the allowable downstream increase in temperature would be based on increasing either the core summer salmonid habitat criterion of 16°C or the spawning criterion of 13°C by less than 0.3°C. However, the dilution factor for May to September would be greater once the controls needed for compliance with the 2003 WQS revision are implemented (since the facility would be discharging less during those months). **Exhibit A-44** shows potential compliance scenario under the proposed 2006 standards, assuming that land application controls for compliance with baseline conditions have been implemented.

Exhibit A-44. Summary of Compliance with the Proposed Rule (2006), McCleary STP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
Core Summer Salmonid (16°C)						
January	4.3	13.0	16.0	15.4	-0.6	0.3
February (1-14)	4.3	14.0	16.0	15.6	-0.4	0.3
July	15	22.0	16.0	16.4	0.4	0.3
August	15	22.0	16.0	16.4	0.4	0.3

Exhibit A-44. Summary of Compliance with the Proposed Rule (2006), McCleary STP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
September	8.3	20.0	16.0	16.4	0.4	0.3
October	4.3	19.0	16.0	16.6	0.6	0.3
November	4.3	15.0	16.0	15.8	-0.2	0.3
December	4.3	14.0	16.0	15.6	-0.4	0.3
Spawning (13°C)						
February (15-28)	4.3	14.0	13.0	13.2	0.2	0.3
March	4.3	15.0	13.0	13.4	0.4	0.3
April	4.3	17.0	13.0	13.8	0.8	0.3
May	8.3	20.0	13.0	13.8	0.8	0.3
June	15	22.0	13.0	13.6	0.6	0.3

1. The facility's 2002 fact sheet indicates that the chronic dilution is 4.3. Those months with a dilution of greater than 4.3 correspond to those months in which the facility would need to implement controls for compliance with baseline conditions.
2. Represent the maximum temperature for each month from the facility's month DMRs.
3. Represents the applicable proposed criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as $t = 28/(T+5)$, where T is the ambient stream temperature.

Exhibit A-44 suggests that the facility would need controls from May to September, as well as during March, April, and October for compliance with the proposed 2006 temperature standards. Assuming the facility would continue to pursue land application for reducing downstream temperatures, **Exhibit A-45** shows the portion of the effluent that would need to be land applied each month.

Exhibit A-45. Summary of Incremental Effluent Needing Treatment Under 2006 Proposal, McCleary STP

Month	Max. Effluent Temperature (°C)	Total Effluent Flow[1] (cfs)	Allowable Discharge to Receiving Water[2] (cfs)	Incremental Effluent to be Land Applied[3] (cfs)
March	15	0.36	0.21	0.15
April	17	0.36	0.10	0.26
May	20	0.16	0.09	0.07
June	22	0.09	0.06	0.03
July	22	0.09	0.06	0.03
August	22	0.09	0.06	0.03
September	20	0.16	0.09	0.07
October	19.0	0.36	0.13	0.23

1. Based on effluent flow used to calculate the dilution factor in the facility's 2002 fact sheet less the amount land applied above.
2. Calculated by solving for the effluent flow (Q_e) in the mixing zone temperature and dilution equations (using parameters shown in Exhibit A-44).
3. Calculated as the difference between the effluent flow less the amount land applied to meet the baseline and the effluent flow that can be discharged without having an impact on the downstream temperature.

For compliance with the 2006 proposed standards, the facility would have to land apply an additional 0.07 cfs during May and September, 0.03 from June to August, and 0.15 cfs, 0.26 cfs, and 0.23 cfs in March, April, and October, respectively. Thus, taking into account the flows that need to be land applied under baseline conditions, the pipes and pumps would have to be able to handle a maximum flow of 0.30 cfs (0.27 cfs + 0.03 cfs). Piping and pumps are usually sold in standard, premanufactured sizes, and are typically able to handle larger flows for which they are originally designed. Thus, since the incremental increase in effluent being discharged is about 10 percent, it is unlikely that additional capital costs would be incurred for compliance with the proposed rule. However, additional O&M costs associated with the additional three months of land application may be necessary (**Exhibit A-46**).

Exhibit A-46. Summary of Potential Annual Incremental Compliance Costs, McCleary STP

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	-	$4,600	$4,600

Sources: RS Means (2005)

1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (based on U.S. EPA, 1998). Capital costs of land application for 5 months are approximately $216,000. Thus, O&M costs for three months are about $1,700 ($220,000 * 4% ÷ 5 months * 3 months).

Note that the facility is planning an upgrade that would include the installation of effluent chillers (although based on effluent data in Exhibit A-41, it does not appear that such treatment has been installed yet.) Once installed, effluent chillers could eliminate the need for any control actions at this facility. Thus, compliance costs may also be zero.

Orting Wastewater Treatment Plant

Facility Summary

The Orting Wastewater Treatment Plant (NPDES No. WA0020303) is located in Pierce County, Washington. The facility was upgraded and expanded in 1999 to include sequencing batch reactors and ultraviolet disinfection. There are no industrial dischargers to the facility, so the facility treats only domestic and commercial wastewater. The facility is classified as a minor facility, and discharges to the Carbon River at river mile 2.

Treatment Processes

The facility's 1999 fact sheet indicates that current treatment processes consist of screening and grit removal, sequencing batch reactors, flow equalization, and ultraviolet disinfection. The facility kept its chlorination facility for possible future water reclamation and reuse. Waste solids removed from the SBR units are stored in the sludge storage lagoon.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Carbon River for noncore rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule, the Carbon River in the vicinity of the discharge is designated for spawning from September 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-47** summarizes the applicable criterion and designated uses.

Exhibit A-47. Designated Use and Applicable Criteria, Orting WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 15 - July 1
Noncore rearing: 17.5°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

The facility is required to monitor for temperature daily. However, because the facility does not have an effluent limit for temperature, the data are not in its monthly DMRs. The facility's fact sheet indicates that monthly average summer temperatures range from 17°C to 20°C.

Summary of Receiving Water Data

There are no temperature data available for the Carbon River.

Controls Needed

There are no receiving water data available to indicate whether the Carbon River is meeting the baseline noncore rearing criterion, or the proposed core summer salmonid habitat or spawning criteria. However, given an effluent temperature of 20°C and a chronic dilution factor of 35, it is unlikely that the facility would cause more than a 0.3°C increase above any criterion at the edge of the mixing zone (**Exhibit A-48**). Therefore, the facility would not incur control costs associated with the proposed rule.

Exhibit A-48. Compliance Summary, Orting WWTP

Component	Baseline	2006 Proposal	
	Noncore Rearing	Core Summer Salmonid Habitat	Spawning (Sep 15-Jul 1)
Dilution Factor[1]	35	35	35
Effluent Temperature[2] (°C)	20.0	20.0	20.0
Background Temperature[3] (°C)	17.5	16.0	13.0
Temperature at Edge of Mixing Zone (°C)	17.6	16.1	13.2
Incremental Increase[4] (°C)	0.1	0.1	0.2
Allowable Increase[5] (°C)	0.3	0.3	0.3

1. The facility's 1999 fact sheet indicates that the chronic dilution is 35.
2. Represent the effluent temperature contained in the facility's 1999 fact sheet.
3. Represents the applicable criterion (baseline or 2006 proposed).
4. Represents the incremental temperature increase above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as t = 28/(T+5), where T is the ambient stream temperature.

Quilcene National Fish Hatchery

Facility Summary

The Quilcene National Fish Hatchery (NPDES No. WA0001872) is located in Jefferson County, Washington.

Treatment Processes

Not available.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Big Quilcene River for core rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the Big Quilcene River in the vicinity of the discharge is designated for spawning from September 15 to July 1, and for core summer salmonid habitat the remainder of the year. **Exhibit A-49** summarizes the applicable criterion and designated uses.

Exhibit A-49. Designated Use and Applicable Criteria, Quilcene Fish Hatchery

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 15 - July 1
Core rearing: 16°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Not available.

Summary of Receiving Water Data

There are no temperature data available for Big Quilcene River.

Controls Needed

There are no data available to indicate that the facility is causing or contributing to an exceedance of the proposed temperature standards or would incur control costs associated with the proposed standards.

Sequim Sewage Treatment Plant

Facility Summary

The Sequim Sewage Treatment Plant (NPDES No. WA0022349) is located in Clallam County, Washington. The facility discharges tertiary reclamation water through Outfall 001 to the Strait of Juan de Fuca (a marine discharge). In the future, Outfall 001 will only be used for emergency and maintenance discharges. Outfall 002 is part of the Reuse Demonstration Site at Carrie Blake Park. Reclaimed water passes through the water quality pond, a vegetated channel, and a re-aeration manhole before reaching Bell Creek through a side-bank chute. Most of the reclaimed water is reused in place of potable water for irrigation, landscape, and fish habitat enhancement, and does not pass through either outfall.

Treatment Processes

The facility's 2005 fact sheet indicates that current treatment processes consist of screening and grit removal, flow equalization, oxidation ditches, secondary clarification, anthracite media filtration, and ultraviolet disinfection. Sludge from the digesters is mixed with lime and polymer is added. It then passes through a rotary screen thickener and a heated screw press.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Bell Creek for core rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule Bell Creek in the vicinity of the discharge is designated for spawning from September 1 to June 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-50** summarizes the applicable criterion and designated uses.

