



APPENDIX C

WATER TYPE MODELING

Introduction

Stream or water classification is a systematic arrangement of streams and other water bodies in groups or classes according to specified criteria. These criteria include physical characteristics, processes, and beneficial uses. In Washington, different stream typing systems are used to manage for the beneficial uses (e.g., fish habitat and water quality) of streams. The Department of Natural Resources (DNR) and other state agencies currently use presence of fish and protection of downstream water quality to classify streams for management purposes. On state and private timberlands, the classification of streams dictates the management activity level permitted adjacent to the stream type.

The system for classification of waters in Washington is a key factor in the framework for landscape management. Currently, forest practices in riparian management zones are regulated according to the stream typing system. Thus, the stream typing system used across the landscape directly affects land management. The land management along streams or riparian areas can beneficially or adversely affect the beneficial uses of the streams and the functions of the riparian areas for aquatic and terrestrial species.

In order to quantify the current extent of water types and riparian protection associated with those types, the existing DNR mapping and classification of streams can be used. This mapping can be used to represent Alternative 1 in this EIS. In order to quantitatively compare Alternative 1 with the other alternatives, modeling must be used to represent Alternatives 2 and 3. This appendix describes the stream typing under the alternatives and the modeling used to represent Alternatives 2 and 3.

Description of Water Typing Under the Alternatives

Under Alternative 1, water typing rules would be the same as the current permanent rules. The waters identified in the state's GIS hydrography coverage have been classified according to these water types. Five water types are recognized as follows:

- Type 1: Major waterways of the state including rivers, lakes, and saltwater. They include all waters inventoried as "shorelines of the state."
- Type 2: Waters, not classified as Type 1, which have high fish, wildlife, or human use. They generally are streams wider than 20 ft. at ordinary high water.
- Type 3: Waters, not classified as Types 1 or 2, which have moderate to slight fish, wildlife, or human use. They generally are less than 20 ft. at ordinary high water.
- Type 4: Waters not classified as Types 1, 2, or 3, which are important for protecting downstream water quality. They generally are streams wider than 2 ft. at ordinary high water.



Appendix C

- Type 5: Waters not classified as Types 1, 2, 3, or 4. They are generally seasonal headwater streams, less than 2 ft. at ordinary high water.
- Type 9: Untyped hydrography that may or may not have definable channels. Type 9 hydrography has no regulatory status.

Under Alternative 2, three water types , plus two subtypes are recognized as follows:

- Type S: All waters inventoried as “shorelines of the state.”
- Type F: Waters not classified as Type S, which contain fish habitat. It also includes some waters diverted for domestic and fish hatchery use.
- Type N: Waters not classified as Type S or F, which are either perennial streams or are physically connected by an above-ground channel system to downstream waters such that water or sediment initially delivered to such waters will eventually be delivered to a Type S or F water. Type N waters include two subtypes: perennial and seasonal streams.

Under Alternative 3, a geomorphic-based system consisting of three water types is recognized as follows:

- Waters with a gradient between 0 and 20 percent; these are channels considered to be important for fish.
- Waters with a gradient between 20 and 30 percent; these are channels considered to be important for coarse sediment storage and as a source of LWD.
- Waters with a gradient greater than 30 percent; these are channels considered to be important because they are prone to channelized landslides and as a source of LWD.

Modeling of the Alternative Water Typing Systems

As discussed above, the DNR’s GIS hydrography coverage can be used to represent Alternative 1 directly. However, to compare Alternative 1 with the other two alternatives, assumptions must be made and Alternatives 2 and 3 modeled using available information. The following approach was followed to represent these two alternatives. It relies on existing hydrography data consisting of stream location and stream type, stream gradient classification (generally based on 10-m digital elevation models [DEMs] and 30-m DEMs where 10-m DEMs were not available), and basin size.

Initial Approach

For both Alternatives 2 and 3, the following initial steps were taken using the sample sections described in Appendix A:

- The DNR hydrography layer was acquired for the sample sections within Washington state. The DNR hydrography layer classifies waters by Types 1 through 5, and Type 9.
- A GIS ArcInfo macro language (AML) script was used to determine the gradients of the streams in the sample sections. Stream gradient classes were mapped along each stream segment; these were broken down into 0-20 percent, 20-30 percent, and greater than 30 percent classes. Gradient classification used the available DEMs, which were generally 10-m DEMs; 30-m



DEMs were used where these were not available. In addition, slope classes were mapped over the entire section based on the DEMs. These were broken down into slope classes of 0-16 percent, 16-20 percent, and greater than 20 percent.