Exhibit A-50. Designated Use and Applicable Criteria, Sequim STP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology	Spawning: 13°C, September 1 - June 15
Core rearing: 16°C	Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Only limited effluent temperature data are available for this facility. Data from the facility's monthly DMRs indicates that from June 2005 to August 2005 average effluent temperatures ranged from 17.5°C to 19.5°C. However, the facility's fact sheet suggests that the maximum effluent temperature may be 20.3°C.

Summary of Receiving Water Data

There are no receiving water data available for Bell Creek.

Controls Needed

The facility's fact sheet indicates that the majority of the effluent is used for reuse, and that Outfall 001 (discharge to the Strait of Juan de Fuca) will be used for emergency and maintenance purposes. Therefore, any remaining wastewater not used for reclamation purposes that would be discharged to Bell Creek and could result in an exceedance of the proposed temperature standards, could be redirected for discharge through Outfall 001. Since the facility already plans to use Outfall 001 in this capacity (e.g., emergency discharge), no additional costs would be incurred. Thus, the facility would not incur costs associated with the proposed rule.

U.S. FWS Abernathy Fish Technology Center

Facility Summary

The U.S. FWS Abernathy Fish Technology Center (NPDES No. WA0000507) is located in Longview, WA, approximately 3 miles upstream of the confluence of Abernathy Creek with the Columbia River at River Mile 57. The facility discharges approximately 0.29 mgd into Abernathy Creek.

Treatment Processes

Not available.

Applicable Designated Uses and Criteria

In 2003, Ecology designated Abernathy Creek for noncore rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule Abernathy Creek in the vicinity of the discharge is designated for spawning from February 15 to June 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-51** summarizes the applicable criterion and designated uses.

Exhibit A-51. Designated Use and Applicable Criteria, U.S. FWS Abernathy Fish Technology Center

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology Noncore rearing: 17.5°C	Spawning: 13°C, February 15 - June 15 Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Not available.

Summary of Receiving Water Data

Exhibit A-52 summarizes available maximum monthly 7-DADM temperature data for 2002 for 2 stations on Abernathy Creek upstream of the discharge, just before the confluence with Wiest Creek.

Exhibit A-52. Maximum 7-DADM Temperatures, upstream of U.S. FWS Abernathy Fish Technology Center Discharge (°C)

Station	Jul	Aug	Sep
Abernathy CR5	18.4	18.8	17.2
Abernathy CR6	18.0	17.0	15.9

Source: Ecology (2005).

Controls Needed

Exhibit A-52 indicates that Abernathy Creek may be exceeding the baseline noncore rearing criterion in July and August, as well the proposed core summer salmonid habitat criterion for those months in which data are available. Based on the 7Q10 stream flow of 4.69 cfs (from the EPA's BASINS database) and assuming that 25 percent of the stream flow is available for dilution (the maximum allowable stream flow under State regulations), the chronic dilution factor would be 5.1. Given this dilution factor, the facility would be able to discharge up to 19.6°C before it would cause or contribute to an exceedance of the baseline criterion of 17.5°C. Similarly, the facility would be able to discharge up to 18.1°C during the core summer salmonid habitat period and 15.1°C during the spawning period before the applicable criterion would be exceeded (**Exhibit A-53**).

Exhibit A-53. Compliance Summary, U.S. FWS Abernathy Fish Technology Center

Component	Baseline	Proposed Rule	
	Noncore Rearing	Core Summer Salmonid Habitat (Jun 16-Feb 14)	Spawning (Feb 15-Jun 15)
Dilution Factor[1]	3.6	3.6	3.6
Background Temperature[2] (°C)	17.5	16	13
Temperature at Edge of Mixing Zone[3] (°C)	17.8	16.3	13.3
Allowable Effluent Temperature[4] (°C)	19.1	17.6	14.6

1. Calculated from 7Q10 (4.693 cfs), effluent flow (0.45 cfs), and assuming that 25 percent of the stream flow is available for dilution.
2. Represents the applicable criterion.
3. Represents the applicable criterion plus the allowable increase, 0.3°C.
4. Represents the maximum effluent temperature that can be discharged without causing an increase above 0.3°C in the temperature at the edge of the mixing zone.

Since there are no effluent data available, it is not clear whether the facility is likely to discharge above the allowable effluent temperatures for compliance with either the existing or proposed temperature standards. Thus, costs may range $0 per year if the facility is already discharging at temperatures below those needed for compliance to $35,400 per year if the facility is required to land apply its entire effluent of 0.45 cfs a portion of the year. Land application costs are summarized in **Exhibit A-54**.

Exhibit A-54. Summary of Potential Incremental Annual Compliance Costs, U.S. FWS Abernathy Fish Technology Center

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	$273,500	$9,600	$27,000

Sources: RS Means (2005)
1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (U.S. EPA, 1998).
2. Capital costs annualized at 2.4 percent over 20 years plus annual O&M costs.

Winthrop Wastewater Treatment Plant

Facility Summary

The Winthrop Wastewater Treatment Plant (NPDES No. WA0020885) is located in Okanogan County, Washington. The facility has a year round service population of about 500 people, however, Winthrop is a resort community and treats wastewater from the nearby Sun Mountain Resort. The facility is classified as a minor facility, and discharges secondary treated domestic and commercial wastewater to the Methow River.

Treatment Processes

The facility's 2004 fact sheet indicates that current treatment processes consist of a two-cell aerated lagoon, a non-aerated polishing cell, a chlorine contact tank, and a dechlorination pond.

Applicable Designated Uses and Criteria

In 2003, Ecology designated the Methow River for noncore rearing. The rule also contained narrative criteria, indicating that, where Ecology determined it was necessary to protect spawning habitat, a criterion of 13°C would apply. Under the proposed rule the Methow River in the vicinity of the discharge is designated for spawning from September 1 to June 15, and for core summer salmonid habitat the remainder of the year. **Exhibit A-55** summarizes the applicable criterion and designated uses.

Exhibit A-55. Designated Use and Applicable Criteria, Winthrop WWTP

Baseline Use and Criteria[1]	Proposed Use and Criteria
Spawning: 13°C, narrative criterion; when and where determined by Ecology Noncore rearing: 17.5°C	Spawning: 13°C, September 1 - June 15 Core summer salmonid habitat: 16°C

1. Represents the 2003 designated use and temperature criteria.

Summary of Effluent Data and Limits

Exhibit A-56 shows the maximum effluent temperatures for the facility for each month from June 2004 through September 2005.

Exhibit A-56. Maximum Effluent Temperatures, Winthrop WWTP (°C)[1]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	3	9	10	16	18	20	23	23	18	na	na	na
2004	na	na	na	na	na	22	23	24	18	15	6	5
Maximum	3	9	10	16	18	22	23	24	18	15	6	5

Source: Winthrop WWTP DMRs provided by EPA Region 10.
na = not available.
1. Maximum temperature for each month.

The facility does not currently have an effluent limit for temperature.

Summary of Receiving Water Data

There are no temperature data available for the Methow River in the vicinity of the discharge.

Controls Needed

Under the proposed 2006 standards, the allowable downstream increase in temperature would be based on increasing either the core summer salmonid habitat criterion of 16°C or the spawning criterion of 13°C by less than 0.3°C. **Exhibit A-57** shows potential compliance scenario.

Exhibit A-57. Summary of Compliance with the Proposed Rule (2006), Winthrop WWTP

Month	Dilution Factor[1]	Effluent Temperature[2] (°C)	Background Temperature[3] (°C)	Temperature at Edge of Mixing Zone (°C)	Incremental Increase[4] (°C)	Allowable Increase[5] (°C)
Core Summer Salmonids (16°C)						
June (16-30)	231	22	16.0	16.0	0.0	0.3
July	231	23	16.0	16.0	0.0	0.3
August	231	24	16.0	16.0	0.0	0.3
Spawning (13°C)						
September	231	18	13.0	13.0	0.0	0.3
October	231	15	13.0	13.0	0.0	0.3
November	231	6	13.0	13.0	0.0	0.3
December	231	5	13.0	13.0	0.0	0.3
January	231	3	13.0	13.0	0.0	0.3
February	231	9	13.0	13.0	0.0	0.3
March	231	10	13.0	13.0	0.0	0.3
April	231	16	13.0	13.0	0.0	0.3
May	231	18	13.0	13.0	0.0	0.3
June (1-15)	231	22	13.0	13.0	0.0	0.3

1. The facility's 2004 fact sheet indicates that the chronic dilution is 231.
2. Represent the maximum temperature for each month from the facility's month DMRs.
3. Represents the applicable proposed criterion.
4. Represents the incremental temperature increase (or decrease) above the criterion at the edge of the mixing zone.
5. If the background temperature is at or above the criterion, the allowable temperature increase above the criterion is 0.3°C at the edge of the mixing zone. However, if the ambient temperature is below the criterion, the allowable temperature increase is calculated as t = 28/(T+5), where T is the ambient stream temperature.

Comparing the incremental temperature increase to the allowable increase in Exhibit A-57 indicates that the facility's discharge is not likely to cause the temperature at the edge of the mixing zone to increase above acceptable levels (e.g., 0.3°C). Therefore, the facility would not incur costs associated with the proposed temperature standards.

Appendix B. Sample Facility Analyses: Dissolved Oxygen

This appendix provides a detailed analysis of the impact of the revised DO criteria on point source dischargers. However, due to significant data limitations, use of a DO model more complex than the DOSAG2 model is not feasible. Thus, this analysis is based on modeling DO concentrations using the DOSAG2 model.