- In order to improve the quality of the gradient classification, an individual map of each section containing the above information, was printed and reviewed by a hydrologist. Where discrepancies were observed between the gradient class of the stream as mapped and the gradient of the topographic location of where the stream should have been mapped, changes were made to stream gradient classes so that they more accurately reflected the available topographic information.

Alternative 2 Approach

For Alternative 2, the following rules were applied for modeling:

- All current Type 1 streams were converted to Type S streams by definition. All current Type 2 and 3 streams were converted to Type F streams.
 - Type 4 streams with the following characteristics were converted to Type F streams:
 - Type 4 streams with gradients between 0 and 16 percent;
 - Type 4 streams with gradients between 16 and 20 percent and a basin size greater than 50 acres in western Washington or 175 acres in eastern Washington
- All other Type 4 streams and all Type 5 streams (including Type 9's on the west side) streams were considered nonfish-bearing, Type N streams.
- The following definitions (from the Forests and Fish Report) were used for separating perennial from seasonal nonfish-bearing streams:
 - Type 4 streams are considered perennial if their basin sizes are greater than 13 acres in the Coastal zone of western Washington (based on the Sitka Spruce zone of Franklin & Dyrness, 1973), 52 acres in all other areas of western Washington, or 300 acres for all areas in eastern Washington. All other Type 4s, as well as all Type 5s and Type 9s (on the west side) are considered seasonal. Type 9 streams on the east side were considered unchanneled dry draws and were excluded from the Alternative 2 classification scheme.

It was recognized that this approach for defining fish-bearing streams probably overestimates the number of fish-bearing waters and underestimates the Type N perennial streams (Pers. Comm., Mark Hunter, Washington Department of Fish and Wildlife, 1999).

Alternative 3 Approach

For Alternative 3, the following rules were applied for modeling:

- All streams were classified based on their gradient class only. Stream type was not taken into account, except that Type 9 streams in eastern Washington were not included since most of these turn out to be dry draws.



Appendix C

Results

Table 1 displays the number of stream miles in the sample sections (see Appendix A) by region and major land ownership for all vegetation types. Table 2 displays the number of stream miles under the current stream typing system (Alternative 1) in the sample sections for state and private forest lands by region. Table 3 displays the number of stream miles in the sample sections under the proposed stream typing broken down in the same way for Alternative 2, and Table 4 displays the same information for the Alternative 3 stream typing system. A graphical comparison of the stream typing systems in the sample sections is displayed in Figure 1.

Since riparian protection rules are a relatively recent phenomenon in Washington state, the majority of riparian forests on private and state lands have been logged at least once. Most streamside vegetation is relatively young or in an early seral stage. In order to estimate the proportion of stream miles in different seral stages, we classified the available vegetation data according to the classification given in Table 5. This produced the seral stage breakdown shown in Table 6 for private lands.

Table 1. Stream Miles by Ownership and Stream Type on Sample Sections West Side-All Vegetation Types

WEST SIDE

REGION NAME	Type 1					Type 2				Type 3			
	Private	Federal	State	County	Total	Private	State	Federal	Total	Private	Federal	State	Total
Lower Columbia	3.9	0.1	0.1	0.0	4.1	0.0	0.0	0.0	0.0	3.5	0.8	0.0	4.3
Olympic Coast	1.6	0.1	0.6	0.0	2.3	0.0	0.0	1.4	1.4	5.1	0.0	2.1	7.2
Puget Sound	13.2	0.0	2.2	0.1	15.5	1.2	0.1	0.0	1.3	17.2	0.0	1.6	18.8
Southwest	8.9	0.0	0.0	0.0	8.9	4.0	0.0	0.0	4.0	27.1	0.0	0.0	27.1
Island Region	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	27.6	0.1	2.9	0.1	30.7	5.3	0.1	1.4	6.7	52.9	0.8	3.7	57.4