Exhibit B-1 summarizes the DOSAG2 model results (critical DO concentration and difference between the critical DO concentration and the upstream DO concentration) for the sample facilities, based on the instream DO at the criterion (or saturation value), CBOD and NBOD at zero, and upstream temperature at the criterion. The complete set of input parameters are provided in tables below.

Exhibit B-1. Potential Effect of Sample Facilities on Downstream DO Concentrations

Facility Name (NPDES No.)	Upstream DO Concentration (mg/L)	Estimated Critical DO Concentration[1] (mg/L)	DO Deficit[2] (mg/L)
Major Municipals			
Enumclaw STP (WA0020575)	9.50	9.38	0.12
Mount Vernon WWTP (WA0024074)	9.50	9.49	0.01
Sumner WWTP (WA0023353)	9.50	9.38	0.12
Walla Walla WWTP (WA0024627)	9.50	9.45	0.05
Minor Municipals			
Buckley WWTP (WA0023361)	9.50	9.43	0.07
Cowlitz County - Ryderwood STP (WA0038695)	9.50	9.10	0.40
Dayton STP (WA0020729)	9.30	9.18	0.12
Ferndale WWTP (WA0022454)	9.50	9.44	0.06
Lynden WWTP (WA0022578)	9.50	9.48	0.02
McCleary STP (WA0024040)	9.50	9.07	0.43
Orting WWTP (WA0020303)	9.50	9.43	0.07
Winthrop WWTP (WA0020885)	9.26	9.23	0.03
Minor Industrials			
Hampton Drying Company (WA0036927)	No discharge	NA	NA
Manke Lumber Company (WA0040339)	9.50	9.50	0.0
US FWS Abernathy Fish Technology Center (WA0000507)	9.50	8.79	0.71
WA DFW Bellingham Hatchery (WA0031500)	9.50	9.50	0.0

Source: based on Ecology's DOSGA2 model.
NA = not applicable
STP = Sewage Treatment Plant
WWTP = Wastewater Treatment Plant
1. Calculated using Ecology's DOSAG2.xls model. Input parameters and output (e.g., distance from discharge) provided in the attachment.
2. Represents the difference between the upstream DO concentration and the critical DO concentration downstream from the discharge.

The exhibit indicates that three facilities (Cowlitz County – Ryderwood STP, McCleary STP, and U.S. FWS Abernathy Fish Technology Center) may have a significant impact on downstream DO concentrations (greater than a 0.2 mg/L decrease). [Ecology uses a 0.2 mg/L threshold value in the Colville DO TMDL (Ecology, 2003a), as well as to assess the downstream impacts of human activities on waters that have DO concentrations naturally below the criterion (e.g., waters in which the saturation value is less than 9.5 mg/L) (Ecology, 2003b)].

For compliance with the revised DO criteria, the Ryderwood STP would most likely have to reduce its flow by about half to 0.25 cfs (e.g., through land application) or increase its minimum effluent DO concentration to 5.4 mg/L (e.g., through aeration). The facility currently operates facultative lagoons. Adding aeration to such a system to increase DO levels could result in increased ammonia total suspended solids concentrations due to shortened detention times (U.S. EPA, 2002). Therefore, it is likely that the facility would land apply a portion of its effluent during those times of the year when it is likely that the discharge would cause downstream DO concentrations to drop below the proposed criterion. **Exhibit B-2** summarizes these land application costs.

Exhibit B-2. Potential Incremental Annual Compliance Costs, Cowlitz County – Ryderwood STP

Control	Total Capital	Annual O&M[1]	Total Annual[2]
Land Application	$220,400	$7,700	$21,700

Sources: RS Means (2005)
1. O&M costs for maintaining the pipeline are estimated as 4 percent of capital costs not including engineering design and analysis (U.S. EPA, 1998).
2. Capital costs annualized at 2.4 percent over 20 years plus annual O&M costs.

Note that the facility only currently discharges to Becker Creek from October to June, and is currently implementing a project to reduce inflow and infiltration (I&I) volumes to the facility. If the facility is successful at reducing the I&I volume, additional storage space within the existing lagoon system may become available and eliminate the need for land application. Thus, compliance costs for the Ryderwood STP may range from $0 to $21,700 per year.

For compliance with the proposed temperature standards revisions, the compliance scenario for the McCleary STP involves land applying a portion of the effluent from March to October (see Appendix A). The DOSAG2 model results represent the critical DO concentration estimated using the highest allowable effluent flow during that time period. However, running the model using a lower effluent flow (i.e., flow of 0.04 cfs, which corresponds to the lowest effluent flow discharged during the critical period for compliance with the revised temperature standards) produces a critical DO concentration of 9.45 mg/L, which is only 0.05 mg/L less than the proposed criterion. Therefore, the facility would likely adjust the volume of its effluent discharged for compliance with revised effluent limits based on the revised DO criterion. Because the land application system would be sized to handle the maximum flows necessary to comply with the proposed temperature standards revisions (i.e., 0.27 cfs), it is unlikely that the facility would incur additional costs as a result of the proposed DO criteria revisions.

There are no effluent data available for CBOD, NBOD, temperature, or DO for the U.S. FWS Abernathy Fish Technology Center. The results shown in Exhibit B-1 are based on inputs from other sample facilities or from the analysis of revised temperature standards described in Appendix A. Therefore, it is uncertain whether the facility would need to implement controls for compliance with the revised DO standards. Compliance scenarios could range from taking no action (zero costs) to land application of the effluent. However, the costs of these compliance scenarios are already reflected in the estimated costs for the revised temperature standards.

Detailed Model Results

Below are the input and output parameters used for the DO modeling results reflected in Exhibit B-1. Effluent discharge flow represents either the design flow or maximum average monthly flow reported in the facilities' fact sheets. The estimates of effluent reflect either the difference between total BOD and NBOD, or 75 percent of the total BOD (based on the ratio of CBOD to NBOD in Buckley's effluent); NBOD is 4.57 times the maximum ammonia concentration, or 25 percent of the total BOD (based on the ratio of CBOD to NBOD in Buckley's effluent). Effluent temperatures represent the maximum reported temperatures from the fact sheets, EPA's PCS database, or facility DMRs. Effluent DO values represent the lowest reported value from the fact sheets, EPA's PCS database, or facility DMRs. Receiving water 7Q10 flows are generally reported in fact sheets, and elevations, channel depth, and stream velocity are from fact sheets or USGS.

Exhibit B-3 provides the input and output parameters of the DO modeling for Enumclaw STP.

Exhibit B-3. DO Model Results, Enumclaw STP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	4.00	Permit fact sheet
CBOD5 (mg/L):	14.70	See note[1]
NBOD (mg/L):	13.30	See note[2]
Dissolved Oxygen (mg/L):	5.60	Permit fact sheet
Temperature (deg C):	20.6	U.S. EPA (2005a)
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	130.0	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	736.00	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.0066	Permit fact sheet
Downstream Average Channel Depth (ft):	0.82	Permit fact sheet
Downstream Average Channel Velocity (fps):	1.45	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	60.09	Tsivoglou-Wallace
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.93	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		

Exhibit B-3. DO Model Results, Enumclaw STP

CBOD5 (mg/L):	0.44
NBOD (mg/L):	0.40
Dissolved Oxygen (mg/L):	9.38
Temperature (deg C):	16.14
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)	
Reaeration (day^-1):	54.83
BOD Decay (day^-1):	0.78
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU	
Initial Mixed CBODU (mg/L):	0.65
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	1.04
4. INITIAL DISSOLVED OXYGEN DEFICIT	
Saturation Dissolved Oxygen (mg/L):	9.58
Initial Deficit (mg/L):	0.20
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00
7. CRITICAL DO DEFICIT (mg/L):	0.20
8. CRITICAL DO CONCENTRATION (mg/L):	9.38

(1) Based on assumption that CBOD = BOD - NBOD; BOD concentration from max value from EPA's PCS database.
(2) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from fact sheet.

Exhibit B-4 provides the input and output parameters of the DO modeling for Mount Vernon WWTP.

Exhibit B-4. DO Model Results, Mount Vernon WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	8.70	Permit fact sheet
CBOD5 (mg/L):	33.00	See note[1]
NBOD (mg/L):	11.00	See note[2]
Dissolved Oxygen (mg/L):	4.50	Permit fact sheet
Temperature (deg C):	23.0	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	5030	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	17.22	USGS (2004)

Exhibit B-4. DO Model Results, Mount Vernon WWTP

Downstream Average Channel Slope (ft/ft):	0.000791	USGS (2005)
Downstream Average Channel Depth (ft):	13.00	Permit fact sheet
Downstream Average Channel Velocity (fps):	1.80	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	0.28	Churchill
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.39	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.06	
NBOD (mg/L):	0.02	
Dissolved Oxygen (mg/L):	9.49	
Temperature (deg C):	16.01	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	0.26	
BOD Decay (day^-1):	0.32	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.08	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.10	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.86	
Initial Deficit (mg/L):	0.37	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	-4.77[3]	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	-140.35[3]	

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from PCS.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from PCS.
(3) Note that when the time or distance to the critical DO concentration is negative, the critical DO concentration is actually the initial mixed DO concentration.

Exhibit B-5 provides the input and output parameters of the DO modeling for Sumner WWTP.