REGION NAME	Type 4				Type 5				Type 9				Grand Total All Streams		
	Private	State	Tribe	Total	Private	Federal	State	Tribe	Total	Private	Federal	State		Tribe	Total
Lower Columbia	16.0	0.4	0.0	16.4	41.3	0.0	0.0	0.0	41.3	38.7	3.3	1.4	0.0	43.4	109.4
Olympic Coast	1.5	1.1	0.4	3.0	6.1	0.5	4.9	1.6	13.1	0.2	0.0	0.1	2.0	2.3	29.3
Puget Sound	12.6	1.1	0.0	13.7	28.7	0.4	4.3	1.1	34.5	29.0	0.0	1.6	0.0	30.6	114.4
Southwest	13.5	0.0	0.0	13.5	73.7	0.0	0.0	0.0	73.7	65.0	0.0	0.0	0.0	65.0	192.2
Island Region	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	43.6	2.5	0.4	46.6	149.8	0.9	9.2	2.7	162.6	132.9	3.3	3.1	2.0	141.3	445.3

EAST SIDE

REGION NAME	Type 1					Type 2				Type 3			
	Private	Federal	State	County	Total	Private	State	Federal	Total	Private	Federal	State	Total
Middle Columbia	2.7	0.0	0.0	2.7	1.5	0.0	0.0	0.0	1.5	4.0	0.0	0.0	4.0
Snake River	0.3	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.1	2.6	0.0	0.0	2.6
Upper Columbia-Dnstrm	1.3	0.4	0.0	1.7	1.4	0.0	0.0	0.0	1.4	1.1	0.7	0.0	1.7
Upper Columbia-Upstrm	8.1	0.0	0.7	8.9	3.5	0.2	0.0	0.8	4.6	5.4	0.7	0.3	6.4
Columbia Basin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	12.4	0.4	0.7	13.6	6.5	0.2	0.0	0.8	7.5	13.2	1.4	0.3	14.8

REGION NAME	Type 4					Type 5				Grand Total All Streams	
	Private	Federal	State	County	Total	Private	State	Federal	Total	Private	Total
Middle Columbia	8.53	0.0	0.3	0.0	8.9	12.9	0.0	0.0	0.0	12.9	30.0
Snake River	1.0	0.0	0.0	0.0	1.0	6.2	0.0	0.0	0.0	6.2	10.2
Upper Columbia-Dnstrm	5.9	1.9	0.0	0.0	7.8	27.9	11.4	0.4	0.0	39.8	52.4
Upper Columbia-Upstrm	14.5	0.8	0.9	0.0	16.2	35.3	2.8	1.2	0.0	39.3	75.3
Columbia Basin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	29.9	2.7	1.2	0.0	33.9	82.3	14.2	1.6	0.0	98.1	167.9



Table 2. Stream Miles by Water Type for Forested Lands in the Sample Sections by Region for Alternative 1

Alternative 1							
Westside-Forested Private Lands							
REGION	WATER TYPE						Grand Total
	1	2	3	4	5	9	
Lower Columbia	1.6	0.0	2.8	14.6	39.4	35.7	94.2
Olympic Coast	0.8	0.0	4.8	1.5	6.1	0.2	13.4
Puget Sound	7.4	1.1	15.5	11.6	28.0	23.7	87.1
Southwest	5.5	3.3	24.7	13.3	72.2	63.1	182.0
Island	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	15.3	4.3	47.8	41.0	145.7	122.6	376.7
Eastside-Forested State Lands							
REGION	WATER TYPE					Grand Total	
	1	2	3	4	5		
Middle Columbia	2.1	0.0	1.2	2.4	7.2	12.9	
Upper Columbia-Dnstrm	0.0	0.0	6.7	4.0	12.5	23.2	
Upper Columbia-Upstrm	0.0	0.0	2.4	0.8	3.4	6.7	
Snake River	0.0	0.0	0.0	0.0	0.0	0.0	
Columbia Basin	0.0	0.0	0.0	0.0	0.0	0.0	
Grand Total	2.1	0.0	10.3	7.2	23.1	42.8	
Eastside-Forested Private Lands							
REGION	WATER TYPE					Grand Total	
	1	2	3	4	5		
Middle Columbia	0.3	0.5	2.8	5.8	10.8	20.1	
Upper Columbia-Dnstrm	0.0	0.3	0.3	2.1	20.2	22.9	
Upper Columbia-Upstrm	2.5	0.3	3.7	7.1	27.9	41.5	
Snake River	0.1	0.0	1.7	1.0	3.2	5.9	
Columbia Basin	0.0	0.0	0.0	0.0	0.0	0.0	
Grand Total	2.9	1.0	8.5	16.0	62.0	90.4	
Total Sample	20.3	5.4	66.5	64.1	230.9	122.6	509.8