Exhibit B-5. DO Model Results, Sumner WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	5.30	Permit fact sheet
CBOD5 (mg/L):	34.50	See note[1]
NBOD (mg/L):	11.50	See note[2]
Dissolved Oxygen (mg/L):	4.75	See note[3]
Temperature (deg C):	21.0	U.S. EPA (2005a)
2. RECEIVING WATER CHARACTERISTICS		

Exhibit B-5. DO Model Results, Sumner WWTP

Upstream Discharge (cfs):	199.00	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	31.95	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.00466	Permit fact sheet
Downstream Average Channel Depth (ft):	1.43	Permit fact sheet
Downstream Average Channel Velocity (fps):	1.01	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	11.22	Owens
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.76	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.90	
NBOD (mg/L):	0.30	
Dissolved Oxygen (mg/L):	9.38	
Temperature (deg C):	16.13	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	10.24	
BOD Decay (day^-1):	0.64	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	1.32	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	1.61	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.83	
Initial Deficit (mg/L):	0.46	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00	
7. CRITICAL DO DEFICIT (mg/L):	0.46	
8. CRITICAL DO CONCENTRATION (mg/L):	9.38	

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from PCS.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from PCS.
(3) Based on average DO for Buckley WWTP and Enumclaw STP because both of these facilities discharge to the same receiving water (White River).

Exhibit B-6 provides the input and output parameters of the DO modeling for Walla Walla WWTP.

Exhibit B-6. DO Model Results, Walla Walla WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.70	See note[1]
CBOD5 (mg/L):	5.90	Permit fact sheet
NBOD (mg/L):	9.37	See note[2]
Dissolved Oxygen (mg/L):	8.99	Permit fact sheet
Temperature (deg C):	17.0	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	6.60	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	10.70	Permit fact sheet
Elevation (ft NGVD):	835.00	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.0116	USGS (2005)
Downstream Average Channel Depth (ft):	1.74	USGS (2005)
Downstream Average Channel Velocity (fps):	1.60	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	10.62	Owens
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	3.33	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.57	
NBOD (mg/L):	0.90	
Dissolved Oxygen (mg/L):	9.45	
Temperature (deg C):	11.30	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	8.64	
BOD Decay (day^-1):	2.23	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.83	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	1.73	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	10.63	
Initial Deficit (mg/L):	1.17	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00	

Exhibit B-6. DO Model Results, Walla Walla WWTP

7. CRITICAL DO DEFICIT (mg/L):	1.17
8. CRITICAL DO CONCENTRATION (mg/L):	9.45

(1) Represents the maximum discharge flow during the critical period once temperature controls have been implemented.
(2) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from fact sheet.

Exhibit B-7 provides the input and output parameters of the DO modeling for Buckley WWTP.

Exhibit B-7. DO Model Results, Buckley WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	1.55	Permit fact sheet
CBOD5 (mg/L):	51.50	Permit fact sheet
NBOD (mg/L):	17.73	Permit fact sheet
Dissolved Oxygen (mg/L):	3.90	Permit fact sheet
Temperature (deg C):	22.3	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	130.0	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.00	Criterion
Elevation (ft NGVD):	720.00	Permit fact sheet
Downstream Average Channel Slope (ft/ft):	0.0066	Permit fact sheet
Downstream Average Channel Depth (ft):	1.19	Permit fact sheet
Downstream Average Channel Velocity (fps):	3.15	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	33.77	Owens
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.94	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.61	
NBOD (mg/L):	0.21	
Dissolved Oxygen (mg/L):	9.43	
Temperature (deg C):	16.07	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	30.77	
BOD Decay (day^-1):	0.79	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		

Exhibit B-7. DO Model Results, Buckley WWTP

Initial Mixed CBODU (mg/L):	0.89
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	1.10
4. INITIAL DISSOLVED OXYGEN DEFICIT	
Saturation Dissolved Oxygen (mg/L):	9.60
Initial Deficit (mg/L):	0.17
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00
7. CRITICAL DO DEFICIT (mg/L):	0.17
8. CRITICAL DO CONCENTRATION (mg/L):	9.43

Exhibit B-8 provides the input and output parameters of the DO modeling for Cowlitz County – Ryderwood STP.

Exhibit B-8. DO Model Results, Cowlitz County – Ryderwood STP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.53	Permit fact sheet
CBOD5 (mg/L):	10.65	See note[1]
NBOD (mg/L):	3.55	See note[2]
Dissolved Oxygen (mg/L):	0.00	See note[3]
Temperature (deg C):	15.80	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	10.10	See note[4]
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.00	Criterion
Elevation (ft NGVD):	232.50	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.040	USGS (2005)
Downstream Average Channel Depth (ft):	0.75	USGS (2005)
Downstream Average Channel Velocity (fps):	1.11	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	182.15	Tsivoglou-Wallace
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	3.23	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.85	
NBOD (mg/L):	0.55	

Exhibit B-8. DO Model Results, Cowlitz County – Ryderwood STP

Dissolved Oxygen (mg/L):	9.10
Temperature (deg C):	16.00
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)	
Reaeration (day^-1):	165.62
BOD Decay (day^-1):	2.69
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU	
Initial Mixed CBODU (mg/L):	1.25
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	1.79
4. INITIAL DISSOLVED OXYGEN DEFICIT	
Saturation Dissolved Oxygen (mg/L):	9.79
Initial Deficit (mg/L):	0.69
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00
7. CRITICAL DO DEFICIT (mg/L):	0.69
8. CRITICAL DO CONCENTRATION (mg/L):	9.10

(1) Based on assumption that CBOD = BOD - NBOD; BOD concentration from facility DMRs.
(2) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from facility DMRs.
(3) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).
(4) Represents the average stream flow (7Q10 not available).

Exhibit B-9 provides the input and output parameters of the DO modeling for Dayton STP.

Exhibit B-9. DO Model Results, Dayton STP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.52	See note[1]
CBOD5 (mg/L):	22.06	See note[2]
NBOD (mg/L):	5.94	See note[3]
Dissolved Oxygen (mg/L):	6.70	Permit application
Temperature (deg C):	22.8	U.S. EPA (2005a)
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	31.90	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.30	Saturation value[4]
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	1567.38	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.04528	USGS (2005)

Exhibit B-9. DO Model Results, Dayton STP

Downstream Average Channel Depth (ft):	2.05	USGS (2005)
Downstream Average Channel Velocity (fps):	1.70	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	5.84	Churchill
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	1.87	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.35	
NBOD (mg/L):	0.10	
Dissolved Oxygen (mg/L):	9.26	
Temperature (deg C):	16.11	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	5.32	
BOD Decay (day^-1):	1.57	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.52	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.62	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.30	
Initial Deficit (mg/L):	0.04	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.28	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	7.75	
7. CRITICAL DO DEFICIT (mg/L):	0.12	
8. CRITICAL DO CONCENTRATION (mg/L):	9.18	

(1) Represents the maximum flow that would be discharged during the critical period once temperature controls have been implemented.
(2) Based on assumption that CBOD = BOD - NBOD; BOD concentration from permit application.
(3) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from permit application.
(4) Scenario reflects saturation value because it is less than the revised DO criterion of 9.5 mg/L.

Exhibit B-10 provides the input and output parameters of the DO modeling for Ferndale WWTP.

Exhibit B-10. DO Model Results, Ferndale WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	5.00	Permit fact sheet
CBOD5 (mg/L):	22.00	Permit fact sheet
NBOD (mg/L):	0.16	See note[1]

Exhibit B-10. DO Model Results, Ferndale WWTP

Dissolved Oxygen (mg/L):	1.4	See note[2]
Temperature (deg C):	21.0	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	664.0	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	12.61	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.000114	Permit fact sheet
Downstream Average Channel Depth (ft):	2.11	Permit fact sheet
Downstream Average Channel Velocity (fps):	2.95	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	9.49	Churchill
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.42	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.16	
NBOD (mg/L):	0.00	
Dissolved Oxygen (mg/L):	9.44	
Temperature (deg C):	16.04	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	8.64	
BOD Decay (day^-1):	0.35	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.24	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.24	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.86	
Initial Deficit (mg/L):	0.42	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00	
7. CRITICAL DO DEFICIT (mg/L):	0.42	
8. CRITICAL DO CONCENTRATION (mg/L):	9.44	

(1) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from fact sheet.
(2) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).

Exhibit B-11 provides the input and output parameters of the DO modeling for Lynden WWTP.

Exhibit B-11. DO Model Results, Lynden WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	1.90	Permit fact sheet
CBOD5 (mg/L):	9.00	See note[1]
NBOD (mg/L):	3.00	See note[2]
Dissolved Oxygen (mg/L):	1.4	See note[3]
Temperature (deg C):	34.30	See note[4]
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	856.0	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	65.19	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.0011	Permit fact sheet
Downstream Average Channel Depth (ft):	2.33	Permit fact sheet
Downstream Average Channel Velocity (fps):	2.30	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	5.53	O'Connor and Dobbins
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.39	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.02	
NBOD (mg/L):	0.01	
Dissolved Oxygen (mg/L):	9.48	
Temperature (deg C):	16.04	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	5.03	
BOD Decay (day^-1):	0.33	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.03	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.04	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.84	
Initial Deficit (mg/L):	0.36	

Exhibit B-11. DO Model Results, Lynden WWTP

5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00
7. CRITICAL DO DEFICIT (mg/L):	0.36
8. CRITICAL DO CONCENTRATION (mg/L):	9.48

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from fact sheet.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from fact sheet.
(3) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).
(4) Represents the highest allowable effluent temperature for compliance with the revised temperature standards.