Appendix C

Table 3. Stream Miles by Water Type^{1/} for Forested Lands in the Sample Sections by Region for Alternative 2

Alternative 2

Westside-Forested Private Lands

REGION	WATER TYPE				Grand Total
	S	F	N _p	N _s	
Lower Columbia	1.6	12.0	4.3	76.1	94.1
Olympic Coast	0.8	6.2	0.0	6.4	13.4
Puget Sound	7.4	24.1	2.9	52.8	87.1
Southwest	5.5	36.3	3.2	136.8	181.7
Island	0.0	0.0	0.0	0.0	0.0
Grand Total	15.3	78.7	10.4	272.1	376.4

Eastside-Forested State Lands

REGION	WATER TYPE				Grand Total
	S	F	N _p	N _s	
Middle Columbia	2.1	5.0	0.3	7.4	12.8
Upper Columbia-Downstream of Grand Coulee	0.0	10.3	0.3	12.5	23.1
Upper Columbia-Upstream of Grand Coulee	0.0	3.0	0.0	3.7	6.7
Snake River	0.0	0.0	0.0	0.0	0.0
Grand Total	2.1	16.4	0.6	23.6	42.6

Eastside-Forested Private Lands

REGION	WATER TYPE				Grand Total
	S	F	N _p	N _s	
Middle Columbia	0.3	8.8	0.2	10.8	20.1
Upper Columbia-Downstream of Grand Coulee	0.0	2.3	0.4	20.2	22.9
Upper Columbia-Upstream of Grand Coulee	2.5	10.8	0.3	27.9	41.5
Snake River	0.1	2.7	0.0	3.2	5.9
Columbia Basin	0.0	0.0	0.0	0.0	0.0
Grand Total	2.9	24.5	0.9	62.1	90.4
Total Sample	20.3	119.6	11.8	357.7	509.4

^{1/}Type S Waters = Shorelines of the State

Type F Waters = Fish-bearing waters, not classified as Type S

Type N_p Waters = Perennial nonfish-bearing waters

Type N_s Waters = Seasonal nonfish-bearing waters



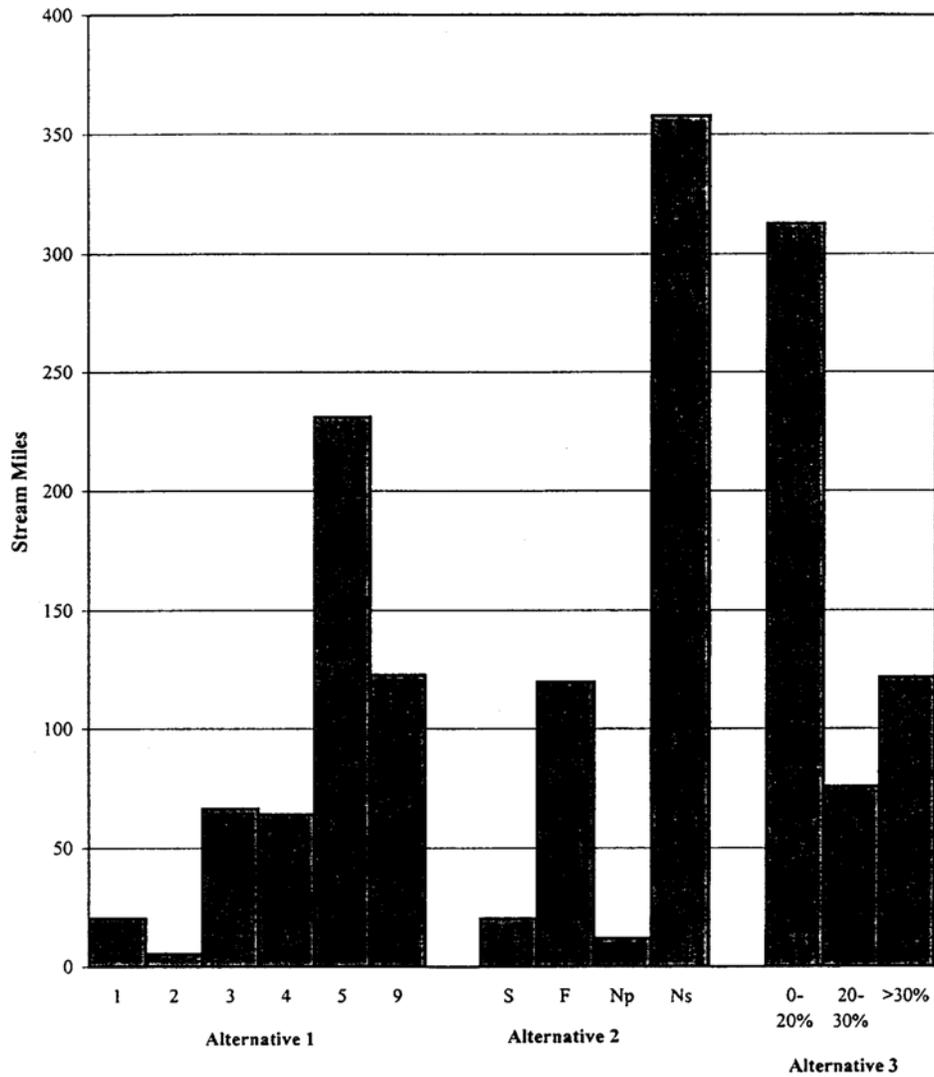
Table 4. Stream Miles by Water Type for Forested Lands in the Sample Sections by Region for Alternative 3

Alternative 3				
Westside-Forested Private Lands				
REGION	STREAM GRADIENT			Grand Total
	0-20%	20-30%	>30%	
Lower Columbia	41.5	21.3	31.3	94.2
Olympic Coast	12.9	0.2	0.3	13.4
Puget Sound	58.8	6.9	21.4	87.2
Southwest	105.3	27.6	49.2	182.1
Island	0.0	0.0	0.0	0.0
Grand Total	218.6	56.0	102.3	376.9
Eastside-Forested State Lands				
REGION	STREAM GRADIENT			Grand Total
	0-20%	20-30%	>30%	
Middle Columbia	9.0	2.4	1.6	12.9
Upper Columbia-Downstream	17.8	3.7	1.6	23.1
Upper Columbia-Upstream	5.4	1.0	0.3	6.7
Snake River	0.0	0.0	0.0	0.0
Columbia Basin	0.0	0.0	0.0	0.0
Grand Total	32.2	7.1	3.4	42.7
Eastside-Forested Private Lands				
REGION	STREAM GRADIENT			Grand Total
	0-20%	20-30%	>30%	
Middle Columbia	17.3	1.2	1.6	20.1
Upper Columbia-Downstream	10.1	4.1	8.6	22.8
Upper Columbia-Upstream	30.2	6.8	4.6	41.5
Snake River	4.2	0.5	1.2	5.9
Columbia Basin	0.0	0.0	0.0	0.0
Grand Total	61.8	12.6	16.0	90.3
Total Sample	312.6	75.7	121.7	509.9



Appendix C

Figure 1. Total Forested Stream Miles in the Sample Sections by Stream Type for each Alternative



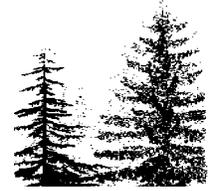


Table 5. Definitions Used for Seral Stage Classification
Private Lands

Seral State	Vegetation Class	Diameter Class (in)
Early	Reprod.	<6
	Conifer pole	6-12
	Hardwood pole	6-12
	Mixed pole	6-12
Mid	Conifer sawtimber	12-24
	Hardwood sawtimber	12-24
	Mixed sawtimber	12-24
Late	Large conifer sawtimber	>24
	Large hardwood sawtimber	>24
	Large mixed sawtimber	>24

State Land

Seral Stage	Age Class of Primary Species (yr)
Early	0-40
Mid	41-100
Late	>100

Table 6. Estimated Percent of Each Seral Stage Along Forested Streams on Private Lands

Water Type	Seral Stage – Percent by Water Type		
	Early	Mid	Late
West Side			
Types 1-3	64%	33%	2%
Types 4-5	81%	18%	1%
All Streams	78%	21%	1%
East Side			
Types 1-3	60%	36%	4%
Types 4-5	61%	33%	6%
All Streams	61%	34%	5%