Exhibit B-12 provides the input and output parameters of the DO modeling for McCleary STP.

Exhibit B-12. DO Model Results, McCleary STP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.21	See note[1]
CBOD5 (mg/L):	17.07	See note[2]
NBOD (mg/L):	11.93	See note[3]
Dissolved Oxygen (mg/L):	8.00	Facility DMRs
Temperature (deg C):	22.00	Facility DMRs
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	1.17	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.00	Criterion
Elevation (ft NGVD):	252.60	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.0179	USGS (2005)
Downstream Average Channel Depth (ft):	0.43	Permit fact sheet
Downstream Average Channel Velocity (fps):	0.22	Permit fact sheet
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	27.20	Tsivoglou-Wallace
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	3.33	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	2.60	
NBOD (mg/L):	1.82	
Dissolved Oxygen (mg/L):	9.27	
Temperature (deg C):	16.91	

Exhibit B-12. DO Model Results, McCleary STP

2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)	
Reaeration (day^-1):	25.28
BOD Decay (day^-1):	2.89
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU	
Initial Mixed CBODU (mg/L):	3.82
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	5.64
4. INITIAL DISSOLVED OXYGEN DEFICIT	
Saturation Dissolved Oxygen (mg/L):	9.60
Initial Deficit (mg/L):	0.32
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.07
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.25
7. CRITICAL DO DEFICIT (mg/L):	0.53
8. CRITICAL DO CONCENTRATION (mg/L):	9.07

(1) Represents the maximum flow that would be discharged during the critical period once temperature controls have been implemented.
(2) Based on assumption that CBOD = BOD - NBOD; BOD concentration from facility DMRs.
(3) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from facility DMRs.

Exhibit B-13 provides the input and output parameters of the DO modeling for Orting WWTP.

Exhibit B-13. DO Model Results, Orting WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	1.40	Permit fact sheet
CBOD5 (mg/L):	22.50	See note[1]
NBOD (mg/L):	7.50	See note[2]
Dissolved Oxygen (mg/L):	2.00	Permit fact sheet
Temperature (deg C):	20.00	Permit fact sheet
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	148.00	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.00	Criterion
Elevation (ft NGVD):	193.00	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.00412	Permit fact sheet
Downstream Average Channel Depth (ft):	0.96	Permit fact sheet
Downstream Average Channel Velocity (fps):	2.18	Permit fact sheet

Exhibit B-13. DO Model Results, Orting WWTP

3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	37.22	Tsivoglou-Wallace
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.89	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.21	
NBOD (mg/L):	0.07	
Dissolved Oxygen (mg/L):	9.43	
Temperature (deg C):	16.04	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	33.88	
BOD Decay (day^-1):	0.74	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.31	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.38	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.79	
Initial Deficit (mg/L):	0.37	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00	
7. CRITICAL DO DEFICIT (mg/L):	0.37	
8. CRITICAL DO CONCENTRATION (mg/L):	9.43	

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from fact sheet.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from fact sheet.

Exhibit B-14 provides the input and output parameters of the DO modeling for Winthrop WWTP.

Exhibit B-14. DO Model Results, Winthrop WWTP

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.24	Permit fact sheet
CBOD5 (mg/L):	39.75	See note[1]
NBOD (mg/L):	13.25	See note[2]
Dissolved Oxygen (mg/L):	1.44	Facility DMRs
Temperature (deg C):	24.0	Facility DMRs
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	149.0	Permit fact sheet

Exhibit B-14. DO Model Results, Winthrop WWTP

Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.26	Saturation value[3]
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	1743.44	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.00316	USGS (2005)
Downstream Average Channel Depth (ft):	3.77	USGS (2005)
Downstream Average Channel Velocity (fps):	2.07	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	2.55	Churchill
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.89	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.06	
NBOD (mg/L):	0.02	
Dissolved Oxygen (mg/L):	9.24	
Temperature (deg C):	16.01	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	2.32	
BOD Decay (day^-1):	0.74	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.09	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.12	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.26	
Initial Deficit (mg/L):	0.01	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.56	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	18.83	
7. CRITICAL DO DEFICIT (mg/L):	0.02	
8. CRITICAL DO CONCENTRATION (mg/L):	9.23	

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from facility DMRs.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from facility DMRs.
(3) Scenario reflects saturation value because it is below the revised DO criterion of 9.5 mg/L.

Exhibit B-15 provides the input and output parameters of the DO modeling for Manke Lumber Company.

Exhibit B-15. DO Model Results, Manke Lumber Company

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.25	Facility DMRs
CBOD5 (mg/L):	20.43	See note[1]
NBOD (mg/L):	6.81	See note[2]
Dissolved Oxygen (mg/L):	1.4	See note[3]
Temperature (deg C):	38.2	See note[4]
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	553.0	Permit fact sheet
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	15.6	Permit fact sheet
Elevation (ft NGVD):	69.00	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.016	USGS (2005)
Downstream Average Channel Depth (ft):	4.50	USGS (2005)
Downstream Average Channel Velocity (fps):	1.86	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	1.71	Churchill
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	0.47	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.01	
NBOD (mg/L):	0.00	
Dissolved Oxygen (mg/L):	9.50	
Temperature (deg C):	15.61	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	1.54	
BOD Decay (day^-1):	0.38	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.01	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.02	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.93	
Initial Deficit (mg/L):	0.43	

Exhibit B-15. DO Model Results, Manke Lumber Company

5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00
7. CRITICAL DO DEFICIT (mg/L):	0.43
8. CRITICAL DO CONCENTRATION (mg/L):	9.50

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration backcalculated from NBOD concentration.
(2) Based on assumption that NBOD = NH3-N * 4.57 (Ecology, 2004); NH3-N concentration from facility DMRs.
(3) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).
(4) Represents the highest allowable effluent temperature for compliance with the revised temperature standards.

Exhibit B-16 provides the input and output parameters of the DO modeling for U.S. FWS Abernathy Fish Technology Center.

Exhibit B-16. DO Model Results, U.S. FWS Abernathy Fish Technology Center

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.45	See note[1]
CBOD5 (mg/L):	24.75	See note[2]
NBOD (mg/L):	8.25	See note[3]
Dissolved Oxygen (mg/L):	1.44	See note[4]
Temperature (deg C):	17.60	See note[5]
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	4.69	U.S. EPA (2005b)
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.00	Criterion
Elevation (ft NGVD):	140.55	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.0328	USGS (2005)
Downstream Average Channel Depth (ft):	1.44	USGS (2005)
Downstream Average Channel Velocity (fps):	1.31	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	13.23	Owens
4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	3.33	Wright and McDonnell, 1979
OUPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	2.17	
NBOD (mg/L):	0.72	
Dissolved Oxygen (mg/L):	8.79	
Temperature (deg C):	16.14	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	12.07	

Exhibit B-16. DO Model Results, U.S. FWS Abernathy Fish Technology Center

BOD Decay (day^-1):	2.79
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU	
Initial Mixed CBODU (mg/L):	3.19
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	3.91
4. INITIAL DISSOLVED OXYGEN DEFICIT	
Saturation Dissolved Oxygen (mg/L):	9.79
Initial Deficit (mg/L):	1.00
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	-0.05[6]
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	-0.99[6]

(1) Flow data from personal communication with Patricia Crandell from the Abernathy Fish Technology Center.
(2) No data available; assumed discharging at same concentrations as Bellingham Fish Hatchery.
(3) No data available; assumed discharging at same concentrations as Bellingham Fish Hatchery.
(4) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).
(5) No data available; assumed discharging at maximum temperature allowable for compliance with the proposed temperature standards.
(6) Note that when the time or distance to the critical DO concentration is negative, the critical DO concentration is actually the initial mixed DO concentration.

Exhibit B-17 provides the input and output parameters of the DO modeling for WA DFW Bellingham Hatchery.

Exhibit B-17. DO Model Results, WA DFW Bellingham Hatchery

INPUT		
1. EFFLUENT CHARACTERISTICS	Value	Source/Comment
Discharge (cfs):	0.009	Permit fact sheet
CBOD5 (mg/L):	24.75	See note[1]
NBOD (mg/L):	8.25	See note[2]
Dissolved Oxygen (mg/L):	1.4	See note[3]
Temperature (deg C):	40.0	See note[4]
2. RECEIVING WATER CHARACTERISTICS		
Upstream Discharge (cfs):	32.58	See note[5]
Upstream CBOD5 (mg/L):	0.00	Set to zero
Upstream NBOD (mg/L):	0.00	Set to zero
Upstream Dissolved Oxygen (mg/L):	9.50	Criterion
Upstream Temperature (deg C):	16.0	Criterion
Elevation (ft NGVD):	308.00	USGS (2004)
Downstream Average Channel Slope (ft/ft):	0.03	USGS (2005)
Downstream Average Channel Depth (ft):	1.80	USGS (2005)
Downstream Average Channel Velocity (fps):	1.66	USGS (2005)
3. REAERATION RATE (Base e) AT 20 deg C (day^-1):	7.09	Churchill

Exhibit B-17. DO Model Results, WA DFW Bellingham Hatchery

4. BOD DECAY RATE (Base e) AT 20 deg C (day^-1):	1.87	Wright and McDonnell (1979)
OUTPUT		
1. INITIAL MIXED RIVER CONDITION		
CBOD5 (mg/L):	0.01	
NBOD (mg/L):	0.00	
Dissolved Oxygen (mg/L):	9.50	
Temperature (deg C):	16.01	
2. TEMPERATURE ADJUSTED RATE CONSTANTS (Base e)		
Reaeration (day^-1):	6.45	
BOD Decay (day^-1):	1.56	
3. CALCULATED INITIAL ULTIMATE CBODU AND TOTAL BODU		
Initial Mixed CBODU (mg/L):	0.01	
Initial Mixed Total BODU (CBODU + NBOD, mg/L):	0.01	
4. INITIAL DISSOLVED OXYGEN DEFICIT		
Saturation Dissolved Oxygen (mg/L):	9.76	
Initial Deficit (mg/L):	0.26	
5. TRAVEL TIME TO CRITICAL DO CONCENTRATION (days):	0.00	
6. DISTANCE TO CRITICAL DO CONCENTRATION (miles):	0.00	
7. CRITICAL DO DEFICIT (mg/L):	0.26	
8. CRITICAL DO CONCENTRATION (mg/L):	9.50	

(1) CBOD5 based on Buckley WWTP ratio of CBOD5 to BOD (75 percent of BOD is CBOD); BOD concentration from facility DMRs.
(2) NBOD based on Buckley WWTP ratio of NBOD to BOD (25 percent of BOD is CBOD); BOD concentration from facility DMRs.
(3) No data available; reflects lowest reported DO concentration for facilities with data (1.4 mg/L for Winthrop WWTP).
(4) Represents the highest allowable effluent temperature for compliance with the revised temperature standards.
(5) Represents 25 percent of average flow (USGS, 2005) because data on 7Q10 flow not available.

References

United States Environmental Protection Agency (EPA). 2005a. Permit Compliance System (PCS) Database. Online at http://www.epa.gov/enviro/html/pcs/adhoc.html.

United States Environmental Protection Agency (EPA). 2005b. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) Version 3.1. Online at http://www.epa.gov/waterscience/basins/b3webdwn.htm.

United States Geological Survey (USGS). 2005. National Hydrography Dataset (NHD). Documentation available online at http://www.epa.gov/waters/NHDPlus%20Workshop/NHDPLUS_Documentation_20050822.pdf.

United States Geological Survey (USGS). 2004. BASINS: USGS 30 Meter Resolution, One-Sixtieth Degree National Elevation Dataset for CONUS, Alaska, Hawaii, Puerto Rico, and the U. S. Virgin Islands. Metadata online at http://www.epa.gov/ost/basins/metadata/ned.htm.

Appendix C. Estimation of Statewide Costs

This appendix provides a summary of the estimated costs of the proposed rule to the sample facilities, and the method for extrapolating costs to the total number of potentially affected facilities (as described in Section 4.2.4).

Temperature Criteria

Exhibit C-1 summarizes the total capital, O&M, and annual costs associated with meeting the temperature criteria as shown in Appendix A.

Exhibit C-1. Summary of Estimated Costs Associated with the Temperature Criteria for the Sample Facilities (2005$)

NPDES	Facility Name	Type	Category	Capital	O&M	Annual Costs[1]
Char						
WA0040789	Weyerhaueser Enumclaw Millpond	Minor	Industrial	$0	$0	$0
Core Summer Salmonids						
WA0024074	Mt Vernon Wastewater Utility	Major	Municipal	$0	$0	$0
WA0022454	Ferndale WWTP	Minor	Municipal	$0	$0	$0
WA0022578	Lynden WWTP	Minor	Municipal	$0	$0	$0
WA0036927	Hampton Drying Company	Minor	Industrial	$0	$0	$0
WA0031500	WADFW Bellingham	Minor	Industrial	$0	$0	$0
Spawning						
WA0020575	Enumclaw STP	Major	Municipal	$430,500	$15,000	$42,400
WA0023973	Port Angeles STP	Major	Municipal	$0	$0	$0
WA0023353	Sumner WWTP	Major	Municipal	$853,900	$29,800	$84,100
WA0024627	Walla Walla WWTP	Major	Municipal	$0	$0	$0
WA0022560	Arlington WWTP	Minor	Municipal	$0	$0	$0
WA0023361	Buckley WWTP	Minor	Municipal	$0	$0	$0
WA0038695	Cowlitz County - Ryderwood STP	Minor	Municipal	$0	$0	$0
WA0020729	Dayton STP	Minor	Municipal	$220,500	$7,700	$21,700
WA0024040	McCleary STP	Minor	Municipal	$0	$0 – $4,600	$0 – $4,600
WA0020303	Orting WWTP	Minor	Municipal	$0	$0	$0
WA0022349	Sequim STP	Minor	Municipal	$0	$0	$0
WA0020885	Winthrop WWTP	Minor	Municipal	$0	$0	$0
WA0000205	Carson National Fish Hatchery	Minor	Industrial	$0	$0	$0
WA0031437	Circle K Store (#5500) – BP Oil	Minor	Industrial	$0	$0	$0
WA0000213	Little White Salmon National Fish Hatchery	Minor	Industrial	$0	$0	$0
WA0040339	Manke Lumber Company	Minor	Industrial	$0	$0	$0
WA0001872	Quilcene National Fish Hatchery	Minor	Industrial	$0	$0	$0
WA0000507	USFWS Abernathy Fish Technology Center	Minor	Industrial	$0 – $273,500	$0 – $9,600	$0 – $27,000

1. Capital costs annualized at a social discount rate of 2.4 percent over 20 years, plus annual O&M costs.

Exhibit C-2 shows the method for extrapolating the sample facility costs to all facilities that may be affected by the different temperature provisions of the rule.

Exhibit C-2. Estimated Statewide Incremental Costs to Point Sources: Temperature Criteria (2005$)

Facility Type	Sum of Annual Sample Facility Costs	Number in Sample	Average Annual Cost Per Facility	Number Potentially Affected	Total Annual Costs[1]
Char					
Minor Industrial	$0	1	NA	1	$0
Core Summer Salmonids					
Major Municipals	$0	1	NA	1	$0
Minor Municipals	$0	2	$0	6	$0
Minor Industrials	$0	2	$0	3	$0
TOTAL	$0	5	NA	10	$0
Spawning					
Major Municipals	$126,500	4	NA	4	$126,500
Minor Municipals	$21,700 – $26,300[2]	8	$2,700 – $3,300	19	$51,500 – $62,500[2]
Minor Industrials	$0 – $27,000	6	$0– $4,500	16	$0– $72,000[3]
TOTAL	$149,000 - $180,700	18	NA	39	$178,000 - $261,000

Note: Detail may not add to total due to rounding.
NA = not applicable.
1. Calculated by multiplying the average cost for the sample facilities by the number of potentially affected facilities, except for major facilities for which all facilities are included in the sample.
2. Represents uncertainty in compliance scenario for McCleary STP.
3. Represents uncertainty in compliance scenario for U.S. FWS Abernathy Fish Technology Center.

The total annual cost attributable to achieving the temperature criteria ranges from approximately $178,000 to $261,000.

Dissolved Oxygen Criteria

The Cowlitz County – Ryderwood STP is the only sample facility evaluated that would incur costs associated with the change in DO criteria under the proposed rule. Thus, the total annual cost to the sample facilities for compliance with the revised DO standards ranges from $0 to $21,700. Extrapolating these sample facility costs to all potentially affected facilities results in total statewide costs of approximately $0 to $57,000. **Exhibit C-3** shows this extrapolation.

Exhibit C-3. Estimated Statewide Incremental Costs to Point Sources: DO Criteria (2005$)

Facility Type	Sum of Annual Sample Facility Costs	Number in Sample	Average Annual Cost Per Facility	Number Potentially Affected	Total Annual Costs[1]
Major Municipals	$0	4	NA	4	$0
Minor Municipals	$0 – $21,700[2]	8	$0 – $2,700	21	$0 – $57,000
Minor Industrials	$0	4	$0	15	$0
TOTAL	$0 – $21,700	16	NA	40	$0 – $57,000

Exhibit C-3. Estimated Statewide Incremental Costs to Point Sources: DO Criteria (2005$)

Facility Type	Sum of Annual Sample Facility Costs	Number in Sample	Average Annual Cost Per Facility	Number Potentially Affected	Total Annual Costs[1]

Note: Detail may not add to total due to rounding.
NA = not applicable.
1. Calculated by multiplying the average cost for the sample facilities by the number of potentially affected facilities, except for major facilities for which all facilities are included in the sample.
2. Represents uncertainty in compliance scenario for Cowlitz County – Ryderwood STP.

Thus, the total annual statewide cost of the rule to point sources ranges from approximately $178,000 to $318,000.

Appendix D. Detailed Land Cover Information

This appendix contains detailed information on the land cover within 100 feet of affected waters. The tables that follow show the number of acres within 100 feet of affected waters, organized by county and land cover type within each provision. **Exhibit D-1** shows land cover adjacent to waters designated for char, **Exhibit D-2** shows land cover adjacent to waters designated for core summer salmonid habitat (and not spawning); and **Exhibit D-3** shows land cover adjacent to waters designated for spawning (and not char). **Exhibit D-4** shows land cover data for the three provisions combined.

Exhibit D-1. Land Cover Within 100 Feet of Waters Designated for Char (acres)

County	Forest	Cropland (Row Crops)	Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers[4]
Asotin	640	0	0	0	0	49	4	693	49
Chelan	3,555	0	0	0	0.5	448	406	4,410	449
Clallam	1,158	0	0	0	0.4	48	90	1,296	48
Garfield	188	0	0	0	0	60	1	249	60
Jefferson	2,132	0.2	0.02	0	7	90	504	2,732	97
King	2,224	0	0	0	2	338	93	2,657	339
Kittitas	227	0	0	0	0	87	11	325	87
Mason	294	0	0	0	0.2	33	21	349	34
Okanogan	5,585	0	0	0	9	407	61	6,062	416
Pend Oreille	2,877	0	2	0	4	100	17	3,000	106
Pierce	1,678	0	0.4	0	2	190	290	2,161	193
Skagit	396	0	0	0	0	77	47	519	77
Snohomish	580	0	0	0	0.4	35	64	679	35
Stevens	53	0	0	0	0	11	0	64	11
Whatcom	852	0	15	0.04	3	46	129	1,045	64
Yakima	901	0	0	0	0	84	61	1,046	84
Total	23,340	0.2	17	0.04	29	2,101	1,800	27,287	2,149

Source: Derived from USGS (1999).

Note: Detail may not add to total due to rounding. For counties or land cover types not shown, there are no lands within 100 feet of affected waters.

1. Urban land includes Commercial/Industrial/Transportation, Low Intensity Residential, High Intensity Residential, and Urban/Recreational Grasses.
2. Other potentially plantable land includes Grasslands/Herbaceous, Shrubland, and Transitional.
3. Unplantable includes Bare Rock/Sand/Clay, Emergent Herbaceous Wetlands, Open Water, Perennial Ice/Snow, Quarries/Strip Mines/Gravel Pits, and Woody Wetlands.
4. Total used in estimate of costs for planting buffers excludes forest land (costs attributable to baseline) and unplantable land.

Exhibit D-2. Land Cover Within 100 Feet of Waters Designated for Core Summer Salmonid Habitat and not Spawning (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers[4]
		Fallow	Row Crops	Small Grains							
Chelan	701	0	0.2	0.1	1	9	7	293	32	1,044	311
Clallam	1,307	0	0	4	75	0.4	15	145	86	1,632	239
Clark	3,923	0	4	10	521	3	233	217	127	5,037	987
Columbia	854	96	0	1,453	62	0	62	737	16	3,280	2,410
Cowlitz	6,238	0.04	6	5	65	0.3	25	323	76	6,738	424
Garfield	2	1	0	4	11	0	6	236	0	259	257
Grays Harbor	12,164	0	2	0	179	0.002	33	617	391	13,385	830
King	5,515	2	12	15	677	13	407	511	690	7,843	1,638
Kitsap	1,255	0	0	0	66	0.4	154	63	86	1,624	283
Kittitas	1,677	0	0.04	0	13	0	0	245	38	1,973	258
Klickitat	10,752	53	0.2	375	195	70	94	4,067	421	16,027	4,854
Lewis	16,178	0	77	45	1,712	8	96	935	776	19,827	2,873
Mason	1,337	0	0	0	54	0	49	79	191	1,711	182
Okanogan	124	0	0	0	0	23	2	238	7	395	264
Pacific	9,875	0	0	0	67	0	7	180	151	10,280	254
Pend Oreille	579	0	0	0	0.02	0	3	81	11	675	84
Pierce	2,352	0	26	0	329	135	136	303	293	3,575	929
Skagit	3,129	0	1	3	101	1	16	166	698	4,114	287
Skamania	3,911	0	0	0	10	1	5	186	92	4,204	202
Snohomish	6,822	1	9	18	550	17	266	434	647	8,763	1,295
Thurston	6,651	0	0.5	0	721	9	171	325	246	8,124	1,227
Wahkiakum	2,538	0	0	0	42	1	1	109	33	2,723	152
Whatcom	4,206	2	60	14	824	18	207	263	630	6,224	1,388
Yakima	1,038	0	0	0	0	0.2	1	0	12	1,435	1
Total	103,126	154	199	1,946	6,273	308	1,995	10,756	5,750	130,507	21,629

Exhibit D-2. Land Cover Within 100 Feet of Waters Designated for Core Summer Salmonid Habitat and not Spawning (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers[4]
		Fallow	Row Crops	Small Grains							

Source: Derived from USGS (1999).

Note: Detail may not add to total due to rounding. For counties or land cover types not shown, there are no lands within 100 feet of affected waters.

1. Urban land includes Commercial/Industrial/Transportation, Low Intensity Residential, High Intensity Residential, and Urban/Recreational Grasses.
2. Other potentially plantable land includes Grasslands/Herbaceous, Shrubland, and Transitional.
3. Unplantable includes Bare Rock/Sand/Clay, Emergent Herbaceous Wetlands, Open Water, Perennial Ice/Snow, Quarries/Strip Mines/Gravel Pits, and Woody Wetlands.
4. Total used in estimate of costs for planting buffers excludes forest land (costs attributable to baseline) and unplantable land.

Exhibit D-3. Land Cover Within 100 Feet of Waters Designated for Spawning and not Char (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers[4]
		Fallow	Row Crops	Small Grains							
Asotin	104	0	0	3	0	0	2	205	4	318	210
Chelan	1,060	1	0	0.0001	6	42	46	255	950	2,359	350
Clallam	7,068	0.2	0	3	85	1	111	411	1,210	8,889	610
Clark	2,523	0.2	3	3	159	2	177	64	351	3,281	407
Columbia	653	15	0	233	119	0	37	649	230	1,937	1,054
Cowlitz	4,816	4	9	5	136	2	48	597	1,663	7,280	801
Garfield	0	0	0	0	1	0	0	2	0	3	3
Grays Harbor	6,646	0	14	0	203	2	68	356	2,025	9,313	643
Jefferson	3,395	0	1	0	147	0.04	50	239	1,804	5,636	437
King	3,641	0.4	2	7	333	6	685	398	1,597	6,670	1,432
Kitsap	70	0	0	0	0	0	3	7	5	84	10
Kittitas	606	2	1	1	71	0.5	21	339	428	1,469	437
Klickitat	1,066	4	0	11	9	0.0001	15	191	427	1,723	231
Lewis	2,711	5	51	53	706	13	46	225	542	4,353	1,100
Mason	2,870	0	0	0	42	0.2	44	122	403	3,480	207
Okanogan	1,183	1	3	20	31	124	108	1,078	705	3,253	1,365
Pacific	4,953	0	0	0	132	0	18	77	152	5,332	227
Pierce	1,901	0	29	0	131	20	112	179	757	3,131	473

Exhibit D-3. Land Cover Within 100 Feet of Waters Designated for Spawning and not Char (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers[4]
		Fallow	Row Crops	Small Grains							
Skagit	2,041	7	1	5	182	4	37	262	2,536	5,076	498
Skamania	3,007	0	0	0	2	0.2	15	71	302	3,398	89
Snohomish	3,668	13	1	12	276	7	447	426	1,841	6,692	1,182
Thurston	609	0	0.01	0	68	2	14	15	125	834	99
Wahkiakum	1,274	0	0	0	198	1	9	71	66	1,619	278
Walla Walla	710	10	187	389	38	52	79	292	64	1,820	1,046
Whatcom	1,276	0.2	35	8	475	25	123	209	1,076	3,228	876
Yakima	2,213	7	0	87	67	566	126	471	642	4,1794	1,324
Total	60,065	71	337	840	3,615	868	2,442	7,213	19,906	95,357	15,389

Source: Derived from USGS (1999).

Note: Detail may not add to total due to rounding. For counties or land cover types not shown, there are no lands within 100 feet of affected waters.

1. Urban land includes Commercial/Industrial/Transportation, Low Intensity Residential, High Intensity Residential, and Urban/Recreational Grasses.
2. Other potentially plantable land includes Grasslands/Herbaceous, Shrubland, and Transitional.
3. Unplantable includes Bare Rock/Sand/Clay, Emergent Herbaceous Wetlands, Open Water, Perennial Ice/Snow, Quarries/Strip Mines/Gravel Pits, and Woody Wetlands.
4. Total used in estimate of costs for planting buffers excludes forest land (costs attributable to baseline) and unplantable land.

Exhibit D-4. Land Cover Within 100 Feet of All Affected Waters (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers (stream miles)[4]
		Fallow	Row Crops	Small Grains							
Asotin	744	0	0	3	0	0	2	254	8	1,011	267 (11)
Chelan	5,316	1	0.2	0.1	7	50	54	997	1,389	7,814	1,115 (46)
Clallam	9,533	0.2	0	7	159	1	126	604	1,387	11,817	897 (37)
Clark	6,446	0.2	7	13	679	5	410	281	477	8,318	1,406 (58)
Columbia	1,507	112	0	1,686	181	0	98	1,387	246	5,217	3,467 (143)
Cowlitz	11,053	4	14	9	201	2	73	921	1,739	14,017	1,237 (51)
Garfield	190	1	0	4	11	0	6	297	1	510	315 (13)
Grays Harbor	18,809	0	16	0	381	2	101	973	2,416	22,698	1,479 (61)
Jefferson	5,527	0	1	0	147	0.04	57	329	2,307	8,368	533 (22)

Exhibit D-4. Land Cover Within 100 Feet of All Affected Waters (acres)

County	Forest	Cropland			Pasture/ Hay	Orchards, Vineyards, Other	Urban[1]	Other Potentially Plantable Land[2]	Unplantable[3]	Total	Total Used in Estimate of Costs for Planting Riparian Buffers (stream miles)[4]
		Fallow	Row Crops	Small Grains							
King	11,381	2	14	22	1,010	20	1,094	1,247	2,380	17,170	3,419 (141)
Kitsap	1,325	0	0	0	66	0.4	157	70	91	1,709	291 (12)
Kittitas	2,510	2	1	1	84	0.5	21	670	477	3,767	780 (32)
Klickitat	11,817	57	0.2	386	204	70	109	4,259	848	17,750	5,092 (210)
Lewis	18,890	5	129	98	2,418	21	143	1,159	1,318	24,180	3,976 (164)
Mason	4,501	0	0	0	96	0.2	93	234	616	5,540	412 (17)
Okanogan	6,892	1	3	20	31	147	119	1,723	773	9,709	2,037 (84)
Pacific	14,828	0	0	0	199	0	25	257	303	15,613	485 (20)
Pend Oreille	3,456	0	0	0	2	0	8	181	28	3,675	194 (8)
Pierce	5,931	0	55	0	460	155	251	672	1,341	8,866	1,600 (66)
Skagit	5,566	7	2	8	283	5	53	505	3,281	9,709	873 (36)
Skamania	6,918	0	0	0	11	1	20	258	394	7,602	291 (12)
Snohomish	11,070	14	10	30	826	24	714	895	2,552	16,135	2,522 (104)
Stevens	53	0	0	0	0	0	0	11	0	64	12 (0.5)
Thurston	7,260	0	0.5	0	789	11	185	341	371	8,958	1,334 (55)
Wahkiakum	3,812	0	0	0	240	2	9	179	99	4,342	436 (18)
Walla Walla	710	10	187	389	38	52	79	292	64	1,820	1,043 (43)
Whatcom	6,334	2	96	22	1,314	43	334	519	1,835	10,497	2,328 (96)
Yakima	4,152	7	0	87	67	566	127	555	715	6,276	1,409 (58)
Total	186,531	225	535	2,786	9,905	1,177	4,466	20,070	27,456	253,151	39,164 (1,616)

Source: Derived from USGS (1999).

Note: Detail may not add to total due to rounding. For counties or land cover types not shown, there are no lands within 100 feet of affected waters.

1. Urban land includes Commercial/Industrial/Transportation, Low Intensity Residential, High Intensity Residential, and Urban/Recreational Grasses.
2. Other potentially plantable land includes Grasslands/Herbaceous, Shrubland, and Transitional.
3. Unplantable includes Bare Rock/Sand/Clay, Emergent Herbaceous Wetlands, Open Water, Perennial Ice/Snow, Quarries/Strip Mines/Gravel Pits, and Woody Wetlands.
4. Total used in estimate of costs for planting buffers excludes forest land (costs attributable to baseline) and unplantable land.

Appendix E. Willingness to Pay Values

Calculations for the WTP estimates in Section 5 use parameter estimates from a censored ranking model developed by the researchers (Layton et al., 1999). Equation 1 shows the model.

$$U_{ij} = \beta_C Cost_{ij} + \beta_{CF}\, f(CF_{ij}) + \beta_{CM}\, f(CM_{ij}) + \beta_{PF}\, f(PF_{ij}) + \beta_{PM}\, f(PM_{ij}) + \beta_{PS}\, f(PS_{ij}) \qquad \text{Eq. 1}$$

Where:

if $x < 5\%$, then $f(x) = x$; otherwise $f(x)=\ln(x)$

U_{ij} = the utility for individual i of alternative j

β_C, β_{CF}, β_{CM}, β_{PF}, β_{PM}, and β_{PS} = parameters estimated using a censored regression analysis

$Cost_{ij}$ = the cost to individual i for alternative j

CF_{ij} = percentage change for the Columbia freshwater fish population shown to individual i for alternative j

CM_{ij} = percentage change for the Columbia migratory fish population shown to individual i in alternative j

PF_{ij} = percentage change for the Pacific freshwater fish population shown to individual i in alternative j

PM_{ij} = percentage change for the Pacific migratory fish population shown to individual i in alternative j

PS_{ij} = percentage change for the Pacific saltwater fish population shown to individual i in alternative j

The parameter estimates derived from the regression analysis differ by status quo. **Exhibit E-1** reports the estimates for each model. In general, the fish population estimates are higher for the low status quo model while the price parameter is lower. Consequently, the parameters from this model will generate higher WTP estimates.

Exhibit E-1. Regression Results for Utility Model with a Modified Log Specification

Parameter	High Status Quo Survey Responses		Low Status Quo Survey Responses	
	Estimate	t-statistic	Estimate	t-statistic
β_C	-0.0266	-21.03	-0.0207	-17.72
β_{CF}	0.0969	6.01	0.0768	4.85
β_{CM}	0.0673	4.72	0.1003	7.37
β_{PF}	0.1051	6.16	0.1526	9.02
β_{PM}	0.1416	8.98	0.1514	9.96
β_{PS}	0.1428	9.28	0.1655	11.07

Source: Layton et al. (1999).

Equation 2 shows the function for calculating WTP for population increases of 5 percent or more from the status quo populations (either high or low). Population increases between 0 percent and 5 percent are linear interpolations between $0 and the calculated WTP at 5 percent.

$$WTP = [\beta_x\, (f(\text{baseline}\%) - \ln(x\%))] / \beta_C \qquad \text{Eq. 2}$$

Where:

f(baseline%) = 0 for a status quo baseline or ln(baseline%) for any nonzero baseline percentage change (times 100) in fish population for CF, CM, PF, PM, or PS
x = CF, CM, PF, PM, or PS
x% = percentage change (times 100) in fish population for CF, CM, PF, PM, or PS.

For example, the WTP for a 5 percent increase in fish populations above the status quo in the Columbia migratory fishery is:

WTP = 0.0673 (0-ln(5)) / -0.0266
= 0.0673 (-1.609) / -0.0266
= -0.1083 / -0.0266
= 4.07

Based on a linear interpolation between $0 and $4.07, the WTP for a 1 percent increase in fish population in the Columbia migratory fishery is $0.81 ($4.07 * 1/5). **Exhibit E-2** shows the high status quo baseline WTP estimates for 5 percent increases in each of the fisheries most likely affected by the proposed rule, and linear interpolations for selected percentage increases between 0.3 percent and 5 percent.

Exhibit E-2. Household Willingness to Pay Values by Region ($1998)

Percent Change in Fish Population	Eastern Washington/Columbia Freshwater	Eastern Washington/Columbia Migratory	Western Washington/Puget Sound Freshwater	Western Washington/Puget Sound Migratory
0.30	$0.35	$0.24	$0.38	$0.51
0.35	$0.41	$0.29	$0.45	$0.60
0.39	$0.46	$0.32	$0.50	$0.67
0.40	$0.47	$0.33	$0.51	$0.69
0.50	$0.59	$0.41	$0.64	$0.86
0.75	$0.88	$0.61	$0.95	$1.29
1.00	$1.17	$0.81	$1.27	$1.71
1.10	$1.29	$0.90	$1.40	$1.88
1.30	$1.52	$1.06	$1.65	$2.23
1.50	$1.76	$1.22	$1.91	$2.57
1.70	$1.99	$1.38	$2.16	$2.91
1.90	$2.23	$1.55	$2.42	$3.26
2.00	$2.35	$1.63	$2.54	$3.43
3.00	$3.52	$2.44	$3.82	$5.14
4.00	$4.69	$3.26	$5.09	$6.85
5.00	$5.86	$4.07	$6.36	$8.57

Source: Based on Layton et al. (1999) results for high status quo scenario.

This second example shows incremental WTP for an overall population increase of 6 percent assuming a baseline population increase of 5 percent will already occur in the Columbia migratory fishery.

$$
\begin{aligned}
WTP &= 0.0673\ (\ln(5)-\ln(6))\ /\ -0.0266 \\
&= 0.0673\ (-0.182)\ /\ -0.0266 \\
&= -0.01225\ /\ -0.0266 \\
&= 0.46
\end{aligned}
$$

Exhibit E-3 shows the high status quo baseline WTP estimates for total increases of 5.5 percent to 10 percent given baseline increases of 5 percent in each of the fisheries most likely affected by the proposed rule.

Exhibit E-3. Incremental Household Willingness to Pay Values Above a Hypothetical Baseline of a 5 percent Population Increase ($1998)

Percent Change in Fish Population	Eastern Washington/Columbia Freshwater	Eastern Washington/Columbia Migratory	Western Washington/Puget Sound Freshwater	Western Washington/Puget Sound Migratory
5.00	$0.00	$0.00	$0.00	$0.00
5.50	$0.35	$0.24	$0.38	$0.51
5.67	$0.46	$0.32	$0.50	$0.67
5.75	$0.51	$0.35	$0.55	$0.74
6.00	$0.66	$0.46	$0.72	$0.97
6.05	$0.69	$0.48	$0.75	$1.01
7.00	$1.23	$0.85	$1.33	$1.79
8.00	$1.71	$1.19	$1.86	$2.50
9.00	$2.14	$1.49	$2.32	$3.13
10.00	$2.53	$1.75	$2.74	$3.69

Source: Based on Layton et al. (1999) results for high status quo scenario.